Expansion of Fosfertil's Complex in Uberaba, Brazil

Details of the increase in phosphoric acid capacity

by the addition of two evaporators.

By

Carlos Moreira Tomáz, tomaz@fosfertil.com.br & Paul Anthony Smith, psmitharaxa@terra.com.br

1- INTRODUCTION

The strategy of expansion of production of phosphate fertilizers at the Fosfertil Industrial Complex in Uberaba Brazil is obviously a function of the production capacity of phosphoric acid. The original two trains of reaction and filtration have been supplemented with an additional train and also "in-house" modifications were made to the two existing evaporators to increase the evaporative capacity. The next phase of expansion envisages the reduction in the strength of acid ex-filter to improve the filterability of the gypsum to gain additional capacity with the existing three trains. The increased evaporative load will be compensated for by the addition of two new evaporators.

The capacity originally envisaged for the complex was a capacity of 940 t P2O5/day, 296,000 t P2O5/year, after a period of de-bottlenecking reached 1200 t P2O5 /day, 400,000 t P2O5/year. The first phase of expansion of the Industrial Complex of Uberaba started up in 1998 with an additional system of phosphoric acid attack and filtration, raising the capacity to 1490 t P2O5/day, 496,000 t P2O5/year. The second phase, which has recently been commissioned, counts with two new evaporators, raising the capacity to 2001 t P2O5/day, 675,500 t P2O5/year. The future plans for Phases III and IV are already being studied and intend to raise the capacity of the Complex to 1,2 Mio t P2O5 /year.

2- OPERATING PRINCIPLES

2.1- GENERAL

The principal of the expansion, which was conceived by Krebs/Technip, is to temporarily operate the three phosphoric acid plants at a greatly reduced strength to improve the filterability and to enable the filters to operate at capacity equivalent to 667 tpd P_2O_5.

Presently the plants previously operated at about 27 – 28% P_2O_5 and the gypsum produced allows capacities of 470 – 500 tpd P_2O_5 to be attained. By reducing the strength to a value of the order of 25% P_2O_5 the filtration rate improves and the filters accept of the order of 670 tpd P_2O_5. The additional evaporative load is compensated for by the use of two additional evaporators. The existing units are of Krebs design with carbon block heat exchangers having an evaporative capacity of the order of 1000 tpd of water. The new units have carbon tube exchangers and are designed to evaporate slightly more water and are sized at 1070 tpd of water evaporated. These are the largest carbon-tube units in the world operating on phosphoric acid.

Two distinct methods of operation may be used, a full parallel operation or a series/parallel operation with blending of concentrated acid from two of the units with ex-filter acid. See Annex 1 and Annex 2.

2.2- REACTION & FILTRATION SECTIONS

The first two reactors were designed for 470 tpd P_2O_5 and were complemented with a third unit with a air-cooling capacity equivalent to 667 tpd P_2O_5. As such the cooling system of the older units, 150 & 160, had to be up-rated to the 667 tpd capacity. This included new surface agitators and air cooling/scrubbing system.

The three reactors now operate with identical operating parameters.

Prior to the expansion the three UCEGO filters, which operate in parallel, had been converted to have the same characteristics

Observation: In this description 25% signifies a design value of 25.41% P_2O_5 and 35% signifies 34.53%.

2.3- EVAPORATION SECTION

Although the evaporators are capable of operating in a purely parallel way it is of interest that they operate in a series/parallel way that produced an intermediate storage operating at about 35% P_2O_5.

The intention is to use the two new units on a duty from 25 – 52% P_2O_5 and blend this acid with the balance of the weak acid ex-filter to produce an acid with 35% P_2O_5 which is fed to the old carbon block units.

3- <u>PRODUCTION CAPACITIES</u>

3.1- REACTION & FILTRATION SECTIONS

The three existing reaction and filtration sections operate at a concentration of about 25% P_2O_5 each having a daily capacity of 667 tpd P_2O_5 a total capacity of 2001 tpd P_2O_5. As the operating factor of the R & F sections here in Uberaba is of the order of 337days per year this is equivalent to an annual capacity of about 675,500 tpa P_2O_5.

3.2- EVAPORATION SECTION

The operating factor of the present carbon-block evaporators is slightly lower than the R & F sections and is equivalent to 328 days per year. As such to attain the 675,500 tpa P_2O_5 the instantaneous capacity needs to be 2056 tpd P_2O_5.

Evaporating from 25% (24.51%) to 52% the evaporative load is 2.01 t H_2O/t P_2O_5. As such the total daily evaporative capacity needs to be 4137 tpd of water.

As each of the present units can evaporate 1000 tpd the water to be evaporated by the two new units is 2137 tpd or equivalent to 1069 tpd each.

In fact the new units will evaporate from 25% to 52% and discharge into a acid blending tank. The evaporative load is equivalent to a capacity of 1062 tpd P_2O_5 when evaporating from 25 – 52% P2O5. This acid mixed with the balance of the ex-filter acid, 994 tpd at 25.41% P_2O_5 produces a total of 2056 tpd P_2O_5 at a strength of 34.53% P_2O_5.

This mixed acid stream is fed to the two old carbon-block evaporators and the evaporative load of the 2056 tpd P_2O_5 from 34.53 to 52%, an evaporation rate of 0.97 t H_2O / t P_2O_5, is equivalent to the present load on these evaporators of 1000 tpd water evaporated each.

4- PRINCIPAL MODIFICATIONS

4.1- REACTION & FILTRATION SECTIONS

The three reaction and filtration sections needed some small modifications.

The older reaction sections, 150 & 160, had additional surface agitators fitted and modifications to the air-cooling system including the fan and gas scrubber.

On the three filters the following modifications had to be made. The following pumps had to be resized; Product acid pump, Return acid pump, Acid wash pump, Cake wash water pump & the Gypsum transfer pump.

4.2- WEAK ACID STORAGE SECTION

Modifications had to be made to enable the product acid from the two new evaporators to be mixed with the balance of the weak acid ex-filter.

Essentially this meant a new feed box to the weak acid storage tanks and additional acid feed pumps of a larger capacity for the old evaporators.

5- PROCESS DESCRIPTION OF THE NEW EVAPORATORS

5.1- GENERAL DESCRIPTION

Each evaporator has a flash-chamber EV-1801, around which a large circulation flow is assured by the axial-flow recirculation pump BA-1818.

The circulating acid is heated on the shell-side with saturated low pressure steam in a carbon-tube heat exchanger TE-1801. The design velocity in the tubes is such so as to minimize scaling and erosion.

The weak acid is fed into the circulation loop in apposition between the heat exchanger outlet and the flash chamber.
A in-line filter FL-1803, is fitted on the discharge side of the recirculation pump to prevent lumps of scale, dislodged from the body of the flash-chamber, blocking the tubes of the heat exchanger.

The liquid level in the flash-chamber is controlled by a stand-pipe overflow which drains by gravity to a self-controlling pump BA-1819.

On leaving the flash-chamber, by a transversal pipe, the evaporated water passes through a chevron-type droplet separator SE-1803, to recover any entrained droplets of acid. This acid also drains to the product acid pump, BA-1819.

The water vapour, free of acid droplets, them passes through a fluorine absorption tower, TA-1803, where the fluorine is recovered as fluosilicic acid. Entrainment of droplets of fluosilicic acid is prevented by a mesh pad mist eliminator installed within the tower.

With most of the fluorine removed the water vapour then passes to a barometric condenser TA-1804, which is fed with cooling water from a cooling tower. Vacuum is assured by the design of the condenser and no ejector or vacuum pump is required.

5.2- OPERATING PRACTICES

The heat exchanger is fed with de-superheated low pressure steam at a constant rate during the whole of the "on-line" cycle.

The concentration o the product acid is controlled by the addition of weak acid to maintain the boiling temperature of the acid in the flash-chamber at the operating vacuum.

Great care is taken to ensure that there are no problems with the evacuation of condensate as if there is a problem with condensate removal then tube breakage can occur. Condensate, after checking the conductivity, is discharged to the utilities section by the condensate pump BA-1823.

In case of contamination of the condensate then it is automatically discharged to effluent under level control.

6. HEAT EXCHANGER & PUMP DATA

Heat Exchanger

Supplier	SGL – Germany
Design pressure	Shell 3 bar gauge, full vacuum
	Tubes 5 bar gauge, full vacuum
Shell diameter	2068 mm i.d.
Tubesheet diameter	2040 mm
Tubesheet thickness	Upper 665 mm + 80 mm,
	Lower 600 mm + 80 mm
Heat Exchange area	1135 m2 based on o.d., 840 m2 based on i.d.
Number & diameter of tubes	979, 50 mm o.d., 37 mm i.d.
Nominal tube length	7500 mm
Tubeside velocity (nominal)	3 m/sec

Remarks

Erosion resistant inserts on the acid inlet to the lower tubesheet
Fitted with carbon-fibre reinforced tubes
Tubesheets reinforced with carbon-fibre
Steam inlet with distribution ring, bussel, to prevent impingement
Lower 1000 mm of shell in stainless steel, DIN 1.4571.

Circulation pump

Supplier	Ensival-Moret
Material	Elbow 904L
	Impeller & Wear-ring Sanicro 28
Type	CAHRM – Axial-flow elbow pump, top inlet
Size	Rotor – 1000 mm
Speed	411 RPM
Flow	11,500 m^3/h
TDH	6.3 meters
Power	800 HP installed

Remarks

Fabricated elbow
Mechanical seal with water flow and pressure controllers
Direct drive without pulleys
Removable wear ring