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Plate heat exchangers are available in a variety of models. Let's look at the principal heat exchanger designs:Brazed Plate Heat ExchangersCompact and with high power efficiency, brazed plate heat exchangers are a common inclusion in hot water systems, industrial and refrigeration equipment. Brazing is a process like soldering in which two pieces of metal are joined by melting a third metal onto the join and baking this into place. Brazed plate heat exchangers normally feature stainless steel brazed by copper or nickel, making them highly resistant to corrosion.Brazed plate heat exchangers cannot be opened. Cleaning is conducted by flushing the device with a suitable cleaning agent.Gasketed Plate Heat ExchangerGasketed plate heat exchangers feature rubber gaskets between the transfer plates. These create watertight seals and control flow rates. These larger, higher capacity models are standard equipment in food and drink production and heating, process engineering and HVAC systems.The gasket seals mean that these devices are easy to disassemble for maintenance and cleaning. Additional plates can also be added to increase the capacity and thermal flow of the device.Plate-Fin Heat ExchangerPlate-fin heat exchangers feature finned chambers alongside the heat transfer plates, the latter typically made from aluminium. These models are usually more compact than other plate heat exchangers but still offer a large heat transfer surface area.Plate fin heat exchangers, also known as plate-fin and tube exchangers, are favoured in industries that require lightweight heat transfer equipment. Examples include aerospace, vehicle engineering and cryogenic chemical processing.Welded Plate Heat ExchangerWelded plate and frame heat exchangers feature plates that have been welded together into a single block. This makes maintenance more difficult and means that the capacity of the devices is fixed because additional transfer plates cannot be added. However, it also makes welded plate heat exchangers highly durable - they can withstand corrosive fluids, high temperatures, and pressures. As a result, they are widely used in heavy industry - you will find them in oil refineries, gas extraction plants, power stations and similar locations.Semi-welded plate heat exchangers are a variant model, combining welded and gasketed plates. Welded plate sets are connected via gaskets to other sets. Therefore, the fluid channels through this device alternate between gasketed and welded seals. This allows hot fluid and corrosive liquids to be directed to one side while servicing is conducted on the other. January 10, 2023 A plate and frame heat exchanger is a type of equipment used to transfer heat between two fluids. These heat exchangers are composed of a series of stainless-steel plates stacked and sealed with gaskets. The plates are designed to create a series of channels through which the fluids can flow, allowing for efficient heat transfer. Advantages of Plate and Frame Heat Exchangers One of the main advantages of plate and frame heat exchangers is their high thermal efficiency. Because of the large surface area created by the stacked plates, plate and frame heat exchangers take up less space. Another advantage of plate and frame heat exchangers is their flexibility. The plates can be removed and cleaned, making maintenance and repair a straightforward process. The plates can be replaced or reconfigured to accommodate changes in the fluid flow or heat transfer requirements. Type of Plate and Frame Heat Exchangers There are a few types of plate and frame heat exchangers, each designed for specific applications. The most common types are: -Gasketed plate heat exchangers: use elastomeric gaskets to seal the plates together. -Welded plate heat exchangers: The plates are welded together to form a sealed unit. -Brazed plate heat exchangers: The plates are bonded together with a brazing alloy to form a sealed unit. When choosing a plate and frame heat exchanger, it is important to consider the types of fluids being used. This includes their temperatures, pressures, and the amount of heat that needs to be transferred. The right heat exchanger will depend on the specific application and operating conditions. Pressure Drop in Plate and Frame Heat Exchangers A pressure drop in a plate and frame heat exchanger (PHE) can occur for several reasons. Some common causes include: Fouling. Over time, particles and other contaminants can accumulate on the plates of the heat exchanger, reducing their effectiveness and creating a pressure drop. Plate damage. Damaged or bent plates can disrupt the flow of fluid and create a pressure drop. Incorrect assembly. If the plates are assembled incorrectly the seal between the plates on't be tight, resulting in a pressure drop. Clogging: If the fluid contains particles that can get stuck in the heat exchanger, it can clog the passages and create a pressure drop. Incorrect design. It may not be able to handle the flow rate or pressure of the fluid, resulting in a pressure drop. Inadequate fluid flow. It may not be able to maintain a consistent flow through the heat exchanger, resulting in a pressure drop. Worn or faulty pump. It may not be able to provide enough pressure to maintain the flow through the heat exchanger, resulting in a pressure drop. It is important to monitor the pressure drop. This is an indication that the heat exchanger is working incorrectly and may need to be cleaned, repaired, or replaced. If a pressure drop is not addressed, it could cause reduced heat transfer efficiency, increase the running costs, and can damage the heat exchanger. In Conclusion A plate and frame heat exchangers are a reliable and efficient means of transferring heat between two fluids. They are widely used in a variety of applications. They are often the best choice when space is limited, and high thermal efficiency is required. , the free encyclopedia that anyone can edit. 111,866 active editors 7,011,211 articles in English 1820 historical world map History is the systematic study of the past with its main focus on the human past. Historians analyse and interpret primary and secondary sources to construct narratives about what happened and explain why it happened. They engage in source criticism to assess the authenticity, content, and reliability of these sources. It is controversial whether the resulting historical narratives can be truly objective and whether history is a social science rather than a discipline of the humanities. Influential schools of thought include positivism, the Annales school, Marxism, and postmodernism. Some branches of history focus on specific time periods, such as ancient history, particular geographic regions, such as the history of Africa, or distinct themes, such as political, social, and economic history. History emerged as a field of inquiry in antiquity to replace myth-infused narratives, with influential early traditions originating in Greece, China, and later in the Islamic world. (Full article...) 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Ongoing: Gaza war Russian invasion of Ukraine timeline Sudanese civil war timeline Recent deaths: Alfred Brendel Ali Shamkhani Hamilton Wanasinghe Afa Ah Loo Geoff Palmer Stella Chen Nominate an article June 19: Juneteenth in the United States (1865) Lou Gehrig baseball card 1785 – The proprietors of King's Chapel, Boston, voted to adopt James Freeman's Book of Common Prayer, thus establishing the first Unitarian church in the Americas. 1838 – The Maryland province of the Jesuits contracted to sell 272 slaves to buyers in Louisiana in one of the largest slave sales in American history. 1939 – American baseball player Lou Gehrig (pictured) was diagnosed with amyotrophic lateral sclerosis, now commonly known in the United States as "Lou Gehrig's disease". 2009 – War in Afghanistan: British forces began Operation Panther's Claw, in which more than 350 troops made an aerial assault on Taliban positions in southern Afghanistan. Étienne Geoffroy Saint-Hilaire (d. 1844)Sarah Rosetta Wakeman (d. 1864)Aage Bohr (b. 1922)Clayton Kirkpatrick (d. 2004) More anniversaries: June 18 June 19 June 20 Archive By email List of days of the year About Dred Scott (c. 1799 – 1858) was an enslaved African American who, along with his wife, Harriet Robinson Scott, unsuccessfully sued for the freedom of themselves and their two daughters, Eliza and Lizzie, in the 1857 legal case Dred Scott v. Sandford. The Scotts claimed that they should be granted freedom because Dred had lived for four years in Illinois and the Wisconsin Territory, where slavery was illegal, and laws in those jurisdictions said that slave holders gave up their rights to slaves if they stayed for an extended period. The Supreme Court of the United States ruled against Scott in a landmark decision that held the Constitution did not extend American citizenship to people of black African descent, and therefore they could not enjoy the rights and privileges that the Constitution conferred upon American citizens. The Dred Scott decision is widely considered the worst in the Supreme Court's history, being widely denounced for its overt racism, judicial activism, poor legal reasoning, and crucial role in the events that led to the American Civil War four years later. The ruling was later superseded by the passage of the Thirteenth Amendment to the United States Constitution, which abolished slavery, in 1865, followed by the Fourteenth Amendment, whose first section guaranteed birthright citizenship for "all persons born or naturalized in the United States and subject to the jurisdiction thereof", in 1868. This posthumous oil-on-canvas portrait of Scott was painted by Louis Schultze, after an 1857 photograph by John H. Fitzgibbon, and now hangs in the Missouri History Museum in St. Louis. Painting credit: Louis Schultze, after John H. Fitzgibbon Recently featured: Garni Temple Igor Stravinsky Sabella pavonina Archive More featured pictures Community portal – The central hub for editors, with resources, links, tasks, and announcements. Village pump – Forum for discussions about Wikipedia itself, including policies and technical issues. Site news – Sources of news about Wikipedia and the broader Wikimedia movement. Teahouse – Ask basic questions about using or editing Wikipedia. Help desk – Ask questions about using or editing Wikipedia. Reference desk – Ask research questions about encyclopedic topics. Content portals – A unique way to navigate the encyclopedia. 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Many other Wikipedias are available; some of the largest are listed below. 1,000,000+ articles العربية Deutsch Español فارسی Français Italiano Nederlands 日本語 Polski Português Русский Svenska Українська Tiếng Việt 中文 250,000+ articles Bahasa Indonesia Bahasa Melayu Bân-lâm-gú Български Català Čeština Dansk Eesti Ελληνικά Esperanto Euskara עברית Հայերեն Magyar Norsk bokmål Română Simple English Slovenčina Srpski Srpskohrvatski Suomi Türkçe Oʻzbekcha 50,000+ articles Asturianu Azərbaycanca □□□□□ Bosanski کوردی Frysk Gaeilge Galego Hrvatski ქართული Kurdî Latviešu Lietuvių □□□□□□ Македонски □□□□□□□□□□ Norsk nynorsk □□□□□□ Shqip Slovenščina □□□ □□□□□□ اردو Retrieved from " 2 This article is about the year 1865. For other uses, see 1865 (disambiguation). Calendar year Years Millennium 2nd millennium Centuries 18th century 19th century 20th century Decades 1840s 1850s 1860s 1870s 1880s Years 1862 1863 1864 1865 1866 1867 1868 vte 1865 by topic Humanities Animation Archaeology Architecture Art Literature Poetry Music By country Australia Belgium Brazil Canada China Denmark France Germany New Zealand Norway Portugal Russia South Africa Sweden United Kingdom United States Other topics Rail transport Science Sports Lists of leaders Sovereign states Sovereign state leaders Territorial governors Religious leaders Law Birth and death categories Births Deaths Establishments and disestablishments categories Establishments Disestablishments Works category Works vte 1865 in various calendarsGregorian calendar1865MDCCCLXVAb urbe condita2618Armenian calendar1314ԹՎ ՌՅԺԴAssyrian calendar6615Baháʼí calendar21–22Balinese saka calendar1786–1787Bengali calendar1271–1272Berber calendar2815British Regnal year28 Vict. 1 – 29 Vict. 1Buddhist calendar2409Burmese calendar1227Byzantine calendar7373–7374Chinese calendar甲子年 (Wood Rat)4562 or 4355 — to —乙丑年 (Wood Ox)4563 or 4356Coptic calendar1581–1582Discordian calendar3031Ethiopian calendar1857–1858Hebrew calendar5625–5626Hindu calendars - Vikram Samvat1921–1922 - Shaka Samvat1786–1787 - Kali Yuga4965–4966Holocene calendar11865Igbo calendar865–866Iranian calendar1243–1244Islamic calendar1281–1282Japanese calendarGenji 2 / Keiō 1(慶応元年)Javanese calendar1793–1794Julian calendarGregorian minus 12 daysKorean calendar4198Minguo calendar47 before ROC民前47年Nanakshahi calendar397Thai solar calendar2407–2408Tibetan calendar阳木鼠年(male Wood-Rat)1991 or 1610 or 838 — to —阴木牛年(female Wood-Ox)1992 or 1611 or 839 Wikimedia Commons has media related to 1865. 1865 (MDCCCLXV) was a common year starting on Sunday of the Gregorian calendar and a common year starting on Friday of the Julian calendar, the 1865th year of the Common Era (CE) and Anno Domini (AD) designations, the 865th year of the 2nd millennium, the 65th year of the 19th century, and the 6th year of the 1860s decade. As of the start of 1865, the Gregorian calendar was 12 days ahead of the Julian calendar, which remained in localized use until 1923. Calendar year January 15: Union captures Fort Fisher. January 4 – The New York Stock Exchange opens its first permanent headquarters at 10-12 Broad near Wall Street, in New York City. January 13 – American Civil War: Second Battle of Fort Fisher – Union forces launch a major amphibious assault against the last seaport held by the Confederates, Fort Fisher, North Carolina. January 15 – American Civil War: Union forces capture Fort Fisher. January 31 The Thirteenth Amendment to the United States Constitution (conditional prohibition of slavery and involuntary servitude) passes narrowly, in the House of Representatives. American Civil War: Confederate General Robert E. Lee becomes general-in-chief. February 3 – American Civil War: Hampton Roads Conference: Union and Confederate leaders discuss peace terms. February 6 – The municipal administration of Finland is established.[1] February 8 & March 8 – Gregor Mendel reads his paper on Experiments on Plant Hybridization at two meetings of the Natural History Society of Brünn in Moravia, subsequently taken to be the origin of the theory of Mendelian inheritance.[2] February 21 – John Deere receives a United States patent for ploughs. February 22 – Tennessee adopts a new constitution that abolishes slavery. February – American Civil War: Columbia, South Carolina burns, as Confederate forces flee from advancing Union forces. March 3 – The U.S. Congress authorizes formation of the Bureau of Refugees, Freedmen and Abandoned Lands. March 4 – Washington College and Jefferson College are merged to form Washington & Jefferson College in the United States.[3] March 13 – American Civil War: The Confederate States of America agrees to the use of African American troops. March 18 – American Civil War: The Congress of the Confederate States of America adjourns for the last time. March 19–21 – American Civil War : Battle of Bentonville: Union troops compel Confederate forces to retreat from Four Oaks, North Carolina. March 25 The Claywater Meteorite explodes just before reaching ground level in Vernon County, Wisconsin; fragments having a combined mass of 1.5 kg (3.3 lb) are recovered. American Civil War: In Virginia, Confederate forces capture Fort Stedman from the Union, although it is retaken the same day. Lee's army suffers heavy casualties: about 2,900, including 1,000 captured in the Union counterattack. Confederate positions are weakened. After the battle, Lee's defeat is only a matter of time. March – Hamm's Brewery opens in St. Paul, Minnesota. April 2: Jefferson Davis. April 9: Appomattox Court House. April 14: Lincoln shot. April 1 – American Civil War – Battle of Five Forks: In Petersburg, Virginia, Confederate General Robert E. Lee begins his final offensive. April 2 – American Civil War: Confederate President Jefferson Davis and most of his Cabinet flee the Confederate capital of Richmond, Virginia, which is taken by Union troops the next day. April 6 – German chemicals producer Badische Anilin- und Sodafabrik (BASF) is founded in Mannheim. April 9 – American Civil War: Confederate States Army General Robert E. Lee surrenders to Union Army General Ulysses S. Grant at Appomattox Court House, effectively ending the war. April 14 Assassination of Abraham Lincoln: President of the United States Abraham Lincoln is shot while attending an evening performance of the farce Our American Cousin at Ford's Theatre in Washington, D.C., by actor and Confederate sympathizer John Wilkes Booth. United States Secretary of State William H. Seward and his family are attacked in his home, by Lewis Powell. April 15 – President Lincoln dies early this morning from his gunshot wound, aged 56. Vice President Andrew Johnson becomes the 17th President of the United States upon Lincoln's death and is sworn in later that morning. April 18 – Confederate President Jefferson Davis and his entire cabinet arrive in Charlotte, North Carolina, with a contingent of 1,000 soldiers. April 21 – German chemicals producer BASF moves its headquarters and factories from Mannheim, to the Hemshof District of Ludwigshafen. April 26 American Civil War: Confederate General Joseph E. Johnston surrenders to Union Major General William Tecumseh Sherman, at Durham Station, North Carolina. Union cavalry corner John Wilkes Booth in a Virginia barn, and cavalryman Boston Corbett fatally shoots the assassin. April 27 The steamboat Sultana, carrying 2,300 passengers, explodes and sinks in the Mississippi River, killing 1,800, mostly Union survivors of the Andersonville Prison.April 27: Steamboat Sultana sinks. Governor of New York Reuben Fenton signs a bill formally creating Cornell University. May 1 – The Treaty of the Triple Alliance of Argentina, Brazil, and Uruguay against Paraguay is formally signed, following the outbreak of the Paraguayan War. May 4 – American Civil War: Lieutenant General Richard Taylor, commanding all Confederate forces in Alabama, Mississippi, and eastern Louisiana, surrenders his forces to Union General Edward Canby at Citronelle, Alabama, effectively ending all Confederate resistance east of the Mississippi River. May 5 – In the United States: In North Bend, Ohio (a suburb of Cincinnati), the first train robbery in the country takes place. Jefferson Davis meets with his Confederate Cabinet (14 officials) for the last time, in Washington, Georgia, and the Confederate Government is officially dissolved. May 10 – American Civil War: Jefferson Davis is captured by the Union Army near Irwinville, Georgia. May 12 – Electric equipment and mobile brand Nokia founded in Tampere, Finland. May 12–13 – American Civil War – Battle of Palmito Ranch: In far south Texas, more than a month after Confederate General Lee's surrender, the last land battle of the civil war with casualties, ends with a Confederate victory. May 17 The International Telegraph Union is founded. French missionary Father Armand David first observes Père David's deer in Peking, China.[4] May 23 – Grand Review of the Armies: Union Army troops parade down Pennsylvania Avenue (Washington, D.C.) to celebrate the end of the American Civil War. May 25 – Mobile magazine explosion: 300 are killed in Mobile, Alabama, when an ordnance depot explodes. May 28 – The Mimosa sets sail with emigrants from Wales for Patagonia.[5] May 29 – American Civil War: President of the United States Andrew Johnson issues a proclamation of general amnesty for most citizens of the former Confederacy. June 2 – American Civil War: Confederate forces west of the Mississippi River under General Edmund Kirby Smith surrender at Galveston, Texas, under terms negotiated on May 26, becoming the last to do so. June 10 – Richard Wagner's opera Tristan und Isolde debuts at the Munich Court Theatre. June 11 – Battle of the Riachuelo: The Brazilian Navy squadron defeats the Paraguayan Navy. July 2: Salvation Army June 19 – American Civil War: Union Major General Gordon Granger lands at Galveston, Texas, and informs the people of Texas of the Emancipation Proclamation (an event celebrated in modern times each year as Juneteenth). June 23 – American Civil War: At Fort Towson in Oklahoma Territory, Confederate General Stand Watie, a Cherokee Indian, surrenders the last significant Rebel army. June 25 – James Hudson Taylor founds the China Inland Mission at Brighton, England. June 26 – Jumbo, a young male African elephant, arrives at London Zoo and becomes a popular attraction. June–August – English polymath Francis Galton first describes eugenics.[6] July 4 – Lewis Carroll publishes his children's novel Alice's Adventures in Wonderland in England[7][8] (first trade editions in December). July 5 The U.S. Secret Service is founded. The first speed limit is introduced in Britain: 2 mph (3.2 km/h) in town and 4 mph (6.4 km/h) in the country. July 7 – Following Abraham Lincoln's assassination on April 14, the four conspirators condemned to death during the trial are hanged, including David Herold, George Atzerodt, Lewis Powell and Mary Surratt. Her son, John Surratt, escapes execution by fleeing to Canada, and ultimately to Egypt. July 14 – First ascent of the Matterhorn: The summit of the Matterhorn in the Alps is reached for the first time, by a party of 7 led by the Englishman Edward Whymper; 4 die in a fall during the descent. July 14: Matterhorn climbed. July 30: Steamer Brother Jonathan sinks. July 21 – Wild Bill Hickok – Davis Tutt shootout: In the market square of Springfield, Missouri, Wild Bill Hickok shoots "Little Dave" Davis Tutt dead over a poker debt, in what is regarded as the first true western fast draw showdown. July 23 – The SS Great Eastern departs on a voyage to lay a transatlantic telegraph cable.[7] July 26 – The New Zealand Parliament first meets in Wellington on a permanent basis, making it de facto the national capital.[9] July 27 Welsh settlers arrive in Argentina at Chubut Valley. Businessman Asa Packer establishes Lehigh University in Bethlehem, Pennsylvania. July 30 – The steamer Brother Jonathan sinks off the California coast, killing 225 passengers and crew. July 31 – The first narrow gauge mainline railway in the world opens at Grandchester, Australia. July – The Christian Mission, later renamed The Salvation Army, is founded in Whitechapel, London, by William and Catherine Booth. August 16 – The Dominican Republic regains independence from Spain. August 25 – The Shergotty meteorite Mars meteorite falls in Sherghati, Gaya, Bihar in India. September 19 – Union Business College (now Peirce College) is founded in Philadelphia. September 26 – Champ Ferguson becomes the first person (and one of only two) to be convicted of war crimes for actions taken during the American Civil War, found guilty by a U.S. Army tribunal on 23 charges, arising from the murder of 53 people. He is hanged on October 20, two days after the conviction of Henry Wirz for war crimes.[10] October 11 – Morant Bay rebellion: Paul Bogle leads hundreds of black men and women in a march in Jamaica; the rebellion is brutally suppressed by the British governor Edward John Eyre with 400 executed.[8] October 25 – Florida drafts its constitution in Tallahassee. October 26 The Standard Oil Company opens. The paddlewheel steamer SS Republic sinks off the Georgia coast, with a cargo of $400,000 in coins. November 6 – American Civil War: The CSS Shenandoah, last remnant of the Confederate States of America and its military, surrenders in Liverpool after fleeing westward from the Pacific. November 10 – Captain Henry Wirz, Confederate superintendent of Andersonville Prison (Camp Sumter) is hanged, becoming the second of two combatants, and only serving regular soldier, to be executed for war crimes committed during the American Civil War. November 11 – Duar War between Britain and Bhutan ends with the Treaty of Sinchula, in which Bhutan cedes control of its southern passes to Britain in return for an annual subsidy.[7] November 17 – Chincha Islands War: Action of 17 November 1865 – A Spanish gunboat is captured by the Chilean tugboat Independencia off Tomé, in the Bay of Concepción, Chile. November 26 – Chincha Islands War: Battle of Papudo – The Spanish ship Covadonga is captured by the Chileans and the Peruvians, north of Valparaíso, Chile. December 11 – The United States Congress creates the United States House Committee on Appropriations and the Committee on Banking and Commerce, reducing the tasks of the House Committee on Ways and Means. December 17 – Leopold II becomes King of the Belgians, following the death (on December 10) of his father, King Leopold I. December 18 – Secretary of State William H. Seward declares the Thirteenth Amendment to the United States Constitution ratified by three-quarters of the states, including those in secession. As of December 6, slavery is legally outlawed in the last two slave states of Kentucky and Delaware, and the remaining 45,000 slaves are freed. December 21 – The Kappa Alpha Order is founded at Washington College, Lexington, Virginia. December 24 – Jonathan Shank and Barry Ownby form the Ku Klux Klan in the American South, to resist Reconstruction and intimidate carpetbaggers and scalawags, as well as to repress the freedpeople. Francis Galton. A forest fire near Silverton, Oregon, destroys about one million acres (4,000 km2) of timber. The National Temperance Society and Publishing House is founded by James Black in the U.S. Nottingham Forest Football Club, an association football based in West Bridgford, Nottingham, England, is founded. January 5 – Julio Garavito Armero, Colombian astronomer (d. 1920) January 9 – Leo Ditrichstein, Austrian-born stage actor, playwright (d. 1928) January 19 – Valentin Serov, Russian portrait painter (d. 1911) January 20 – Yvette Guilbert, French cabaret singer, actress (d. 1944) January 27 – Nikolai Pokrovsky, Russian politician, last foreign minister of the Russian Empire (d. 1930) January 28 Lala Lajpat Rai ("The Lion of Punjab"), a leader of the Indian independence movement (d. 1928) Kaarlo Juho Ståhlberg, 1st President of Finland (d. 1952)[11] January 31 – Henri Desgrange, French cycling enthusiast, founder of the Tour de France (d. 1940) February 4 – Ernest Hanbury Hankin, English bacteriologist, naturalist (d. 1939) February 9 – Beatrice Stella Tanner, later Mrs. Patrick Campbell, English theatre actress, producer (d. 1940) February 12 Enrico Millo, Italian admiral and politician (d. 1930)[12] Kazimierz Tetmajer, Polish writer (d. 1940) February 17 – Ernst Troeltsch, German theologian (d. 1923). February 19 – Sven Hedin, Swedish scientist, explorer (d. 1952) February 21 – John Haden Badley, English author, educator (d. 1967) February 28 – Wilfred Grenfell, English medical missionary to Newfoundland and Labrador (d. 1940) Elma Danielsson March 1 – Elma Danielsson, Swedish socialist, journalist (d. 1936) March 10 – Tan Sitong, Chinese reformist leader (d. 1898) March 15 – Sui Sin Far, English-born writer (d. 1914) March 19 – William Morton Wheeler, American entomologist (d. 1937) March 30 – Heinrich Rubens, German physicist (d. 1922) April – Richard Rushall, British sea captain and businessman (d. 1953) April 1 – Richard Adolf Zsigmondy, Austrian-born chemist, Nobel Prize laureate (d. 1929) April 2 – Gyorche Petrov, Macedonian and Bulgarian revolutionary (d. 1921) April 6 – Victory Bateman, American stage and screen actress (d. 1926) April 9 Violet Nicolson, English poet (d. 1904) Erich Ludendorff, German general (d. 1937) Charles Proteus Steinmetz, German-American engineer, electrician (d. 1923) April 14 – Alfred Hoare Powell, English Arts and Crafts architect, and designer and painter of pottery (d. 1960) April 16 – Harry Chauvel, Australian Army general (d. 1945)[13] April 18 – Leónidas Plaza, 16th President of Ecuador (d. 1932) April 26 – Akseli Gallen-Kallela, Finnish artist (d. 1931)[14] April 28 Vital Brazil, Brazilian physician, immunologist (d. 1950) Charles W. Woodworth, American entomologist (d. 1940) Pieter Zeeman King George V of the United Kingdom May 2 – Clyde Fitch, American dramatist (d. 1909) May 3 – Martha M. Simpson, Australian educationalist ((d. 1948) May 23 – Epitácio Pessoa, 11th President of Brazil (d. 1942) May 25 John Mott, American YMCA leader, recipient of the Nobel Peace Prize (d. 1955) Pieter Zeeman, Dutch physicist, Nobel Prize laureate (d. 1943) May 26 – Robert W. Chambers, American artist (d. 1933) June 2 – George Lohmann, English cricketer (d. 1901) June 3 – George V of the United Kingdom (d. 1936) June 9 Albéric Magnard, French composer (d. 1914) Carl Nielsen, Danish composer (d. 1931) June 13 – W. B. Yeats, Irish writer, Nobel Prize laureate (d. 1939) June 19 Alfred Hugenberg, German businessman, politician (d. 1951) May Whitty, British stage and screen actress (d. 1948) June 21 – Otto Frank, German physiologist (d. 1944) June 26 – Bernard Berenson, American art historian (d. 1959) June 29 – Shigechiyo Izumi, Japanese supercentenarian (d. 1986) Philipp Scheidemann Julia Marlowe July 1 – Granville Ryrie, Australian Army general, politician, and diplomat (d. 1937)[15] July 13 – Gérard Encausse, French occultist (d. 1916) July 15 – Alfred Harmsworth, 1st Viscount Northcliffe, Irish-born British publisher; founder of the Daily Mail and Daily Mirror (d.1922) July 23 Max Heindel, Danish-born Christian occultist, astrologer, and mystic (d. 1919) Edward Terry Sanford, Associate Justice of the Supreme Court of the United States (d. 1930) July 26 – Philipp Scheidemann, 11th Chancellor of Germany (d. 1939) August 2 Irving Babbitt, American literary critic (d. 1933) John Radecki, Australian stained glass artist (d. 1955) August 10 – Alexander Glazunov, Russian composer (d. 1936) August 15 – Usui Mikao, Japanese founder of reiki (d. 1926) August 17 – Julia Marlowe, English-born American stage actress (d. 1950) August 20 – Bernard Tancred, South African cricketer (d. 1911) August 22 – Templar Saxe, British actor and singer (d. 1935) August 24 – King Ferdinand I of Romania (d. 1927) August 27 – James Henry Breasted, American Egyptologist (d. 1935) September 4 – Maria Karlowska, Polish Roman Catholic religious professed and blessed (d. 1935) September 11 – Rainis, Latvian poet, playwright (d. 1929) September 13 – William Birdwood, 1st Baron Birdwood, British field marshal (d. 1951) September 26 – Mary Russell, Duchess of Bedford, English aviator, ornithologist (d. 1937) Charles W. Clark Hovhannes Abelian Warren G. Harding Jean Sibelius Rudyard Kipling October 1 – Paul Dukas, French composer (d. 1935) October 9 – Arthur Hayes-Sadler, British admiral (d. 1952) October 10 – Rafael Merry del Val, Spanish Roman Catholic Cardinal and Secretary of the Congregation of the Holy Office (d. 1930) October 12 – Arthur Harden, English chemist, Nobel Prize laureate (d. 1940) October 15 – Charles W. Clark, American baritone (d. 1925) October 16 – Rudolph Lambart, 10th Earl of Cavan, British field marshal (d. 1946) October 17 – James Rudolph Garfield, U.S. politician (d. 1950) October 22 Charles James Briggs, British general (d. 1941) Raymond Hitchcock, American actor (d. 1929) October 23 – Hovhannes Abelian, Armenian actor (d. 1936) October 26 – Benjamin Guggenheim, American businessman (d. 1912) October 27 – Tinsley Lindley, English footballer (d. 1940) November 2 – Warren G. Harding, 29th President of the United States (d. 1923) November 11 – Edwin Thanhouser, American actor, businessman, and film producer, founder of the Thanhouser Company (d. 1956) December 8 Rüdiger von der Goltz, German general (d. 1946) Jean Sibelius, Finnish composer (d. 1957) December 12 – Edwyn Alexander-Sinclair, British admiral (d. 1945) December 16 – Olavo Bilac, Brazilian poet (d. 1918) December 19 – Minnie Maddern Fiske, American stage actress (d. 1932) December 20 – Elsie de Wolfe, American socialite, interior decorator (d. 1950) December 23 Anna Farquhar Bergengren, American author and editor (unknown year of death) James M. Canty, American educator, school administrator, and businessperson (d. 1964)[16] Albrecht, Duke of Württemberg, German field marshal (d. 1939) December 25 Evangeline Booth, 4th General of The Salvation Army (d. 1950) Fay Templeton, American musical comedy star (d. 1939) December 28 – Félix Vallotton, Swiss painter, printmaker (d. 1925) December 30 – Rudyard Kipling, Indian-born English writer, Nobel Prize laureate (d. 1936) Ernest Hogan, African-American dancer, musician, and comedian (d. 1909) Habibullah Qurayshi, Bengali Islamic scholar and educationist (d. 1943)[17] Abraham Lincoln John Wilkes Booth January 14 – Marie-Anne Libert, Belgian botanist (b. 1782) January 19 – Pierre-Joseph Proudhon, French philosopher, anarchist (b. 1809) January 28 – Felice Romani, Italian poet, librettist (b. 1788) February 6 – Isabella Beeton, British cook, household management expert (b. 1836)[18] March 1 – Anna Pavlovna of Russia, queen consort of the Netherlands (b. 1795) March 20 – Yamanami Keisuke, Japanese samurai (b. 1833) March 30 – Alexander Dukhnovich, Russian priest, writer and social activist (b. 1803 April 1 John Milton, Governor of Florida (b. 1807) Giuditta Pasta, Italian soprano (b. 1798) April 2 – A. P. Hill, American Confederate general (b. 1825) April 13 – Achille Valenciennes, French zoologist (b. 1794) April 15 – Abraham Lincoln, 16th President of the United States (b. 1809) April 18 – Léon Jean Marie Dufour, French medical doctor, naturalist (b. 1780) April 24 – Nicholas Alexandrovich, Tsarevich of Russia (b. 1843) April 26 – John Wilkes Booth, American actor, assassin of Abraham Lincoln (b. 1838) April 28 – Sir Samuel Cunard, Canadian businessman, founder of the Cunard Line (b. 1787) May 5 – Ben Hall, Australian bushranger (b. 1837) May 10 – William Armstrong, American lawyer, civil servant, politician, and businessperson (b. 1782)[19] Paul Bogle Henry John Temple Leopold I of Belgium July – Dimitris Plapoutas, Greek military leader (b. 1786) July 6 – Princess Sophie of Sweden, Grand Duchess of Baden (b. 1801) July 7 – The Lincoln assassination conspirators (executed) Lewis Powell (b. 1844) David Herold (b. 1842) George Atzerodt (b. 1835) Mary Surratt (b. 1823) July 25 – James Barry, British military surgeon (b. 1795) August 4 – Percival Drayton, United States Navy officer (b. 1812) August 12 – William Jackson Hooker, English botanist (b. 1785) August 13 – Ignaz Semmelweis, Hungarian physician (b. 1818) August 16 – Sir Frederick Stovin, British army general (b. 1783) August 27 – Thomas Chandler Haliburton, Canadian author (b. 1796) August 29 – Robert Remak, German embryologist, physiologist and neurologist (b. 1815) September 2 – William Rowan Hamilton, Irish mathematician (b. 1805) September 10 – Maria Silfvan, Finnish actor (b. 1802) September 25 – Andrés de Santa Cruz, Peruvian military officer, seventh President of Peru and President of Bolivia (b. 1792) October 16 – Andrés Bello, Venezuelan poet, lawmaker, teacher, philosopher and sociologist (b. 1781) October 18 – Henry John Temple, 3rd Viscount Palmerston, Prime Minister of the United Kingdom (b. 1784) October 24 – Paul Bogle, Jamaican activist, Baptist deacon and leader of the Morant Bay rebellion. (executed) (b. 1820) November 10 – Henry Wirz, Swiss-born American Confederate military officer, prisoner-of-war camp commander (executed) (b. 1823) November 12 – Elizabeth Gaskell, British novelist, biographer (b. 1810) November 28 José Manuel Pareja, Spanish admiral (suicide) (b. 1813) William Machin Stairs, Canadian businessman, statesman (b. 1789) November 29 – Isaac A. Van Amburgh, American animal trainer (b. 1811) December 6 – Sebastián Iradier, Spanish composer (b. 1809) December 10 – King Leopold I of Belgium (b. 1790) December 14 – Johan Georg Forchhammer, Danish geologist (b. 1794) December 17 – Luigi Ciacchi, Italian cardinal (b. 1788) ^ "Kunnallinen itsehallinto 150 vuotta" [150 years of local self-government]. Nopolanews (in Finnish). February 6, 2015. Archived from the original on February 24, 2015. Retrieved February 6, 2024. ^ Moore, Randy (May 2001). "The "Rediscovery" of Mendel's Work" (PDF). Bioscene. 27. Archived from the original (PDF) on February 2, 2017. 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Millennia 2nd millennium Centuries 17th century 18th century 19th century Timelines 17th century 18th century 19th century State leaders 17th century 18th century 19th century Decades 1700s 1710s 1720s 1730s 1740s 1750s 1760s 1770s 1780s 1790s Categories: Births – Deaths Establishments – Disestablishments vte Political boundaries at the beginning of year 1700 Storming of the Bastille, 14 July 1789, an iconic event of the French Revolution. Development of the Watt steam engine in the late 18th century was an important element in the Industrial Revolution in Europe. The American Revolutionary War took place in the late 18th century. The 18th century lasted from 1 January 1701 (represented by the Roman numerals MDCCI) to 31 December 1800 (MDCCC). During the 18th century, elements of Enlightenment thinking culminated in the Atlantic Revolutions. Revolutions began to challenge the legitimacy of monarchical and aristocratic power structures. The Industrial Revolution began mid-century, leading to radical changes in human society and the environment. The European colonization of the Americas and other parts of the world intensified and associated mass migrations of people grew in size as part of the Age of Sail. During the century, slave trading expanded across the shores of the Atlantic Ocean, while declining in Russia[1] and China.[2] Western historians have occasionally defined the 18th century otherwise for the purposes of their work. For example, the "short" 18th century may be defined as 1715–1789, denoting the period of time between the death of Louis XIV of France and the start of the French Revolution, with an emphasis on directly interconnected events.[3][4] To historians who expand the century to include larger historical movements, the "long" 18th century[5] may run from the Glorious Revolution of 1688 to the Battle of Waterloo in 1815[6] or even later.[7] France was the sole world superpower from 1659, after it defeated Spain, until 1815, when it was defeated by Britain and its coalitions following the Napoleonic Wars. In Europe, philosophers ushered in the Age of Enlightenment. This period coincided with the French Revolution of 1789, and was later compromised by the excesses of the Reign of Terror. At first, many monarchies of Europe embraced Enlightenment ideals, but in the wake of the French Revolution they feared loss of power and formed broad coalitions to oppose the French Republic in the French Revolutionary Wars. Various conflicts throughout the century, including the War of the Spanish Succession and the Seven Years' War, saw Great Britain triumph over its rivals to become the preeminent power in Europe. However, Britain's attempts to exert its authority over the Thirteen Colonies became a catalyst for the American Revolution. The 18th century also marked the end of the Polish–Lithuanian Commonwealth as an independent state. Its semi-democratic government system was not robust enough to prevent partition by the neighboring states of Austria, Prussia, and Russia. In West Asia, Nader Shah led Persia in successful military campaigns. The Ottoman Empire experienced a period of peace, taking no part in European wars from 1740 to 1768. As a result, the empire was not exposed to Europe's military improvements during the Seven Years' War. The Ottoman military consequently lagged behind and suffered several defeats against Russia in the second half of the century. In South Asia, the death of Mughal emperor Aurangzeb was followed by the expansion of the Maratha Confederacy and an increasing level of European influence and control in the region. In 1739, Persian emperor Nader Shah invaded and plundered Delhi, the capital of the Mughal Empire. Later, his general Ahmad Shah Durrani scored another victory against the Marathas, the then dominant power in India, in the Third Battle of Panipat in 1761.[8] By the middle of the century, the British East India Company began to conquer eastern India,[9][8] and by the end of the century, the Anglo-Mysore Wars against Tipu Sultan and his father Hyder Ali, led to Company rule over the south.[10][11] In East Asia, the century was marked by the High Qing era, a period characterized by significant cultural and territorial expansion. This period also experienced relative peace and prosperity, allowing for societal growth, increasing literacy rates, flourishing trade, and consolidating imperial power across the vast Qing dynasty's territories. Conversely, the continual seclusion policy of the Tokugawa shogunate also brought a peaceful era called Pax Tokugawa and experienced a flourishment of the arts as well as scientific knowledge and advancements, which were introduced to Japan through the Dutch port of Nagasaki. In Southeast Asia, the Konbaung–Ayutthaya Wars and the Tây Sơn Wars broke out while the Dutch East India Company established increasing levels of control over the Mataram Sultanate. In Africa, the Ethiopian Empire underwent the Zemene Mesafint, a period when the country was ruled by a class of regional noblemen and the emperor was merely a figurehead. The Atlantic slave trade also saw the continued involvement of states such as the Oyo Empire. In Oceania, the European colonization of Australia and New Zealand began during the late half of the century. In the Americas, the United States declared its independence from Great Britain. In 1776, Thomas Jefferson wrote the Declaration of Independence. In 1789, George Washington was inaugurated as the first president. Benjamin Franklin traveled to Europe where he was hailed as an inventor. Examples of his inventions include the lightning rod and bifocal glasses. Túpac Amaru II led an uprising that sought to end Spanish colonial rule in Peru. For a chronological guide, see Timeline of the 18th century. See also: Georgian era Main articles: 1700s, 1710s, 1720s, 1730s, and 1740s Europe at the beginning of the War of the Spanish Succession, 1700 The Battle of Poltava in 1709 turned the Russian Empire into a European power. John Churchill, 1st Duke of Marlborough 1700–1721: Great Northern War between the Russian and Swedish Empires. 1701: Kingdom of Prussia declared under King Frederick I. 1701: The Battle of Feyiase marks the rise of the Ashanti Empire. 1701–1714: The War of the Spanish Succession is fought, involving most of continental Europe.[12] 1702–1715: Camisard rebellion in France. 1703: Saint Petersburg is founded by Peter the Great; it is the Russian capital until 1918. 1703–1711: The Rákóczi uprising against the Habsburg monarchy. 1704: End of Japan's Genroku period. 1704: First Javanese War of Succession.[13] 1706–1713: The War of the Spanish Succession: French troops defeated at the Battle of Ramillies and the Siege of Turin. 1707: Death of Mughal Emperor Aurangzeb leads to the fragmentation of the Mughal Empire. 1707: The Act of Union is passed, merging the Scottish and English Parliaments, thus establishing the Kingdom of Great Britain.[14] 1708: The Company of Merchants of London Trading into the East Indies and English Company Trading to the East Indies merge to form the United Company of Merchants of England Trading to the East Indies. 1708–1709: Famine kills one-third of East Prussia's population. 1709: Foundation of the Hotak Empire. 1709: The Great Frost of 1709 marks the coldest winter in 500 years, contributing to the defeat of Sweden at Poltava. 1710: The world's first copyright legislation, Britain's Statute of Anne, takes effect. 1710–1711: Ottoman Empire fights Russia in the Russo-Turkish War and regains Azov. 1711: Bukhara Khanate dissolves as local begs seize power. 1711–1715: Tuscarora War between British, Dutch, and German settlers and the Tuscarora people of North Carolina. 1713: The Kangxi Emperor acknowledges the full recovery of the Chinese economy since its apex during the Ming. 1714: In Amsterdam, Daniel Gabriel Fahrenheit invents the mercury-in-glass thermometer, which remains the most reliable and accurate thermometer until the electronic era. 1715: The first Jacobite rising breaks out; the British halt the Jacobite advance at the Battle of Sheriffmuir; Battle of Preston. 1716: Establishment of the Sikh Confederacy along the present-day India-Pakistan border. 1716–1718: Austro-Venetian-Turkish War. 1718: The city of New Orleans is founded by the French in North America. 1718–1720: War of the Quadruple Alliance with Spain versus France, Britain, Austria, and the Netherlands. 1718–1730: Tulip period of the Ottoman Empire. 1719: Second Javanese War of Succession.[15] 1720: The South Sea Bubble. 1720–1721: The Great Plague of Marseille. 1720: Qing forces oust Dzungar invaders from Tibet. 1721: The Treaty of Nystad is signed, ending the Great Northern War. 1721: Sack of Shamakhi, massacre of its Shia population by Sunni Lezgins. 1722: Siege of Isfahan results in the handover of Iran to the Hotaki Afghans. 1722–1723: Russo-Persian War. 1722–1725: Controversy over William Wood's halfpence leads to the Drapier's Letters and begins the Irish economic independence from England movement. Mughal emperor Muhammad Shah with the Persian invader Nader Shah. 1723: Slavery is abolished in Russia; Peter the Great converts household slaves into house serfs.[16] 1723–1730: The "Great Disaster", an invasion of Kazakh territories by the Dzungars. 1723–1732: The Qing and the Dzungars fight a series of wars across Qinghai, Dzungaria, and Outer Mongolia, with inconclusive results. 1724: Daniel Gabriel Fahrenheit proposes the Fahrenheit temperature scale. 1725: Austro-Spanish alliance revived. Russia joins in 1726. 1727–1729: Anglo-Spanish War ends inconclusively. 1730: Mahmud I takes over Ottoman Empire after the Patrona Halil revolt, ending the Tulip period. 1730–1760: The First Great Awakening takes place in Great Britain and North America. 1732–1734: Crimean Tatar raids into Russia.[17] 1733–1738: War of the Polish Succession. Qianlong Emperor 1735–1739: Austro-Russo-Turkish War. 1735–1799: The Qianlong Emperor of China oversees a huge expansion in territory. 1738–1756: Famine across the Sahel; half the population of Timbuktu dies.[18] 1737–1738: Hotak Empire ends after the siege of Kandahar by Nader Shah. 1739: Great Britain and Spain fight the War of Jenkins' Ear in the Caribbean. 1739: Nader Shah defeats a pan-Indian army of 300,000 at the Battle of Karnal. Taxation is stopped in Iran for three years. 1739–1740: Nader Shah's Sindh expedition. 1740: George Whitefield brings the First Great Awakening to New England 1740–1741: Famine in Ireland kills 20 percent of the population. 1741–1743: Iran invades Uzbekistan, Khwarazm, Dagestan, and Oman. 1741–1751: Maratha invasions of Bengal. 1740–1748: War of the Austrian Succession. 1742: Marvel's Mill, the first water-powered cotton mill, begins operation in England.[19] 1742: Anders Celsius proposes an inverted form of the centigrade temperature, which is later renamed Celsius in his honor. 1742: Premiere of George Frideric Handel's Messiah. 1743–1746: Another Ottoman-Persian War involves 375,000 men but ultimately ends in a stalemate. The extinction of the Scottish clan system came with the defeat of the clansmen at the Battle of Culloden in 1746.[20] 1744: The First Saudi State is founded by Mohammed Ibn Saud.[21] 1744: Battle of Toulon is fought off the coast of France. 1744–1748: The First Carnatic War is fought between the British, the French, the Marathas, and Mysore in India. 1745: Second Jacobite rising is begun by Charles Edward Stuart in Scotland. 1747: The Durrani Empire is founded by Ahmad Shah Durrani. 1748: The Treaty of Aix-La-Chapelle ends the War of the Austrian Succession and First Carnatic War. 1748–1754: The Second Carnatic War is fought between the British, the French, the Marathas, and Mysore in India. 1750: Peak of the Little Ice Age. Main articles: 1750s, 1760s, 1770s, 1780s, 1790s, and 1800s 1752: The British Empire adopts the Gregorian Calendar, skipping 11 days from 3 September to 13 September. On the calendar, 2 September is followed directly by 14 September. 1754: The Treaty of Pondicherry ends the Second Carnatic War and recognizes Muhammed Ali Khan Wallajah as Nawab of the Carnatic. 1754: King's College is founded by a royal charter of George II of Great Britain.[22] 1754–1763: The French and Indian War, the North American chapter of the Seven Years' War, is fought in colonial North America, mostly by the French and their allies against the English and their allies. 1755: The great Lisbon earthquake destroys most of Portugal's capital and kills up to 100,000. 1755: The Dzungar genocide depopulates much of northern Xinjiang, allowing for Han, Uyghur, Khalkha Mongol, and Manchu colonization. 1755–1763: The Great Upheaval forces transfer of the French Acadian population from Nova Scotia and New Brunswick. 1756–1763: The Seven Years' War is fought among European powers in various theaters around the world. 1756–1763: The Third Carnatic War is fought between the British, the French, and Mysore in India. 1757: British conquest of Bengal. Catherine the Great, Empress of Russia. 1760: George III becomes King of Britain. 1761: Maratha Empire defeated at Battle of Panipat. 1762–1796: Reign of Catherine the Great of Russia. 1763: The Treaty of Paris ends the Seven Years' War and Third Carnatic War. 1764: Dahomey and the Oyo Empire defeat the Ashanti army at the Battle of Atakpamé. 1764: The Mughals are defeated at the Battle of Buxar. 1765: The Stamp Act is introduced into the American colonies by the British Parliament. 1765–1767: The Burmese invade Thailand and utterly destroy Attuthaya. 1765–1769: Burma under Hsinbyushin repels four invasions from Qing China, securing hegemony over the Shan states. 1766: Christian VII becomes king of Denmark. He was king of Denmark to 1808. 1766–1799: Anglo-Mysore Wars. 1767: Taksin expels Burmese invaders and reunites Thailand under an authoritarian regime. 1768–1772: War of the Bar Confederation. 1768–1774: Russo-Turkish War. 1769: Spanish missionaries establish the first of 21 missions in California. 1769–1770: James Cook explores and maps New Zealand and Australia. 1769–1773: The Bengal famine of 1770 kills one-third of the Bengal population. 1769: The French East India Company dissolves, only to be revived in 1785. 1769: French expeditions capture clove plants in Ambon, ending the Dutch East India Company's (VOC) monopoly of the plant.[23] 1770–1771: Famine in Czech lands kills hundreds of thousands. 1771: The Plague Riot in Moscow. 1771: The Kalmyk Khanate dissolves as the territory becomes colonized by Russians. More than a hundred thousand Kalmyks migrate back to Qing Dzungaria. 1772: Gustav III of Sweden stages a coup d'état, becoming almost an absolute monarch. Encyclopédie, ou dictionnaire raisonné des sciences, des arts et des métiers 1772–1779: Maratha Empire fights Britain and Raghunathrao's forces during the First Anglo-Maratha War. 1772–1795: The Partitions of Poland end the Polish–Lithuanian Commonwealth and erase Poland from the map for 123 years. 1773–1775: Pugachev's Rebellion, the largest peasant revolt in Russian history. 1773: East India Company starts operations in Bengal to smuggle opium into China. 1775: Russia imposes a reduction in autonomy on the Zaporizhian Cossacks of Ukraine. 1775–1782: First Anglo-Maratha War. 1775–1783: American Revolutionary War. 1776: Several kongsi republics are founded by Chinese settlers in the island of Borneo. They are some of the first democracies in Asia. 1776–1777: A Spanish-Portuguese War occurs over land in the South American frontiers. 1776: Illuminati founded by Adam Weishaupt. 1776: The United States Declaration of Independence is adopted by the Second Continental Congress in Philadelphia. 1776: Adam Smith publishes The Wealth of Nations. 1778: James Cook becomes the first European to land on the Hawaiian Islands. 1778: Franco-American alliance signed. 1778: Spain acquires its first permanent holding in Africa from the Portuguese, which is administered by the newly-established La Plata Viceroyalty. 1778: Vietnam is reunified for the first time in 200 years by the Tay Son brothers. The Tây Sơn dynasty has been established, terminating the Lê dynasty. 1779–1879: Xhosa Wars between British and Boer settlers and the Xhosas in the South African Republic. 1779–1783: Britain loses several islands and colonial outposts all over the world to the combined Franco-Spanish navy. 1779: Iran enters yet another period of conflict and civil war after the prosperous reign of Karim Khan Zand. 1780: Outbreak of the indigenous rebellion against Spanish colonization led by Túpac Amaru II in Peru. 1781: The city of Los Angeles is founded by Spanish settlers.George Washington 1781–1785: Serfdom is abolished in the Austrian monarchy (first step; second step in 1848). 1782: The Thonburi Kingdom of Thailand is dissolved after a palace coup. 1783: The Treaty of Paris formally ends the American Revolutionary War. 1783: Russian annexation of Crimea. 1785–1791: Imam Sheikh Mansur, a Chechen warrior and Muslim mystic, leads a coalition of Muslim Caucasian tribes from throughout the Caucasus in a holy war against Russian settlers and military bases in the Caucasus, as well as against local traditionalists, who followed the traditional customs and common law (Adat) rather than the theocratic Sharia.[24] 1785–1795: The Northwest Indian War is fought between the United States and Native Americans. 1785–1787: The Maratha–Mysore Wars concludes with an exchange of territories in the Deccan. 1786–1787: Wolfgang Amadeus Mozart premieres The Marriage of Figaro and Don Giovanni. 1787: The Tuareg occupy Timbuktu until the 19th century. 1787–1792: Russo-Turkish War. 1788: First Fleet arrives in Australia 1788–1790: Russo-Swedish War (1788–1790). 1788: Dutch Geert Adriaans Boomgaard (1788–1899) would become the first generally accepted validated case of a supercentenarian on record.[25][26] Declaration of the Rights of Man and of the Citizen 1788–1789: A Qing attempt to reinstall an exiled Vietnamese king in northern Vietnam ends in disaster. 1789: George Washington is elected the first President of the United States; he serves until 1797. 1789: Quang Trung defeats the Qing army. 1789–1799: French Revolution. 1789: The Liège Revolution. 1789: The Brabant Revolution. 1789: The Inconfidência Mineira, an unsuccessful separatist movement in central Brazil led by Tiradentes 1791: Suppression of the Liège Revolution by Austrian forces and re-establishment of the Prince-Bishopric of Liège. 1791–1795: George Vancouver explores the world during the Vancouver Expedition. 1791–1804: The Haitian Revolution. 1791: Mozart premieres The Magic Flute. 1792–1802: The French Revolutionary Wars lead into the Napoleonic Wars, which last from 1803–1815. 1792: The New York Stock & Exchange Board is founded. 1792: Polish–Russian War of 1792. 1792: Margaret Ann Neve (1792–1903) would become the first recorded female supercentenarian to reach the age of 110.[27][28] 1793: Upper Canada bans slavery. 1793: The largest yellow fever epidemic in American history kills as many as 5,000 people in Philadelphia, roughly 10% of the population.[29] 1793–1796: Revolt in the Vendée against the French Republic at the time of the Revolution. 1794–1816: The Hawkesbury and Nepean Wars, which were a series of incidents between settlers and New South Wales Corps and the Aboriginal Australian clans of the Hawkesbury river in Sydney, Australia. 1795: The Marseillaise is officially adopted as the French national anthem.Napoleon at the Bridge of the Arcole 1795: The Battle of Nuʻuanu in the final days of King Kamehameha I's wars to unify the Hawaiian Islands. 1795–1796: Iran invades and devastates Georgia, prompting Russia to intervene and march on Tehran. 1796: Edward Jenner administers the first smallpox vaccination; smallpox killed an estimated 400,000 Europeans each year during the 18th century, including five reigning monarchs.[30] 1796: War of the First Coalition: The Battle of Montenotte marks Napoleon Bonaparte's first victory as an army commander. 1796: The British eject the Dutch from Ceylon and South Africa. 1796–1804: The White Lotus Rebellion against the Manchu dynasty in China. 1797: John Adams is elected the second President of the United States; he serves until 1801. 1798: The Irish Rebellion fails to overthrow British rule in Ireland. 1798–1800: The Quasi-War is fought between the United States and France. 1799: Dutch East India Company is dissolved. 1799: Austro-Russian forces under Alexander Suvorov liberates much of Italy and Switzerland from French occupation. 1799: Coup of 18 Brumaire - Napoleon's coup d'etat brings the end of the French Revolution. 1799: Death of the Qianlong Emperor after 60 years of rule over China. His favorite official, Heshen, is ordered to commit suicide. 1800: On 1 January, the bankrupt VOC is formally dissolved and the nationalized Dutch East Indies are established.[31] Main articles: Timeline of historic inventions § 18th century, and Timeline of scientific discoveries § 18th century The spinning jenny 1709: The first piano was built by Bartolomeo Cristofori 1711: Tuning fork was invented by John Shore 1712: Steam engine invented by Thomas Newcomen 1714: Mercury thermometer by Daniel Gabriel Fahrenheit 1717: Diving bell was successfully tested by Edmond Halley, sustainable to a depth of 55 ft c. 1730: Octant navigational tool was developed by John Hadley in England, and Thomas Godfrey in America 1733: Flying shuttle invented by John Kay 1736: Europeans encountered rubber – the discovery was made by Charles Marie de La Condamine while on expedition in South America. It was named in 1770 by Joseph Priestley c. 1740: Modern steel was developed by Benjamin Huntsman 1741: Vitus Bering discovers Alaska 1745: Leyden jar invented by Ewald Georg von Kleist was the first electrical capacitor 1751: Jacques de Vaucanson perfects the first precision lathe 1752: Lightning rod invented by Benjamin Franklin 1753: The first clock to be built in the New World (North America) was invented by Benjamin Banneker. 1755: The tallest wooden Bodhisattva statue in the world is erected at Puning Temple, Chengde, China. 1764: Spinning jenny created by James Hargreaves brought on the Industrial Revolution 1765: James Watt enhances Newcomen's steam engine, allowing new steel technologies 1761: The problem of longitude was finally resolved by the fourth chronometer of John Harrison 1763: Thomas Bayes publishes first version of Bayes' theorem, paving the way for Bayesian probability 1768–1779: James Cook mapped the boundaries of the Pacific Ocean and discovered many Pacific Islands 1774: Joseph Priestley discovers "dephlogisticated air", oxygen The Chinese Putuo Zongcheng Temple of Chengde, completed in 1771, during the reign of the Qianlong Emperor. 1775: Joseph Priestley's first synthesis of "phlogisticated nitrous air", nitrous oxide, "laughing gas" 1776: First improved steam engines installed by James Watt 1776: Steamboat invented by Claude de Jouffroy 1777: Circular saw invented by Samuel Miller 1779: Photosynthesis was first discovered by Jan Ingenhousz 1781: William Herschel announces discovery of Uranus 1784: Bifocals invented by Benjamin Franklin 1784: Argand lamp invented by Aimé Argand[32] 1785: Power loom invented by Edmund Cartwright 1785: Automatic flour mill invented by Oliver Evans 1786: Threshing machine invented by Andrew Meikle 1787: Jacques Charles discovers Charles's law 1789: Antoine Lavoisier discovers the law of conservation of mass, the basis for chemistry, and begins modern chemistry 1798: Edward Jenner publishes a treatise about smallpox vaccination 1798: The Lithographic printing process invented by Alois Senefelder[33] 1799: Rosetta Stone discovered by Napoleon's troops Main articles: 18th century in literature and 18th century in philosophy 1703: The Love Suicides at Sonezaki by Chikamatsu first performed 1704–1717: One Thousand and One Nights translated into French by Antoine Galland. The work becomes immensely popular throughout Europe. 1704: A Tale of a Tub by Jonathan Swift first published 1712: The Rape of the Lock by Alexander Pope (publication of first version) 1719: Robinson Crusoe by Daniel Defoe 1725: The New Science by Giambattista Vico 1726: Gulliver's Travels by Jonathan Swift 1728: The Dunciad by Alexander Pope (publication of first version) 1744: A Little Pretty Pocket-Book becomes one of the first books marketed for children 1748: Chushingura (The Treasury of Loyal Retainers), popular Japanese puppet play, composed 1748: Clarissa; or, The History of a Young Lady by Samuel Richardson 1749: The History of Tom Jones, a Foundling by Henry Fielding 1751: Elegy Written in a Country Churchyard by Thomas Gray published 1751–1785: The French Encyclopédie 1755: A Dictionary of the English Language by Samuel Johnson 1758: Arithmetika Horvatzka by Mihalj Šilobod Bolšić 1759: Candide by Voltaire 1759: The Theory of Moral Sentiments by Adam Smith 1759–1767: Tristram Shandy by Laurence Sterne 1762: Emile: or, On Education by Jean-Jacques Rousseau 1762: The Social Contract, Or Principles of Political Right by Jean-Jacques Rousseau 1774: The Sorrows of Young Werther by Goethe first published 1776: Ugetsu Monogatari (Tales of Moonlight and Rain) by Ueda Akinari 1776: The Wealth of Nations, foundation of the modern theory of economy, was published by Adam Smith 1776–1789: The History of the Decline and Fall of the Roman Empire was published by Edward Gibbon 1779: Amazing Grace published by John Newton 1779–1782: Lives of the Most Eminent English Poets by Samuel Johnson 1781: Critique of Pure Reason by Immanuel Kant (publication of first edition) 1781: The Robbers by Friedrich Schiller first published 1782: Les Liaisons dangereuses by Pierre Choderlos de Laclos 1786: Poems, Chiefly in the Scottish Dialect by Robert Burns 1787–1788: The Federalist Papers by Alexander Hamilton, James Madison, and John Jay 1788: Critique of Practical Reason by Immanuel Kant 1789: Songs of Innocence by William Blake 1789: The Interesting Narrative of the Life of Olaudah Equiano by Olaudah Equiano 1790: Journey from St. Petersburg to Moscow by Alexander Radishchev 1790: Reflections on the Revolution in France by Edmund Burke 1791: Rights of Man by Thomas Paine 1792: A Vindication of the Rights of Woman by Mary Wollstonecraft 1794: Songs of Experience by William Blake 1798: Lyrical Ballads by William Wordsworth and Samuel Taylor Coleridge 1798: An Essay on the Principle of Population published by Thomas Malthus (mid–18th century): The Dream of the Red Chamber (authorship attributed to Cao Xueqin), one of the most famous Chinese novels 1711: Rinaldo, Handel's first opera for the London stage, premiered 1721: Brandenburg Concertos by J.S. Bach 1723: The Four Seasons, violin concertos by Antonio Vivaldi, composed 1724: St John Passion by J.S. Bach 1727: St Matthew Passion composed by J.S. Bach 1727: Zadok the Priest is composed by Handel for the coronation of George II of Great Britain. It has been performed at every subsequent British coronation. 1733: Hippolyte et Aricie, first opera by Jean-Philippe Rameau 1741: Goldberg Variations for harpsichord published by Bach 1742: Messiah, oratorio by Handel premiered in Dublin 1749: Mass in B minor by J.S. Bach assembled in current form 1751: The Art of Fugue by J.S. Bach 1762: Orfeo ed Euridice, first "reform opera" by Gluck, performed in Vienna 1786: The Marriage of Figaro, opera by Mozart 1787: Don Giovanni, opera by Mozart 1788: Jupiter Symphony (Symphony No. 41) composed by Mozart 1791: The Magic Flute, opera by Mozart 1791–1795: London symphonies by Haydn 1798: The Pathétique, piano sonata by Beethoven 1798: The Creation, oratorio by Haydn first performed ^ Volkov, Sergey. Concise History of Imperial Russia. ^ Rowe, William T. China's Last Empire. ^ Anderson, M. S. (1979). Historians and Eighteenth-Century Europe, 1715–1789. Oxford University Press. ISBN 978-0-19-822548-5. OCLC 185538307. ^ Ribeiro, Aileen (2002). Dress in Eighteenth-Century Europe 1715–1789 (revised ed.). Yale University Press. ISBN 978-0-300-09151-9. OCLC 186413657. ^ Baines, Paul (2004). The Long 18th Century. London: Arnold. ISBN 978-0-340-81372-0. ^ Marshall, P. J., ed. (2001). 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View (previous 50 | next 50) (20 | 50 | 100 | 250 | 500)List of decades, centuries, and millennia (links | edit) Goths (links | edit) Industrial espionage (links | edit) Romania (links | edit) 20th century (links | edit) 15th century (links | edit) 16th century (links | edit) 17th century (links | edit) 1870s (links | edit) 1624 (links | edit) 1626 (links | edit) 1642 (links | edit) 1661 (links | edit) 1756 (links | edit) 1791 (links | edit) 1608 (links | edit) 1818 (links | edit) 1743 (links | edit) 1826 (links | edit) 1828 (links | edit) 14th century (links | edit) 1860s (links | edit) 1788 (links | edit) 1st century (links | edit) 13th century (links | edit) 1787 (links | edit) 1863 (links | edit) 4th century (links | edit) 12th century (links | edit) 11th century (links | edit) 1859 (links | edit) 1900 (links | edit) 1848 (links | edit) 1866 (links | edit) 1896 (links | edit) 1895 (links | edit) 1861 (links | edit) 1648 (links | edit) 1623 (links | edit) 1662 (links | edit) 1640s (links | edit) 1770s (links | edit) 1780s (links | edit) 1789 (links | edit) 1782 (links | edit) 1840 (links | edit) 1840s (links | edit) 1883 (links | edit) 1800s (decade) (links | edit) 1801 (links | edit) View (previous 50 | next 50) (20 | 50 | 100 | 250 | 500) Retrieved from " WhatLinksHere/18th_century" This article will give an in-depth discussion about plate heat exchangers. This article will give a better understanding of: How Plate Heat Exchangers Work Design of Plate Heat Exchangers Plate Types and Patterns of Plate Heat Exchangers Applications of Exchangers Advantages and Maintainability of Plate Heat Exchangers And Much More… A plate heat exchanger (PHE) is a compact and efficient device designed to facilitate the exchange of heat between two fluids, typically at different temperatures, using a series of thin metal plates. Functionality of Plate Heat Exchangers This section delves into how plate heat exchangers operate. Fundamentals of a Plate Heat Exchanger PHEs work based on thermodynamic principles. Each plate is paired with a specific concave tubular shell. The arrangement creates narrow, rectangular channels, enabling effective heat transfer through these segmented regions. Fluids flow through these narrow channels encased by gaskets, which help control the fluid movement. These gaskets ensure that one fluid type (potentially a heated canvas) passes over one plate while another fluid (like heated water) moves over the adjacent plate. The visual below displays two neighboring plates. In this arrangement, cold and hot fluids alternate over the plates, enabling heat transfer between them. The extensive surface area of the plates enhances the rate of heat transfer compared to tubular heat exchangers. As demonstrated in the diagram, the cold fluid inlet (blue) is positioned at the bottom, with the outlet at the top, while the hot fluid outlet (red) is also strategically located. This setup allows the cooler fluid to rise as the warmer fluid descends, transferring heat across the plates. This mechanism results in cooling of the heating medium and the warming of the cooling medium. Plate heat exchangers are celebrated for their compact design, efficient heat transfer, adaptability, and ease of installation and maintenance. Design and Function of Plate Heat Exchangers Operating a plate heat exchanger involves several steps: Pressure Drop Considerations Maintaining a specified pressure drop is critical. Excess energy may be necessary if it deviates from the design, signifying potential fouling or clogging. Monitor the flow rate against specifications to uncover discrepancies: If the pressure drop exceeds specified values, verify the temperature program. If temperature readings are accurate, examine the exchanger for blockages and open the system if necessary. If channels constrict and temperature readings differ, CIP (Cleaning in Place) might be required. Installation of a Plate Heat Exchanger Install the device on a stable, level surface. Ensure at least 1.5 meters of clearance from walls for maintaining tasks like replacing or tightening plates. The installation manual specifies required free space. Connections for Plate Heat Exchangers Before pipe connections, confirm compressed dimensions match specifications if extensions are on a removable plate. Allow 1.5 meters of clearance around the device for optimal working conditions during installation and maintenance. Plate Heat Exchanger Safety Measures Pre-Startup Cautions Ensure all bolts are secure and the plate pack is correctly assembled before startup. Initiate operation gradually, avoiding pressure shocks or water hammer to prevent equipment damage. Key points include: Apply correct pressure to the plate pack. Avoid drastic temperature and pressure shifts to prevent damage. Review pump instructions and manage the stopcock between the pump and the system to control the flow rate. Fully open the exit stopcock if present. Engage articulation. Start the pump incrementally. Smoothly open the stopcock. After air removal, close the articulation. Repeat these steps for the other fluid medium. Design limits for pressure and temperature must not be exceeded; these are indicated on the nameplate. Operational Conditions of Plate Heat Exchangers Consider these aspects when operating plate heat exchangers: Avoid liquid hammers. Ensure the device operates within permitted flow media, pressure, and temperature conditions. Ensure proper venting of the exchanger. Standard Operating Procedure for Plate Heat Exchangers Employ the following essential procedure: Begin with the cold circuit. Completely vent the system. Shut the cock located between the pump and exchanger. Open the return line cock from the exchanger fully. Start the pump circulation as usual. Smoothly open the shut-off cock between the pump and exchanger. Re-vent the system if required. Precautions for Temporary Shutdown Follow these precautions: Close the control cock on the hot circuit while maintaining complete flow in the cold circuit. Deactivate the hot circuit pump. Allow the exchanger to cool down. Shut the cold circuit control cock. Turn off the cold circuit pump. Close all remaining shut-off valves. Long-term Shutdown Precautions Steps for disconnecting the unit include: Never open a heat exchanger when hot; allow cooling first. Reduce both fluid pressures. Fully drain all fluids from the unit. Lubricate all bolts. Loosen the setting bolts until the plate pack is relaxed. Refrain from removing tie bolts. Cover the plate pack to shield it from sunlight. Chapter 2: What is the Design of Plate Heat Exchangers? Plate heat exchangers (PHEs) are high-efficiency heat transfer devices used extensively across HVAC systems, chemical processing, food and beverage production, power generation, and other industrial applications. Their design enables effective heat exchange between two or more fluids, typically liquids or gases, without mixing. To optimize their performance and functionality for different operating conditions, plate heat exchangers are available in a variety of configurations and materials. Below, we explore the essential design components and variations, highlighting why plate heat exchangers are the preferred solution for compact, cost-effective, and versatile thermal management. Carrying Beam in Plate Heat Exchangers The carrying beam, located in the upper section of the plate heat exchanger, is secured between the supporting column and the fixed plate. This critical component supports both the pressure plates and the heat exchanger plates, facilitating the proper alignment and distribution of pressure during operation. Ensuring structural integrity, the carrying beam helps maintain consistent heat transfer efficiency and system reliability. Fixed Plate in Plate Heat Exchangers The fixed plate acts as a stationary frame plate, forming the backbone of the plate heat exchanger. Typically constructed from highly durable stainless steel or other corrosion-resistant materials, the fixed plate is designed to withstand high pressures and temperatures. Heat exchanger pipes are often welded or bolted to this part, ensuring secure fluid connections and optimal operation over extensive cycles of use. Support Column in Plate Heat Exchangers This robust, stationary component enhances the frame’s stability. It features attached guiding bars and a supporting shaft, which contribute to the precise positioning of the plate pack and facilitate maintenance. The support column is essential for heavy-duty operations where vibration resistance and longevity of the plate heat exchanger are critical. Pressure Plate in Plate Heat Exchangers An integral part of plate heat exchanger design, the movable pressure plate frame is connected to the carrying shaft. It enables the uniform compression of the stack of exchanger plates, ensuring proper plate-to-plate contact. This compression is fundamental for leak-free operation and consistent thermal transfer, making the pressure plate indispensable in both maintenance and overall thermal performance. Guiding Bar in Plate Heat Exchangers The guiding bar is a precision-engineered component that ensures smooth movement and precise positioning of both the pressure plate and the exchanger plates. Its design improves assembly, maintenance, and uniform distribution of compressive forces, extending gasket life and minimizing operational wear. Tightening Unit in Plate Heat Exchangers The tightening unit, often consisting of tensioning nuts, washers, and bolts, is used to apply and maintain uniform compression on the frame corridor of the plate pack. Proper tightening is crucial in preventing leaks and maintaining the integrity of gaskets and plates, especially during rapid thermal cycling or when processing aggressive fluids. Gaskets in Plate Heat Exchangers Gaskets play a vital role in the performance and safety of plate heat exchangers. Installed between the pressure plate and the fixed frame plate, these sealing elements ensure tight, leak-free operation by directing the flow along prescribed paths and preventing cross-contamination between media. Various compounds—such as Nitrile (NBR), EPDM, Viton, and PTFE—are selected based on chemical compatibility, temperature tolerance, and resistance to aging or compression set. Gasket Types in Plate Heat Exchangers The types of gaskets used in plate heat exchangers are: Slit-in Gasket (Glue-free type) The slit-in gasket—often referred to as the “clip-on gasket”—is engineered for rapid replacement and minimal downtime. This glue-free design is ideal for industries demanding frequent sanitation or inspection, such as water treatment, dairy processing, or pharmaceuticals. Additionally, these gaskets reduce odors associated with adhesive application and minimize residual contaminants. EPDM Gasket Ethylene propylene diene monomer (EPDM) gaskets are recommended for processes involving high temperatures or aggressive chemicals. EPDM gaskets retain elasticity and sealing performance far longer than standard rubber gaskets, making them ideal for heat exchanger operations where reliability and resistance to steam, glycol, or acidic cleaning agents are necessary. PTFE Cushion Gaskets (TCG) PTFE (Polytetrafluoroethylene) cushion gaskets are engineered for highly corrosive or chemically aggressive fluid media, outlasting typical synthetic rubber alternatives. Their elastic core requires less tightening torque, minimizing the risk of heat exchanger plate deformation. PTFE gaskets are commonly used in petrochemical processing, pharmaceutical manufacturing, and any processes requiring the highest standards of chemical resistance. Generally, a TCG gasket is placed on one side with a conventional gasket on the other when one stream is corrosive and the other is non-corrosive. Types of Plate Heat Exchangers Plate heat exchangers are available in distinct types, each tailored for specific industrial, commercial, or residential thermal applications. Understanding their operating principles and practical benefits is important for selecting the best solution based on heat transfer efficiency, ease of maintenance, chemical compatibility, and installation constraints. Gasketed Plate Heat Exchanger This type of heat exchanger leverages high-performance gaskets to seal and direct fluid between the plates. The design allows for quick and convenient removal of plates, supporting fast relief, expansion, or deep cleaning to manage fouling or routine maintenance. Gasketed plate heat exchangers are commonly specified in HVAC, district heating and cooling, chemical plants, and food and beverage processing due to their versatility, serviceability, scalability, and overall energy efficiency. When selecting a gasketed plate heat exchanger, important buying factors include plate material compatibility (such as stainless steel or titanium), gasket compound resilience, maximum allowable pressure drop, and ease of disassembly for CIP (clean-in-place) operations. Brazed Plate Heat Exchanger Brazed plate heat exchangers are compact yet highly efficient, with plates permanently bonded using copper or nickel brazing for enhanced corrosion resistance and thermal stability. These heat exchangers are ideally suited for refrigeration systems, hydronic heating, oil cooling, and small-scale process applications where space is limited and maintenance intervals are long. Their all-metal construction enables operation at higher temperatures and pressures compared to gasketed designs. Advantages of brazed plate heat exchangers include: Most widely used for small-to-medium heat transfer duties in refrigeration and process cooling Minimal heat loss to the environment due to compact, efficient design Cost-effective solution for heating, cooling, and heat recovery applications Minimal maintenance requirements due to the absence of gaskets Welded Plate Heat Exchangers Welded plate heat exchangers use plates that are either laser- or spot-welded together, eliminating the need for gaskets and allowing for operation under severe temperatures, elevated pressures, or when handling aggressive, fouling, or abrasive fluids. These plate heat exchangers are prevalent in petrochemical, pulp and paper, power generation, and process industries. However, please note that welded construction can limit mechanical cleaning options; thus, chemical cleaning is often recommended for long-term fouling management. Semi-Welded Plate Heat Exchanger Semi-welded plate heat exchangers combine the benefits of both gasketed and welded designs. Alternating pairs of welded and gasketed plates form channels, making these exchangers well-suited for cooling tasks involving ammonia, aggressive chemicals, or fluids prone to leakage. The hybrid solution eases maintenance procedures on the gasketed side, allowing for regular inspection and cleaning, while the welded side withstands more corrosive or high-pressure media streams. This makes them ideal for demanding process cooling, chemical mixing, or ammonia refrigeration duties. Plate and Frame Heat Exchanger Plate and frame heat exchangers consist of a series of corrugated plates mounted within a rigid frame, optimizing surface area for maximum heat transfer between fluids at controlled pressures. The corrugated design increases turbulence, enhancing wall shear and reducing risk of fouling. These exchangers are common in building services (such as district heating, cooling, or swimming pool heat recovery), food processing, pharmaceuticals, and other critical process industries where hygiene, heat transfer rate, and reliable maintenance are paramount. This heat exchanger features gaskets that both seal and route the working fluids via grooves along the plate edges. Standard plate and frame exchangers are ideal for medium-pressure and moderate-temperature applications, but can be adapted for higher demands by switching to welded or semi-welded versions. Features of plate and frame heat exchangers include: Fast and straightforward assembly, expansion, or disassembly for inspection Customizable flow rates and thermal capacity by changing number or material of plates Premium gasket materials can handle a wide range of fluids and process conditions Maximum design temperature and pressure limited by gasket specification Material selection impacts resistance to corrosion, fouling, and compatibility with cleaning regimens For facility engineers and maintenance professionals, factors such as ease of cleaning, service intervals, and compatibility with CIP (clean-in-place) systems are critical when selecting a plate and frame heat exchanger. Chapter 3: What are the Different Types and Patterns of Plates Used in Plate Heat Exchangers? The key components of plate heat exchangers and their respective functions are crucial for achieving efficient heat transfer in a variety of industrial and commercial applications. Selecting the optimal plate type and surface pattern directly impacts the performance, thermal efficiency, and reliability of a plate heat exchanger—often abbreviated as PHE. Specialized plate designs meet the unique needs of industries ranging from food processing and chemical manufacturing to HVAC, power generation, and more. Types of Plate Element Patterns A single plate heat exchanger can accommodate up to 700 plates. As the plate stack is compressed, the corner holes in each plate form a continuous pathway or manifold, enabling process fluids to move through the plate stack and exit the exchanger. The narrow plate spacings create a network of channels where hot and cold fluids flow alternately, supporting counterflow heat exchange and maximizing temperature differentials. This structure is designed for minimal resistance to heat transfer while accommodating a high surface area to volume ratio. Types of plate element patterns commonly used in modern plate heat exchangers include: Corrugated Pattern The corrugated pattern, known in the industry as a marsh board pattern, features a wave-like design with reduced contact points between plates. This configuration facilitates the undisturbed flow of process fluids containing particulates, fibers, or sludge, minimizing the risks of fouling and blockages. Corrugated plates are often preferred for wastewater treatment, slurry handling, and applications with fibrous or solid-laden fluids, thanks to their ability to withstand challenging operating conditions while maintaining effective heat transfer rates. Herringbone Pattern The herringbone plate pattern is characterized by its distinct V-shaped press grooves, which resemble the bones of a herring fish. This innovative design enhances turbulence and creates a highly efficient, countercurrent flow path for thermal exchange. By alternating the orientation of the V-shaped plates at 180°, multiple contact points are formed, increasing mechanical strength and resistance to elevated pressures. The resulting complex flow pattern leads to excellent heat transfer coefficients and improved thermal performance. Herringbone plate heat exchangers deliver up to three to five times higher efficiency compared to conventional shell and tube heat exchangers (S&T heat exchangers), making them popular choices for HVAC systems, district heating, and demanding industrial processes where energy optimization is vital. Plate Types in Plate Heat Exchangers Modern plate heat exchangers feature several types of heat exchanger plates, each engineered to address specific operating requirements, media characteristics, and industry standards. Below are the principal types of plate heat exchanger plates and their key performance attributes. Condenser/Gas Cooler Characteristics of Condenser Plates The heat transfer measure is about two times more advanced than that of shell & tube heat exchangers. The compacting face is always secured, and the heat transfer rate is superior as condensate is directly drained out. The specialized plate design enables a lower vapor pressure drop compared to conventional plate heat exchangers. TCG (Thermal Chemical Gasket) gaskets are extensively used to permit a wide range of chemical, thermal, and pressure operations. Low maintenance requirements, as the plates can be rapidly disassembled and inspected for cleaning or troubleshooting. The vapor connection port sizes are the same for both inlets and outlets, allowing reliable operation as a cooling condenser for vapor and inert gas applications. Meets various international Pressure Vessel Codes and Standards like ASME, JIS, and CE, ensuring safety and regulatory compliance. Applications for Condenser Plates Exodus condensers for distillation columns and chemical processes Condensers/preheaters for evaporators in refrigeration and HVAC systems Condensers for gas drying and air extraction units Heat recovery exchangers for exhaust gases in energy or manufacturing plants Gas coolers and related thermal management devices Multi Gap Plate Multi Gap Characteristics Wide gap channels up to 10 mm (and channel combinations up to 20 mm) facilitate the smooth transfer of solid-rich fluids and slurries. Offers reliable performance when processing viscous materials, making it ideal for handling slurry, sludge, and fiber-containing media. Extensive use of electrolytic polishing for sanitary and food-grade applications, ensuring product integrity and hygiene. Reduces maintenance time with easy-open gash-in gaskets, promoting fast cleaning and routine inspections. Typical Applications for Multi-Gap Plates Chemical Processing Efficient thermal exchange for liquids with solids, such as PVC (polyvinyl chloride) slurry, latexes, and resins Ideal for fluids of high viscosity or slurry content Dyeing and Textile Industry Handling fluids containing fiber waste, effluents from dyeing or painting equipment Suitable for high viscosity process liquids Food and Beverage Processing Transfers fluids with particulates, such as sauces, juice with pulp, or plant-based wastewater Processes dense mixtures including mayonnaise, gravies, saccharified syrups, and high-solids content solutions Sugar Industry Thermal management of fluids like raw sugar juice or syrup containing suspended solids Pulp and Paper Manufacturing Efficient for handling black liquor, white liquor, and fiber-laden process streams Other Industrial Applications Plating solutions containing sludge, industrial quenching oils High concentration chemicals such as sodium hypochlorite or sodium aluminate Processes with significant variance in flow rates between hot and cold fluid streams Heating for snow melting and thermal management in processing facilities Exclusive Food Application Plate Exclusive Food Application Plate Characteristics Optimized for hygienic processes, the invariant distribution pattern and smoothed shoulder section ensure a gentle, laminar inflow for sensitive food products. Reduced contact points—down to one quarter of conventional designs—lessen risks of fouling, clogs, and scale formation, supporting longer operating intervals and minimal downtime. Streamlined channel geometry and piston flow design reduce product retention and minimize loss during changeover, ideal for high-value food production runs. Minimal dead space inside flow channels and a small hold-up volume lead to improved CIP (Clean-In-Place) cleaning effectiveness, supporting food safety standards. Advanced slit-in TCG gasket technology eliminates contamination from gasket odors, upholds taste and aroma integrity, and enhances product purity when switching between batches. These plates are highly recommended for dairy processes, beverage pasteurization, juice manufacturing, and any food or pharma application where product integrity, shelf life, and safety are paramount, and regulatory compliance is essential. Dual Wall Plate Dual Wall Characteristics The dual wall or double wall design creates a physical barrier between fluids, incorporating an air gap and alternate plate stack to eliminate the risk of cross-contamination if one plate fails. Double-seal gasket technology prevents fluid mixing, ensuring rapid detection and containment of leakage, thus supporting high safety standards in critical process environments. Applications for Dual Wall Plates Cooling of transformer oil or specialized lubricants where mixing with water could cause hazardous reactions Thermal management for lubrication or hydraulic oils to protect sensitive bearings, rotors, and hydraulic systems Contamination prevention in food, beverage, and pharmaceutical manufacturing Energy fluid (e.g., marine gas oil or MGO) thermal conditioning where pulsation fatigue may occur Bioprocess and chemical industries where accidental mixing could result in significant environmental, safety, or compliance issues Critical chemical processes where intermixing of streams would lead to unintended reactions or pollutant generation Double-Lined Gasket Plate Double Line Gasket Characteristics The double-gasket line design protects the inner gasket from oxidation by sealing it from the outside air, supporting extended performance in challenging operating conditions. Contains any possible leaks, ensuring that fluids remain isolated even if the inner gasket fails. Enhanced gasket compounds and groove geometry deliver superior heat and pressure resistance, extending gasket longevity and maintaining seal integrity even at high temperatures (up to 250°C) and pressures (up to 9.5MPa). Reinforced design ensures five times the service life compared to conventional plate heat exchanger gaskets. Double-Lined Plate Applications High temperature, high pressure plate heat exchangers for industrial processes and heavy-duty boiler circuits Shell-and-tube replacement applications in conventional and nuclear power plants Safe handling of hazardous or flammable thermal fluids, including those requiring robust containment and leak prevention Semi-Welded Plate Semi-Welded Plate Characteristics Comprises pairs of plates laser-welded together with O-ring sealing at the port holes, supporting both aggressive and refrigerant media applications. Allows modular disassembly for thorough cleaning of individual plates and channels. The laser-welded cassette configuration is designed for high pressure service, compatibility with Freon refrigerants, and superior corrosion resistance against media attacking standard synthetic gaskets. Available with high-performance ring gaskets, including synthetic rubber and PTFE (TCG) for robust chemical resistance and temperature stability. Semi-Welded Plate Applications Thermal management of corrosive fluids that would degrade conventional rubber gaskets Heat transfer for hazardous media, such as sulphuric acid, in chemical production and processing Applications subject to high thermal or mechanical loads, exceeding the limits of standard plate heat exchangers Refrigeration cycles, especially where operating with aggressive or high-pressure refrigerants—ensuring reliability in demanding HVAC and process cooling setups Choosing the best plate pattern and plate type for your unique process conditions—fluid characteristics, operating temperature and pressure, service media, and required hygienic or safety standards—will ensure optimal heat transfer efficiency, equipment longevity, and cost-effectiveness. Consulting an experienced heat exchanger supplier or manufacturer will help in specifying the right plate heat exchanger solution, tailored to your industry and processing needs. Chapter 4: What are the applications, advantages, and maintenance considerations of plate heat exchangers? This chapter will cover the applications, benefits, and maintenance of plate heat exchangers. Applications of Plate Heat Exchangers Plate heat exchangers are used in the following applications: Heat Pump Isolation Mash Coolers Glycol Coolers Cooling Tower Isolation Lube Oil Coolers Batch Heating and Cooling Free Cooling Heat Recovery Interchangers Process Heating and Cooling Water Heaters Waste and Recovery Advantages of Plate Heat Exchangers Although plate heat exchangers may have some drawbacks, such as high pressure drops and limitations on operating temperature due to the heat resistance of the sealing materials, their advantages often outweigh these issues. Some benefits of plate heat exchangers include: The plate heat exchanger’s design is more user friendly These types of heat exchangers have a large heat transfer rate than the Shell and Tube heat exchangers The exchanger does not need extra space for disassembly They have simple maintenance and cleaning The plate heat exchangers are smaller than the Shell and Tube heat exchangers. They have a small fouling factor It has easy repairing and washing These exchangers have low installation costs Maintenance of a Plate Heat Exchanger The following steps outline the general maintenance procedures for a plate heat exchanger: Pre-Teardown of a Plate Heat Exchanger The initial step is to disassemble the plate heat exchanger. Procedure for opening: Shut down the heat exchanger close the faucets Drain the heat exchanger Strike pipes from the pressure plate Check the sliding shells of the carrying bar The outside of the plate assembly must be marked by a slant line Measure and note the dimension Remove the locking bolts Use the tensing bolts to open the heat exchanger. Always use the same tightening confines when you remove and place back the plates in the heat exchanger Cleaning Heat Exchanger Plates The plates are suitable for both manual cleaning and cleaning-in-place (CIP) procedures. Before disassembly, ensure that the unit is fully de-pressurized, locked out, and drained. Manual cleaning generally involves washing the plates with a mild detergent, water, and a non-abrasive cloth. To prevent bending, it's advisable to clean the plates on a flat surface. When reassembling, especially if the heat exchanger has been heavily fouled, make sure to remove all debris from the gasket sealing surfaces. Steps for Cleaning-in-Place (CIP): Open the unit Clean each plate independently No way use a steel wool or a steel brush Don't scratch the gasket shells Wash each plate with clean water (free from swab, Sulfur, chlorine or high iron attention) Use high pressure wash Always wipe the gaskets clean Wipe off the lovemaking face Examination and installation of each plate and after that the unit may be closed Procedure for Cleaning-in-Place (CIP): Drain both sides of the unit. Use warm water to flush the unit on both sides. Drain the water used during flashing from the unit and connect CIP pump Wash with warm water or warm water with quieter at outside inflow rate-the cleaning works best in the rear direction of normal inflow. Flush completely with clean water after CIP cleaning. Caution, Don't use chlorine or chlorinated water to clean the pristine sword. Don't use phosphoric or sulfamic acid for drawing titanium plates. Testing Heat Exchanger Plates During the inspection, it’s crucial to examine the plates for any cracks or perforations. Start with a visual inspection of the heat exchanger plates, paying special attention to areas where the plates make contact with each other. Perforations are often found at these contact points. To aid in the inspection, use a light to help identify potential issues. However, note that visual and light inspections may not uncover all defects in the heat exchanger plates. Gasket Installation After testing the gasket plates, proceed with their installation. Mechanical professionals should attach the gaskets to the plates. Ensure the gasket grooves are clean and free from debris. The flow paths can be either parallel or diagonal, depending on the plate model. Refer to the technical drawings in your plate manual for detailed guidance on the flow paths. Verification Ensure that each unit is operating correctly. Conclusion It has been seen that the PHE offers numerous advantages over other types of heat exchangers. However there is a variety of plate heat exchangers that are suitable in different applications and each having its own advantages and disadvantages. Therefore one must be aware of the specifications when choosing a heat exchanger for a particular application. The PHE must be generally well maintained for a long lasting life. Heat exchanger that uses metal plates to transfer heat between two fluids A plate heat exchanger is a type of heat exchanger that uses metal plates to transfer heat between two fluids. This has a major advantage over a conventional heat exchanger in that the fluids are exposed to a much larger surface area because the fluids are spread out over the plates. This facilitates the transfer of heat, and greatly increases the speed of the temperature change. Plate heat exchangers are now common and very small brazed versions are used in the hot-water sections of millions of combination boilers. The high heat transfer efficiency for such a small physical size has increased the domestic hot water (DHW) flowrate of combination boilers. The small plate heat exchanger has made a great impact in domestic heating and hot-water. Larger commercial versions use gaskets between the plates, whereas smaller versions tend to be brazed. The concept behind a heat exchanger is the use of pipes or other containment vessels to heat or cool one fluid by transferring heat between it and another fluid. In most cases, the exchanger consists of a coiled pipe containing one fluid that passes through a chamber containing another fluid. The walls of the pipe are usually made of metal, or another substance with a high thermal conductivity, to facilitate the interchange, whereas the outer casing of the larger chamber is made of a plastic or coated with thermal insulation, to discourage heat from escaping from the exchanger. The world's first commercially viable plate heat exchanger (PHE) was invented by Dr Richard Seligman in 1923 and revolutionized methods of indirect heating and cooling of fluids. Dr Richard Seligman founded APV in 1910 as the Aluminum Plant & Vessel Company Limited, a specialist fabricating firm supplying welded vessels to the brewery and vegetable oil trades. Also, it set the norm for today's computer-designed thin metal plate Heat Exchangers that are used all over the world.[1] Schematic conceptual diagram of a plate and frame heat exchanger. An individual plate for a heat exchanger The plate heat exchanger (PHE) is a specialized design well suited to transferring heat between medium- and low-pressure fluids. Welded, semi-welded and brazed heat exchangers are used for heat exchange between high-pressure fluids or where a more compact product is required. In place of a pipe passing through a chamber, there are instead two alternating chambers, usually thin in depth, separated at their largest surface by a corrugated metal plate. The plates used in a plate and frame heat exchanger are obtained by one piece pressing of metal plates. Stainless steel is a commonly used metal for the plates because of its ability to withstand high temperatures, its strength, and its corrosion resistance. The plates are often spaced by rubber sealing gaskets which are cemented into a section around the edge of the plates. The plates are pressed to form troughs at right angles to the direction of flow of the liquid which runs through the channels in the heat exchanger. These troughs are arranged so that they interlink with the other plates which forms the channel with gaps of 1.3–1.5 mm between the plates. The plates are compressed together in a rigid frame to form an arrangement of parallel flow channels with alternating hot and cold fluids. The plates produce an extremely large surface area, which allows for the fastest possible transfer. Making each chamber thin ensures that the majority of the volume of the liquid contacts the plate, again aiding exchange. The troughs also create and maintain a turbulent flow in the liquid to maximize heat transfer in the exchanger. A high degree of turbulence can be obtained at low flow rates and high heat transfer coefficient can then be achieved. As compared to shell and tube heat exchangers, the temperature approach (the smallest difference between the temperatures of the cold and hot streams) in a plate heat exchangers may be as low as 1 °C whereas shell and tube heat exchangers require an approach of 5 °C or more. For the same amount of heat exchanged, the size of the plate heat exchanger is smaller, because of the large heat transfer area afforded by the plates (the large area through which heat can travel). Increase and reduction of the heat transfer area is simple in a plate heat-exchanger, through the addition or removal of plates from the stack. Partially dismantled exchanger, with visible plates and gaskets All plate heat exchangers look similar on the outside. The difference lies on the inside, in the details of the plate design and the sealing technologies used. Hence, when evaluating a plate heat exchanger, it is very important not only to explore the details of the product being supplied but also to analyze the level of research and development carried out by the manufacturer and the post-commissioning service and spare parts availability. An important aspect to take into account when evaluating a heat exchanger are the forms of corrugation within the heat exchanger. There are two types: intermating and chevron corrugations. In general, greater heat transfer enhancement is produced from chevrons for a given increase in pressure drop and are more commonly used than intermating corrugations.[2] There are so many different ways of modifications to increase heat exchangers efficiency that it is extremely doubtful that any of them will be supported by a commercial simulator. In addition, some proprietary data can never be released from the heat transfer enhancement manufacturers. However, it does not mean that any of the pre-measurements for emerging technology are not accomplish by the engineers. Context information on several different forms of changes to heat exchangers is given below. The main objective of having a cost benefit heat exchanger compared to the usage of a traditional heat exchanger must always be fulfilled by heat exchanger enhancement. Fouling capacity, reliability and safety are other considerations that should be tackled. First is Periodic Cleaning. Periodic cleaning (on-site cleaning) is the most efficient method to flush out all the waste and dirt that over time decreases the efficiency of the heat exchanger. This approach requires both sides of the PHE (Plate Heat Exchanger) to be drained, followed by its isolation from the fluid in the system. From both sides, water should be flushed out until it runs completely clear. The flushing should be carried out in the opposite direction to regular operations for the best results. Once it is done, it is then time to use a circular pump and a solution tank to pass on a cleaning agent while ensuring that the agent is compatible with the PHE (Plate Heat Exchanger) gaskets and plates. Lastly, until the discharge stream runs clear, the system should be flushed with water again. To achieve improvement in PHEs, two important factors have to be considered, namely the amount of heat transfer and pressure drop, such that the amount of heat transfer needs to be increased and pressure drops need to be decreased. In plate heat exchangers, due to the presence of corrugated plate, there is a significant resistance to flow with high friction loss. Thus to design plate heat exchangers, one should consider both factors. For various ranges of Reynolds numbers, many correlations and chevron angles for plate heat exchangers exist. The plate geometry is one of the most important factors in heat transfer and pressure drop in plate heat exchangers; however, such a feature is not accurately prescribed. In the corrugated plate heat exchangers, because of narrow paths between the plates, there is a large pressure capacity and the flow becomes turbulent along the path. Therefore, it requires more pumping power than the other types of heat exchangers. Therefore, higher heat transfer and less pressure drop are targeted. The shape of plate heat exchanger is very important for industrial applications that are affected by pressure drop.[citation needed] Design calculations of a plate heat exchanger include flow distribution and pressure drop and heat transfer. The former is an issue of Flow distribution in manifolds.[3] A layout configuration of plate heat exchanger can be usually simplified into a manifold system with two manifold headers for dividing and combining fluids, which can be categorized into U-type and Z-type arrangement according to flow direction in the headers, as shown in manifold arrangement. Bassiouny and Martin developed the previous theory of design.[4][5] In recent years Wang [6][7] unified all the main existing models and developed a most completed theory and design tool. The total rate of heat transfer between the hot and cold fluids passing through a plate heat exchanger may be expressed as: $Q = UA\Delta T_m$ where U is the Overall heat transfer coefficient, A is the total plate area, and ΔT_m is the Log mean temperature difference. U is dependent upon the heat transfer coefficients in the hot and cold streams.[2] Manifold arrangement for flow distribution Their cleaning helps to avoid fouling and scaling without the heat exchanger needing to be shut down or operations disrupted. In order to avoid heat exchanger performance to decrease and service life of the tube extension, the OnC (Online Cleaning) can be used as a standalone approach or in conjunction with chemical treatment. The re-circulating ball type system and the brush and basket system are some of OnC techniques. OfC (Offline Cleaning) is another effective cleaning method that effectively increases the performance of heat exchangers and decreases operating expenses. This method, also known as pigging, uses a shape like bullet device that is inserted in each tube and using high air pressure to force down the tube. Chemical washing, hydro-blasting and hydro-lancing are other widely used methods other than OfC. Both these techniques, when used frequently, will restore the exchanger into its optimum efficiency until the fouling and scaling begin to slip slowly and adversely affecting the efficiency of the heat exchanger. Operation and maintenance cost is necessary for a heat exchanger. But there are different ways to minimize the cost. Firstly, cost can be minimized by reducing fouling formation on heat exchanger that decreases the overall heat transfer coefficient. According to analysis estimated, effect of fouling formation will generate a huge cost of operational losses which more than 4 billion dollars. The total fouling cost including capital cost, energy cost, maintenance cost and cost of profit loss. Chemical fouling inhibitors is one of the fouling control method. For example, acrylic acid/hydroxypropyl acrylate (AA/HPA) and acrylic acid/sulfonic acid (AA/SA) copolymers can be used to inhibit the fouling by deposition of calcium phosphate. Next, deposition of fouling can also be reduced by installing the heat exchanger vertically as the gravitational force pulls any of the particles away from the heat transfer surface in the heat exchanger. Second, operation cost can be minimized when saturated steam is used compared to superheated steam as a fluid. Superheated steam acts as an insulator and poor heat conductor, it is not suitable for heat application such as heat exchanger. Plate fin heat exchanger Heat transfer LMTD ^ "Plate Heat Exchangers". Techtrans Engineers. 19 February 2022. ^ a b Hewitt, G (1994). Process Heat Transfer. CRC Press. ^ Wang, J.Y. (2011). "Theory of flow distribution in manifolds". Chemical Engineering J. 168 (3): 1331–1345. doi:10.1016/j.cej.2011.02.050. ^ Bassiouny, M.K.; Martin, H. (1984). "Flow distribution and pressure drop in plate heat exchanges. Part I. U-Type arrangement". Chem. Eng. Sci. 39 (4): 693–700. doi:10.1016/0009-2509(84)80176-1. ^ Bassiouny, M.K.; Martin, H. (1984). 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Butterworth Heinemann. ISBN 978-0-7506-4444-0. Wikimedia Commons has media related to Plate and frame heat exchangers. A list of published articles pertaining to plate heat exchangers A screening method for the optimal selection of plate heat exchanger configurations by J.M.Pinto and J.A.W.Gut, University of São Paulo, Brazil. Seeking the optimal design of a typical plate heat exchanger (PHE) by Athanasios G. Kanaris, Aikaterini A. Mouza and Spiros V. Paras, Aristotle University of Thessaloniki. Retrieved from " Plate heat exchangers are available in a variety of models. Let’s look at the principal heat exchanger designs:Brazed Plate Heat ExchangersCompact and with high power efficiency, brazed plate heat exchangers are a common inclusion in hot water systems, industrial and refrigeration equipment. Brazing is a process like soldering in which two pieces of metal are joined by melting a third metal onto the join and baking this into place. Brazed plate heat exchangers normally feature stainless steel brazed by copper or nickel, making them highly resistant to corrosion.Brazed plate heat exchangers cannot be opened. Cleaning is conducted by flushing the device with a suitable cleaning agent.Gasketed Plate Heat ExchangerGasketed plate heat exchangers feature rubber gaskets between the transfer plates. These create watertight seals and control flow rates. These larger, higher capacity models are standard equipment in food and drink production and heating, process engineering and HVAC systems.The gasket seals mean that these devices are easy to disassemble for maintenance and cleaning. Additional plates can also be added to increase the capacity and thermal flow of the device.Plate-Fin Heat ExchangerPlate-fin heat exchangers feature finned chambers alongside the heat transfer plates, the latter typically made from aluminium. These models are usually more compact than other plate heat exchangers but still offer a large heat transfer surface area.Plate fin heat exchangers, also known as plate-fin and tube exchangers, are favoured in industries that require lightweight heat transfer equipment. Examples include aerospace, vehicle engineering and cryogenic chemical processing.Welded Plate Heat ExchangerWelded plate and frame heat exchangers feature plates that have been welded together into a single block. This makes maintenance more difficult and means that the capacity of the devices is fixed because additional transfer plates cannot be added. However, it also makes welded plate heat exchangers highly durable - they can withstand corrosive fluids, high temperatures, and pressures. As a result, they are widely used in heavy industry - you will find them in oil refineries, gas extraction plants, power stations and similar locations.Semi-welded plate heat exchangers are a variant model, combining welded and gasketed plates. Welded plate sets are connected via gaskets to other sets. Therefore, the fluid channels through this device alternate between gasketed and welded seals. This allows hot fluid and corrosive liquids to be directed to one side while servicing is conducted on the other. Heat Exchanger Types of Heat Exchanger: Definition, Parts and Application :-Heat exchangers are mainly used for transferring of heat from one fluid to another fluid with indirect contact between them. Heat exchangers design is essential for their high efficiency. Heat exchanger is a very essential industrial device therefore it is very important that we should know the parts of the heat exchanger. Heat exchanger has various parts which are assembled together for a efficient heat exchanger. There are various parts of heat exchanger having different advantage as well as disadvantage. Instead all of this we are going to discuss different parts of heat exchanger and their functions. On the basis of design characteristics, heat exchangers are categorized in numerous categories. Most common types of heat exchanger are given below: Tube and Shell Heat Exchanger Shell and tube heat exchangers are the very common type of heat exchangers among all others. They are usually constructed from series or a parallel tube which is also known as tube bundle or a single tube which are enclosed under cylindrical pressure vessel which are sealed. Shell and tube exchangers are designed in such a way that one fluid flows within small tube provided in the heat exchanger while the other fluids flows at the outside in between them under sealed shell. There are various of other parameters for the designing of shell and tube heat exchanger such as single or two phase heat transfer, finned tubes, crossflow arrangements or concurrent flow, counter current flow and multiple, single or two pass configurations. In some shell and tube heat exchangers have double pipe heat exchangers and helical coil heat exchangers. Power generation Oil cooling Marine applications Refrigeration Pharmaceuticals Metals and mining Pulp and paper industries Plate Heat Exchanger Plate heat exchangers are also known as plate type heat exchangers. Plate heat exchangers are made up of several corrugated, thin plates which are bundled with each other. Pair of plates make channel by which flow of fluid takes place and the pairs of plates are being attached and stacked with the help of brazing, bolting or welding in such a way that another passage is created within the pairs by which another fluid flow. The standard design of the plate is also found with variations like pillow plate heat exchangers or plate fin exchangers. In plate fin exchangers, multiple flow configurations are provided by using a spacer or fin in between the plates. In this case more than two fluids are able to pass by the device while the pillow plate heat exchangers exert pressure on plate which results in increasing the efficiency of heat transfer across the surface of plate. In this category there are some other types of exchangers available which are plate and shell, plate and frame and spiral plate heat exchangers. Geothermal applications Heat pump system Pressure interceptor Diesel engine cooling Heat recovery Double Pipe Heat Exchanger Double pipe heat exchangers are in the form of shell and tube type of heat exchanger. The design and configuration of the double pipe heat exchangers are very simple in which there are two or more cylindrical pipes or tubes (one small tube while the second one is the larger tube) which are concentric. In two concentric cylindrical tubes or pipe, fluid flow within one pipe while the other fluid flows in the larger tube around the smaller tube. The double pipe heat exchangers have the design characteristics of indirect contact types and recuperative as stated earlier that fluids flow are separate and they flow within own channels along the process of heat transfer. In the design of double pipe heat exchangers, some flexibility is provided to them such as their design may have counter current flow or concurrent flow arrangements and they can be used in parallel, series, or series – parallel configurations in a system. Petroleum refining Refrigeration Sewage treatment Heating and cooling in engineering systems Compressors and boilers because they have very high pressure and temperature. Evaporators, condensers and boilers are heat exchangers which use the mechanism of two phase heat transfer. In case of a two phase heat exchanger the phase of one or more than one fluids are changed at the process of heat transfer which can be either changing from gas to liquid or a liquid to gas. Operation of steam engines and turbines Reciprocating pumps operations Thermal power stations Industrial process work Automotive Refrigeration Steam power turbine Pharmaceuticals Foods and beverages Resins and polymers Paper and pulp industry Condensers are defined as those heat exchanging devices which are used to take vapor or gas (which is heated) and cool them to their condensation point which results in changing of vapor or gas into liquid form. In case of boilers and evaporators, the process of heat transfer changes the fluids from liquid state to gaseous state. Heat exchangers are used for various of different applications in various of industries. Therefore, some heat exchangers variants are used which is suitable for particular type of specification and requirement of application such as fan cooled heat exchangers, air cooled heat exchangers and adiabatic wheel heat exchangers. Different heat exchanger parts are: Heat exchanger tubes are one of the very essential part of heat exchanger which is used for transferring the liquids. These tubes are generally seamless or welded but welded are highly economical in comparison with the seamless. The diameter of heat exchanger tubes are generally 1 inch, 0.75 inch and 0.625 inch but some heat exchanger tubes have smaller diameters but the cleaning of small diameter tubes are very problematic. Large diameter heat exchanger tubes are used for achieving low pressure drop. Supplements like twisted tapes are provided with some tubes for enhancing the process of heat transferring at the time when we are dealing with laminar flow condition of the fluids. Generally all the heat exchanger tubes are bundled and are kept in a casing or a shell. Heat exchanger tubes are generally made up of zirconium, nickel alloys, titanium and stainless steel and these materials are suitable for all types of heat exchanger applications of re-heaters, heaters, evaporators, coolers and condensers. From front header the fluid enters in the heat exchanger and the rear header is exit before the entrance of fluid from front header for passing it through tubes for various times. Front header is also known as stationary header. Front header are of various types such as A type, B type, C type, D type, N type, Y type. They are generally fixed type and on the basis of flow pressures, repair and ease of cleaning their application varies. Generally B type of front header is cheaper than A type front header and type B are used for high pressure but A type front header can repair easily. C type and D type front header are used for pressures which is more than 100 bar. N type front header are accessed without creating any disturbance to the system and Y type front header are cheapest and can be directly installed to the pipeline. There are two main rear headers floating and fixed. For standard types of services fixed types are preferred which have N type, L type and M type and they are used when high mechanical stress are not developed. Fixed rear head with bellow are used when thermal expansion is expected to occur. Fixed rear head is used when pressure does not exceed 35 bar, the shell do not require cleaning and the fluid is not dangerous. For overcoming the problem of thermal expansion as well as facilitate cleaning of bundle by its removal a U tube rear header are used. When thermal expansion is must to provide then a S type header are used and it is a floating type. It is essential to reach out both the side of exchanger for cleaning it. Type T header are also a floating header which is simple for extracting the bundle as well as cheap in comparison with type S. Type T provide thermal expansion unrestrictedly. Air cooling system of a heat exchanger has chillers, condensers and fin fans. Fin fans are design in such a way that they can blow over hot tubes for keeping them cool very efficiently. Condenser is used for cooling the object till the changing of phase from gaseous to liquid. Chillers use water as a coolant for cooling and lowering the temperature of water which results in cooling the device. Transfer line exchangers are used to cool down hot gases quickly. Transfer line exchanger’s design is based on the pattern of heat exchanger tubing but for efficient work they require special design. With the help of welded or flange junction transfer line exchangers join radiating coil outlets. They need internal insulation especially for those regions which is exposed to the hot gases and these gases are not cooled with water. On the side of shell baffles are mounted for supplying high heat transfer rate by increasing the flow turbulence. Baffles help in supporting the tube as well as they decrease the vibration problem. Baffles are generally installed with several of arrangements like most common single segmental, double segmental. Baffle pitch are the centre to centre distance between the baffles. Baffles are also used for vary cross flow velocity. Generally baffle pitch are less than shell’s inside diameter or can be lesser than 20 percent of diameter. Baffle window or baffle cut size is considered with baffle pitch. Baffle window size are fully dependent on the type of baffle but generally taken as 45 percent for single segmental type and 25 percent for double segmental type. There are various type of baffle based on uses, cost and size. Single segmental baffles Double segmental baffles Longitudinal flow baffles: These are used when there are two pass shells. Generally there are two baffle which serves as longitudinal baffle: Rod baffle and orifice baffle. In these baffles turbulence are generated by the flow of fluid through the baffle. Impingement baffle: These valves are used to maintain the bundle at the time of high entry velocity. Detuning baffles or de-resonating baffle which is used for decreasing the vibration of tube. Blanking baffles or support baffles In heat exchanger shell one fluid flows inside the shell and the other fluid flows inside the tubes. Heat exchanger shells are large pressure vessel and pipe bundles are placed inside the heat exchanger shell. Heat exchanger shells are the most expensive part of heat exchanger. Generally low pressure fluid flow in the heat exchanger shell while the high pressure fluid flow in the tubes. The relief valves or rupture discs are used by the heat exchanger shell to maintain for high pressures. The shell diameter is dependent on the tube bundle’s diameter. Generally standard pipes are used for heat exchanger shell of diameter less than 24 inches and for shell diameter more than 24 inches rolled plate are used. Generally the diameter of shell is in between 6 inches to 120 inches. Heat exchanger tie rods are very essential part of heat exchanger. Tie rods are secured by the tube sheet at one end and by last baffle at the other end. Heat exchanger tube sheets are used for supporting and isolating the tubes. Heat exchanger tube sheets are connected with tube sheet with applying roller expansion or by hydraulic pressure. The tube sheet is generally covered with the clad which resist the corrosion and act as a insulator. Nozzles are provided for both tube side and the fluids shell side, two for outlet and two for the inlet. Spacers are used for keeping the baffles at their position and for avoiding the vibration and they are fixed on the tie rod. These plate are placed at the head which guide the path to fluid in more than one pass heat exchangers. Whenever high temperature variation is provided to the heat exchanger then expansion joints are very essential. Expansion joint can prevent the contraction and expansion of heat exchanger which can prevent shell cracking. Image Source :- thermofin Plate heat exchangers are one of the most common types of heat exchanger employed today; the other common type of heat exchanger is the shell and tube heat exchanger. The spiral heat exchanger is also used for industrial applications, but its use is minor compared to the other two types of heat exchanger. Plate heat exchangers have gained widespread application throughout the engineering world because they are efficient, robust, and relatively easy to maintain. Assembled Plate Heat Exchanger Plate Heat Exchanger (PHE) Components Plate heat exchangers consist of relatively few parts. Because plate heat exchangers are used for transferring heat, they require inlets and outlets where the flowing mediums -or fluids- can enter and leave the heat exchanger. A fluid may be a liquid or a gas. As fluids are often assumed to be liquid only, we will use the term flowing medium to avoid confusion. Plate Heat Exchanger (Exploded View) Gaskets and plates are used to separate the flowing mediums and prevent them mixing; gaskets are adhered to one side of each plate only. The plates hang upon a carry bar and are pressed together using clamping bolts. When the plates are compressed together, they are referred to as a ‘plate stack’. A guide bar ensures the plates are aligned correctly when the plate stack is opened and closed. Plate Heat Exchanger Components The final components of interest are the two covers at opposite ends of the plate stack. One cover is movable whilst the other is fixed. The movable cover and fixed cover are also sometimes referred to as the frame plate and pressure plate. Note that the inlets and outlets are mounted to the fixed cover only. Enjoying this article? Then be sure to check out our Introduction to Heat Exchangers Video Course and Plate Heat Exchanger Fundamentals Video Course. Each course has a quiz, handbook, and you will receive a certificate when you finish the course. Enjoy! How Plate Heat Exchangers Work The below video is an extract from our Heat Exchangers Online Video Course. Throughout this article, we will assume a hypothetical plate heat exchanger has two flowing mediums, one is cold and the other is hot. The hot medium needs to be cooled by the cold medium, and this will occur in the plate heat exchanger. The hot medium enters the heat exchanger through the hot medium inlet. Gaskets direct the hot medium as it flows through the heat exchanger. Each plate has an alternating gasket pattern. The hot medium flows into the space between a pair of plates, but does not flow into the space between the next pair of plates because the gaskets prevent this. The process continues so that each second set of plates is filled with the hot flowing medium. Plate Heat Exchanger Plate Gaskets At the same time, the cold medium enters the heat exchanger through the cold medium inlet, but this time, the gaskets are positioned to allow the cold medium to flow into the space where no hot medium is present. The heat exchanger is now full of both hot and cold flowing mediums. Each medium flows out of its associated outlet and the process is continuous. Notice that the two flowing mediums are always adjacent to each other throughout the heat exchanger. The flowing mediums thus have a hot, cold, hot, cold, flow pattern, as they flow through the heat exchanger. Both flowing mediums are completely separated from each other by the gaskets and plates, they do not mix. Alternating Cold/Hot Pattern Due to the close proximity of the flowing mediums, heat is exchanged between them. The hot medium heats-up the plate and the plate passes some of this heat to the cold flowing medium; thus the hot medium temperature decreases whilst the cold medium temperature increases. Plate Heat Exchanger Design The plates are the main reason plate heat exchangers are so efficient. The plates on a plate heat exchanger may appear to have a simple design, but each plate is full of interesting engineering design features. For example: When the plates are compressed together to form a plate stack, the gap between each of the plates is very small, which ensures good thermal contact between the two flowing mediums. The gap between the plates is also known as ‘clearance’. Plates are thin and have a large contact surface area, which gives each plate a high heat transfer rate. Plates are manufactured from a material with high thermal conductivity, which further increases the heat transfer rate. Corrugations on the plate surfaces prevent laminar flow and promote turbulent flow, which increases the heat transfer rate whilst also reducing the likelihood of deposits accumulating upon the plate surfaces. The corrugations also serve to stiffen the plate structure, which allows a thinner plate to be used compared to a plate that has no corrugations. Note that plate corrugations are sometimes referred to as having a ‘herringbone’ pattern. Corrugated Herringbone Pattern The plates are not the only part of a plate heat exchanger with extensive design features, the gaskets also have interesting design features: Gaskets are able to maintain a seal between the plates even when the system pressure and temperature varies. Holes in each gasket -known as telltales- are used to identify leaking gaskets. This feature allows operators to change the affected plate before the leaking medium leaks through the next gasket and contaminates the other flowing medium. Plate Heat Exchanger Telltale Because the gaskets guide flow through the heat exchanger, it is essential they be installed in the correct order. For this reason, gaskets are often fitted with markings so that operators can check each plate is installed in the correct order throughout the entire plate stack. Another way of ensuring the order of the plate stack is correct, is to spray paint a diagonal line across the entire plate stack when it is assembled. Plate Stack with Diagonal Line Although we have only shown two gasket designs so far in this article, there are three! Gaskets alternate throughout the heat exchanger except for the first and last plates within the plate stack, which press against the fixed and movable covers. Plates that press against the fixed and movable covers are known as start and end plates, because of their position within the plate stack. The purpose of the start and end plates is to prevent flow into the space between the fixed cover and start plate, and to prevent flow into the space between the movable cover and end plate. In this way, the covers are not actively used to exchange heat; this makes sense as the covers are quite thick, do not have corrugations and are poorly suited to exchange heat. Plate Gaskets (end plate gasket shown on the right) Varying the Cooling Capacity There are several ways to vary the cooling capacity of a plate heat exchanger: Regulate the outlet valves so that the flow is increased or decreased; this method is useful because no dismantling of the heat exchanger occurs. Do not throttle/regulate the inlet valves as this may starve the heat exchanger and cause localised overheating. Increase or decrease the number of plates in the plate stack. Increasing the number of plates in the plate stack gives a corresponding increase in cooling capacity. Decreasing the number of plates in the plate stack gives a corresponding decrease in cooling capacity. In short, more plates equals more cooling capacity and less plates equals less cooling capacity. Use a single pass or multi-pass design. Single pass heat exchangers allow the two flowing mediums to flow past each other only once. Multi-pass heat exchangers allow the flowing mediums to flow past each other several times. Most plate heat exchangers use the single pass design. Single and Multi-Pass Design Flow Types Flow through a plate heat exchanger may be parallel, cross or counter. Plate heat exchangers usually use counter flow as this is the most efficient type of flow for heat transfer. Counter flow is sometimes known as contra flow. Parallel, Counter and Cross Flow Design Considerations for Plates Because plate heat exchangers are used for wide ranging applications, they must be designed to withstand the process conditions in which they operate, this may include corrosive and erosive environments. Its possible to construct plate heat exchangers from various materials, including metals, alloys and plastics. Different materials make the plate heat exchanger more suitable for different applications. For example, if a particular flowing medium reacts aggressively when coming into contact with certain metals, polymer-based materials such as Teflon may be used instead. Plate Heat Exchanger Advantages There are numerous advantages associated with plate heat exchangers: Plate heat exchangers weigh less, require less space and are more efficient compared to other heat exchanger designs of the same size. Replacing and cleaning of the plates is a simple task because the plate stack can be opened easily. And unlike shell and tube heat exchangers, plate heat exchangers do not require additional space for dismantling. Plate Heat Exchanger Disadvantages But there are also some disadvantages associated with plate heat exchangers: Plate heat exchangers tend to be more expensive than other heat exchanger designs. If there is a leaking gasket causing one flowing medium to mix with the other, the leaking plate is often difficult to locate. Replacement of plate gaskets in-situ can be difficult, or impossible. Some plate gaskets must be returned to the manufacturer for replacement, which costs both time and money. When the plates are compressed together to form a plate stack, the clearance between each of the plates is small, this increases the likelihood of fouling with a corresponding reduction in heat transfer. When reassembling the plate stack, over-tightening the clamping bolts can lead to crushing of the plates, which damages the plate corrugations and squeezes-out the gaskets. If the gaskets are squeezed-out, the plate will no longer seal correctly. Plate heat exchangers are not suitable for high pressure applications because the gaskets would be expelled by the system pressure; this situation is referred to as ‘gasket blow-out’. However, it is possible to get around this problem by using a gasket-less design; these designs usually use brazed or welded plates. Brazed and welded plate heat exchangers are more suitable for higher temperature and higher pressure applications, but also for applications where leakage would be hazardous/catastrophic e.g. toxic or poisonous flowing mediums. Additional Resources The primary purpose of heat exchangers are to transfer thermal energy from one fluid to another fluid without the mixture of the fluids; i.e. the fluids are separated. Typically this is used when one loop is connected to a boiler/chiller and another loop is connected to a heat rejection system such as an evaporative cooling tower. The concept of fluids not being mixed allows for different types of fluids to transfer thermal energy, i.e. glycol & water. Figure 1 below displays an assembled plate & frame heat exchanger. Figure 1: Tranter Branded Plate & Frame Heat Exchanger Below are some of the key advantages of plate heat exchangers: Very compact Very efficient Low maintenance & service required Varying demand can be accomplished Plate & frame heat exchangers are comprised of a front & back cover which can be referred to as a frame, a plethora of plates in between as well as gaskets, and tightening bolts assembled with nuts to hold the heat exchanger together. Figure 2 below depicts the blown out assembly of this type of heat exchanger. Figure 2: Blown out assembly of the plate & frame heat exchangers The front covers are typically made of some form of mild steel as they are meant to be extremely strong in order to hold everything together. The nuts sit on the tightening bolts which run through the entire length of the heat exchanger which will compress the plates & gaskets together very tightly, making the heat exchanger leak proof. The plates is where the heat transfer occurs and the gaskets allow for the fluid to not leak. Larger heat exchangers will come with large supporting bars that are assembled along the top and the bottom in order to hold the frames & plates together. In smaller heat exchangers, since they are assembled with the tightening bolts only, the frame

& plates can easily be removed by sliding it out. The plates themselves are usually made of some form of steel or titanium with a groove/pattern designed and/or stamped onto them as portrayed in figure 3. These patterns are incredibly thin but strengthen the plate. They also allow for an increase of heat transfer as the surface area increases as well as creating a rough and turbulent flow. The gaskets are typically made of a type of rubber that allows the prevention of leaks. These gaskets fit in between the plates and also are designed with the grooved pattern. These gaskets allow one type of fluid to travel through the plates/sheets but prevent other types of fluids from travelling through that sheet. Figure 3: Zoomed in image displaying the plate & it's grooved patterns A key advantage of plate & frame heat exchangers is that they can be increased in size (or decreased) in order to match the demand. This is able to be completed due to the extended length of the tightening bolts. With any extra length on the tightening bolts, one may simply add on more plates that can slide along and be completely tightened with the frame & nuts. This ability of simply adding more plates is a great benefit as it allows owners to match an increase in demand without the requirement of purchasing new equipment. There are many methods of how the fluids travel through the heat exchanger. One of the more popular methods is the primary fluid that requires to be cooled will enter the front frame from the bottom and travel through every subsequent plate up to the top channel which will then travel outwards from the front frame again. While this occurs, the fluid which is being heated up also travels through the front frame but from the top channel this time, which travels downwards through every other plate into a channel below allowing the fluid to travel outwards from the front frame as well. Figure 4 displays this concept below. Figure 4: Fluids method of travel through heat exchanger The above version of the heat exchanger is the most popular/common version as it does not require any of the piping to be altered with if the heat exchanger is changed in the future (such as an increase of plates due to increase of demand). There are other versions as well where the fluid being cooled can enter from the front frame and exit through the back frame while the fluid being heated can enter through the back frame and exit through the front frame. This method however is not as practical as it requires piping to be re-worked if the heat exchanger is ever in need to be altered in the future. The channel will only allow access of fluid being able to travel through certain plates but won't allow it to be so through certain other plates. This is what allows the prevention of fluid mixture while still creating an efficient method of heat transfer. The key idea is that the gasket will allow fluid to pass through certain plates but not others. Some key terminology worth nothing is that the plate & frame heat exchanger can sometimes be referred to as a gasketed plate heat exchanger of GPHE. In reference to the Tranter brand SuperChanger GPHE, the transfer typically occurs between two different waters or even from steam to a liquid. Other key advantages not mentioned in detail are in regards to the reduced footprint which inevitably results in a cheaper cost. The GPHEs fit into 20-50% of a shell & tube heat exchanger footprint which includes the maintenance space. The GPHEs are highly versatile with hundred of plate styles, patterns & draw depths to precisely match certain application requirements. When it comes to heat exchangers, although simple in concept, choosing the right fit in sizing and plate pattern can become a challenge. Always reach out to your local manufacturer's representative and/or HVAC expert to discuss the best selections for your applications! By: Nash Mohammad, B.Eng Plate heat exchangers are available in a variety of models. Let's look at the principal heat exchanger designs:Brazed Plate Heat ExchangersCompact and with high power efficiency, brazed plate heat exchangers are a common inclusion in hot water systems, industrial and refrigeration equipment. Brazing is a process like soldering in which two pieces of metal are joined by melting a third metal onto the join and baking this into place. Brazed plate heat exchangers normally feature stainless steel brazed by copper or nickel, making them highly resistant to corrosion.Brazed plate heat exchangers cannot be opened. Cleaning is conducted by flushing the device with a suitable cleaning agent.Gasketed Plate Heat ExchangerGasketed plate heat exchangers feature rubber gaskets between the transfer plates. These create watertight seals and control flow rates. These larger, higher capacity models are standard equipment in food and drink production and heating, process engineering and HVAC systems.The gasket seals mean that these devices are easy to disassemble for maintenance and cleaning. Additional plates can also be added to increase the capacity and thermal flow of the device.Plate-Fin Heat ExchangerPlate-fin heat exchangers feature finned chambers alongside the heat transfer plates, the latter typically made from aluminium. These models are usually more compact than other plate heat exchangers but still offer a large heat transfer surface area.Plate fin heat exchangers, also known as plate-fin and tube exchangers, are favoured in industries that require lightweight heat transfer equipment. Examples include aerospace, vehicle engineering and cryogenic chemical processing.Welded Plate Heat ExchangerWelded plate and frame heat exchangers feature plates that have been welded together into a single block. This makes maintenance more difficult and means that the capacity of the devices is fixed because additional transfer plates cannot be added. However, it also makes welded plate heat exchangers highly durable - they can withstand corrosive fluids, high temperatures, and pressures. As a result, they are widely used in heavy industry - you will find them in oil refineries, gas extraction plants, power stations and similar locations.Semi-welded plate heat exchangers are a variant model, combining welded and gasketed plates. Welded plate sets are connected via gaskets to other sets. Therefore, the fluid channels through this device alternate between gasketed and welded seals. This allows hot fluid and corrosive liquids to be directed to one side while servicing is conducted on the other. The original idea for the plate heat exchangers was patented in the latter half of the nineteenth century, the first commercially successful design being introduced in 1923 by Dr. Richard Seligman. The basic design remains unchanged, but continual refinements have boosted operating pressures from 1 to 25 atmospheres in current machines. The plate and frame heat exchanger (see Figure 1) consists of a frame in which closely spaced metal plates are clamped between a head and follower. The plates have corner ports and are sealed by gaskets around the ports and along the plate edges. A double seal forms pockets open to atmosphere to prevent mixing of product and service liquids in the rare event of leakage past a gasket. Recent developments have introduced the double wall plate. The plates are grouped into passes with each fluid being directed evenly between the paralleled passages in each pass. An important, exclusive feature of the plate heat exchanger is that by the use of special connector plates it is possible to provide connections for alternative fluids so that a number of duties can be done in the same frame [Lane (1966), Hargis et al. (1966), and Marriott (1971)]. Plates are made from a range of materials, for example, the "Paraflow" plates are pressed from stainless steel, titanium, Hastelloy, Avesta 254 SMO, Avesta 254 SLX or any material ductile enough to be formed into a pressing. The special design of the trough pattern strengthens the plates, increases the effective heat transfer area and produces turbulence in the liquid flow between plates. Plates are pressed in materials between 0.5 and 1.2 mm thick and plates are available with effective heat transfer area from 0.03 to 3.5 m2. Up to 700 plates can be contained within the frame of the largest Paraflow exchanger, providing over 2400 m2 of surface area. Flow ports and associated pipework are sized in proportion to the plate area and control the maximum liquid throughput. Figure 1. Plate heat exchanger. (With permission of APV p/c.)As detailed in Table 1, various gasket elastomers are available which have chemical and temperature resistance coupled with good sealing properties. The temperatures shown are maximum, therefore possible simultaneous chemical action must be taken into account when selecting the most suitable material for a particular application.Plate performance is determined by the plate geometry but it is not possible to estimate the film coefficient from the trough dimensions with some accuracy as can be obtained with a tube. The geometrical parameters involved such as plate gap, height, pitch and angle of the trough are too numerous for this to be possible but some work has been done on evaluating the effect of these variables [Kays and London (1958); Maslov (1965)]. In a plate heat exchanger, the heat transfer can best be described by a Dittus-Boelter type equation: Typical values of the constant and exponents are where d is the equivalent diameter defined in the case of the plate heat exchangers as approximately 2 × the mean gap. Table 1. Where α=heat transfer coefficient ,λ=thermal conductivity ,η=viscosity ,cp=specific heat , subscription w = wail.Typical velocities in plate heat exchangers for waterlike fluids in turbulent flow are 0.3-0.9 m/s but true velocities in certain regions will be higher by a factor of up to 4 due to the effect of the geometry of the plate design. All heat transfer and pressure drop relationships are based on either a velocity calculated from the average plate gap or on the flow rate per passage.Figure 2 illustrates the effect of velocity on pressure drop and film coefficient. The film coefficients are very high and can be obtained for a moderate pressure drop. One particularly important feature of the plate heat exchanger is that the turbulence induced by the troughs reduces the Reynolds number at which the flow becomes laminar. Typical values at which the flow becomes laminar varies from about 100 to 400, according to the type of plate. The friction factor is correlated with: where y varies from 0.1 to 0.4 according to the plate and B is a constant for the plate. Figure 2. In many applications, the heat transfer surface of the plate is less susceptible to fouling than a tubular unit. This is due to 4 principle advantages of the plate design: There is a high degree of turbulence, which increases the rate of foulant removal and results in a lower asymptotic value of fouling resistance. The velocity profile across a plate is good. There are no zones of low velocity compared with certain areas on the shell side of tubular exchangers.Corrosion is maintained at an absolute minimum by careful selection of use of corrosive resistant materials.Materials used for pressing the plates have a very smooth surface.The most important of these is turbulence. HTRI (Heat Trasfer Research Incorporated) has shown that for tubular heat exchangers, fouling is a function of low velocities and friction factor. Although flow velocities are low with the plate heat exchanger, friction factors are very high, and this results in lower fouling resistance. The effect of velocity and turbulence is plotted in Figure 3. The lower fouling characteristics of the plate heat exchanger compared to the tubular has been verified by HTRI's work [Suitor (1976)]. Tests have been carried out which tend to confirm that fouling varies for different plates, with the more turbulent type of plate providing lower fouling resistances. Heat Transfer CoefficientsHigher overall heat transfer coefficients are obtained with the plate heat exchanger compared with the tubular for a similar loss of pressure because the shell side of tubular exchanger is basically a poor design from a thermal point of view. Considerable pressure drop is used without much benefit in heat transfer due to the turbulence in the separated region at the rear of the tube. Additionally, large areas of tubes even in a well-designed tubular unit are partially bypassed by liquid and low heat transfer area are thus created. Bypassing in a plate type exchanger is less of a problem and more use is made of the flow separation which occurs over the plate troughs since the reattachment point on the plate gives rise to an area of very high heat transfer. For most duties, the fluids have to make fewer passes across the plates than would be required through tubes or in passes across the shell. Since in many cases a plate unit can carry out the duty with one pass for both fluids, the reduction in the number of required passes means less pressure lost due to entrance and exit losses and therefore more effective use of the pressure. Figure 3. Effect of velocity and turbulence.Figure 4. A diagrammatic view of a two way flow system.For condensing duties where permissible pressure loss is less than 7 kPascals the tubular unit is most efficient. Under such pressure conditions only a portion of the length of a plate heat exchanger plate would be used and a substantial surface area would be wasted. However, when less restrictive pressure drops are available the plate heat exchanger becomes an excellent condenser, since very high heat transfer coefficients are obtained and the condensation can be carried out in a single pass across the plate.Pressure Drop of Condensing VaporThe pressure drop of condensing steam in the passage of plate heat exchangers has been investigated experimentally for a series of different Paraflow plates. It is interesting to note that for a set of steam flow rates and given duty the steam pressure drop is higher when the liquid and steam are in countercurrent rather than cocurrent flow. It can be shown that for equal duties and flow the temperature difference for countercurrent flow is lower at the steam inlet than at the outlet, with most of the steam condensation taking place in the lower half of the plate. The reverse holds true for cocurrent flow. In this case, most of the steam condenses in the top half of the plate, the mean vapor velocity is lower and a reduction in pressure drop of between 10-40% occurs. This difference in pressure drop becomes lower for duties where the final approach temperature between the steam and process fluid becomes larger. The pressure drop of condensing steam is a function of steam flow rate, pressure and temperature difference. Since the steam pressure drop affects the saturation temperature of the steam, the mean temperature difference, in turn, becomes a function of steam pressure drop. This is particularly important when vacuum steam is being used, since small changes in steam pressure can give significant alterations in the temperature at which the steam condenses. Plate Heat Exchangers also are used for gas cooling. The problems are similar to those of steam heating since the gas velocity changes along the length of the plate due either to condensation or to pressure fluctuations. Designs usually are restricted by pressure drop, therefore machines with low-pressure drop plates are recommended. A typical allowable pressure loss would be 3.5 kPascals with low gas velocities giving overall heat transfer coefficients in the region of 300 W/m2K.The plate heat exchanger can also be used for evaporation of highly viscous fluids when the evaporation occurs in plate or the liquid flashes after leaving the plate. Applications generally have been restricted to the soap and food industries. The advantage of these units is their ability to concentrate viscous fluids of up to pascal seconds. The unit is particularly suitable for high concentration especially as a finishing stage to a larger evaporator where the quantity of vapor is low and can be handled by the comparatively small ports of the plate [Jackson and Trouper (1966)]. One other field suitable for the plate heat exchanger is that of laminar flow heat transfer. It has been previously pointed out that the exchanger can save surface by handling fairly viscous fluids in turbulent flow because the critical Reynolds number is low. Once the viscosity exceeds 20-50 cP, however, most plate heat exchanger designs fall into the viscous flow range. Considering only Newtonian fluids since most chemical duties fall into this category, laminar flow can be said to be one of three types: Fully developed velocity and temperature profiles (i.e., the limiting Nusselt case);Fully developed velocity profile with developing temperature profile (i.e., the thermal entrance region); orThe simultaneous development of velocity and temperature profiles.The first type is of interest only when considering fluids of low Prandtl number, and this does not usually exist with normal plate heat exchanger applications. The third is relevant only for fluids such as gases, which have a Prandtl number of about one. For type 2 correlations for heat transfer and pressure drop in laminar flow are in the form where Nu = Nusselt number (αd/λ.), Re = Reynolds number (Vdρ/η), Pr = Prandtl number (cpη/λ) , η/ηp = Sieder Tate correction factor (see Convective Heat Transfer), and where f is the friction factor and a is a characteristic of the plate. From this correlation it is possible to calculate the film heat transfer coefficient, for laminar flow. This coefficient, combined with that of the metal and the calculated coefficient for the service fluid together with the fouling resistance, are then used to produce the overall coefficient. As with turbulent flow, an allowance has to be made to the Log Mean Temperature Difference to allow for either end-effect correction for small plate packs and/or concurrency caused by having concurrent flow in some passes. This is particularly important for laminar flow since these exchangers usually have more than one pass. (See also Heat Exchangers and Mean Temperature Difference; Overall Heat Transfer Coefficient.) Comparing Plate and Tubular Exchangers For liquid/liquid duties, the plate heat exchanger will usually give a higher overall heat transfer coefficient and in many cases the required pressure loss will be no higher.The effective mean temperature difference will usually be higher with the plate heat exchanger.Although the tube is the best shape of flow conduit for withstanding pressure it is entirely the wrong shap for optimum heat transfer performance since it has the smallest surface area per unit of cross-sectional flow area.Because of the restrictions in the flow area of the ports on plate units it is usually difficult (unless a moderate pressure loss is available) to produce economic designs when it is necessary to handle large quantities of low- density fluids such as vapors and gases.A plate heat exchanger is more compact than a tubular and in many instances will occupy less floor space.From a mechanical viewpoint, the plate passage is not the optimum and gasketed plate units are usually not made to withstand operating pressures much in excess of 25 kgf/cm.For most materials of construction, sheet metal for plates is less expensive per unit area than tube of the same thickness.When materials other than carbon steel are required, the plate will usually be more economical than the tube for the application.When carbon steel construction is acceptable and when a closer temperature approach is not required, the tubular heat exchanger will often be the most economic solution since the plate heat exchanger is rarely made in carbon steel.Until recently, applications for plate heat exchangers were restricted by the need for the gaskets to be elastomeric. Recent advances is design have introduced brazed plates and welded plates, thereby widening the range of applications. Hargis, A. M., Beckman, A. T., and Loiacono, J. (1966) The Heat Exchanger, ASME Publication. PET, 21. Jackson, B. W. and Troupe, R. A. (1966) Plate heat exchanger design by ENTU method chemical, Engineer Prog, Symp. Serv. 62 (No 64), 185 Kays, W. M. and London, A. L. (1958) Compact Heat Exchangers, McGraw-Hill, New York. Lane, D. E. (1966) Design trends in plate heat exchangers, Chemical Process Engineering Heat Transfer Summary, 127, August. Marriott, J. (1971) Where and how to use the plate heal exchangers, Chemical Engineering, 78 (no 8), 127. Maslov, A. (1965) Calculation of the Heat Exchange of Plate Apparatus on the Basis of Diagram (Graphs), Kholod ekh. 6, 25. Suitor, J. W. (1976) Plate Heat Exchanger Fouling Study, HTRI Report No. F-EX-18. Sustainable solutions for a better world We not only offer solutions that respond to the needs of our customers but also to those of our planet. Our latest Sustainability Report documents the work we're doing to help create better everyday conditions for everyone. While simple in construction, plate heat exchanger is intricate in its design and operation. Looking at the different types of plate heat exchanger from gasket type, brazed plate type, welded type, and microplate type as well as their applications, this article will focus on this one of the most popular versions of the heat exchanger. So, follow us in Linquip. plate heat exchanger applications Different types of plate heat exchanger have many potential applications. This includes pasteurizers, beverage processing, connectors between chillers, boilers, and cooling towers, and other process engineering applications. plate heat exchanger is a modular system that offer excellent heat transfer while being a fraction of the size of most conventional designs. It also supplies water and most other fluids instantly while keeping the appropriate fixed-point temperature within 1 or 2 degrees for your particular use. In addition, it is standard practice to use a plate heat exchanger as a central heating system split to shield a costly piece of equipment such as a commercial-sized boiler. Plate heat exchanger is used in these systems to divide the central heating system into two circuits, one devoted to the boiler and the other to the radiators and related devices. The general concept behind the Central Heating System Break is to divide the heating into two circuits so that any deposits floating in an old heating system do not disrupt or shorten the life of the costly boiler. Types of plate heat exchanger There are four main types of plate heat exchanger: Multiple sheets of thin metal are arranged to form channels in gasket-style heat exchangers. Through inserting or removing internal plates, gasket plate heat exchangers may increase or decrease their heating or cooling capability. They can also be disassembled for washing and repair purposes. The plates are generally made of stainless steel, sometimes platinum, the endplates are typically made of mild steel, and the gaskets are typically made of rubber. Gasket plate heat exchangers can be used in a variety of heavy-duty HVAC, automotive, and process engineering applications. They have an extraordinarily high thermal efficiency despite their small size. These types of plate heat exchanger use high-quality gaskets and a well-designed seal to keep plates together and prevent leaks. Plates may be quickly removed for washing, extension, or replacement, significantly lowering maintenance costs. Welded plate heat exchangers are similar to gasket plate heat exchangers, except the plates are welded together instead of bolted together. These types of plate heat exchanger are highly robust and are suitable for moving fluids that are hot or corrosive. Since the plates are welded together, mechanical plate washing is not an alternative, as it is with plate and frame heat exchangers. Semi-welded plate heat exchangers combine welded and gasket plates. They are made up of two-plate pairs that are welded together and then gasketed on other pairs since one fluid path is welded and the other fluid path is gasketed. This produces a plate heat exchanger that is easy to service on one hand while still being capable of transferring more intense fluids on the other. Since these types of plate heat exchanger have a relatively low chance of fluid loss, semi-welded heat exchangers are ideal for moving heavy materials. Brazed plate heat exchangers are usually found in smaller applications, but in recent years, this has begun to change, with larger units being manufactured and used in industry. These types of plate heat exchanger are used in a wide range of automotive and refrigeration applications. They are highly corrosion-resistant due to the stainless-steel plate composition and copper brazing. Brazed Plate heat exchangers are economical because they are efficient and lightweight. These heat exchangers often use thin plates to isolate the fluids, but the plates are brazed together to form a full seal. The seal is formed by the brazing and positioning of the plates, which determines which channel each fluid will flow into. A unit composed entirely of surfaces that specifically move forward heat transfer and can endure both high temperature and high-pressure conditions. plate heat exchanger advantages and disadvantages Any types of plate heat exchanger have their pros and cons. Here we present some of the very important advantages and disadvantages of plate heat exchanger: Plate heat exchanger is Easy to Remove and Clean. Simply cut the tie bolts and slip the movable frame on. If required, the plate pack may be inspected, pressure washed or withdrawn for refurbishment. Plate heat exchanger is Expandable. The plate heat exchanger has the advantage of being expandable, which allows for an improvement in heat transfer capabilities. If the heat transfer specifications adjust, you can easily install plates rather than purchasing a whole new frame unit, saving you time and money. It has High Efficiency. Because of the pressed plate patterns and short spaces, there is a lot of noise at a low fluid velocity. Heat transfer coefficients are very high when combined with counter-directional flow. Find it with a Compact Size. Because of the high performance, less heat transfer area is needed, resulting in a much smaller heat exchanger than would be required for the same effectiveness of other heat exchanger models. A plate heat exchanger usually takes up 20-40% less space than a shield and tube heat exchanger. One Single Unit but Multiple Duties. The plate heat exchanger may be constructed in parts that are divided by basic divider plates or more complex divider frames with additional connections. This enables the heating, regeneration, and cooling of a fluid in a single heat exchanger, as well as the heating or cooling of several fluids from the same cooling or heating source. Less Fouling. The pattern of the plates, the many touchpoints, and the small distance between the plates all contribute to extremely high turbulence. This, along with the flat plate surface, significantly prevents fouling as compared to other forms of heat exchangers. Not Much Cost. High heat transfer coefficients imply a smaller heat transfer region and, in some cases, fewer heat exchangers. This, as well as reduced space needs, lower flow speeds, and smaller pumps imply. The concept of plate heat exchanger advantages and disadvantages is not done. Despite the above advantages, plate heat exchangers are not the right option for all applications. In cases where there is an extreme temperature difference between two fluids, it is usually more cost-effective to use a Shell & Tube heat exchanger. Due to the vast amount of turbulence produced by the small flow channels in a plate heat exchanger, there may be a high-pressure loss. Applications requiring a low-pressure loss may often want to consider a Shell & Tube heat exchanger. Summary In a nutshell, the plate heat exchanger is one way of exchanging heat between two fluids, and it is particularly useful for heat transfer between two liquids. It is made up of layered corrugated plates stacked one on top of the other. There are openings between the various plate layers through which a cold and a warm medium migrate. This article presented an understanding of different types of plate heat exchanger. Moreover, you found out about the applications as well as the advantages and disadvantages. For more information, consult our experts. Feel free to register at Linquip and get more about types of plate heat exchanger. Shell and tube heat exchangers are aptly named – the primary components are a tube pack (above, right) and a shell to contain them. One fluid goes through the tubes, and the second goes through the larger shell, surrounding the tubes. The prototypical shell and tube heat exchanger has only one inner tube, and is typically used to teach engineering students the basic concept of a heat exchanger. However, in practice, a pack of smaller tubes is much more effective because it greatly increases the heat transfer surface area (and has a minor positive effect on turbulence, to boot). The shell and tube heat exchanger in the photo above has about twelve times the efficiency of a hypothetical single-tube heat exchanger of the same size. However, smaller tubes have a disadvantage—if the fluid in your application is very viscous or has particulates, it can foul up the tube and undermine the heat transfer process.Shell and tube heat exchangers dominated the market until the latter part of the 20th century, when plate heat exchangers began to be replaced in many industrial and most HVAC applications.Due to their simple design, they also hold a prominent place in engineering curricula around the globe. They have many advantages that helped them earn those achievements. First, they're relatively cheap – they're essentially just a bunch of tubes. Also, due to their hydro- and aerodynamic design, they can support higher operating temperatures and pressures than your typical plate heat exchanger, which, due to its compactness, has to change the flow direction many times per cycle. This also means that the pressure drop from input to output is smaller, which can save on energy costs.Despite the advantages, plate heat exchangers are becoming preferred due to better heat transfer (we'll see why in a moment), easier maintenance and cleaning, modularity and compactness. Plate heat exchangers are available in a variety of models. Let's look at the principal heat exchanger designs:Brazed Plate Heat ExchangersCompact and with high power efficiency, brazed plate heat exchangers are a common inclusion in hot water systems, industrial and refrigeration equipment. Brazing is a process like soldering in which two pieces of metal are joined by melting a third metal onto the join and baking this into place. Brazed plate heat exchangers normally feature stainless steel brazed by copper or nickel, making them highly resistant to corrosion.Brazed plate heat exchangers cannot be opened. Cleaning is conducted by flushing the device with a suitable cleaning agent.Gasketed Plate Heat ExchangerGasketed plate heat exchangers feature rubber gaskets between the transfer plates. These create watertight seals and control flow rates. These larger, higher capacity models are standard equipment in food and drink production and heating, process engineering and HVAC systems.The gasket seals mean that these devices are easy to disassemble for maintenance and cleaning. Additional plates can also be added to increase the capacity and thermal flow of the device.Plate-Fin Heat ExchangerPlate-fin heat exchangers feature finned chambers alongside the heat transfer plates, the latter typically made from aluminium. These models are usually more compact than other plate heat exchangers but still offer a large heat transfer surface area.Plate fin heat exchangers, also known as plate-fin and tube exchangers, are favoured in industries that require lightweight heat transfer equipment. Examples include aerospace, vehicle engineering and cryogenic chemical processing.Welded Plate Heat ExchangerWelded plate and frame heat exchangers feature plates that have been welded together into a single block. This makes maintenance more difficult and means that the capacity of the devices is fixed because additional transfer plates cannot be added. However, it also makes welded plate heat exchangers highly durable - they can withstand corrosive fluids, high temperatures, and pressures. As a result, they are widely used in heavy industry - you will find them in oil refineries, gas extraction plants, power stations and similar locations.Semi-welded plate heat exchangers are a variant model, combining welded and gasketed plates. Welded plate sets are connected via gaskets to other sets. Therefore, the fluid channels through this device alternate between gasketed and welded seals. This allows hot fluid and corrosive liquids to be directed to one side while servicing is conducted on the other. Since saVRee started in 2017, we have helped over 50,000 online students increase their engineering knowledge. We have also helped our clients train thousands of their own employees particularly in the HVAC, Mechanical, Marine, Electrical, Automobile, Chemical and Power Engineering industries. Page 2 Page 3 We provide a wide range of interactive 3D models, videos, Handbooks, podcasts, and learning materials for use in technical training and education. Pricing varies depending on content type, licensing requirements, and intended usage (e.g. internal training, external distribution, academic integration). Please complete the contact form below and a member of our team will get in touch with you to discuss things further. We look forward to hearing from you! The plate and frame heat exchanger consists of a series of rectangular parallel plates. These plates are arranged in a frame and are pressed together to form a series of channels for the flow of fluid through it. Plates are separated by gaskets and have corrugated faces, which provide a high degree of turbulence. It has inlet and outlet nozzles at the end. Hot fluid passes through the alternate pairs of plates which transfer heat to the plates, eventually, heat is transferred to the cold fluids in the adjacent plates. These exchangers provide a high heat transfer area which results in a high heat transfer rate with low-temperature differences as well. Table of content How do plate and frame heat exchangers work? Plate and Frame Heat Exchanger Sizing Cleaning & Maintenance of Plate and Frame Heat Exchanger How do plate and frame heat exchangers work? A plate and frame heat exchanger works by allowing two different fluids to flow through separate channels, with the heat being transferred from one fluid to the other through the metal plates. The fluids are typically separated by a gasket, which forms a seal between the plates, creating two separate flow channels. Due to the temperature difference between two fluids and thermal conductivity of the metal heat transfer takes place. The heat transfer process in plate and frame heat exchanger is as follows: The hot fluid flows through one set of channels on one side of the plates. The hot fluid transfers heat to the plates through conduction. The cold fluid flows through the other set of channels on the opposite side of the plates. The cold fluid absorbs heat from the plates through conduction. As the hot fluid flows through the heat exchanger, it loses some of its heat to the cold fluid. This causes the temperature of the hot fluid to decrease, and the temperature of the cold fluid to increase. The heat transfer process continues until the temperature of the hot fluid reaches equilibrium with the cold fluid. The heat exchanger working principle has been discussed thoroughly here. Plate and Frame Heat Exchanger Sizing Sizing a plate and frame heat exchanger involves selecting the appropriate size and number of plates, determining the correct flow rates and pressure drops for the fluids, and selecting the appropriate materials for the plates, gaskets, and frame. The first step in the design of a plate and frame heat exchanger is to determine the maximum amount of heat that needs to be transferred and the desired temperature difference between the fluids. This calculated heat duty and the temperature difference will be used to determine the size and number of plates required. Fluid properties, inlet/outlet temperature of fluids, the inlet pressure of fluids, and allowable pressure drop must be defined to size a plate and frame heat exchanger. The fluids should be flowing through the heat exchanger at the correct flow rates to ensure optimal heat transfer and to prevent any damage to the heat exchanger. The pressure drops across the heat exchanger also need to be within acceptable limits to prevent any damage to the heat exchanger. We can calculate the number of plates required by using, N =S/s Where, N = Number of plates required S = Total heat exchanger area (m2) s = size of the single plate (m2) The plates are typically made of stainless steel or other high-grade metals that are resistant to corrosion. Gaskets are made of materials such as rubber, silicone, or PTFE, and are chosen based on their chemical compatibility with the fluids. The frame is typically made of steel so that it can withstand the pressure of the fluids. It is required to go into detail about the many options available for the plates and use correlations that will allow us to recalculate the overall heat transfer coefficient and then a required exchange area. The calculation will then be iterative until the calculated heat exchange area is equal to the assumed area. This is the detailed design procedure for the heat exchanger design. Finally, the inlet and outlet connections and flow distribution devices need to be designed. The inlet and outlet connections can be made of various materials such as copper, steel, or plastic. The flow distribution device can be a simple pipe or a more complex system of nozzles, to ensure that the fluid flows evenly across the heat exchanger. Effects of fouling must be taken into account and the fouling factor must be calculated accurately for the adequate design of the plate and frame heat exchanger.This is the p&id symbol of plate and frame heat exchangers used in process industries. Cleaning & Maintenance of Plate and Frame Heat Exchanger To maintain high a heat transfer area, it is necessary to keep the heat exchanger clean, as buildup or deposits on the plates can reduce the heat transfer area and decrease the efficiency of the heat exchanger. The cleaning process will depend on the type of fluids and the degree of fouling or buildup on the plates and gaskets. Here are a few cleaning methods discussed for plate and frame heat exchangers: Chemical Cleaning Chemical cleaning of plate and frame heat exchangers involves circulating a specialized descaler, such as acid or alkali, to remove any buildup or deposits on the plates and frames. The descaler is circulated through the heat exchanger and allowed to soak for some time to loosen and remove the buildup. After cleaning, the heat exchanger is flushed with water to remove any remaining cleaning solution and debris. It is important to use appropriate chemicals for chemical cleaning as some chemicals may be corrosive to the metal. Nitric acid, Sulfuric acid, Citric acid, Phosphoric acid, EDTA, etc chemicals are used for chemical cleaning. Mechanical Cleaning Mechanical cleaning involves opening up the heat exchanger unit and using synthetic bristle brushes, high-pressure water spray, and other specialized tools to mechanically wash the plates. The manual method involves using a brush or scraper to remove dirt, debris, and buildup from the plates and gaskets. This method is typically used for heat exchangers that have a light amount of fouling or for heat exchangers that are difficult to access. This method is typically used for heat exchangers that have a light amount. The automated method involves the use of a high-pressure water jet machine. A high-pressure water jet is used to remove the dirt, debris, and buildup from plates and gaskets. This method is typically used for heat exchangers that have a moderate amount of fouling. Ultrasonic Cleaning This cleaning technology of plate and frame heat exchangers involves using high-frequency sound waves to agitate a cleaning solution and remove buildup and deposits from the plates and frames. Ultrasonic cleaning technology cleans heat exchangers continuously and during operation using ultrasound. This technology uses calibrated high-frequency ultrasound to mitigate the formation and adherence of fouling and scale deposits from settling on heat transfer surfaces. Plate heat exchangers are one of the most common types of heat exchanger employed today; the other common type of heat exchanger is the shell and tube heat exchanger. The spiral heat exchanger is also used for industrial applications, but its use is minor compared to the other two types of heat exchanger. Plate heat exchangers have gained widespread application throughout the engineering world because they are efficient, robust, and relatively easy to maintain. Assembled Plate Heat Exchanger Plate Heat Exchanger (PHE) Components Plate heat exchangers consist of relatively few parts. Because plate heat exchangers are used for transferring heat, they require inlets and outlets where the flowing mediums -or fluids- can enter and leave the heat exchanger. A fluid may be a liquid or a gas. As fluids are often assumed to be liquid only, we will use the term flowing medium to avoid confusion. Plate Heat Exchanger (Exploded View) Gaskets and plates are used to separate the flowing mediums and prevent them mixing; gaskets are adhered to one side of each plate only. The plates hang upon a carry bar and are pressed together using clamping bolts. When the plates are compressed together, they are referred to as a 'plate stack'. A guide bar ensures the plates are aligned correctly when the plate stack is opened and closed. Plate Heat Exchanger Components The final components of interest are the two covers at opposite ends of the plate stack. One cover is movable whilst the other is fixed. The movable cover and fixed cover are also sometimes referred to as the frame plate and pressure plate. Note that the inlets and outlets are mounted to the fixed cover only. Enjoying this article? Then be sure to check out our Introduction to Heat Exchangers Video Course and Plate Heat Exchanger Fundamentals Video Course. Each course has a quiz, handbook, and you will receive a certificate when you finish the course. Enjoy! How Plate Heat Exchangers Work The below video is an extract from our Heat Exchangers Online Video Course. Throughout this article, we will assume a hypothetical plate heat exchanger has two flowing mediums, one is cold and the other is hot. The hot medium needs to be cooled by the cold medium, and this will occur in the plate heat exchanger. The hot medium enters the heat exchanger through the hot medium inlet. Gaskets direct the hot medium as it flows through the heat exchanger. Each plate has an alternating gasket pattern. The hot medium flows into the space between a pair of plates, but does not flow into the space between the next pair of plates because the gaskets prevent this. The process continues so that each second set of plates is filled with the hot flowing medium. Plate Heat Exchanger Plate Gaskets At the same time, the cold medium enters the heat exchanger through the cold medium inlet, but this time, the gaskets are positioned to allow the cold medium to flow into the space where no hot medium is present. The heat exchanger is now full of both hot and cold flowing mediums. Each medium flows out of its associated outlet and the process is continuous. Notice that the two flowing mediums are always adjacent to each other throughout the heat exchanger. The flowing mediums thus have a hot, cold, hot, cold, flow pattern, as they flow through the heat exchanger. Both flowing mediums are completely separated from each other by the gaskets and plates, they do not mix. Alternating Cold/Hot Pattern Due to the close proximity of the flowing mediums, heat is exchanged between them. The hot medium heats-up the plate and the plate passes some of this heat to the cold flowing medium; thus the hot medium temperature decreases whilst the cold medium temperature increases. Plate Heat Exchanger Design The plates are the main reason plate heat exchangers are so efficient. The plates on a plate heat exchanger may appear to have a simple design, but each plate is full of interesting engineering design features. For example: When the plates are compressed together to form a plate stack, the gap between each of the plates is very small, which ensures good thermal contact between the two flowing mediums. The gap between the plates is also known as 'clearance'. Plates are thin and have a large contact surface area, which gives each plate a high heat transfer rate. Plates are manufactured from a material with high thermal conductivity, which further increases the heat transfer rate. Corrugations on the plate surfaces prevent laminar flow and promote turbulent flow, which increases the heat transfer rate whilst also reducing the likelihood of deposits accumulating upon the plate surfaces. The corrugations also serve to stiffen the plate structure, which allows a thinner plate to be used compared to a plate that has no corrugations. Note that plate corrugations are sometimes referred to as having a 'herringbone' pattern. Corrugated Herringbone Pattern The plates are not the only part of a plate heat exchanger with extensive design features, the gaskets also have interesting design features: Gaskets are able to maintain a seal between the plates even when the system pressure and temperature varies. Holes in each gasket -known as telltales- are used to identify leaking gaskets. This feature allows operators to change the affected plate before the leaking medium leaks through the next gasket and contaminates the other flowing medium. Plate Heat Exchanger Telltale Because the gaskets guide flow through the heat exchanger, it is essential they be installed in the correct order. For this reason, gaskets are often fitted with markings so that operators can check each plate is installed in the correct order throughout the entire plate stack. Another way of ensuring the order of the plate stack is correct, is to spray paint a diagonal line across the entire plate stack when it is assembled. Plate Stack with Diagonal Line Although we have only shown two gasket designs so far in this article, there are three! Gaskets alternate throughout the heat exchanger except for the first and last plates within the plate stack, which press against the fixed and movable covers. Plates that press against the fixed and movable covers are known as start and end plates, because of their position within the plate stack. The purpose of the start and end plates is to prevent flow into the space between the fixed cover and start plate, and to prevent flow into the space between the movable cover and end plate. In this way, the covers are not actively used to exchange heat; this makes sense as the covers are quite thick, do not have corrugations and are poorly suited to exchange heat. Plate Gaskets (end plate gasket shown on the right) Varying the Cooling Capacity There are several ways to vary the cooling capacity of a plate heat exchanger: Regulate the outlet valves so that the flow is increased or decreased; this method is useful because no dismantling of the heat exchanger occurs. Do not throttle/regulate the inlet valves as this may starve the heat exchanger and cause localised overheating. Increase or decrease the number of plates in the plate stack. Increasing the number of plates in the plate stack gives a corresponding increase in cooling capacity. Decreasing the number of plates in the plate stack gives a corresponding decrease in cooling capacity. In short, more plates equals more cooling capacity and less plates equals less cooling capacity. Use a single pass or multi-pass design. Single pass heat exchangers allow the two flowing mediums to flow past each other only once. Multi-pass heat exchangers allow the flowing mediums to flow past each other several times. Most plate heat exchangers use the single pass design. Single and Multi-Pass Design Flow Types Flow through a plate heat exchanger may be parallel, cross or counter. Plate heat exchangers usually use counter flow as this is the most efficient type of flow for heat transfer. Counter flow is sometimes known as contra flow. Parallel, Counter and Cross Flow Design Considerations for Plates Because plate heat exchangers are used for wide ranging applications, they must be designed to withstand the process conditions in which they operate, this may include corrosive and erosive environments. Its possible to construct plate heat exchangers from various materials, including metals, alloys and plastics. Different materials make the plate heat exchanger more suitable for different applications. For example, if a particular flowing medium reacts aggressively when coming into contact with certain metals, polymer-based materials such as Teflon may be used instead. Plate Heat Exchanger Advantages There are numerous advantages associated with plate heat exchangers: Plate heat exchangers weigh less, require less space and are more efficient compared to other heat exchanger designs of the same size. Replacing and cleaning of the plates is a simple task because the plate stack can be opened easily. And unlike shell and tube heat exchangers, plate heat exchangers do not require additional space for dismantling. Plate Heat Exchanger Disadvantages But there are also some disadvantages associated with plate heat exchangers: Plate heat exchangers tend to be more expensive than other heat exchanger designs. If there is a leaking gasket causing one flowing medium to mix with the other, the leaking plate is often difficult to locate. Replacement of plate gaskets in-situ can be difficult, or impossible. Some plate gaskets must be returned to the manufacturer for replacement, which costs both time and money. When the plates are compressed together to form a plate stack, the clearance between each of the plates is small, this increases the likelihood of fouling with a corresponding reduction in heat transfer. When reassembling the plate stack, over-tightening the clamping bolts can lead to crushing of the plates, which damages the plate corrugations and squeezes-out the gaskets. If the gaskets are squeezed-out, the plate will no longer seal correctly. Plate heat exchangers are not suitable for high pressure applications because the gaskets would be expelled by the system pressure; this situation is referred to as 'gasket blow-out'. However, it is possible to get around this problem by using a gasket-less design; these designs usually use brazed or welded plates. Brazed and welded plate heat exchangers are more suitable for higher temperature and higher pressure applications, but also for applications where leakage would be hazardous/catastrophic e.g. toxic or poisonous flowing mediums. Additional Resources A poorly functioning heat exchanger may affect safety, product quality and energy costs. Failure may lead to costly downtime and major losses in production. By regular and proactive maintenance of your gasketed plate heat exchanger performance is preserved and operations kept trouble-free and predictable. We have the expertise to help you whether you experience a problem today, wish to prevent future issues or want to solve the problem yourself with our online troubleshooter. Watch the video to find our how Alfa Laval's comprehensive gasket plate heat exchanger service offerings can help to boost your energy efficiency. By taking advantage of our services, you can: Save energy and costs Optimize uptime Extend the equipment's lifetime Reduce emissions Request service for your Plate Heat Exchangers . If fouling should occur, an Alfa Laval CIP system provides quick and easy in-line cleaning without having to dismantle your heat exchanger. This comes with: Lower operating costs Production reliability Lower maintenance cost Reconditioning a gasket plate heat exchanger restores performance and reduces the total operating costs. It also: Extends product lifetime Improves thermal efficiency Minimizes energy consumption A Performance Audit from Alfa Laval can determine the actual heat transfer performance of your heat exchangers. This helps optimize your maintenance plan and: Ensure production reliability Secure maximum throughput Mediate your maintenance budget Connected solutions Connected services help you monitor the conditions in your heat exchangers so that you can improve the sustainability, insight, reliability, and performance of your assets. By doing so, you can: Optimize your maintenance plan and budget Maximize production uptime Reduce water and energy consumption, CO2e (CO2 equivalent) Enable smart decisions Spare parts With Alfa Laval Spare Parts, you can rest assured that the correct material is specified according to its intended use and: Prolong equipment lifetime Secure uptime Minimize costs Contact us Integrity Test An integrity test identifies any potential leakages in your heat exchanger before they occur in hygienic applications. This is possible using a mix of hydrogen and nitrogen gas to detect small plate cracks. The key benefits are: Product safety Production reliability and equipment uptime Compliance Learn more . 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More service offerings for your heat exchanger . Visual Condition Assessment (VCA) Thanks to our unmatched heat exchanger expertise, Alfa Laval can perform a visual inspection of your gasketed plate heat exchanger while it is in operation, identifying potential issues before they become major problems. Using infrared camera technology, we also evaluate the actual heat transfer performance of the heat exchanger. We then provide you with recommendations based on our findings and analysis of the thermal images. . Skills and knowledge empower When you buy Alfa Laval equipment, you buy peace of mind. But you must also rely on your equipment operators to get the job done. That's why competence development is invaluable to your everyday operations. If you have any specific need for training, let us know and we will get back to you soon. Register your training interest . Online troubleshooter - be the expert A leaking heat exchanger? Reduced thermal performance? Identify the causes of various issues you might experience with your plate heat exchanger, or even better – how to prevent them from happening, through our online troubleshooter. If needed our experienced and skilled troubleshooters are at your service. Troubleshoot your heat exchangers Use technology to face new challenges with an upgrade or redesign them to optimize the overall performance. Our wide range of re-design and upgrade solutions ensure that your Alfa Laval equipment features the latest technology and continues to meet current and future requirements. Whenever you need to make process or capacity changes, contact us so we can support you to optimize the process or increase efficiency. Contact us . Plate heat exchangers are available in a variety of models. Let's look at the principal heat exchanger designs:Brazed Plate Heat ExchangersCompact and with high power efficiency, brazed plate heat exchangers are a common inclusion in hot water systems, industrial and refrigeration equipment. Brazing is a process like soldering in which two pieces of metal are joined by melting a third metal onto the join and baking this into place. Brazed plate heat exchangers normally feature stainless steel brazed by copper or nickel, making them highly resistant to corrosion.Brazed plate heat exchangers cannot be opened. Cleaning is conducted by flushing the device with a suitable cleaning agent.Gasketed Plate Heat ExchangerGasketed plate heat exchangers feature rubber gaskets between the transfer plates. These create watertight seals and control flow rates. These larger, higher capacity models are standard equipment in food and drink production and heating, process engineering and HVAC systems.The gasket seals mean that these devices are easy to disassemble for maintenance and cleaning. Additional plates can also be added to increase the capacity and thermal flow of the device.Plate-Fin Heat ExchangerPlate-fin heat exchangers feature finned chambers alongside the heat transfer plates, the latter typically made from aluminium. These models are usually more compact than other plate heat exchangers but still offer a large heat transfer surface area.Plate fin heat exchangers, also known as plate-fin and tube exchangers, are favoured in industries that require lightweight heat transfer equipment. Examples include aerospace, vehicle engineering and cryogenic chemical processing.Welded Plate Heat ExchangerWelded plate and frame heat exchangers feature plates that have been welded together into a single block. This makes maintenance more difficult and means that the capacity of the devices is fixed because additional transfer plates cannot be added. However, it also makes welded plate heat exchangers highly durable - they can withstand corrosive fluids, high temperatures, and pressures. As a result, they are widely used in heavy industry - you will find them in oil refineries, gas extraction plants, power stations and similar locations.Semi-welded plate heat exchangers are a variant model, combining welded and gasketed plates. Welded plate sets are connected via gaskets to other sets. Therefore, the fluid channels through this device alternate between gasketed and welded seals. This allows hot fluid and corrosive liquids to be directed to one side while servicing is conducted on the other. According to the law of thermodynamics, heat flows from one system to another due to heat or temperature differences between both systems. The heat exchanger works according to the equilibrium principle. The heat exchangers have different types, and a plate heat exchanger (PHE) is one of them. The plate heat exchanger extracts heat from the surface and separates the cold fluid from the hot fluid. This article explains the plate heat exchanger working, types, parts, and applications.What is a Plate Heat Exchanger?A plate heat exchanger is a type of heat exchanger that uses a series of metal plates to move heat from one fluid to another. These plates are positioned over each other to create a channel series so that fluid can move between them.In the 1920s, Dr. Richard Seligman invented the plate heat exchanger (PHE).The main benefit of plate heat exchangers over conventional heat exchangers is that the fluid is distributed over the plate due to that fluid is exposed to a larger surface area. This increases the heat transfer rate and significantly speeds up the rate of temperature change.Nowadays, plate heat exchangers are widely used, and very small welded designs utilize millions of combi boilers in the hot water section. The high heat transfer efficiency with such a small size increases the flow of domestic hot water (DHW) in a combi boiler.Small plate heat exchangers have a big influence on household heating and hot water. The large business models utilize gaskets between the plates, while the smaller models tend to weld.Working of Plate Heat ExchangerA plate heat exchanger is a type of heat exchanger that contains a series of metal plates to transmit heat between fluids. The plate heat exchanger works on the principle of thermodynamics. In these heat exchangers, each plate has a confined, hollow tubular shell.The plates are arranged in such a way that thin rectangular channels are developed to exchange heat through half pieces. The operating fluid moves between these twisted and narrow channels.The plates of this exchanger are surrounded by gaskets to control the fluid flow. These gaskets arrange in such a way that only one type of liquid (such as oil which is being heated) distributes on one plate and another fluid (such as hot water) distributes on the next plate. The following figure represents two adjacent boards.After this arrangement, the cold and hot fluids alternately pass through the plate, whereby a heat exchange takes place. The plates have a large surface area; therefore, they offer an excellent heat transfer rate than tubular heat exchangers.As you can see in the above diagram, the cooling fluid inlet (blue) is on the bottom, the cooling fluid outlet is on the top, and contrariwise for the hot fluid outlet (red). The cool fluid flows upward and the fluid to be cooled flows downward, transporting the heat through the plates. After the completion of this process, the heating medium is finally cooled, and the cooling medium is heated.The heat transfer principle and design of the plate heat exchangers characterize by their compact design, low heat loss, wide range of applications, flexible operation, high heat transfer efficiency, small installation area, and convenient installation and cleaning functions.Read Also: Working and Types of Shell & Tube Heat Exchanger Parts and Function of the Plate Heat ExchangerThe plate heat exchanger has the following major parts:PlatesCarrying beamFixed PlateSupport columnPressure PlateGuiding BarTightening UnitPHE Plates and gasket1) PlatesA single-plate heat exchanger can contain a maximum of 700 plates. As the plate pack compresses, the holes in the plate's corners create a constant tunnel or manifold that allows fluid to flow through the plate pack and exit the device.The space between the thin plates of the heat exchanger makes a tight channel that alternately traverses by cold and hot fluids and offers very small resistance to heat transfer.2) Carrying Beam The upper part installs between the supporting column and the fixed plate on which the pressure plates and the exchanger plates are connected.3) Fixed PlateThe fixed plate is a fundamental part of the plate heat exchanger. As the name of this plate represents that it is a fixed frame plate. Generally, the heat exchanger pipes connect with the fixed plates.4) Support ColumnThis is a non-moveable part of the PHE. The guiding bar and carrying beam are attached to this part.Read Also: Types of Shell & Tube Exchanger 5) Pressure Plate The PHE has a mobile pressure plate frame attached to the exchanger carrying beam. This frame compresses the plates of the exchanger.6) Guiding Bar This part guides the pressure plate and heat exchanger plates downward.7) Tightening Unit It is used to compress the frame components of the plate pack. It has tightening washers, tightening nuts, and tightening bolts.8) PHE Plates and Gasket The packing of plates is installed between the pressure plate and the fixed frame plate. This plate pack compresses by tightening the screws fastened between the two plates. The gaskets cover the plates to regulate the flow.Read More: Double-Plate Heat Exchanger Working and TypesTypes of Plate Heat ExchangersThe plate heat exchanger has the following major types:Gasketed plate heat exchangersBrazed heat exchangerWelded plate heat exchangers Semi-Welded heat exchangerPlate and Frame heat exchanger1) Gasketed plate heat exchanger This heat exchanger uses top-quality gaskets and construction. This gasket seals the plates and stops leakage. You can easily remove the plates of this exchanger for the replacement, expansion, or cleaning of the plates, which significantly reduces maintenance costs.2) Brazed Plate Heat ExchangerThe brazed plate heat exchanger is used in multiple refrigeration and industrial applications. Since the stainless-steel plate is brazed with copper because it has excellent corrosion resistance.These types of plate heat exchangers are an economically superior option because of their compact design and excellent efficiency.Advantages of Brazed Plate Heat Exchangers:-It has low heat lossThese exchangers have a compact designThey have low costs3) Welded Plate Heat ExchangerThe working of these heat exchangers is the same as gasket heat exchangers, but the plates of these heat exchangers are welded with each other.These have excellent durability and are best suitable for transporting hot fluids and corrosive substances. These exchangers have welded plates; therefore, you can't clean the plate mechanically like the plate and frame heat exchanger.4) Semi-Welded Plate Heat ExchangerThis heat exchanger is a combination of gasketed plates and welded plates. It has a pair of two plates welded with each other and then a gasket with another pair of plates so that one fluid can flow through welded and the other fluid can flow through the gasketed part.This arrangement of the plate heat exchanger makes it easy to repair. Therefore, this exchanger can also transfer more powerful fluid on the other.These exchangers have very little risk of fluid loss and are well-suited for the transportation of expensive materials.5) Plate and Frame Heat ExchangerThe heat exchanger in which the plates create a frame is known as a plate and frame heat exchanger. This exchanger consists of corrugated plates in the frame. This construction produces high wall shear stress and turbulence, leading to high stain resistance and a high heat transfer rate.This heat exchanger has gaskets. In addition to the sealing effect, the gasket also guides the liquid flow and is installed along the groove on the plate edge.The plate and frame heat exchanger uses to exchange heat between liquid and liquid at medium to low pressure. You can safely use a plate and frame heat exchanger without a gasket at high temperature and pressure. This type of heat exchanger has high flexibility as plates can be compressed or added in various situations.The characteristics of the plate and frame heat exchanger are given below:The plate and frame heat exchanger has easy and quick assembly and disassembly.It has the capacity to work with different working conditions by removing or adding heat plates to vary the flow rate.The gaskets of this exchanger have high costs.This heat exchanger limits the maximum temperature and pressure due to the operation of the gasket.It has high costs because of its moulds and complex design.We cannot use materials that are not suitable for welding, such as titanium.Construction of Plate Heat ExchangerPlate heat exchangers (PHE) are specifically designed to transfer heat between low-pressure fluid and medium-pressure fluid. Brazed, semi-welded, and welded exchangers use to heat exchange between high-pressure fluids.Instead of a tube running by the chamber, this exchanger has two alternating chambers, which are usually very thin, the larger surface being separated via a corrugated metal plate.The plates are made of stainless steel because steel has high corrosion resistance, strength, and temperature resistance.Plate heat exchangers have multiple plates installed on each other to form a series of channels through which fluid can flow. A rubber gasket uses to separate these plates. This gasket attaches to the parts around the edge of the plate.The gap between two adjacent plates generates a channel for the flow of the fluid.The outlet and inlet holes in the plate corners permit the cold and hot medium to pass by the heat exchanger alternating channels so that the plate can always make contact with the cold medium on one end and the hot medium on the other.The plate heat exchanger uses multiple plates to achieve an exchange area of up to thousands of square meters.Plate Heat Exchanger Heat TransferThe heat transfer coefficient of the fluid flowing by the plate heat exchanger can be calculated by the below-given formula:In the above-given equation:ΔTm = Effective mean temperature differenceA = total area of the plateU = overall heat transfer coefficient You may calculate the total area of the plate by the below-given formula:In the above equation:Np = number of platesAp = each plate areaThe coefficient of the overall heat transfer may find by the below-given equation: Wherehhot = hot fluid's convective heat transfer coefficient hcold = cold fluid's convective heat transfer coefficient tp = plate thicknesskp = plate conductivity Rf, hot = hot fluid fouling factorRf, cold = cold fluid fouling factorThe heat transfer rate of the heat exchanger can be calculated by the two different approaches:log-mean temperature difference (LMTD)thermal effectivenessThe below-given formula can calculate the heat transfer by applying the first approach:ΔTlm = log mean temperature difference F = correction factorΔTlm can calculate by the below given formula:The above formula represents to temperature difference for the parallel flow heat exchangers. This temperature is further evaluated in the following equation: The second method to find the heat transfer rate of the plate and frame heat exchanger is the ratio between the actual heat transfer to the highest theoretical heat transfer:Advantages and Disadvantages of Plate Heat ExchangersAdvantages of Plate Heat ExchangerThe plate heat exchanger has an easy design.These types of heat exchangers have a large heat transfer rate than shell & tube heat exchangers.There is no need for extra space for the exchanger disassembly.They have simple maintenance and cleaning.The plate heat exchangers have a small size than the shell & tube heat exchangers.It has a small fouling factor.It has easy repairing and washing.These exchangers have low installation costs.Disadvantages of plate heat exchangersThese exchangers have poor sealing and are easy to leak.The plate heat exchangers have large flow resistance than the tube exchangers.These have a high-pressure drop.It has a high clogging index, particularly suspended matter in the fluid.The heat resistance of the sealing material limits the operating temperature.It has a limited working pressure which is typically less than 1.5 MPa.Inadequate sealing can lead to leaks and make replacement difficult.Applications of Plate Heat ExchangersThe plate heat exchangers are used in the following applications:Heat pump isolationMash CoolersGlycol CoolersCooling tower isolationLube Oil CoolersBatch Heating & CoolingFree coolingHeat Recovery InterchangersProcess Heating & CoolingWater heatersWaste heat recoveryFAQ SectionA plate heat exchanger is an exchanger used to transfer heat between two fluids, usually by using a series of metal plates. These plates make a large surface area to transfer heat efficiently. The cold and hot fluids flow on opposite sides of the plates, permitting heat to be exchanged through the plate material.The plate heat exchangers are one of the most efficient heat exchangers. The efficiency rate of the plate heat exchanger is approx—90%.A plate heat exchanger is a well-suitable exchanger to exchange heat between low-pressure and medium-pressure fluids. They are used in boilers, compressors, free cooling, and mash coolers applications.Plate heat exchangers are most effective because of the turbulence on both sides. High turbulence and high heat transfer rate are important for even flow distribution. Plate heat exchangers are limited to low-viscosity fluids.In 1923, Dr. Richard Seligman invented the plate exchanger.A heat exchanger can continuously work for up to 10 years.GasketsPlatesFramePressure platesConnectionsInlet and outlet portsChannel platesTie boltsRead More The primary purpose of heat exchangers are to transfer thermal energy from one fluid to another fluid without the mixture of the fluids; i.e. the fluids are separated. Typically this is used when one loop is connected to a boiler/chiller and another loop is connected to a heat rejection system such as an evaporative cooling tower. The concept of fluids not being mixed allows for different types of fluids to transfer thermal energy, i.e. glycol & water. Figure 1 below displays an assembled plate & frame heat exchanger. Figure 1: Tranter Branded Plate & Frame Heat Exchanger Below are some of the key advantages of plate heat exchangers: Very compact Very efficient Low maintenance & service required Varying demand can be accomplished Plate & frame heat exchangers are comprised of a front & back cover which can be referred to as a frame, a plethora of plates in between as well as gaskets, and tightening bolts assembled with nuts to hold the heat exchanger together. Figure 2 below depicts the blown out assembly of this type of heat exchanger. Figure 2: Blown out assembly of the plate & frame heat exchangers The front covers are typically made of some form of mild steel as they are meant to be extremely strong in order to hold everything together. The nuts sit on the tightening bolts which run through the entire length of the heat exchanger which will compress the plates & gaskets together very tightly, making the heat exchanger leak proof. The plates is where the heat transfer occurs and the gaskets allow for the fluid to not leak. Larger heat exchangers will come with large supporting bars that are assembled along the top and the bottom in order to hold the frames & plates together. In smaller heat exchangers, since they are assembled with the tightening bolts only, the frame & plates can easily be removed by sliding it out. The plates themselves are usually made of some form of steel or titanium with a groove/pattern designed and/or stamped onto them as portrayed in figure 3. These patterns are incredibly thin but strengthen the plate. They also allow for an increase of heat transfer as the surface area increases as well as creating a rough and turbulent flow. The gaskets are typically made of a type of rubber that allows the prevention of leaks. These gaskets fit in between the plates and also are designed with the grooved pattern. These gaskets allow one type of fluid to travel through the plates/sheets but prevent other types of fluids from travelling through that sheet. Figure 3: Zoomed in image displaying the plate & it's grooved patterns A key advantage of plate & frame heat exchangers is that they can be increased in size (or decreased) in order to match the demand. This is able to be completed due to the extended length of the tightening bolts. With any extra length on the tightening bolts, one may simply add on more plates that can slide along and be completely tightened with the frame & nuts. This ability of simply adding more plates is a great benefit as it allows owners to match an increase in demand without the requirement of purchasing new equipment. There are many methods of how the fluids travel through the heat exchanger. One of the more popular methods is the primary fluid that requires to be cooled will enter the front frame from the bottom and travel through every subsequent plate up to the top channel which will then travel outwards from the front frame again. While this occurs, the fluid which is being heated up also travels through the front frame but from the top channel this time, which travels downwards through every other plate into a channel below allowing the fluid to travel outwards from the front frame as well. Figure 4 displays this concept below. Figure 4: Fluids method of travel through heat exchanger The above version of the heat exchanger is the most popular/common version as it does not require any of the piping to be altered with if the heat exchanger is changed in the future (such as an increase of plates due to increase of demand). There are other versions as well where the fluid being cooled can enter from the front frame and exit through the back frame while the fluid being heated can enter through the back frame and exit through the front frame. This method however is not as practical as it requires piping to be re-worked if the heat exchanger is ever in need to be altered in the future. The channel will only allow access of fluid being able to travel through certain plates but won't allow it to be so through certain other plates. This is what allows the prevention of fluid mixture while still creating an efficient method of heat transfer. The key idea is that the gasket will allow fluid to pass through certain plates but not others. Some key terminology worth nothing is that the plate & frame heat exchanger can sometimes be referred to as a gasketed plate heat exchanger of GPHE. In reference to the Tranter brand SuperChanger GPHE, the transfer typically occurs between two different waters or even from steam to a liquid. Other key advantages not mentioned in detail are in regards to the reduced footprint which inevitably results in a cheaper cost. The GPHEs fit into 20-50% of a shell & tube heat exchanger footprint which includes the maintenance space. The GPHEs are highly versatile with hundred of plate styles, patterns & draw depths to precisely match certain application requirements. When it comes to heat exchangers, although simple in concept, choosing the right fit in sizing and plate pattern can become a challenge. Always reach out to your local manufacturer's representative and/or HVAC expert to discuss the best selections for your applications! By: Nash Mohammad, B.Eng