Fertilizer FOCUS

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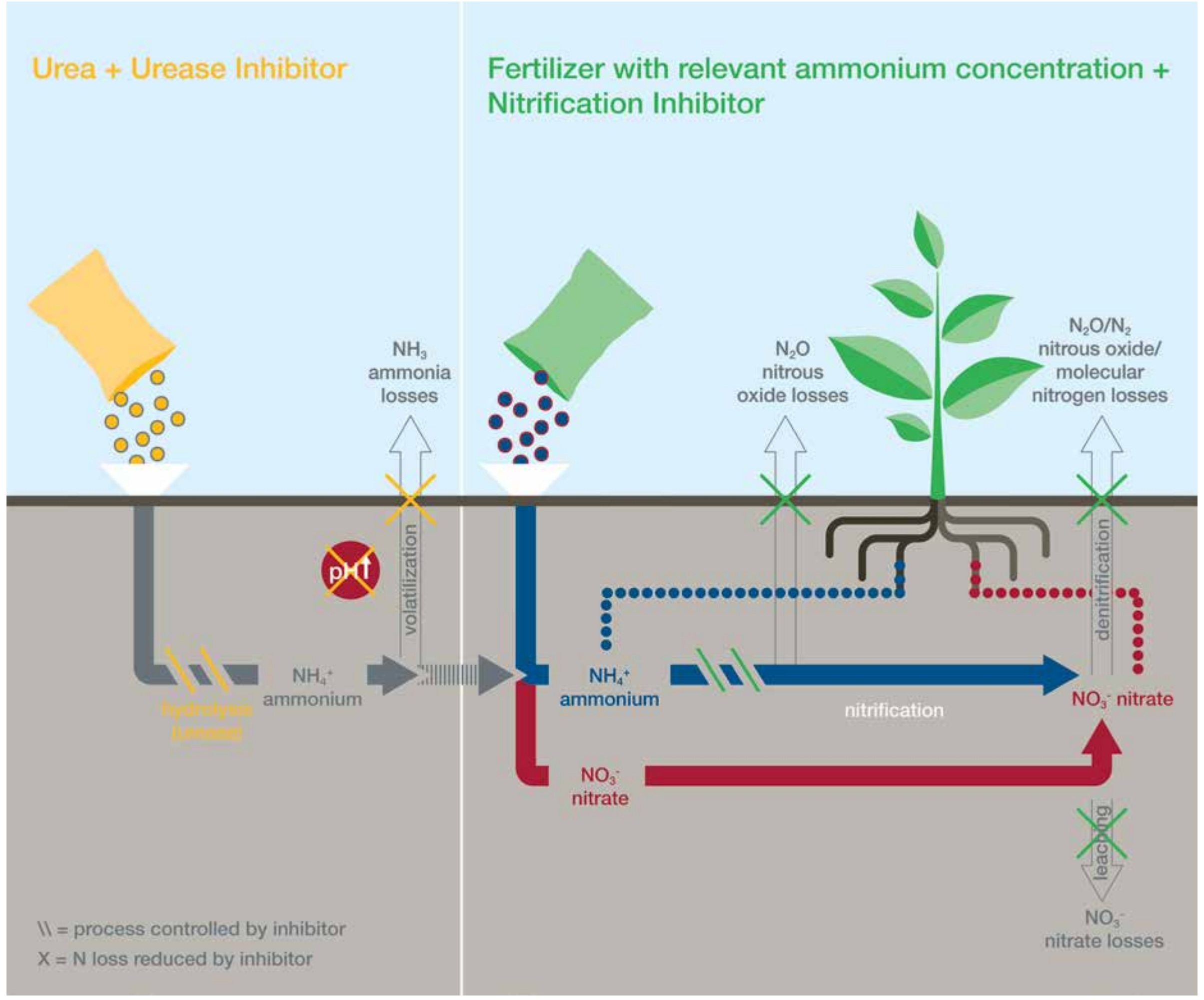
Fertilizer transport logistics

Trade routes through Brazil and Mexico

2019 market outlook | Water solubles | Secondary nutrients

Figure 1. Diagram showing the effects of using EEF inhibitors



already indicating that EEFs can play a significant role in more sustainable agricultural production, the challenge for our industry will be to ensure that innovation at least keeps pace with these regulations. In fact, we in the industry have a good track record of working with farmers to help them make best use of their fertilizers, ensuring the dissemination of research findings and thereby minimizing any fertilizer mismanagement.

Targeted nutrient application

We have already seen transformative shifts in how the agricultural sector operates. The introduction of new technologies, greater adoption of precision agriculture through tools such as GPS, yield monitors and advanced soil analysis, mean that the farmer is better equipped than ever with knowledge about the existing nutrient levels in their fields. With all this data and other information, farmers are now able to target nutrient application appropriately. This means fewer fertilizer losses to the environment.

Add in the industry's determination to play its role by encouraging nutrient stewardship and it ensures a focus on delivering a science-based approach to crop nourishment and the best ways to use fertilizers.

EEFs are the latest step in encouraging farmers to manage nutrients. By reducing nutrient losses to the environment and increasing their availability to the plant, they not only represent a science-based answer to the environmental questions being raised by farmers but, at the same time, a solution to the societal challenge we all face – how to grow enough food for the ever-increasing numbers of people inhabiting our planet.

Perhaps if this happens we can expect to see a more positive view of our industry, one fuelled by an acknowledgement that we again reached into science and through our research efforts found an answer to one of the great challenges facing mankind. And maybe then, when we are reading those much-loved 'top ten' articles about the greatest innovations of all time, fertilizer will again feature in the rankings. ■

Bridging the gap

for small scale ammonia production

by **Derek Lennon,** Consultant, Capital Plant International (CPI)

A new process design is now available for small ammonia plants which could achieve production costs similar to large-scale plants. This design could bridge this gap and enable people who want to use ammonia on a small scale for production of ammonium nitrate, DAP or chemicals to produce ammonia locally at an economic cost without recourse to importation of ammonia from remote major scale plants.

"There is a need to mitigate the scale factor for smaller plants

The developments which led to the present-day technologies for the production of ammonia started in the early part of the twentieth century. At this time Casale were among the pioneers and leaders in developing ammonia synthesis technology. The company favoured a high synthesis pressure of 600 bar so the produced ammonia could be condensed by cooling water without a refrigeration unit. Carbon dioxide removal from the synthesis gas was carried out by water wash.

Concept development

In the mid-twentieth century, plants were built to produce 100-300 t per day at a synthesis pressure of 300 bars. Water wash was supplanted by MEA (monoethanolamine), potassium carbonate and to some extent by the Giammarco-Vetrocoke process which used an arsenious absorbent solution.

In this period, Franco Torresy and Herb Hamilton of C&I Girdler designed a skid mounted plant with a capacity of either 100 or 200 t per day. Some thirty of these plants each in 17 skids were sold worldwide and one or two are still operating today.

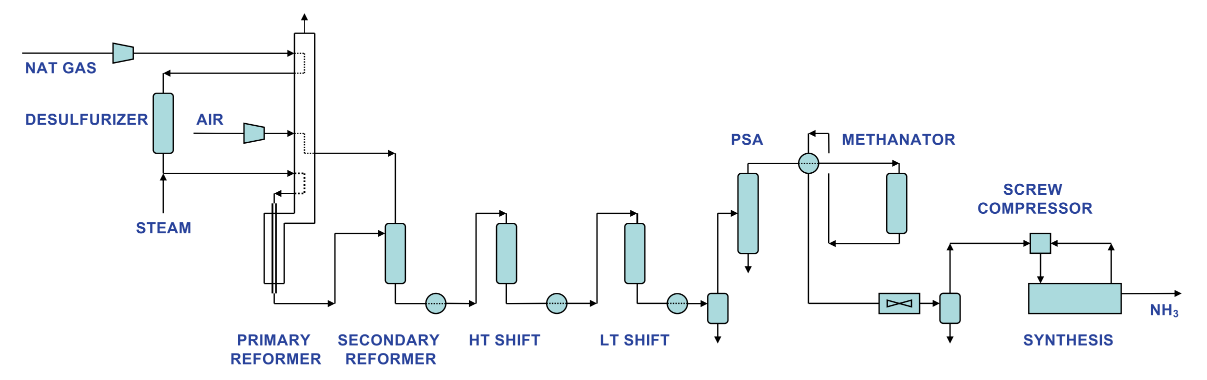
Compression of the natural gas feed, synthesis gas and ammonia for refrigeration was undertaken by an integral horizontally opposed reciprocating compressor driven by a synchronous electric motor. The energy consumption was 61 GJ/tonne of ammonia (52.5 MMBTU/short ton).

In the 1960s the Kellogg International Corporation developed a new process scheme in which the ammonia plant incorporated a 100 bar steam system and the steam produced was utilised to drive centrifugal compressors for all the process requirements. The synthesis was carried out at 160 bar. The ability of centrifugal compressors to handle large volumes of gas meant much larger ammonia plants could be designed. The first was engineered for Mississippi Chemical with a capacity of 1000 t per day. From this time, large new ammonia plants have used this process concept and capacities have increased to 300 t per day to take advantage of the scale factor and reduce the impact of the per t capital cost. However, the process could not be used for plants much below a capacity of 500 t per day because of the limitations of the synthesis gas compressor. So most plants below 500 t per day still had to use reciprocating compressors.

Enhanced capacity

Various incremental improvements to the process were developed over the years. One of the most important was the introduction of axial/radial flow

Figure 1. Schematic flow sheet for the new CPI small ammonia plant.



internals in the ammonia converter which enhanced the capacity and diminished the energy requirement. Casale are a leader in this field revamping many of the world's existing ammonia plants.

When we look at the present world situation, plants have now been built up to 3000 t per day because of the economies of scale in the production cost of the ammonia which depends primarily on the cost of the gas and the impact of capital cost.

The question is how can we overcome or mitigate this scale factor for smaller plants? CPI can do this with the small ammonia plant designed because of the following factors:

1. Shorter project execution time of 24 months against the normal 36 months for a major plant with consequent saving of interest during construction
2. Skid mounting therefore minimizing field construction. Field construction for major plants is often in remote or expensive areas, but even in the US some projects have been abandoned because of uncertainty concerning construction costs.
3. Buyers normally require quotations for large plants on a lump sum turnkey basis which means the EPC contractor may add in a 30% profit and contingency element to cover risks.
4. Reciprocating compressors are eliminated. The CPI screw compressors system patented in the US is expected to operate for 4-5 years without maintenance so the cost impact of annual shutdowns is eliminated.
5. The CPI smaller plant will produce ammonia at a cost of USD50-100/t more than a 3,000 tonne per day plant given the same gas costs. However, the small user of ammonia making ammonium nitrate, DAP or for chemical production is faced with the substantial shipping costs, effect on cash flow and the need of costly refrigerated storage facilities for bought out ammonia. Even in the US where there are pipelines, the difference between the FOB Tampa price and the price to the mid-west US farmers is often around USD100/t. (See figure 1).

The natural gas feed is compressed to 40 bar and is desulphurized before flowing to the primary reformer. The reformed gas is partially combusted with excess compressed air in the secondary reformer to provide the requirements of nitrogen for ammonia production. The carbon monoxide is then converted to hydrogen and carbon dioxide in the shift converter. Removal of the carbon dioxide and excess nitrogen is achieved by a PSA unit. The synthesis gas is compressed in the US patented CPI system in Kobe screw compressors for synthesis at 100 bar. The plant has been designed for air cooling to avoid cooling water problems and to minimise permitting problems, particularly in the USA.

The approximate capital costs for a plant with offsites on a greenfield site range from USD65 mn for a 100 tonnes per day to USD175 mn for 500 tonnes per day. Trevor Brown of Ammonia Industry has written an excellent article on the 'Capital Intensity of Small-Scale Ammonia Plants'. This article says the lowest capital cost of greenfield plants per annual tonne of ammonia built in the US in the last five years was USD1,300. CPI's estimated capital cost figure for a 500 tonne per day plant is USD1,028.

The Manfredonia ammonia urea plants were relocated to Russia and Lithuania

Alternative power sources

The expected specific energy consumption is typically 33.5 GJ/t (29 mn BTU per t) of ammonia subject to climatic conditions. Johnson Matthey catalysts are used throughout.

There is considerable interest in the production of ammonia from wind and solar power to provide the electricity for electrolysis. The ammonia and compression system described in this article would be ideal for this route, but the overall economics are not favourable at the moment due to the cost of the electrolysers and the power consumption. Shell's 'REFHYNE project', for example, is for an electrolyser producing 1,300 t/year of hydrogen with 10 MW of power and a cost of EUR20 mn which would result in a cost of hydrogen almost double that from the steam methane reforming of natural gas. CPI is negotiating with selected EPC contractors for sales on a global basis.

Note: Conversion factors: 1GJ = 0.2388 Gcal = 0.9478 MMBTU ■

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