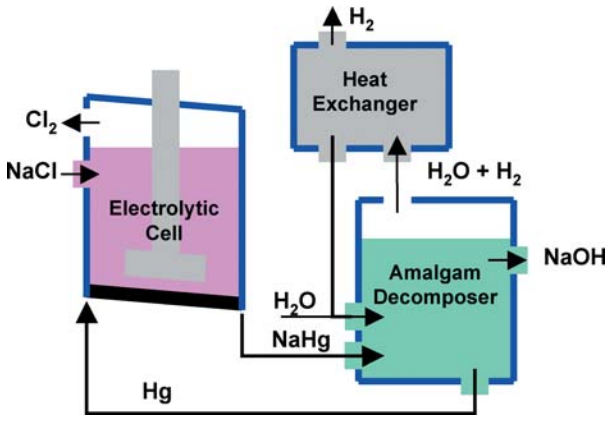
Plate heat exchangers in chlor-alkali electrolytic plants

HIGH-PERFORMANCE IN A SMALL SPACE

Typical cases of use for welded plate heat exchangers lie not only in applications with high pressures and temperatures, intensive alternating stresses or chemically aggressive media. Their use in chlor-alkali electrolytic plants shows that heat exchangers in plate & shell design can also be well suited to making the operation of technical processing plant safer and less maintenance intensive even at low pressures and temperatures.

In the chlor-alkali industry chlorine and other secondary products are manufactured by electrolysis of a salt solution. A fundamental manufacturing technology is the mercury or amalgam process. Here highly pure sodium chloride is dissolved in water as electrolytic brine. The endothermic reaction takes place in electrolytic cells in which energy in the form of direct current is fed through electrodes of mercury and titanium. Elemental chlorine gas forms at the titanium anode and metallic sodium, which is tied up as sodium amalgam, is precipitated at the mercury cathode. This mercury alloy is then broken down with pure water, generating gaseous hydrogen and aqueous caustic soda.

INEOS ChlorVinyls is one of the major chlor-alkali producers in Europe and a global leader in chlorine derivatives. The Company has 2.440 employees and production sites in Great Britain, Germany, France, Norway, Sweden and Thailand with a total capacity of 7,3 million tons per year.



Process schematic Chlor-alkali electrolysis

At production site Wilhelmshaven a large number of electrolytic cells with downstream amalgam decomposers is arranged in so-called cell halls. Installed above the decomposers are heat exchangers, in which the gaseous nitrogen is cooled and then taken for further processing. On entry into the heat exchanger, the nitrogen is saturated with water vapour which condenses and after further super-cooling is fed back into the decomposer.

The particular challenge lies in the fact that the operating pressure in the electrolytic cell is below 1 barg and a pressure loss is only permissible in the millibar range. In addition to this particles entrained from the brine tend to settle in the entry area of the heat exchanger which leads to a narrowing of the entry cross section and thus to a pressure rise and back pressure in the electrolytic cell. This results in an impairment of the production operation. In addition to this the apparatus should weigh little because it is mounted directly on the amalgam decomposers without additional mountings.

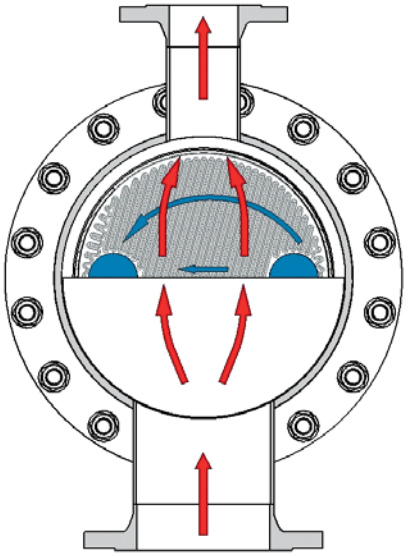
High heat transfer rates

To ensure trouble-free operation of the plant, GESMEX plate heat exchangers from the XPS range are used. After intensive consultation with INEOS the plate & shell model, which is proven for condensation tasks, was further developed and optimised for the application.

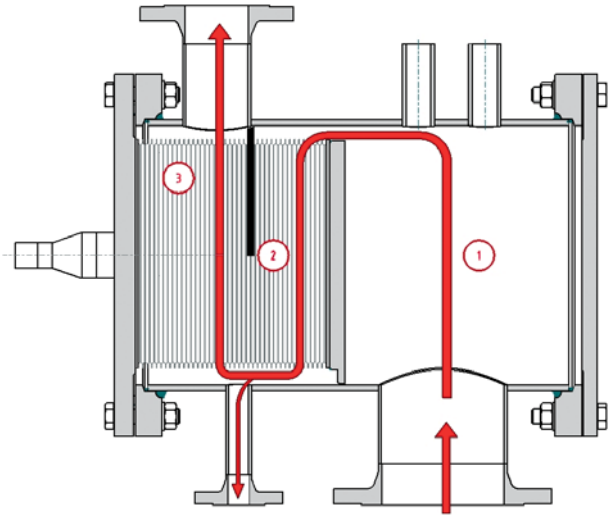
The media are run in a cross flow. On the primary side the cooling water flows into the flow channels on the plate side at a steep angle over the corrugated pressed plate surfaces. On the secondary side the gas is conducted on the shell side at a flat angle to the direction of the pressing. Due to this on the primary side a deliberately high pressure loss occurs which through high heat transfer rates leads to a limitation in the cooling water flow required. On the secondary side the gas has little flow resistance to overcome, due to

XPS-Plate Heat exchanger in Plate & Shell Design

which less pressure loss and thus back pressure occurs in the electrolytic cell.



Media running in cross flow



Several baffles on the shell side

The gas is re-directed several times on the shell side. This means the gas is led through the heat exchanger in three passes. The first pass contains no heat exchanger plates. Here the gaseous medium can be calmed and entrained particles lose their energy of flow. A large proportion goes back into the cell due to gravity.

In the second pass the condensation of the water vapour takes place. The condensate is further cooled and after the second flue is discharged from the heat exchanger and fed back into the electrolytic cell.

In the third pass further cooling of the gas stream takes place.

Maintenance made easy

The shell is designed to open at both ends. The construction allows the plate pack to be withdrawn for inspection and cleaning at planned maintenance intervals. INEOS keeps a replacement plate pack in reserve so the heat exchanger can go back into operation after a short shut-down. In addition to this the openable construction permits inspection of the vapour chamber at the gas entry side. If, after a lengthy period operation, particle accumulations should continue to occur, the retrofitting and later the regular maintenance of a filter element is possible here.

All installed parts are made of metallic material. The laser welded plate pack is already free of gaskets. Also in the construction of flow directors, of baffles on the shell side and other installed parts elastomers have been completely dispensed with. Leakages due to hardened or porous materials are thus ruled out in advance.

The apparatus weighs little. In principle plate heat exchangers offer large exchange surfaces in a small space. The XPS plate packs are made of plates only 0.6 mm thick. In addition to this the cylindrical build has a high shape stability which allows the use of lower shell thicknesses. With external dimensions of 650 x 720 mm an apparatus weight of less than 190 kg was able to be achieved. The connection geometry is matched to the existing installation. Since it is about the replacement of existing apparatus it was important to limit expenditure for pipeline changes. By individual design of the connection arrangement, the connection nominal diameters and the fitting of connections for further safety equipment, this requirement was also able to be met.

Dipl. Ing. Thomas Bieler

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