Trends towards process- and energy-optimization in the industrial evaporation and crystallization

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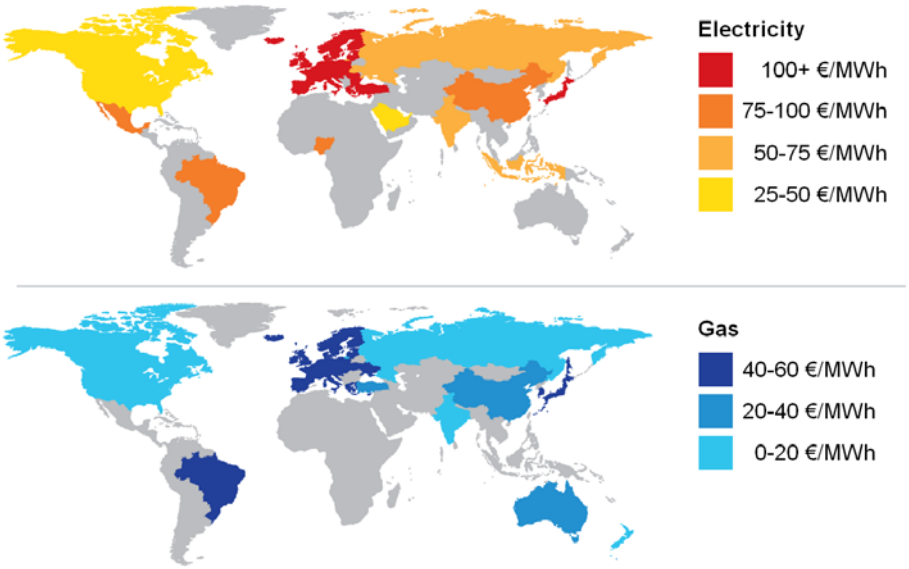
Due to the constantly increase in global population and the rising standard of living in many countries, the consumption of high-quality food will continue to increase in the future. At the same time, there is a worldwide reduction in the usable cultivation areas through erosion, karstification, progressive climate change as well as the loss of land through the urbanization, the new construction of road and rail networks and the like. This means that, despite decreasing cultivation areas for agriculture, the total yield on the available land must continue to rise in order to meet the challenge of a sufficient world nutrition in the future.

As higher yields for smaller cultivation areas can be increased mainly through higher use of fertilizers or the use of high-yielding plants, fertilizer production should also continue to rise in the future.

As is known, fertilizer production is a relatively energy-intensive production, resulting in high greenhouse gas emissions. However, a large number of countries around the world have settled on a climate agreement that calls for a reduction in greenhouse gas emissions, so that greater attention must be paid to energy consumption in the future. Furthermore, primary energy prices will continue to rise. In particular, electricity in Central Europe is likely to be disproportionately more expensive in order to reduce CO_2 emissions and to finance alternative energies. Also the subsidization of energy is likely to be reduced more and more in the future.

Since evaporation and crystallization in fertilizer production are often the most energy-intensive sub-processes in the overall process, it must be focused on the reduction of energy consumption in the future. This is especially necessary for European potash producers in view of their international competitiveness. Here the energy prices are already higher than in most other countries (Average retail electricity and gas prices for industrial consumers in 2012. Source: Eurostat Ert Benchmarking Report 2015):



There are generally two possibilities for reducing energy demands, which must be weighed against one another on the basis of different considerations depending on the application:

1. The retrofitting of existing plants with possibly simultaneous increase in performance.
2. Replacement of existing plants with new installations with lower energy consumption.

Typically, the types of plants used in the potash industry for the production of potash salts are e.g.

- 2-stage evaporation
- 3-stage evaporation
- cooling crystallization plants

The following is an overview of the possibilities for reducing the energy consumption in the different types of plants:

Evaporation

Action	**Saving potential approx.**
Upgrade of a 2-stage plant to 3-stage plant	35% of steam consumption
Upgrade of a 3-stage plant to 4-stage plant	25% of steam consumption
Upgrade of the pre-heating section	Depending on application, up to 10% of steam consumption
Upstream connection of a MVR*-plant	Depending on application
Conversion of a multi-stage plant to a MVR*-plant or new construction of a MVR*-plant and operation instead of multi-stage plant	Up to 100% of the steam consumption, but per ton of water evaporation depending on the solution 40-55kWh electrical energy are required

* MVR = Mechanical vapour recompression. The vapor steam evaporated in the evaporator is mechanically compressed and used to heat the stage itself.

Cooling Crystallization

Also in the case of cooling crystallization it is possible to indirectly reduce the energy consumption. Thus, the defined measures describe possibilities for preheating the mother liquor recirculated for the hot dissolution to a higher temperature. This reduces the amount of steam required to preheat the target temperature required in the hot dissolution.

Action	**Saving potential approx.**
Increase in the number of crystallization stages with heat recovery	Up to 15% of steam consumption
Enlargement of the heat transfer surfaces of the surface condensers in the stages with heat recovery	Up to 20% of steam consumption
Design of the first stage with direct condensation on recirculated mother liquor (if permitted within the framework of the water balance)	Up to 10% of steam consumption

Also the yield can be increased by deeper cooling in the last stage, whereby the rate of the lye circulation in the entire factory can be reduced with the same production quantity saving pumping energy. This could be done e.g. by the use of a refrigerating machine which consumes relatively little electrical energy at the required low temperature difference (approx. 0,1 kWh electrical energy per kWh cooling performance).

In all relevant plants the process can also be optimized by

- Increasing the automation for reduction of personnel requirements and optimization of the process.
- Use of frequency converters for pumps to save electrical energy, especially when operated at low load. This is possible since the pumps are generally designed with reserves, which are spoiled in control valves. A further advantage of the frequency converters is that wearing control valves can be omitted.
- Minimization of the amount of extraneous water in the plants by means of control mechanisms such as flow sensors or flow meters at all points where unnecessary water can enter the plant.
- Increase of the flushing intervals of the plant by installing a functioning flushing system in the vapor chamber of the apparatus for wall washing. This should also reduce the clogging of the heating pipes and thus enlarge cleaning intervals.
- Reduction of the amount of water required for the flushing at droplet separators by using a differential pressure measurement and thus controlled automatic flushing.
- Increase of the crystal concentration in the apparatuses by means of a suspension extraction with density measurements in order to operate optimally. Higher concentration means larger grain-size and less salt caking.

The limits for the above conversions are set by the following:

- The boiling point elevation of the solution to be processed
- The existing cooling water conditions
- The investment costs depending on current and future energy prices or profitability calculations of the customers

As is often the case, it is difficult to make a general statement. It must be weighed in each individual case whether it is worthwhile to carry out appropriate conversion measures or new construction measures. However, the rule of thumb is that the older a plant is, the higher is the savings potential as in the past, less emphasis was placed on low energy consumption. That is why a conversion should be more profitable in this case. EBNER would be glad to check the savings potential of your plant.

Unfortunately, due to the current management structure and the copy of the American system of shareholder value, there is at present too little focus on

necessary initial-, replacement- or conversion investments. However, taking into account the necessary reduction of CO_2 emissions because of climate protection reasons and the future competitive mode of operation, greater attention should be paid to appropriate investments. After a few years, when the investments are long forgotten, the running costs determine the profit and survival of a company and not the amount that has been distributed to shareholders in advance.