ISMA* Technical Meetings

Cambridge, United Kingdom
15-17 September 1953

**In 1982, the name of the International Superphosphate Manufacturers' Associations (ISMA) was changed to International Fertilizer Industry Association (IFA).*

International Fertilizer Industry Association - Secretariat: 28 rue Marbeuf - 75008 Paris - France
Tel. +33 1 53 93 05 00 - Fax +33 1 53 93 05 45/47 - ifa@fertilizer.org - www.fertilizer.org

No Diagram.

THE INTERNATIONAL SUPERPHOSPHATE MANUFACTURERS' ASSOCIATION

AGRICULTURAL COMMITTEE
1, AVENUE FRANKLIN D. ROOSEVELT
PARIS (8E)
TEL. BALZAC 57-25

CENTRAL OFFICE
32 OLD QUEEN STREET
LONDON, S.W. 1.
TEL. WHITEHALL 7262

LE 397
TECHNICAL MEETINGS 1953.
Paper (B) 3

September 1953

CONFIDENTIAL

This paper will be presented at the Technical Meetings in Cambridge on 15th and 17th September, 1953. It must not be published prior to that date and, in any case, it must not be published without the permission of the author.

ENLARGEMENT OF A CHAMBER SULPHURIC ACID PLANT BY ADDITION OF PETERSEN TOWERS

By Montecatini, Societa Generale per l'Industria Mineraria e Chimica, Milan, Italy.

It often happens that old chamber plants for the production of sulphuric acid, to be used in the superphosphate industry, become inadequate to meet the heavier and heavier fertiliser demand. Although a low cost of production and a good quality acid may be possible to obtain, it follows that such plants must be examined by the technicians in order to increase their capacity.

Such was the position of one of the Montecatini's plants, the capacity of which, calculated in 50 Be sulphuric acid had to be increased from 50 tons/d to 80 tons/d, - an increase of 60%.

For such an increase, it was possible to add to the plant the furnaces necessary to meet the larger requirements of sulphurous gases from pyrite roasting, but it was not possible to enlarge the other installations, particularly the Glover tower, except by rebuilding them completely with consequent considerable expense and interruption of production.

Our technicians knew the possibility of increasing the capacity of chamber plants by inserting an independent unit consisting of a group of towers.(see e.g. the paper "The Petersen towers system" by Gerd Petersen, presented to the I.S.M.A. Technical Meetings in September 1949) and so they chose said installation to solve the above mentioned problem. Dr. Petersen of Wiesbaden gave his help as an adviser.

We think it will perhaps be useful for the Delegates of the I.S.M.A. Meetings to know the results obtained.

The chamber plant, before the enlargement, consisted of:-

4 multiple hearth furnaces for pyrites roasting and an ordinary, hardly efficient dust chamber.
1 Glover Tower in Volvic stone, m.3.8 inside diameter, packed with 150 x 150 stoneware rings, the packing height being m.7.5 and the overall height m.10.5.
7 - 5 x 5 m. lead chambers, 20 m. high, crossed in cascade

by gases, their total volume being m^3 3.500 and their overall cooling surface m^2 2.800.
2 Gay Lussac towers, m.2.3 diameter, packed with 110 x 110 stoneware rings, the packing height being m.16.4 and overall height m.18.7

As mentioned above, the average annual capacity of the plant was 50 tons/d of 50 Be sulphuric acid, with an average consumption of kg.0.75 36 Be nitric acid per 100 kg. 50 Be sulphuric acid. (0.63 HNO_3 % H_2SO_4).

Two towers were added to the plant, between the last chamber and the first Gay Lussac tower. These towers will be referred to henceforth as "Added Towers (A.T.)" The flow-sheet shows the circulation attained.

As you will note, the gas leaving the last lead chamber enters the first Added Tower at the bottom, flowing upwards and entering the top of the second Added Tower wherein it flows downwards. It follows successively the ordinary cycle, entering the first Gay Lussac of the original plant.

The acid circulation was designed in such a way as to get a closed circulation on the two Added Towers, sending the acid leaving the first Added Tower through a water cooler to the top of the second Tower, and the acid leaving the bottom of the second Added Tower to the top of the first one.

A part of the acid leaving the second Tower is sent to the Glover for denitration, while a known quantity of weak acid from the chambers vessels and, also, if desired, a part of the acid from the first Gay Lussac outlet are sent to the second and first Added Tower tanks respectively. The acid circulation in the old Gay Lussac and Glover Towers is the same as before.

The two Added Towers are 4.5 metres in diameter and 16 metres in height; they are only partially packed with packing material, so as to leave a large vacant space on top for the reoxidation of nitrous gases.

It is known in fact that the first Added Tower packing is intended to absorb and oxidise the small SO_2 quantity escaping the last lead chamber owing to the larger quantity of SO_2 to be converted. The second Added Tower packing is intended to absorb the nitrous products re-oxidised in the empty space existing between the two packings.

The strength of the acid circulating in closed cycle in the two towers is controlled at 58 to 59 Be, and 15°C. by adding weak acid (47 to 50 Be) from the chambers vessels, to match the quantity of SO_3 produced in the first Added Tower.

An acid volume corresponding to this addition is sent to the Glover as 58 to 59 Be acid containing nitrous products corresponding to 90 to 110 g. 36 Be nitric acid per litre.

This procedure has two purposes:-

a) to denitrate the acid produced in the Added Towers,
b) to add to the Glover Tower and following chambers such an amount of nitrous products as to control the SO_2 absorption and oxidation in order to exhaust it completely just at the outlet of the first Added Tower.

In order to control the mentioned addition of nitrous products to the Glover, it may sometimes be necessary to take off from the Added Towers circulation a nitrous acid amount larger than the corresponding amounts of the acid produced by the towers plus the weak acid taken from the chambers. The requirement of weak acid depends on its water content and on the necessity to keep the Added Towers' circulating acid strength at 58 to 59 Be.

In such a case, the difference is taken from the acid leaving the first Gay Lussac with 15 to 20 g./l nitrous vitriol content.

A very efficient and effective operating control of the plant is obtained by varying the flow of acid taken off from the Added Towers circulation.

We have noted moreover that the two towers and their empty space play a role of automatic-control as to NO re-oxidation, with consequent increased stability in the plant operation.

The plant has been operating for over four months and it can be stated that with different production rates (from 66 to 88 tons/d 50 Be sulph.acid, viz. the maximum allowed by furnaces capacity) the nitric acid consumption is 0.75 kg. 36 Be nitric acid per 100 kg. 50 Be sulphuric acid, that is almost the same as before the enlargement. Sulphur utilisation too is unchanged.

The already existing installations are not submitted to a greater strain under the new working conditions than before. The Glover tower improved its denitrating effect owing to the higher temperature of the entering sulphurous gas and has always required the whole weak acid production of the chambers (less the quantity supplied to the first Added Tower;) sometimes it required also some water.

All the acid produced is 58 to 59 Be strong though a remarkable quantity of water is sprayed in the chambers, with consequent advantage for lead maintenance.

Thermic conditions of chambers vary by raising the last chamber temperature from 45° /50°C. to 70°/ 75°C., but never allowing a temperature higher than 100°C. in the first chamber.

The Gay Lussac towers proved in excess for the recovery of nitrous products still existing in the gas leaving the second Added Tower.

The Montecatini technicians planned the new installation so as to attain a low construction cost and, at the same time, to test materials and building methods almost new in a field where lead was of paramount importance: lead was absolutely excluded in the construction of the new towers.

Let us rapidly summarize the principal features of the installation:

a) The added Towers were built in the open air with a concrete base some thirty centimeters high on ground level.
The bottom of the towers operates also as a tank and its capacity is designed large enough to contain the acid dropping from packing even during stoppages.

b) Two small tanks (ø 1.m.) directly connected, through a short big pipe to each tower bottom form the support of chromium-molybdenum iron vertical pumps for acid circulation in the Added Towers. These tanks contain also the level meters and the connections for acids added to the circulation of the new towers.

c) It was proved that in Italy the use of 20 to 35 mm. crushed quartz "breccia" as tower packing material is less expensive than stoneware. We used therefore quartz breccia arranged in

c) continued
bulk, the tower shell being planned so as to withstand the lateral thrust of this heavy and coarse packing.

As an experiment, the two towers were built in different materials, their cost being estimated to be the same. The first Added Tower and the two little tanks containing the vertical pumps were built in steel sheet lined with a thin (mm.0.8) coat of "vipla" (polyvinyl chloride). This lining was protected, in the tank and in the lower part containing the packing, by stoneware tiles cemented with acid-proof mortar.

The Second Added Tower was built in Volvic stone, with the exception of the cover, which consisted of a 3 mm. thick polyvinyl chloride sheet supported by an outside frame of steel pipes.

The outside plating of the bottom of the Volvic tower also consists of polyvinyl chloride, to ensure its tightness, and the protection of the steel bindings of the Volvic layers.

d) Acid cooling is obtained through acid-proof cast iron cascade water coolers, placed in an elevated position so that they are automatically emptied into the lower tanks during shut-downs.

The installation covers a narrow area (m.22 x 8) viz. about 6 m^2/ton/d, considering that the enlargement capacity is of 30 tons/d, whilst a chamber plant requires 14 to 15 m^2/ton/d, furnaces area excluded.

The cost of the new installation, excluding the new furnaces building and including the expenses for the larger quantity of cooling water required, was 70 million lire, viz. 2.33 million lire/ton/d, considering the capacity enlargement, while a 100 tons/d 50 Be acid chamber plant costs today 3.8 million lire/ton/d, furnaces excluded.

Production cost, whilst unchanged as far as raw materials (pyrites and nitric acid) are concerned rose slightly for water and power. On the other hand, savings in labour,due to a greater production, covered by far the increase.

We cannot yet submit any data on maintenance cost because of the short period the plant has been operating, and we have no data available on the durability of polyvinyl chloride. We think anyway that the cost will be lower than in the past.

Finally we can state that with the enlargement of a chamber acid plant by addition of Petersen towers, we can obtain:-

- a lower installation cost,
- a lower working cost,
- all the acid production at 58 to 59 Be.