Harnessing power from plant synergies

J.R. Ferrer and **L. Marzo** report on recent process developments to ESPINDESA's nitric acid and ammonium nitrate processes. They include the installation of a power generator linked to the nitric acid compressor train to produces enough energy to operate the nitric acid-ammonium nitrate complex, and improvements to the design of pipe reactors and recirculation vessels for nitric acid neutralisers in ammonium nitrate plants

ESPINDESA designs different types of nitric acid units (mono-pressure plants or dual-pressure plants, optimising either the steam export or the electric power generation) and granulation or prill ammonium nitrate plants equipped with pipe reactor or recirculation neutralisers.

Nitric acid-ammonium nitrate complex

Ammonium nitrate units are generally linked to their corresponding nitric acid unit and the design of the complex must optimise the synergies between both units and outside battery limits (OSBL) to maximise their efficiency.

When considering the overall complex, the nitric acid unit is a steam producer while the ammonium nitrate unit is a steam consumer. The levels of steam pressure and sources of steam have to be selected. In the absence of other steam sources, apart from the start-up boiler, it is common practice to supply the ammonium nitrate unit with steam from the nitric acid unit and to maximise the use of internal low pressure steam produced in the ammonium nitrate neutralisation. The level of steam in the nitric acid unit is selected to maximise the efficiency of the steam turbine in the nitric acid compressor train.

In some cases a power generator is installed, linked to the shaft of the nitric acid compressor train to convert the excess steam into electric power. In other cases the option exists to produce enough energy in the power generator to supply all the power needs of the ammonium nitrate and OSBL Units in such a way that the complex can operate as an island making it independent of electricity frequency fluctuations occurring in the external electrical network. This arrangement can be particularly advantageous in remote locations.

PHOTO: ESPINDESA

Nitric acid unit

Another synergy between the nitric acid and ammonium nitrate both units is the recirculation of contaminated condensates from ammonium nitrate to nitric acid unit: part can be used as process water in the absorption systems and the rest can be converted into demineralised water for steam generation.

Nitric acid plants

The nitric acid units could be designed in different ways as a mono-pressure plant where reaction and absorption take place at the same pressure (nowadays at pressures ranging from 8 to 16 bar) or as a dual-pressure plant where reaction takes place at lower pressure level than absorption.

The current trends towards higher ammonia prices, together with high effi-

ciency catalyst recovery systems and long catalyst campaigns, is moving the market towards dual pressure plants, mainly for high capacity plants, despite the slightly higher investment cost. Only small- or medium-size plants and strategic units, where the efficiency is not crucial, select mono-pressure plants.

Above: Ammonium nitrate prill tower
Below: Nitric acid compressor

Photos courtesy of Espindesa

Ammonium nitrate plants

When selecting an ammonium nitrate plant design, there are a number of choices to be made, the first one being the type of reactor e.g. pipe reactor or recirculation reactor. In ESPINDESA designs, a pipe reactor is commonly used for capacities up to 250 t/d and a recirculation vessel for larger capacities, up to 1,200 t/d.

The reaction pressure has to be selected to avoid risks derived from running the reactor at high temperatures. On the other hand, the steam pressure has to be high enough to make it valuable: neutraliser pressures ranging from 0.5 bar to 3.5 bar are being used for this purpose.

Steam scrubbers, dryer scrubbers, and the recirculation prill tower scrubber need to be designed to minimise pollutant emissions to the atmosphere.

A complete study of the different steam condensates has to be carried out in any plant design to maximise the reuse of contaminated condensates and to select the appropriate purification methods.

Recent project experience

The last project started-up by ESPINDESA a few months ago was the new nitric acid and industrial grade ammonium nitrate (IGAN) units for the Chilean company Enaex at its Mejillones complex in the north of Chile. The capacities of the plants are 925 t/d for nitric acid and 1,060 t/day for IGAN. This new plant is a good example of what has been explained above.

The Enaex complex is located in the well known mining area near the city of Antofagasta in the north. Due to the existence of several big mines, this regions suffers from many problems with the electricity network such as sudden drops in the electrical network and even several electrical shutdowns thoughout the year.

These electrical shutdowns cause a lot of problems in the normal operations of nitric acid and ammonium nitrate plants, as well as loss of production due to unexpected shutdowns and time required restart the plants and reach stable operation.

For all these reasons, ESPINDESA installed a power generator attached to the compressor train that utilises all excess steam, plus some steam imported from the complex, to produce enough electrical power to maintain operation in all nitric acid units in the complex when there is a electrical failure. This also helps to avoid damage to the catalyst gauzes due to multiple start-up and shutdowns. ■