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OBSERVATIONS ON SUPERPHOSPHATE AND SULPHURIC ACID PLANT AND MANUFACTURE IN INDIA – WITH PARTICULAR REFERENCE TO THE PLANTS AT ALWAYE

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SUMMARY.

(a) A description of the 75 ton Sulphuric acid Plant.
(b) Some points that we have noticed during the operation of the Sulphuric acid plant for 2 years.
(c) A short account of the Superphosphate Plant fabricated locally.
(d) A note on the economics of handling of materials in small superphosphate works.
(e) Some points regarding Superphosphate manufacture in India.
(f) A brief note on a development proposal, namely manufacture of Ammonium Phosphate.

SULPHURIC ACID PLANT.

The Sulphuric acid plant at Alwaye has a rated capacity of 75 S.Tons (of 2,000 lbs.) a day, of which about 58 tons is used for the production of Ammonium Sulphate and the balance for Superphosphate manufacture. It is a Monsanto Plant. It was erected during 1946-1947 and went into production in March 1947. Till date we have produced over 35,000 tons of acid.

The raw material is pure sulphur imported and we have used over 12,000 tons. The plant is an out-door type, i.e. only the control room, blower and feed water pumps are under cover.

Sulphur supply: Sulphur is imported in ship loads and brought and stored in the sulphur godown similar to the rock phosphate described elsewhere. We have extended the godown flooring for additional storage envisaged by the installation of the new plant. But the extension will have no roof.

Our plant is an example of a most modern one with excellent heat utilisation.

A description of the flow and process: The first portion is the drying tower where 98% acid comes from the top 2 layers of pebbles and Berl saddles. Air is forced up by a blower. From the top of the drying tower air goes into the secondary heat exchanger and then to the primary heat exchanger and enters the burner at 720°F

The sulphur is melted using steam from waste heat boiler. The molten sulphur is pumped into the sulphur burner. The temperature of the gas leaving the burner is about 1,800° F. and SO_2 concentration 8%. The heat produced in the burning of sulphur is utilised for producing steam in the waste heat boiler. After heating the waste heat boiler the gas enters the hot gas filter at 800°F. and then to the first converter at 750°F. and leaves it at about 1000°F. From the first converter the gas goes to the first heat exchanger to be cooled, and then to the second converter at 800°. From the second converter the gas passes through the secondary heat exchanger at 450°F. This gas goes up the absorbing tower from which 98.4% acid at 130° F. trickles down. Water is introduced into the pumping tank. SO_3 is absorbed and the rest of the gas goes by a 40 ft. stack. The 98.4% acid goes to a tank.

The main pieces of equipment comprising the Plant:

1. Absorbing tower.

This is about 9' in diameter and 21' high made of 3/8" M.S. plate and lined with acid proof bricks. It is packed with 3" spirals to a height of 12' from the bottom and 3' of graded pebbles over the spirals. The tower has 2' dia. inlet, outlet and necessary manhole. There is a distributor with 60 Nos. distributor tubes and chemical stoneware orifices are provided for each distributor tube.

2. Blower.

Roots Connersville Positive Pressure type blower of size 22" x 42", capacity 7000 c.f.m. against 80" total pressure.

The new plant has also the same type of blower and the discharge of the two blowers will be interconnected. In case a blower fails, the other could supply enough air to maintain temperatures in the plant, and this avoids shut down and consequent restart of the plant.

3. Sulphur Melter.

Size: 39'9" long, 8'2" wide and 5'3" deep with R.C. walls provided with overflow and underflow chambers. The top portion is covered with 3/8" plate with necessary manholes. Steam coils for the melter are 1½" steel pipes with supports. The total length of piping is about 750'. There is an agitator in the sulphur melting pit, driven by a 5 H.P. motor. There are two vertical centrifugal submerged molten sulphur pumps, driven by 5 H.P. variable drive motors.

4. Burner.

A sketch of the burner is given.

(Note: To be forwarded later, if reproduction is possible).

5. Waste heat boiler.

The waste heat boiler is a Foster Wheeler type. Water tubes with a total heating surface of 1288 Sft.

6. Hot gas filter.

Size: 11'6" dia. x 3'6" high and shell made of ¼" thick plate with inlet, outlet and manholes. It is packed with milled quartz pebbles, and in the new plant, we propose to have the flow of the gas reversed and the new plant will have an up-flow.

7. Sulphur Burner.

Sketch enclosed. (Note: see under 4.)

8. SO_3 Converter.

Size: 10'3" x 17'8" - Convertor shell of 5/8" plate. The unit is divided into two, the top portion called No.1 Converter and the bottom No. 2 Converter. For spreading gas flow over the entire area there are cast iron baffles. ½" Milled quartz pebbles are spread over the cast iron grids on which the catalyst mass rests. No.1Converter contains about 30% of the catalyst and No.2 the balance.

Catalyst had been made up after screening the mass and adding nearly 10% to make up for loss due to powdering of the catalyst. Original quantity of catalyst per charge is about 430 Cu.ft. Pressure drop increases due to powdering of catalyst but there is no deterioration in conversion efficiency.

In two years' working we have found the conversion efficiency to be 97%. The strength of acid that we make is 98.3%. The overall yield of H_2SO_4 per ton of sulphur is over 2.9 tons. The quantitative determination of sulphur feed is determined volumetrically by an and off calibration of the feed bin.

9. SO_3 Coolers, Nos. 1 and 2.

They are about 22 ft. high and of ¼" steel plate. They are having manholes as well as inlets and outlets for air and gas. They contain tubes.

10. Absorbing Tower.

Similar to drying tower.

11. Acid Pumps.

Acid pumps are of all iron type. The impeller, internal bearings, journals etc. are of illium. Direct connector motor through flexible coupling.

12. Acid Cooler.

The acid cooler is of 6" cast iron pipe mounted on steel frame. The cooler of the new acid plant also will be mounted on the same structure.

13. Instruments.

The instruments are all mounted on one panel board and consist of the following:

1. SO_2 Recorder.
2. Temperature Recorder & Temperature Indicator.
3. Tankometers.
4. Hydrometers.
5. Electrolytic Recorder for acid strength.
6. Rotometer for water measurement.

Personnel: 1 Senior Operator, 1 Junior Operator and 1 Helper.

The control panel of the new acid plant will also be on the same floor, and with one more operator the whole plant will be taken care of.

The plant has given satisfactory operation for over 2 years. We propose to increase the production of superphosphate to 200 tons a day. Along with the installation of the new superphosphate plant we have programmed to have one more acid plant. We expect to have the new acid plant and the new superphosphate plant completed by the middle of 1950.

Some of the salient points that we have noticed during the operation of the present sulphuric acid plant are given below:

1. In order to facilitate the cleaning of the sulphur melting pit we have to arrange for another melting pit, and we find this useful.

2. The plant is designed for 75 short tons of acid at 40" discharge. But we have found that for the production of 75 tons the optimum pressure is about 50". This is due to increase in pressure in hot gas filter, convertor etc. and generally in the system

3. With full production we can get about 60 tons of steam of which 13 tons is used in the plant and 47 tons goes to the mains.

4. The SO_2 in the exit gas is about 0.25% on the average.

5. The hot gas filter has been cleaned twice completely and 3 times raked. This is important. If the filter is not cleaned at least twice a year and raked at frequent intervals the pressure in the filter alone is bound to increase and at times even to 29".

6. The H.E. pipes have been cleaned only once in the last 2 years.

7. It is also important to have good quality boiler feed water. The reciprocating pumps (2 Nos.) had often given mechanical difficulties like piston being worn out. We feel this could be obv[iated] by having motor-driven centrifugal pumps. In the acid plant we propose having one motor driven and one turbine driven centrifugal pump, and we expect better performance.

8. The heat exchanger tubes get clogged, due to formation of acid mist and consequent $FeSO_4$, and this has to be cleaned at least once a year. The cleaning is a difficult job since each tube has to be dealt with.

9. Without impairing the efficiency of the plant it is possible to force up the production to 80 to 85 tons and lower the output to 30 to 35 tons level.

10. It is always economically sound to have larger capacity units of sulphuric acid plant, the optimum size being 50 to 100 tons a day; 50 tons for a superphosphate plant and the plants to be located as near the ports as possible to avoid long distance transport of the only raw material: sulphur. This applies to superphosphate plants also. For India the economic unit will be a 50 ton acid and 100 t[on] superphosphate a day, situated very near a port of entry.

SUPERPHOSPHATE PLANT.

Because of the need of phosphatic fertilisers for the food production drive we proposed to instal a superphosphate plant locally to make about 30 to 50 tons of superphosphate a day, with the acid available from the 75 ton sulphuric acid plant. We had to improvise methods for making use of the best available materials and space. We converted a storage godown into the main plant building. This building measures 250' x 100' and has tiled roofing. The height of the building is 30'. The floor is concreted and the sides are covered up to 14 ft (with brick + balance) with A.C. sheets.

The plant essentially consists of the following equipment:

1. Powdering equipment.

A Canary Pulveriser of the centrifugal type was available and we had to design a system of multicones for getting powder about 40% through 200 mesh. The powder is weighed on ordinary platform balance in 500 lbs. lime and elevated to the mixer platform 15 ft. from the ground level by means of a ½ ton motor driven hoist.

2. Mixing equipment.

We had to fabricate locally two mixers of the well-known Pratt type. The size of the mixers is 4 ft in diameter, 2 ft. deep and a capacity of ½ ton.

3. Acid dilution equipment.

Acid is drawn from the Sulphuric acid plant 1000 ft. away by a 2" line and stored in the Superphosphate plant in a 40 ton storage tank from which it is pumped up to the dilution tanks by a Worthington pump. There are two dilution tanks of size 9' diameter x 5 ft. high, provided with a set of cooling coils. Agitation of acid is done by means of compressed air. From the dilution tanks acid is drawn to the measuring tanks. Measuring of acid is done only volumetrically.

4. Dens. Mixed superphosphate is dumped into 3 stationary type dens, measuring 13' x 4' x 4'. The front of the den is covered by plant doors which are lifted by hoists. The digging of super from the den is done manually and transportation is done in wheeled carts. Now we have a pay loader, and we are using the same.

We have started erection of the new 200 ton superphosphate plant and now we are utilising part of the erected plant for the manufacture of 50 tons of superphosphate a day. A description of the new superphosphate plant under erection is given in an article by the writer in "Fact" Magazine, September Number, 1949.

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ECONOMICS OF HANDLING OF MATERIALS IN SMALL SUPERPHOSPHATE WORKS.

In superphosphate works, the transportation and moving and handling of raw materials and finished products at various stages of manufacture present a number of problems and the cost of production is largely dependent on these.

In works of small size where the output does not exceed say 15,000 tons per annum (like our present plant) manual labour is still employed. In our country where unskilled manual labour is cheap, it is necessary to study the comparative economics of mechanical and manual labour before installing modern mechanical handling equipment. The following example will make my point clear:

With our production rate of 50 tons of super a day we had to handle 50 tons of superphosphate and 30 tons of rock phosphate a day inside the building over an area of 300 ft. x 100 ft.

HA Payloader with ½ Ton capacity bucket:

Capital cost: Rs. 18,000.

For this the depreciation of an automobile of 20% can be allowed:

So depreciation: $\frac{18,000 \times 20}{100}$ = Rs. 3,600

Depreciation per day:	= Rs. 12.
Petrol 9 gals. at Rs.2 1/8 per gal.	= Rs. 19 1/8
Maintenance	= Rs. 1¼
Driver's salary per day	= Rs. 7¼
Total	Rs. 40

If the payloader had not been employed then, as per our experience, 40 men (unskilled labour) have to be employed and per day the expenditure is Rs. 80/- (40 x 2). So there is a saving of 50% in the employment of the payloader for internal transport per day, and this is quite an amount of saving annually.

Let us take another example:
A standard sewing machine for sewing of bags costs Rs.25,00[illegible] and we found that it is not an economically sound investment. Assumi[illegible] 10% depreciation for the machine:

the daily depreciation:	Rs. 8.1/3
other expenses & maintenance	" 1.2/3
Total	Rs.10.-

whereas, if manual labour had been employed and if we leave the work on piece work contract, the rate for stitching one bag is ¼ anna. Our daily production is 50 tons. So the charges for sewing bags for 50 tons a day is Rs.7-13-0. Hence, unless we go in for 100 ton production, the purchase of an automatic sewing machine is not an economically sound proposition. We have also to take into account that Rs.25,000 have to be invested as capital expenditure.

What I have tried to make out is that, in our country, in small fertiliser works, at every step before mechanisation, the relative financial advantages have to be carefully worked out.

The above point has added importance as far as India is concerned. Even if, in the balance of cost, manual labour and mechanical handling are equal or a bit high, in the case of manual labour, we have to go in for manual labour only because it is in the larger interest of the country and provides employment for as many as possible. If this is clearly kept in mind, fertiliser works can, to a small extent contribute towards raising the standard of living in the country.

(1/10/49)

SALIENT POINTS ABOUT SUPERPHOSPHATE MANUFACTURE IN INDIA.

1. The estimated requirement of superphosphate for the next 5 years is 100,000 tons per annum. But since India has decided to stop import of food grains by 1951, there is a possibility of the requirements shooting up.

2. The actual output in 1948 from the 11 superphosphate plants in India is about 24,500 tons, though the installed capacity is over 80,000 tons.

3. Both the raw materials have to be imported. Acid is produced partly in chamber plants and partly in contact plants.

4. Since transport is a vital question any new plant going up should be as near the port as possible.

5. Inland transport is also comparatively costly and concessional rates for fertilisers and fertiliser raw materials will be of great help to the farmer as well as the manufacturer.

6. It is possible to fabricate the necessary equipment for superphosphate manufacture locally. Only certain items of equipment would have to be imported.

7. The average analysis of superphosphate manufactured in India is as follows:

Moisture ....11 to 12%
Free acid ... 4%
W.S.P.A. 18%
T. P_2O_5.......19 to 20%

8. The curing period to be allowed is 4 weeks.

9. Experience has shown that there should be ample storage space for 3 months production of superphosphate and 6 months storage of raw material.

10. Local timber could be used as much as possible for the manufacture of plant, steel being in short supply.

11. It pays to give careful attention to keep the rock phosphate dry in transport and storage. Grinding difficulties will be experienced if the percentage of moisture exceeds 2%. In such cases it is always advisable to have a dryer installed. Our new plant has a flash drying equipment.

(1/10/49).

CONCENTRATED FERTILISER.

The National Planning Committee (India) in their report state:-

" If we import phosphate rock it will be necessary to start manufacture of super and triple super. We also recommend that the manufacture of ammonium phosphate should be fully investigated when the problems relating to manufacture of synthetic ammonia and phosphoric acid have been successfully tackled".

The manufacture of superphosphate, sulphuric acid and ammonia have been successfully carried out. We had to investigate how best to manufacture concentrated fertilisers, and had to study the trend in the demand and developments of concentrated fertilisers, and what is the best fertiliser for our country.

There is a growing demand for ammonium phosphate in India and until now we have been depending on imports. As far as we are concerned, we are very favourably situated for the production of Ammophos. In an extensive country like India, where distances are great and transport is not cheap, concentrated fertilisers will have a good future and Ammophos, containing the 2 plant nutrients, is very much in demand by the Indian farmer.

We have the advantage of all the raw materials ready at site.

1. Ammonia: We could draw from the 40 ton ammonia plant.

2. Acid: With our additional plant we will have enough acid.

3. Rock Phosphate: We import large quantities of rock in connection with our superphosphate plant.

4. The resultant gypsum could be utilised in the Sulphate plant.

All necessities are available.

We are thoroughly investigating the possibility of installing a 20 or 40 ton a day Ammophos plant.

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