The first complete plant from Sulzer Chemtech for ethanolamine production has been operating in Fushun (NE China) since 1997. The second is also located in NE China, the third is under construction in Taiwan.

Sulzer Chemtech has more than 25 years’ experience in the field of ethanolamine technology. This know-how enables offers to be made for comprehensive engineering services as well as key components, such as distillation packings, and for the modernization of existing plants. Sulzer Chemtech has been supplying complete plants for the production of ethanolamine for some years.

The distillation technology for ethanolamines, especially structured packings, for the majority of the plants worldwide and the most important producers emanates from Sulzer Chemtech. The first Sulzer packings were installed more than 25 years ago, and since then Sulzer Chemtech has continuously extended its spectrum of products in the field of ethanolamine technology. For example, existing columns can also
be retrofitted now with Sulzer packings. Complete plants (systems) have also been supplied for some years (Fig. 1). As a minimum, Sulzer Chemtech provides the basic engineering, key components (Fig. 2), as well as the licence for the distillation technology. Sulzer Chemtech acquired the services of the Italian company Conser S.p.A., the licensor for the reaction, with which it first became possible to offer complete plants. Beside the structured packing (Mellapak), the key components include the heat exchangers and the vacuum system for the columns, the mixers for the reaction, as well as the complete plant control system. The supply of the key components enables Sulzer Chemtech to guarantee the reliable operation. Furthermore, important parameters such as production purity and the capacity of the plant comply with the respective specifications.

THIRD COMPLETE PLANT UNDER CONSTRUCTION

Two complete plants from Sulzer Chemtech are already in operation; both are located in NE China. The guaranteed values for the product purity, colour (quality characteristic) and capacity have been attained. Since the climatic conditions which prevail in this part of China during the winter warrant special consideration, the plants have to be provided with steam-trace heating to ensure that the amines do not solidify at the very low temperatures (down to –20 °C).

One of the plants produces 10 000 t ethanolamine a year, the other 5 000 t. Sulzer Chemtech is now extending the first plant with a second production line, which will double the output capacity. A third complete plant from Sulzer Chemtech is being under construction in Kaohsiung (Taiwan) and will be commissioned in the second half of this year. In this case, Sulzer Chemtech is not only responsible for the engineering, but also for the commissioning. The Oriental Union Chemical Corporation wants to produce 40 000 t/a amine in this plant. Further projects are being processed.

So-called product teams, comprising various experts and product departments, are formed for the project development: One person each from the sales, process engineering and contract-processing departments handle the contract together. This maximizes the customer benefits.

RANGE OF APPLICATION FOR ETHANOLAMINES

Irrespective of whether it is needed for gas purification or raw material for the synthesis of fine chemicals, the range of application for ethanolamines is very diverse (Fig. 3). The mostly utilized feature of ethanolamines is the surface tension reducing effect, which enables the mixing of water-soluble and water-insoluble substances. There are three different ethanolamines: mono-, di- and triethanol. Monoethanolamine is used primarily for the extraction of CO₂ and H₂S from natural gas. Diethanolamine is employed, first and foremost, for organic synthesis. 85% triethanolamine serves among others as an additive in the cement industry.
Principal area of application for ethanolamines is the gas purification process, by which CO₂ and H₂S are extracted from natural gas (a). In addition, they are also employed as raw material, e.g. for pesticides (b), toilet requisites (shaving foam, c) or detergents (d), as well as an additive in the cement industry (e).

At the moment, the world market for all three ethanolamines is about 1 mio. t/a, whereby approximately 50% is sold in the USA and Western Europe. The most important producers are located in the USA, Europe and Japan. The worldwide growth rate is estimated to be 3–4% per annum, and it is probably as much as 6–8% in the non-producing Asian countries. Many of these countries plan to manufacture ethanolamine themselves in future to cover their own requirements.

FEW BY-PRODUCTS AND HIGH FLEXIBILITY

The raw materials for the reaction are ammonia/water and ethylene oxide (Fig. 4). The reaction takes place without catalyst and is significantly exothermic, i.e., the developed heat has to be removed continuously. Due to the high reactivity of ethylene oxide (among others the danger of explosion), care must be taken that its conversion is complete. Alternative processes operate with highly concentrated ammonia. Since pure ammonia is gaseous under normal conditions, it is necessary to work under high pressure (50–70 bar) with this process.

The formation of mono-, di- or triethanolamine depends thereby on whether an ammonia molecule reacts with one, two or three ethylene oxide molecules. The composition of the resulted mixture depends on the ratio of the raw materials and can be varied in a goal-oriented manner. The higher the proportion of ammonia, the more monoethanolamine is formed – with the Sulzer Chemtech process it is a maximum of 70%.

HIGH QUALITY THANKS TO LOW TEMPERATURES

One of the major difficulties is the separation of the products, because ethanolamines are sensitive to heat and they have to be separated with every care. The higher the temperature (the pressure), the more yellow the ethanolamines become. The colour, however, is the most important quality characteristic; the colourless the substances are, the higher the market value. After the reaction, the surplus ammonia is stripped out and the water removed from the reaction mixture by distillation. Both are returned to the reaction again. After this, the ethanolamines are separated from each other in a three-step distillation unit. Thanks to the low pressure losses, for which the structured packings from Sulzer Chemtech are renowned, it is possible to perform the distillations at very low pressures (head pressure 2 mbar) and therefore also at low temperatures. The liquid ring-vacuum pumps from Sulzer Burckhardt also contribute to the gentle distillation, because their reliable and stable operation keep constant pressure in the column. In addition, so-called falling-film evaporators are applied to vaporize the bottom product with the utmost care again.
ECOLOGY-FRIENDLY PROCESS
A purity of more than 99% is attained with all three products. Technical grade triethanolamine with a purity of 85% is obtained as a residual product of the distillation, which is also a valuable product. In other words, there are no organic waste products throughout the complete process and only 0.1% of the used water has to be disposed as waste water. Thanks to the high separation efficiency of the packings, the energy consumption of the columns is low and smaller columns can be employed.

This process may be rightfully described as ecology-friendly.

FURTHER TECHNOLOGIES
In addition to the ethanolamine technology, Sulzer Chemtech offers together with customers and partners further technologies for reaction and separation, for instance the purification of ethylene oxide as well as the technology and the key components for ethylene glycols, alkylethanolamines and glycol ethers. Glycol ethers (reaction of ethylene oxide with alcohols) are employed as solvents for paints or for brake fluids. Sulzer Chemtech can, together with a partner, offer the technology for the production of brake fluids. At the moment, the worldwide demand for glycol ether is about 750,000 t/a.

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A mixture is formed from the three kinds of ethanolamine (mono-, di- and triethanolamine) by means of a non-catalytic reaction and is then separated by means of distillation.