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TO STUDY THE PERFORMANCE OF BOILER, THEIR ACCESSORIES AND MOUNTINGS, THEIR FAILURE AND ANALYSIS OF FAILURE OF VARIOUS VALVES AND THEIR CONDITION AND MONITORING IN ACID PLANT

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ABSTRACT - *In the present industrial scenario great importance is given for the conservation of energy. Electrical energy or Electricity is considered as one of the most important commodities required to satisfy the physical needs of mankind. In the modern world the demand for electricity is increasing day by day. A solution for this problem is to prevent the wastage of energy in any form and ensure that not even a single way of power generation is ignored. The sulphuric acid plant generates steam as by product of manufacturing acid. This steam is used in the drive turbines of air blowers and boiler feed water pumps and also in the cooling water pumps. After meeting all these requirements, about 20% of the steam vented out. This steam can be effectively used for producing power by introducing the necessary steam turbines and generators.*

1. INTRODUCTION

Sulfuric acid is believed to be the world's largest-volume industrial chemical. The production of phosphate fertilizer materials, especially wet-process phosphoric acid, is the major end-use market for sulfuric acid, accounting for nearly 60% of total world consumption. The balance is consumed in a wide variety of industrial and technical applications.

The primary environmental issue that has affected the sulfuric acid industry is restrictions on sulfur dioxide emissions in other industries, such as copper smelting. Smelters have been required to recover increasing percentages of the sulfur dioxide that is emitted during the smelting process. In many cases, smelters have chosen to recover the by-product sulfur dioxide in the form of sulfuric acid. Other industries such as power plants are also coming under increased pressure to reduce their sulfur dioxide emissions. At the present time, these industries have generally chosen to limit sulfur dioxide emissions by burning low-sulfur coal or using limestone scrubbing systems. However, several companies are recovering the sulfur dioxide as sulfuric acid.

In view of above facts, this project on "Failure of Rotary Equipments in Sulphuric Acid Plant" has been taken up to meet following objectives.

i. Identification of Rotary Equipments
ii. Functions of Rotary Equipments
iii. To Study the Operational Problems
iv. Maintenance Problems
v. Analysis and Repairability

1.1 Sulphuric Acid Plant

A) Combustion of air with Sulphur to produce a gas mixture of Sulphur dioxide and oxygen in the desired ratio for conversion to Sulphur trioxide

$$S+O_2 \longrightarrow SO_2$$

B) Catalytic oxidation of Sulphur dioxide to Sulphur trioxide

$$S+{}^{1/2}O_2 \longrightarrow SO_3$$

C) Combining the Sulphur trioxide and water in 98.4% sulphuric acid.

$$SO_3+H_2O \longrightarrow H_2SO_4$$

The raw material is Sulphur that is available with a purity of 99.55%. It may contain moisture and solid impurities like ash and bitumen. If the moisture is not eliminated it will lead to corrosion, difficulties in the process and reduction in the quality of sulphuric acid. The solid impurities if not removed would be caught in the catalyst layers and gradually increase the pressure drop that will result in decreased production.

The Sulphur is fed into one of the melting pits that contain agitator and steam coils supplied with saturated steam at 6kg/cm^2. The molten Sulphur overflows from the melting pit to the intermediate pit where the acidity in the Sulphur is neutralized by continuous addition of hydrated line. An agitator is provided in this pit. Steam is admitted in the coils at 3.5 kg/cm^2 to keep the temperature of molten Sulphur about 135^{0}C at its optimum viscosity. The moisture in the Sulphur gets evaporated in the three pits. The molten Sulphur from the intermediate pit flows into the pre coat pit by means of steam heated valves. In the pre coat pit there is an agitator to mix the pre coat agent thoroughly the molten Sulphur. A pump is also provided to feed the Sulphur filter.

1.2 Waste Heat Boiler (WHB) System:

The heat evolved due to the combustion of the sulphur in the combustion furnace and due to catalytic oxidation of sulphur dioxide to sulphur trioxide in the converter is used for steam generation in the water tube boiler and economizer. Steam is produced at 36 kg/cm^2 and 325^{0}c. The superheated steam is used for driving the turbine (N-2) of air blower and the feed water pump (W-1). Low pressure steam is used for sulphur melting and de-aeration is obtained by pressure reduction. The condensate from the plant is revel the WHB system.

Demineralised water from the water treatment plant is pumped into the de-aerator where the water is de aerated using steam. The de aerated water is stored in the deaerated water storage tank. The de aerated water is pumped by the boiler feed water pump or through economizer for the common steam drum. Water flows by natural convection to the evaporator element. There is a provision to draw dry saturated steam from the drum at 40 kg/cm.

Facilities for using chemicals to maintain the desired quantity of boiler feed water are made with the help of twin dozing pump. Trisodium phosphate, sodium hydroxide can be dozed with this pump

1.3 Condenser

Condenser is used to convert the low pressure steam in to water. Refer the process (2) to (3). The low pressure steam is passing through the condenser where heat is liberated from the steam. So the steam becomes water. To cool the steam, separate cooling water is circulated through condenser from the cooling tower. This cooling water and the steam will not mix together inmost of the condensers.

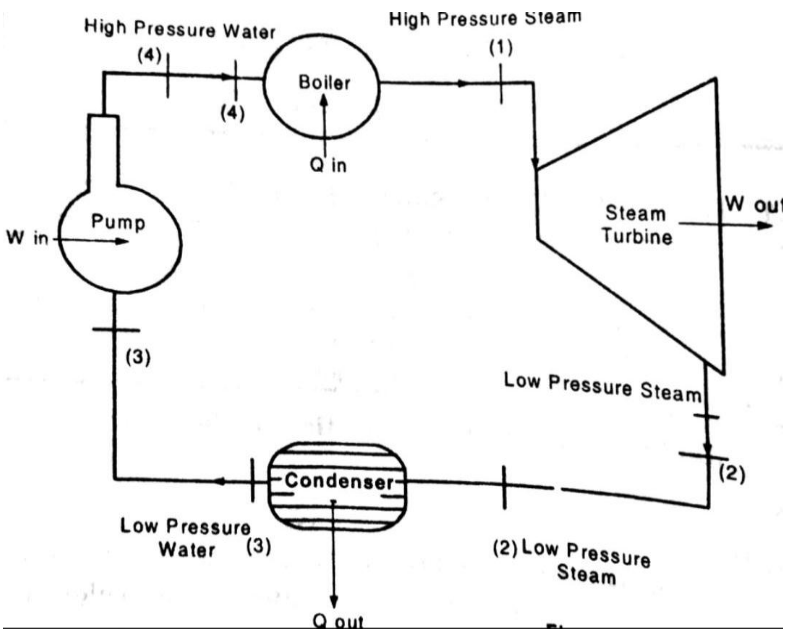

Fig. 1.4

1.4 Benson Boiler

It is high pressure vertical fire tube boiler. The fig 1.31 shows the schematic arrangement of a Benson boiler. This boiler has no drum and is designed to operate at critical pressure of 225 bar.

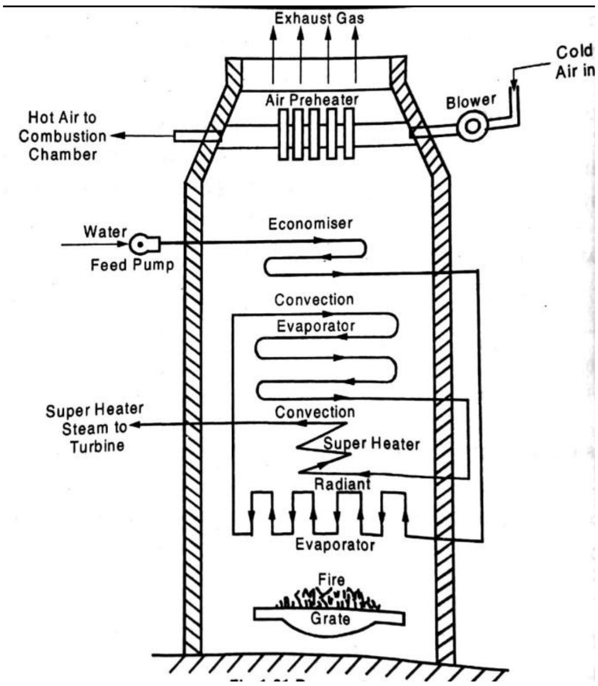

Fig. 1.15

1.5 Boiler Accessories

The appliances used to increase the efficiency of the boiler are known as boiler accessories The important boiler accessories are,

- Feed pump
- Economiser
- Air preheater
- Super heater
- Steam separator
- Injector

1.6 Boiler Mountings

The devices used for the efficient operation, proper maintenance, safe operation, etc. are called boiler mountings. The different boiler mountings are given below

- Water gauge or water level indicators: it indicates the level of the water inside the boiler. It is a glass tube covered with a special glass cover. It is used to maintain the quantity of water at safe level
- Pressure gauge or steam gauge: It is the device used to indicate the pressure inside the boiler. It is mounted in the front end, at the top of the steam drum
- Safety valves: It is used to maintain safe pressure inside the boiler. When the pressure exceeds the limit the excess steam will be allowed to escape through the safety valves to the atmosphere to reduce the pressure inside the boiler.
- Fusible plug: It is fitted just above the grate in the furnace. It is used to extinguish the fire in the furnace when the water level falls below safe level to avoid bursting

- Stop valve: It is used to control the amount of the steam passing through the steam pipe. It is hand operated. It is fitted with the steam pipe
- Blow off cock: it is fitted at the bottom of the boiler. When it is opened during the running of the boiler, the high pressure steam pushes out the impurities like mud, sand etc. In the water collected at the bottom
- Feed Back Valve: The feed back valve is used to allow the supply of water to the boiler at the high pressure continuously. It prevents the back flow of water from the boiler, when the pump pressure is less than the boiler pressure. It is fitted to the shell slightly below the normal water level of the boiler.

1.7 Failure of boiler

- Deaerator Cracking
- Feedwater Line Erosion
- Economizer Tubes
- Failures Due to Overheating
- Failures Due to Corrosion

2. TYPES OF VALVES

2.1 Most Common Types of Actuated Valves

What is an Actuated Valve?

A valve is a component in a piping system that is used to control the flow of the media through the system. This control is achieved by the manipulation of some type of obstructer within the valve. Actuated valves use mechanical devices called "actuators" to operate the valve using a power source such as compressed air or electricity. Most actuated valves are also available in a manually operated version, or as an actuated valve with a manual override.

All of the most common types of automated valves fall into one of three main categories. They are linear, rotary, and self-actuated. There are a variety of valve types within each of these categories each having its own benefits. This training course is focused on rotary and linear actuated valves.

Rotary Valves *(also referred to as "quarter-turn" valves)*

These types of valves rely on the rotary motion of the flow obstructer In most cases this rotation is limited to 90 degrees (one quarter-turn), however, there are valves that operate using a larger degree of rotation and have more than 2 positions that are used in regular operation. Valves that are truly quarter-turn are completely closed at 0˚ and completely open at 90˚. Examples of quarter-turn valves are ball valves, plug valves, and butterfly valves.

Fig 2.1.

2.2 Linear Valves

There are 2 distinct types of linear valves: rising stem (multi-turn) and axial. While both valve types rely on the linear motion of the flow obstructer, they are very different in construction and operation. Multi-turn rising stem valves move the obstructer by the rotation of a threaded rod (stem) which is attached to the obstructer Examples of multi-turn valves are gate valves, globe valves, pinch valves, diaphragm valves, and needle valves. These valve types are commonly used for flow control applications. Axial valves use pneumatic or electro-magnetic force to slide the obstructer along an axis. Some examples of these are coaxial valves, and angle seat valves. These valves are typically fast acting and only used for on/off process applications. Types of (Quarter-turn) Rotary Valves

2.3 Ball Valves

Quarter-turn 2-way ball valves are by far the most common type of process control valve. They are 2-way (inlet and outlet), 2-position (open and closed) valves that are used for shut-off or isolation of a system, or a loop or component within a system. The basic construction of a ball valve includes a ball as the obstructer which is sandwiched between two cup shaped seals referred to as "seats". Typically the ball has a bore straight through it. Media flows through this bore when the valve is open. When the ball is rotated 90˚, the flow of media is stopped by the sides of the ball which now completely fill the opening in the seats. 3, 4, and even 5-way ball valves are also available, but far less common. These types of ball valves are covered in the lesson on Ball Valves. Ball Valves are best suited for on/off applications. Throttling is possible, but not an ideal use for most standard ball valves. Specialty ball valves are available for throttling.

2.4 Plug Valves

The basic construction of a plug valve is practically identical to that of a ball valve with the exception of the shape of the obstructer used. In this case, the ball is replaced by a slightly tapered cylinder. This cylinder has a bore through it just like a ball valve, and it operates the same way where it is open in one position, and closed when rotated 90˚.

There are advantages to plug valves that make them the preferred choice in certain applications. One is that they contain no voids or cavities in which media can get trapped. Another is that they can be adjusted to fix leaks that may develop over time, where as a ball valve would need to be repaired or replaced. Like ball valves, plug valves are typically used for on/off applications. Plug valves are often used in extreme service applications such as refineries and chemical plants, where the environment of use is corrosive

3. USES OF VALVES

3.1 Industries

Valves play a large role in most industries. They are used in many parts of daily mechanical devices, including in HVAC and water systems in an office and the gasoline mechanism for an automobile. Below are a few examples of the many industries in which valves play a major role in proper operation.

3.2 Pipelines

This use is an essential aspect of many industries, but there are hundreds of thousands of miles of crucial pipelines that transport media from its source to the place where it will be transformed into its final product. This media could include piping for crude oil and gas, both onshore and offshore. Valves are used to optimize the pipeline operating conditions, and can be found in the upstream, midstream and downstream section of the piping. Upstream starts at the bottom of the hole in the ground and covers everything on the wellhead up to the choke. In this case, the choke is a specialized globe valve that is mounted on the wellhead to regulate the output of the well. Midstream starts at the output of the choke and ends at the fence of the final destination (usually a refinery). Downstream is everything inside the area of the destination. The most important factor to consider when selecting a valve for a pipeline application is whether the valve is piggable – that is, the inside is designed to be cleaned or inspected.

4. FAILURE OF VALVES

Fig. (a) Installation and adjustment errors, *(b)* Incorrect valve clearance settings

Cause: The valve clearance has been set too tight or the maintenance intervals have been exceeded.

Consequence: The value no longer closes properly. Combustion gases flow past the valve seat and heat up the valve head. This causes the valve head to overheat and burns through in the seat area.

Incorrectly installed valve springs

Fig. 2.9

Cause:
The spring was not inserted correctly during installation. The tilted spring has caused a lateral bending moment (M) on the valve stem.

Consequence:
The resultant alternating bending stress ultimately caused a fracture of the valve stem face and destroyed the valve guide.

5. CONCLUSION

Improving the performance of an acid plant is not a simple matter. Equipment cannot be placed in a haphazard piecemeal fashion. Rather, the entire acid plant must be viewed holistically and improvements need to be made in a way that consider the interplay of all the various unit operations. Acid mist emissions cannot be reduced by simply optimizing tower operation, nor by simply enhancing mist capture. Indeed, the operational performance, and ultimately, the profitability of many sulphuric acid plants will be improved only by incorporating and maintaining efficient tower acid distribution and superior mist elimination. This holistic approach is likely to reduce maintenance costs, avoid loss of production, and reduce stack acid mist emissions.

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