

Facility Inspection Report

Sulfuric Acid Plant



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Prepared by:

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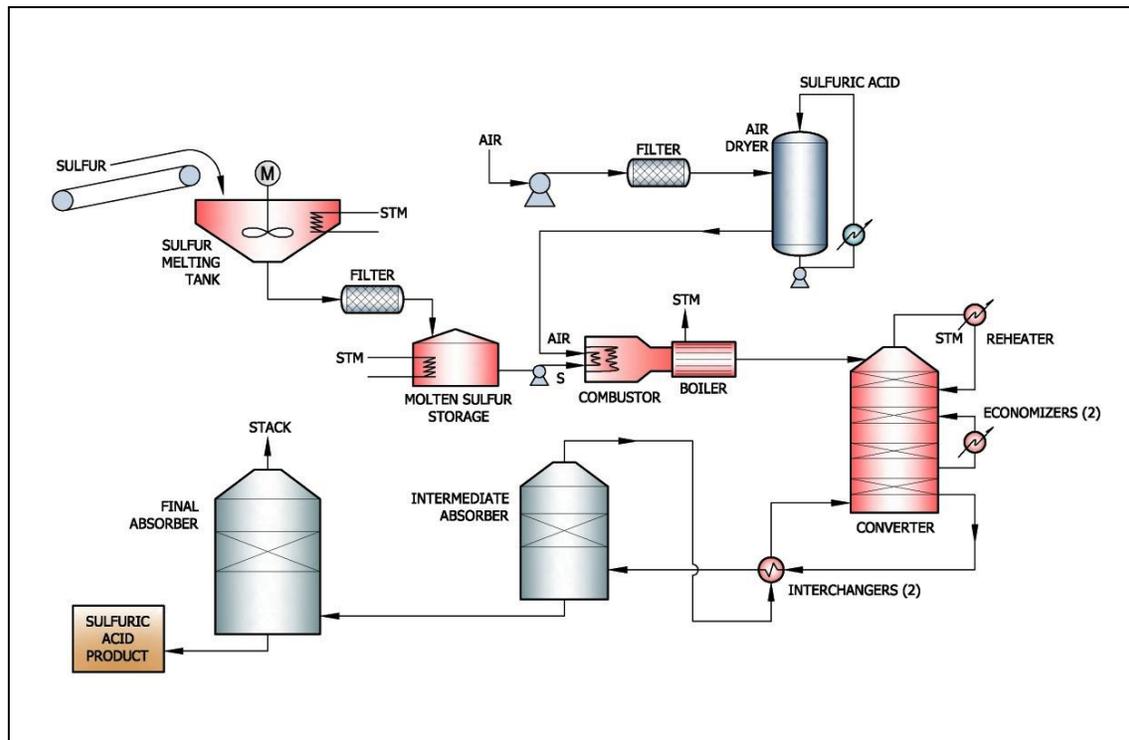
Sulfuric Acid Plant

Executive Summary

- This Lurgi Double-Absorption Type Sulfuric Acid plant started up in 2000 and shut down in December, 2010. It is rated for 2,400 mt/day of sulfuric acid (100% basis). It can run as low as 960 mt/day. The plant produces sulfuric acid at 98.5% concentration. The plant sends less than 300 ppm of SO₂ out of the exhaust stack.
- There is also a small 150 mt/day Oleum Plant (103% sulfuric acid) included.
- This location has excellent transportation options by road, rail, and water. Barges and ships can be loaded only a few kilometers from the plant site.
- Documentation is excellent; process flow diagrams, P&IDs, operating procedures, process control logic, and equipment files were all inspected with good results.
- The process control system is Honeywell TDC 2000. All field instrumentation is electronic.
- The owner is leaving the lube oil systems running on the major equipment and are “slow-rolling” the equipment weekly to keep the bearings in good condition.
- Approximately 100 mt of VnO₅ catalyst will remain in the converter. About 75% of it is still in good condition. The top bed may need to be sent out for reclamation.
- Spare parts are abundant and available.
- There is also a phosphoric acid plant available on this same site.

Sulfuric Acid Plant Description

(Photo on report cover)



Sulfuric Acid Process Flow Diagram

The Lurgi designed Sulfuric Acid Plant started up in 2000 and shut down in December, 2010. It is rated for 2,400 mt/day of sulfuric acid (100% basis). It can run as low as 900 mt/day. The plant produces sulfuric acid in 98.5-99.5% concentrations. The plant sends less than 300 ppm of SO₂ out of the exhaust stack. There is also a small 150 mt/day Oleum Plant (103% sulfuric acid).

Consumptions are 0.33 mt sulfur per mt of sulfuric acid (100% basis). Electricity usage is 37.5 kW per mt of acid. Approximately 1.4 mt of 60 bar steam is produced per mt of sulfuric acid produced. This is equivalent to 135 mt/hr of steam. It takes about 35 people to run this sulfuric acid plant.

The sulfur is first melted in a large, carbon steel tank with heating coils. The molten sulfur is then filtered using a carbon steel filter unit which is approximately 1.6 m diameter and 11.6 m tall. The primary feed rates to the combustor are 16,400 kg/hr of molten sulfur, 6,825 m³/hr of primary air, and 90,675 m³/hr of secondary air. The minimum molten sulfur feed rate is 5,460 kg/hr. Diesel oil is used for the combustor start-up.



Sulfur Burner (retracted from combustor)

The two rotary cup atomizing burners feed the combustor, which is approximately 5.0 m diameter by 5.2 m long. It is constructed of carbon steel and has three separate layers of refractory measuring 125 mm, 125 mm, and 230mm. The combustor is rated for 1100°C, but the sulfur is burned with oxygen (from air) at about 900°C. This produces SO₂ gas which is sent through the heat-recovery boiler to produce steam.

This drops the process temperature to 550°C. The waste heat boiler has the process gas on the tubes and water on the shell. It is rated for 68 bar at 291°C and weighs 183 mt without the CS steam drum. One has a steam-turbine drive (682 kW unit) and one has an electric drive. There is a spare electric drive motor for this pump. There is a water treatment facility and a de-aerator for the boiler feed water.



Combustor



Boiler

Filtered air is supplied to the sulfur burners with a very large blower. The main air blower still has the lube oil

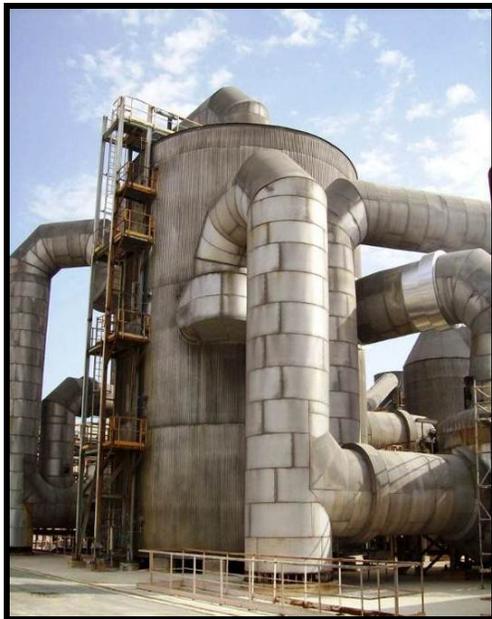
system running. They “slow-roll” this machine weekly to maintain the bearings. It has a 4,030 kW, water-

cooled, electric drive motor. There is a spare motor stored next to the air blower. The air blower runs at 6000 rpm with the help of a high-speed gearbox. The gearbox and blower are fitted with vibration monitors. The blower capacity is 170 cubic meters per hour of air.



Air Blower

The air is dried using a large drying column with circulating sulfuric acid for water removal. The sulfuric acid is re-concentrated after reaching the point of dilution. The drying column is approximately 6.4 m diameter and 15.4 m tall with packing and internal cooling tubes. The top section and tubes are constructed out of a special stainless steel which is basically 316L with 4-5% silicon. The bottom sections of these vessels are constructed out of brick-lined carbon steel. It is rated for full vacuum at 75°C.



Converter

The SO_2 from the burners then proceeds to the converter, where it is converted to SO_3 with VnO_5 catalyst at 540°C. The converter is constructed of carbon steel with 321 stainless steel plates and internal pipes. It is approximately 11.6 m diameter and 18.1 m tall and is rated for full vacuum at 614°C. There are four catalyst beds in the converter which hold a total of about 100 mt of catalyst. Only the top bed needs recycling. The other sections should be in good condition. The catalyst, specifically used are three types: S6, SR10x5, and SS11x4. These catalysts are good for a 400-600°C operating range.



Intermediate Absorber

The SO_3 is then absorbed into water using an intermediate and final absorber column. The intermediate absorber is approximately 7.8 m diameter and 20.7 m tall. It is rated for full vacuum at 150°C . The final absorber is approximately 7.6 m diameter and 17.6 m tall. It is rated for full vacuum at 140°C . The top section and tubes of both absorbers are constructed out of a special stainless steel which is basically 316L with 4-5% silicon. The bottom sections of these vessels are constructed out of brick-lined carbon steel.

The piping connecting all of these large vessels is generally brick-lined carbon steel pipe which is approximately 2.2 m diameter.

There are several economizer exchangers and interchangers to increase the efficiency of the operations. These are all constructed entirely of carbon steel. The economizers either produce steam or they heat the steam to a higher temperature. The interchangers are gas-gas exchangers for recovery of waste heat by cross-exchanging hot product streams with cooler feed streams. The two largest interchangers are approximately 4.8 m diameter and 14 m long and weigh 108 mt each. They have $3,385 \text{ m}^2$ of surface area. The three economizers have the following surface areas: 490 m^2 , $1,469 \text{ m}^2$, and $4,030 \text{ m}^2$. They have the following weights: 22.6 mt, 32 mt, and 102.5 mt. The re-heater weighs 44 mt. More details on all of this equipment can be found in the equipment listing at the end of this report.



Oleum Plant

There is a 150 mt/day Oleum Plant (103% “fuming” sulfuric acid) in this facility. It consists of only two small columns with some auxiliary equipment.

There are nine tanks in the tank farm. Five of them are 7,500 cubic meters capacity and four of them are 5,000 cubic meters capacity. There is also one 7,500 cubic meter capacity tank in another area for liquid sulfur storage. All of these tanks are constructed of carbon steel.

The metal exhaust stack is about 6 meters diameter by 45 meters tall. It is constructed of carbon steel which is brick-lined in the lower sections.

Sulfuric Acid Plant Utilities



B&W Boiler

There is an auxiliary boiler which produces 60 mt/hr of steam at 68 bar with natural gas as the fuel (rating is 71 bar at 350°C). It has its own de-aerator and is supplied with demineralized water from the main plant. This system was installed in 2000, and it is approximately 6.5 m diameter and 9 m tall. It has 940 m² of fire-tube surface area and 112 m² in the convection section.

There is a 15 MW Siemens steam-turbine driven generator. It was installed in 1990 but is still in good condition. It uses 140 mt/hr of steam at 60 bar. They are slow-rolling this equipment weekly to maintain the bearings. There is an overhead crane for dismantling and removal of the turbo-generator.



Siemens Turbo-Generator

The turbine is a Siemens model NG 40/32-3 DA back-pressure unit (8 bar of back-pressure) running at 7116 rpm. It is rated for 15,000 kW. The gearbox is a Siemens model G-100/1 unit running at 7116 rpm on the input shaft and 1500 rpm on the output shaft. It is rated for 16,200 kW. The Siemens generator is designed for producing 6,300 v electricity at 50 Hz. It is rated for 17,500 kVA with a 0.8 efficiency at 1500 rpm. The generator weighs 36.3 mt and the turbine with auxiliary equipment weighs 25 mt. The exciter is also a Siemens unit running at 200 Hz.

There are six transformers for this plant which are rated for seven MW each.