

Research on The Corrosion and Protection Measures of Sulfur Recovery Device

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Abstract: The main corrosion patterns of high temperature sulfur corrosion, dew point corrosion, stress corrosion, air corrosion and hydrogen sulfide corrosion in sulfur recovery plant are discussed, and the corresponding corrosion mechanisms of various corrosion patterns are analyzed, and targeted anti-corrosion measures are proposed in terms of structural design, equipment material selection, start-up and shutdown protection and operation specification.

Keywords: Sulfur recovery, Equipment corrosion, Anti-corrosion measures.

1. Introduction

Most of the sulfur recovery devices use partial combustion method Kraus process, whose process method is shown in Schematic diagram 1.1. It has been more than 100 years since the British chemist Claus proposed the original claus process for sulfur production in 1883, and in 1938 the German company Farben made a major reform of the original claus process, the main point of which was to divide the oxidation of H₂S into two stages. The first stage is the thermal reaction stage, where 1/3 of the volume of H₂S is oxidized to SO₂ in the combustion (reaction) furnace, releasing a large amount of reaction heat while generating sulfur; the second stage is the catalytic reaction stage, where the remaining 2/3 of the volume of H₂S continues to react with the generated SO₂ over the catalyst to produce elemental sulfur. Due to the

installation of a waste heat boiler after the reactor. Not only can 80% of the heat released from the reaction in the furnace be recovered, but also the temperature of the catalytic conversion reactor can be adjusted by controlling the temperature of the process gas, which basically eliminates the problem of difficult reactor temperature control and greatly improves the sulfur recovery rate and processing capacity of the plant, laying the foundation for the modern (conventional) Krauss method sulfur recovery process. In this process, H₂ S, SO₂, CS₂, water vapor, sulfur vapor and surrounding atmosphere and other gases in the process medium of sulfur recovery unit will produce different degrees of corrosion to the equipment and pipelines of the unit. Therefore, it is important to understand and analyze the corrosion types of sulfur recovery unit and take corresponding measures to ensure the long-cycle safe operation of the unit.

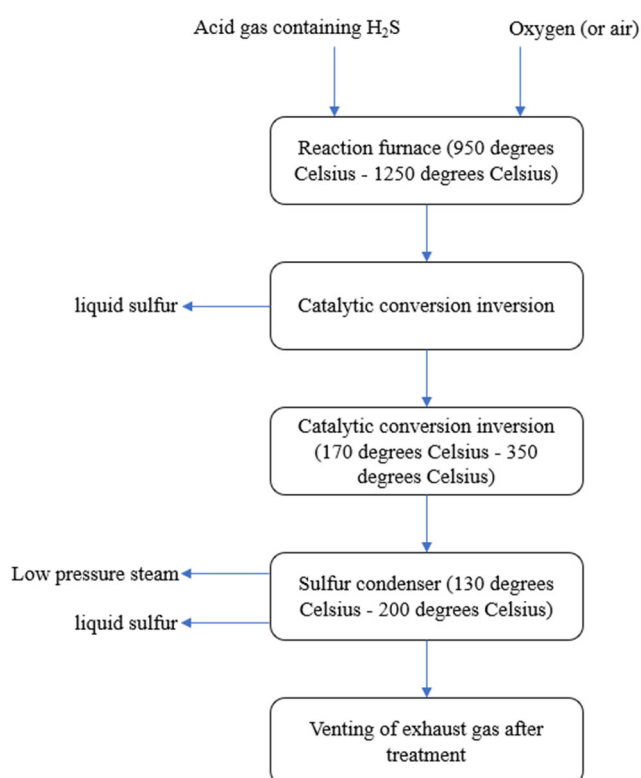


Figure 1. Schematic diagram of conventional claus process

2. Analysis of Corrosion Causes

2.1. High Temperature Sulfur Corrosion

High temperature sulfur corrosion often occurs in the high temperature part of the device equipment, such as high temperature doping valve, waste heat boiler tube plate, the pipeline before the primary cooler. High temperature for the sulfur device provides the basis for corrosion conditions, in a high-temperature environment, generally at a high temperature of about 300 °C, extremely easy to produce the phenomenon of high-temperature sulfur corrosion[1]. Under high temperature environment, hydrogen sulfide and monomeric sulfur easily react chemically with iron, and this process will be accompanied by the combustion of acidic gases, and the resulting substances and gases will also undergo certain transformations. Many internal leakage phenomena are caused by the consequences of high temperature sulfur corrosion, because in the process of this work, part of the ceramic protection device is very easy to break the phenomenon, and then produce cracks, so the high temperature gas will corrode the device, the phenomenon of internal leakage is very likely.

2.2. Dew Point Corrosion

Dew point corrosion is mainly distributed in various gas pipelines and tail gas treatment parts. Among them, sulfur dioxide dew point corrosion and sulfur trioxide dew point corrosion are the two basic types of dew point corrosion. In the sulfur recovery process[2], the gas produced is mainly composed of carbon dioxide, sulfur dioxide and water vapor, and is more likely to occur at low temperatures. When the dew point temperature is higher than the temperature of sulfuric acid steam generation, it is very likely to produce high concentrations of the material, thus causing corrosion to the carbon steel equipment and devices.

2.3. Stress Corrosion

Stress corrosion generally occurs in different levels and different sizes of condensing or cooling equipment. At high temperatures[3], after the gas has passed through the condensing and cooling equipment, there will be significant thermal stress due to temperature differences, in the case of uneven heating. In addition, there are gaps in the welding, the probability of stress corrosion is relatively high, the process of high-temperature welding itself is a heating and cooling uneven process, under certain reaction conditions, stress and lead to corrosion phenomena.

2.4. Air Corrosion

Air corrosion generally occurs to varying degrees in the device equipment pipeline corrosion is the most serious is exposed equipment, low temperature parts, low temperature water pipeline. Such as air-cooled system, the upper water pipe, water collection tank and the wall of the device. And corrosion part in the role of fluid scouring will continue to fall off, and then lead to fall off parts further suffer from corrosion, the formation of a vicious circle[4].

2.5. Hydrogen Sulfide Corrosion

Corrosion location distribution in the poor / rich liquid pipeline, regeneration tower, regeneration tower bottom reboiler, etc.. The most serious corrosion is the higher temperature parts, such as regeneration tower bottom reboiler

and inlet and outlet pipeline, poor / rich liquid heat exchanger. The corrosive effect of hydrogen sulfide is very destructive. Hydrogen sulfide corrosion has a great impact on petrochemical companies, and the corrosion of hydrogen sulfide may lead to cracks and cracks in very strong steel alloy products[5]. In this case, if timely protective measures are not taken and effective measures are not implemented, there is a high risk of equipment leakage and other phenomena, which will cause irreversible consequences and damage the entire sulfur recovery process.

3. Corrosion Protection Measures

3.1. Structure Design

Through the control of temperature, the corrosion of sulfur recovery device can be controlled to a certain extent. The actual operating temperature of the sulfur recovery plant is easily restricted by the process and environment and cannot be reduced normally, so the staff is required to maintain the normal operating temperature of the plant while controlling the temperature to the lower operating limit. Although it is not possible to completely eliminate the effect of temperature on the corrosion of sulfur recovery plant process equipment, it is possible to avoid the possibility of dew point corrosion. For example, in the design of the reactor, high stress concentrations are prevented. It is also necessary to install a heat- and wear-resistant lining and a heat- and rain-resistant cover, and to install a heat- and fire-resistant lining in the combustion furnace. In this way, dew point corrosion can be avoided. For dew point corrosion, we can avoid the exhaust gas temperature to be close to the dew point temperature of sulfur dioxide and sulfur trioxide. In addition, in the work process to minimize the appearance of oxygen, which can reduce the possibility of sulfur trioxide dew point corrosion.

3.2. Equipment Material Selection

Equipment in the main combustion furnace waste heat boiler and incinerator steam superheater heat exchanger tube generated by high-temperature sulfur corrosion, so you need to choose the right material to ensure that the shell will not produce high-temperature sulfur corrosion, low temperature dew point corrosion. Secondly, it is also reasonable to coat the corrosion-prone parts with anti-corrosion materials.

3.3. Open Shutdown Protection

After the equipment shutdown, which the pipeline can not have acidic substances, these substances include residual sulfur, process gas, etc.. If you do not need to open the inspection of the pipeline and equipment, it should be purged by nitrogen and filled with nitrogen, so that it is sealed to avoid the system of wet air penetration condensation, and the temperature should be maintained in the system pressure relative to the dew point. In the maintenance of equipment, inert gas must be used to purge the equipment to remove the acidic substances.

3.4. Operation Specification

In the actual operation of the sulfur recovery plant, the chance of corrosion of the equipment can be reduced as much as possible by strictly regulating the operation means, timely inspection and maintenance of the equipment, and the use of online analysis instruments to achieve control of the sulfur dioxide content in the gas.

4. Conclusion

Sulfur recovery equipment and its susceptibility to corrosion affects the operation of the equipment. For this reason, the structural design, equipment selection, start-up and stoppage and operation specifications can be done well, it can better improve the corrosion resistance of the device and promote more stable and safe operation of the equipment.

References

- [1] Peng Lixing. Corrosion and protection of combined sulfur recovery plant [J]. Corrosion & Protection in Petrochemical Industry,2019,36(01):31-36.
- [2] Liang Hongwei,Shi Bin.Corrosion analysis of 30,000 tons sulfur recovery plant[J]. Chemical Enterprise Management, 2017 (22): 139.
- [3] Liu Yandun. Analysis of the causes of corrosion and protection countermeasures of sulphur recovery plant process equipment [J]. Petro-Chemical Equipment Technology,2010,31(04):43-48+53+27.
- [4] Wang Huiqiang. Corrosion and protection of combined sulfur recovery unit[J]. Refining and Chemical Industry,2020,31(04):45-48.DOI:10.16049/j.cnki.lyyhg.2020.04.014.
- [5] Zhao Min. Analysis of the corrosion problem in the tail gas treatment unit of sulfur recovery unit[J]. Corrosion & Protection in Petrochemical Industry,2017,34(03):29-32.