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CONSTRUCTION DETAILS OF A SULPHURIC ACID PLANT OF THE PETERSEN TYPE COMPLETED IN 1953

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1. INTRODUCTION

(a) The plant recently completed in the Sandilands Chemical Works, Aberdeen, of Scottish Agricultural Industries, has a designed capacity of 110 long tons per 24 hours (calculated in monohydrates) at an acid strength of 78% H_2SO_4 (60°Be).

(b) The paper only deals in detail with a few of the less common features of the plant, but it is hoped to make arrangements to publish elsewhere a more complete report on the whole construction.

(c) Work on the site commenced with pile driving on 12th March, 1951, and the acid making section went into production on 27th January, 1953, a constructional period of 22½ months.

2. GENERAL DESCRIPTION.

(a) Flash Roaster: The plant for roasting 80 long tons per day of pyrites fines or concentrates, comprises drying and grinding units, a single flash roaster vessel, and a waste heat boiler. Gas cleaning is by Buell cyclones and an electrostatic precipitator.

(b) Tower Section: The six towers of this section are mounted on a 17 ft. high (5.2 m.) "L" shaped platform one leg of which measures 77 ft. (23.5 m.) and the other 67 ft. (20.4 m.). The platform is extended over the acid coolers arranged along one leg of the "L", for support of a water cooling tower and storage pond.

(c) Site: The combination of a flash roaster and a tower system permits a very compact layout and the whole manufacturing installation (i.e. exclusive of storage) is provided within an area of 14,400 sq. ft. (1337 sq.m.).

A more detailed description of certain of the features now follows.

3. PETERSEN TOWERS.

(a) The conventional design for these towers is by an external structural steel frame supporting lead curtains, inside which is built a protective course of brickwork. Consideration was given to alternative methods, because at the time of construction lead prices were very high and, moreover, unless the brickwork is built tightly against the lead, the life of the latter can be disappointingly low. Towers without lead sheath have been erected in the past but in many cases they have become objectionable in the course of time, due to leakage through the brickwork or masonry. After taking all the known factors into consideration it was decided to form the towers without lead but to improve the permeability of the walls by an Alkathene (Polythene) barrier. This is not in any way intended to make the tower an acid tight tank but rather to provide a damp proof course which would prevent seepage through the walls.

(b) The internal diameters of the towers vary from 14ft. 6 in. to 26 ft. 6 in. (4.42 m. to 8.08m.) and the height to the centre of the domes is 46 ft. (14 m.). They are constructed with a 9 in. (0.2m.) internal wall and a $4\frac{1}{2}$ in. (0.1 m.) external wall in between which are placed two layers of 0.01 in. (0.25 mm.) Alkathene. The Alkathene, which is supplied in rolls of 46 in. (1.2 m.) wide, was wrapped round the outside of the inner wall in horizontal bands and heat sealed at joints, provision being made for the natural shed to be inward. The sealing was done by an electric iron about 5 in. long x $\frac{3}{4}$ in. wide (127 mm x 19 mm.) supplied through a variable transformer, and after completion all sealed surfaces were tested for puncturing by a portable spark tester. Protection of the Alkathene against puncturing was provided for by first dressing the inside wall with an electric buff and then applying a layer of building paper. A further layer of building paper was applied outside the Alkathene to prevent damage during the construction of the outer wall. This outer wall was brought up fairly close behind the Alkathene in order to give protection and support as soon as possible.

(c) The thrust from the tower filling has to be supported ultimately by external steel straps after being transmitted through the walls and timber laths. For this reason it is essential that there should be no gap between the inner and outer walls, otherwise the former may move outwards to meet the latter and in doing so suffer fracture. Considerable difficulty was experienced in dealing with this requirement because the air trapped within the inner layer of Alkathene and the wall and between the two layers of Alkathene was sufficient to push the $4\frac{1}{2}$ in. wall out while the cement was still in a plastic state. Many methods were tried whereby the bricks or the Alkathene were held in position by bands, but none of these proved successful. The method finally evolved, and subsequently protected by patent, was to evacuate the two spaces using a vacuum pump. By a simple method of distribution the influence of the suction was equalised round the tower and the membranes held tightly against the brickwork. The suction was continued for about an hour after the last bricklaying each day, thus ensuring that no subsequent movement would take place.

4. ACID COOLING.

(a) Provision had to be made for cooling 375 g.p.m. (100 cu.m/hr.) of nitrous acid at $90^{\circ}C$ and 45 g.p.m. (12 cu.m/hr.) of denitrated acid at $120^{\circ}C$. This is normally done in cast iron coolers for the former and lead coolers for the latter. At the time of construction vertical cast iron could not be obtained in this country and lead was expensive. Moreover, neither material used in their respective coolers give entirely satisfactory performance and so there seemed to be a case for examining other fields.

(b) After consideration of all the likely alternatives, the decision was made in favour of Pyrex heat resisting glass (boron silicate) for all coolers. The apparent advantages of this material were that it would be immune from chemical attack from nitrous or de-nitrated acid, and that it would not be affected externally by slight leakage from above. Moreover, it would not suffer from the fall off in heat transfer as is caused by external rust films on cast iron.

(c) The joints were made in fluon (polytetrafluorethylene) sheathed asbestos with Bakelite flanges and stainless steel bolts. The cooler units were of 3 in. (76 mm.) internal diameter formed in 'U' bends with 10 ft. (3.1 m.) legs. The coolers are in banks of four pipes wide by seventeen pipes high with external water cooling. The number of banks required is ten and the total length of glass is 2.7 miles (4.3 km.).

5. INSTRUMENTS.

The instrumentation is more comprehensive than normally provided on Peterson plants and practically all of it has been grouped in a small control room. The principle instruments are:-

(a) Flowmeters:

Each main acid pumping line is provided with an orifice type flowmeter having a gauge local to the pump and another on the main panel.

(b) Pressure Gauges:

The correct distribution of acid from a tower spray is a function of flow and pressure. The latter is determined by air reaction gauges showing the pressure required to inject a small quantity of dry air into the acid stream at the top of the tower.

(c) Thermometers:

Electric resistance thermometers are provided to indicate the temperature of important points in the acid and gas streams and in certain cases the differential temperature between two such points.

(d) Colour Tube:

In order to provide a visual indication of the colour of the exit gases independent of atmospheric conditions or time of day, a colour tube was introduced behind the panel. To this a sample of gas is drawn from the outlet of the main fan and returned to the inlet. The tube is constructed in welded polythene and is provided with glass ends and a light source.

6. OPERATING EXPERIENCE.

This paper is primarily concerned with the constructional aspect of the acid plant, but some reference will also be made to operating experience as influenced by the methods of construction. So far the plant has not operated as a complete unit because the flash roasting section is not yet finished. Towards the end of 1952 it became clear that the acid making section would be ready long before the flash roasting section which was running far behind schedule. In view of this position and the urgent requirement for acid, arrangements were made to run the acid making section on a temporary sulphur burner. This condition has applied up to the time of writing (April, 1953) - a period of about three months.

(a) Towers:

So far the tower walls have remained completely free from any sign of acid penetration, but some leakage has been disclosed at the foot. This has been dealt with by proper clamping of the lead round the acid outlet pipes.

(b) Acid Coolers:

The only serious difficulty on the plant has been with the glass coolers, and here the troubles of breakage and leakage have been so bad that it has been necessary to shut down the plant on many occasions. Careful study of the conditions has suggested that the faults can be corrected, and arrangements are in hand to carry out major modifications. Three main deficiencies have shown up:-

(i) Even slight inaccuracy in installation will cause severe stress in the bends of the cooler units, whereas the use of standard straight pipes with short 'U' bends enables the minor differences to be taken up in the joints. In view of this the units are to be replaced by straight pipes and short bends.

(ii) The asbestos jointing material within the fluon sheath was very hard and did not readily deform to variations in the faces of the glassware. This is being replaced by a high temperature synthetic rubber which has much greater resiliency. As before, a protecting sheath of fluon will be used.

(iii) Many of the bakelite flanges split after an operating period of four to six weeks. This trouble was traced to the fact that the flange has three faces wet and one face dry, which by localised moisture absorption sets up internal stress in excess of the ultimate stress of the material. Alternative moulding powders are available which are not subject to this deficiency and new flanges made of these materials will be fitted.

Despite the interruptions caused by these features the plant has produced a most useful contribution to the acid requirements in the current season and, furthermore, it has amply demonstrated the ease with which this type of unit can be started and stopped.