PAPER • OPEN ACCESS

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To cite this article: Yunlong Cui 2019 *IOP Conf. Ser.: Earth Environ. Sci.* **300** 052008

IOP Conf. Series: Earth and Environmental Science **300** (2019) 052008 doi:10.1088/1755-1315/300/5/052008

Transformation and Analysis of High Temperature Thermocouple in Sulfur Recovery Burning Furnace

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Abstract. The furnace temperature of the sulfur-burning furnace of the sulfur recovery unit is an important parameter to ensure the overall Claus reaction, and it is of great significance to accurately evaluate the extent of the reaction. At present, the temperature measurement of sulfur recovery furnace is a recognized technical problem in the industry, mainly affected by high temperature, high temperature H2 S corrosion and thermal shock. Therefore, the material of the thermocouple protection sleeve is difficult to select. Through the analysis of the high temperature thermocouple modification process of the sulfur recovery furnace in the sulfur recovery unit of this department, the paper summarizes the transformation plan to extend the service life of the high temperature thermocouple of the device.

1. Introduction

Since the sulfur recovery unit of CNOOC Huizhou Petrochemical Co., Ltd. has been put into production, the temperature measuring components of the sulfur-burning furnace have adopted ordinary B-type blown thermocouples. However, in the actual use process, the ordinary blown thermocouple corundum tube is easily broken, and the service life is generally within one year, resulting in higher damage rate of the thermocouple and increased maintenance cost. At the same time, the sulfur recovery sulfur furnace is a positive pressure furnace, and the thermocouple cannot be replaced online after being damaged, so that it cannot accurately measure the furnace temperature. Regardless of whether the measured temperature is too high or low, it has a huge impact on the service life of equipment pipelines and furnace linings. In severe cases, it will accelerate the deactivation of the catalyst, causing excessive emissions of flue gas, resulting in greater environmental impact. Therefore, there is an urgent need to develop a thermocouple that can be used for continuous and stable measurement in a high temperature environment.

2. The cause of damage

At the initial stage of the sulfur recovery unit, the ordinary blown thermocouple used in the sulfur-burning furnace does not fully consider or eliminate the influence of deformation and stress concentration, and there is no structural stress-relieving component to protect the nitrogen from lack of control or control. The service life of the thermocouple is generally within one year, and the sulfur-burning furnace is a positive pressure furnace. After the thermocouple is damaged, it cannot be replaced online, which makes it impossible to accurately measure the furnace temperature. Moreover, in a long time high temperature environment, the thermocouple opening nozzle and the thermowell material are burnt, and the thermowell is difficult to be taken out from the open nozzle during each disassembly process, and the thermowell needs to be first used. It can be taken out after being knocked off from the inside of the furnace. As shown in Figure 1, it is a physical diagram of a damaged thermocouple.

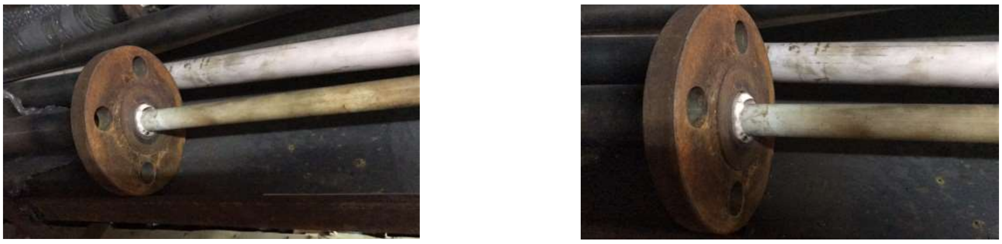

Figure 1. Physical diagram of damaged thermocouple

3. Reform plan

As shown in Figure 2, a schematic diagram of a high temperature thermocouple for a sulfur burning furnace of the improved sulfur recovery unit.

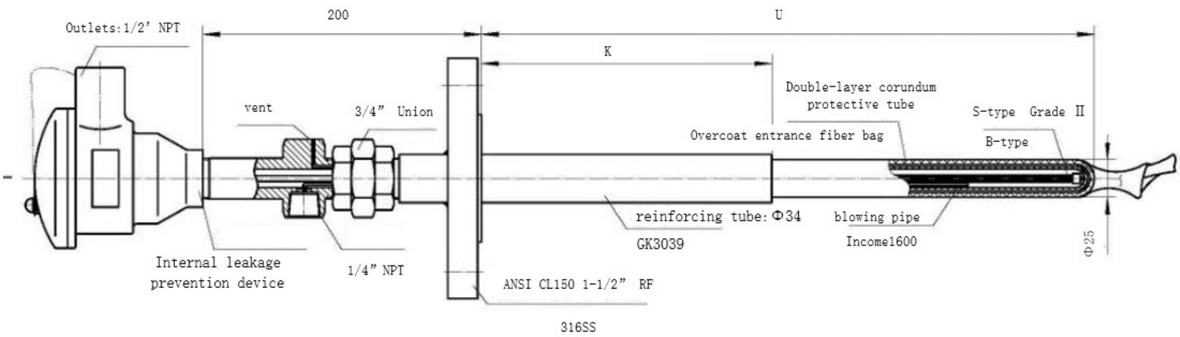

Figure 2. High temperature thermocouple reconstruction structure

(1) According to the calculation of the process professional, under the current ratio of processing crude oil, the acid gas concentration of the sulfur recovery unit is 80%~85% in one maintenance cycle, and the main components are S, H_2S and NH_4, in Crow. In the case where the reaction is complete, the furnace temperature is about 1250℃.

In the high temperature environment, the presence of various corrosive components of SO_2, H_2S and H_2O in the furnace, especially the strong reduction of H_2S, reacts with the metal components in the protective sleeve, accelerating the thermocouple protection sleeve. Cracked or brittle. Secondly, after the thermocouple protection sleeve is cracked or brittle, H_2S will quickly corrode the precious metal thermocouple wire and accelerate the failure of the thermocouple.

In the case that the thermocouple is damaged and cannot be measured or the measurement is inaccurate, it is easy to cause a mismatch in the process air distribution. If the air distribution is too small, the decomposition of hydrocarbons in the furnace is incomplete, so that the system will accumulate carbon, causing blockage of the furnace tube and accelerating the deactivation of the catalyst. If the air distribution is too large, excessive combustion will occur in the furnace, and the generated SO_2 will enter the hydrogenation reaction. In the reactor, the hydrogenation reactor bed is overheated.

Considering the need to withstand high temperatures, it is also necessary to solve the problem of H_2S corrosion. The material of the ordinary blown thermocouple corundum protective sleeve is upgraded to a cermet composite material, and at the same time, the content of impurities in the non-metal material is strictly controlled, so that the high temperature resistance of the thermocouple protection sleeve can be realized, and the Good thermal shock resistance.

(2) According to the analysis of the process medium, the inner layer corundum tube and the outer corundum tube with the theoretical thickness outside the thermocouple core are calculated, and the ceramic fiber ribbon is wound and filled between the thermocouple core and the inner corundum tube, and the outer corundum tube and the inner layer are wound. The freshly circulated inert protective gas nitrogen is filled between the corundum tubes through the purge tube.

(3) In order to accurately ensure the circulation amount of the shielding gas, the blowing flowmeter is installed with the rotameter, and the toxic gas deep into the thermowell is taken out to protect the thermocouple wire from corrosion.

(4) In order to eliminate the influence of deformation and stress concentration, an alloy reinforcing tube is installed on the outer side of the outer corundum tube, and the two are filled with high-temperature sealant. At the same time, the stress-relieving ring is added to the top of the alloy reinforcing tube.

(5) The instrument protection nozzle of the burner body is made of ordinary carbon steel, which is corroded and deformed in a high temperature environment, so that the thermocouple cannot be extracted. In response to this problem, the protective nozzle material of the burner unit body is upgraded to an alloy material resistant to high temperature and corrosion.

4. Technical comparison with similar products

As shown in Table 1, the performance of the modified high-temperature thermocouple is compared with that of similar products at home and abroad.

5. Relevant analysis data and operation data during the effect verification period

In the case of the same amount of processing, several production cycles are run, and the recorded data is as follows.

Table 1. Comparison of technical parameters

Key technology point	domestic	International	Problem	Renovation patent	Transformation effect
High temperature resistance	Use ordinary corundum casing	High precision corundum casing	Unable to solve the hidden danger of fracture	Cermet composite pipe	Up to 2200 ° C
preservative					
Thermal shock resistance	Thermal shock resistance is easy to break	Good thermal shock resistance	International product guarantee for 1 year	Prevent breakage by adding stress relief ring measures	Good thermal shock performance, guaranteed for more than 3 years
measurement accuracy	Good measurement accuracy	Good measurement accuracy	Basically meet the requirements of the specification	System lifting accuracy	Accuracy is higher than the specification
stability	Poor stability	Better stability	Guaranteed to be stable within 1 year	Detection environment optimization	Guaranteed to be stable for more than 3 years
Leak prevention	No leak proof design	Partial leak proof design	Toxic gas leak	Special leak proof design	Ensure zero leakage
Anti-poisoning	Even silk poisoning	Can eliminate the filth poisoning	Long-term accuracy degradation	Increase protection N2	Anti-corrosion and anti-poisoning accuracy
Sintering	No requirement for furnace nozzle	No furnace nozzle requirements	The furnace nozzle is easy to melt	Newly designed furnace body nozzle	Easy to disassemble and prevent melting
Anti-crystallization	Generally no purge	Generally unprotected	Easy to form sulfur impact measurement	N2 purge protection	Check point is clean
Online maintenance	Protection wind is not adjustable	Protection wind is not adjustable	Sulfur crystallization influence measurement	Flow adjustable attachment	Measuring accurate delay life

Table 2. Process system operation data of #114-F-101

Operating parameters	unit	Transformation of the former	After transformation
Furnace temperature fluctuations	Times	5	no
Air ratio		1.9	1.4
Combustion furnace air intake	Kg/h	5000	4500
Hydrogenation reactor bed temperature	℃	255,258,260	240,245,243
SO_2 exhaust emissions	Mg/m³	120	90
Furnace pressure	kp	30	24

Table 3. Process system operation data of #114-F-201

Operating parameters	unit	Transformation of the former	After transformation
Furnace temperature fluctuations	Times	5	no
Air ratio		1.8	1.4
Combustion furnace air intake	Kg/h	4800	4500
Hydrogenation reactor bed temperature	℃	258,260,250	243,245,243
SO_2 exhaust emissions	Mg/m³	120	90
Furnace pressure	kp	28	23

6. Conclusion

(1) After the transformation, the high-temperature thermocouple casing is double-layered cermet composite pipe and stress relief ring, and its strength and high temperature resistance are improved.

(2) The thermocouple opening pipe is changed from ordinary steel pipe to alloy pipe, and its strength and high temperature resistance are greatly improved.

(3) After the transformation, the high-temperature thermocouple can maintain the shape variable within a reasonable range for a longer period of time due to the improvement of strength and performance, and the thermocouple filament is not easily poisoned and the service life is greatly improved. Stable and continuous measurements are guaranteed for at least one service cycle.

(4) After the transformation, the device can maintain continuous and smooth operation for a longer period of time, avoiding the loss caused by the fluctuation of the device caused by the failure of the thermocouple, and increasing the economic benefit of the device.

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