Hotspot Seal Pot Detection of PLTU Teluk Sirih

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Abstract. Hotspots are the primary factor causing instability in the sealpots of CFB-type power plants. This occurs due to cracks in the refractory, material bed accumulation, or material entrapment within the refractory. The presence of hotspots has a negative impact on boiler performance and increases the load.

According to API 936 standards, temperatures above 200°C can lead to hotspots, which cannot be prevented at that temperature. To avoid hotspots, it is necessary to replace the refractory with appropriate new materials and ensure proper installation to prevent thermal leaks.

Out of the 44 measurement points conducted in Unit 1 on the two sealpots of the boiler, only 6 points were found to be in normal condition, while the remaining 5 points experienced hotspots. This condition is highly dangerous as the temperature exceeds 200°C, and the abnormal conditions at those points need to be addressed promptly.

Keyword : Hot spots, temperature measurements, PLTU pot seals

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Introduction

Hotspot is a high-temperature area that often occurs on the walls of a boiler, which can lead to failure or inefficiency of the material system in withstanding heat. This occurrence is common in boiler operation. Hotspots can result in heat leakage, reducing the performance of the boiler and preventing it from generating heat as intended in its design. Excessive heat conditions and the occurrence of hotspots indicate the presence of ambiguity that needs to be critically evaluated [1]. Heat becomes concentrated in the area of heat leakage, which, in turn, leads to further heat escalation. Hotspots can cause greater heat losses in the boiler. The presence of hotspots can also damage the structural integrity of the walls as heat transfer components or parts of the boiler.

The phenomenon of hotspots in boilers shares similarities with what occurs in other heat transfer equipment, such as pipes and boiler walls, due to insulation imperfections [2]. Pipes or boiler walls can experience hotspots due to heat leakage. The excess heat in those areas can cause degradation or damage to the surface of the walls, which can then spread throughout the walls due to excessive heat from other locations. The heat conducts to the surrounding areas and can lead to damage to refractory walls, depending on the location of the hotspot [3]. There is a series of chemical reactions in this case that cause changes in the physical, chemical, and mechanical properties of the wall materials.

The formation of hotspots represents a loss of energy in the form of heat and is an undesirable heat transfer phenomenon. It occurs when the thermal resistance becomes lower than it should be. Hotspots are potential energy failures that can lead to serious consequences within a boiler, including the risk of accidents, personnel injuries, or even fires. To prevent such adverse impacts, it is important to use external insulators such as fire-resistant bricks or refractories on the boiler walls. However, despite the use of refractories, there are unavoidable open areas in the construction, which can result in the formation of hotspots and reduce the effectiveness of the refractory work. To address this issue, enhancements and repairs to the refractories at the hotspot areas or additional insulation around the hotspots can be implemented. The purpose of improving and repairing the refractories is to reduce heat transfer to the surroundings, thereby eliminating hotspots and reducing the risks of fire, injuries, or other negative impacts. Additionally, the addition of secondary insulation inside the boiler can also be considered. This secondary insulation serves not only as additional protection but also helps prevent energy loss.

The objective of this research is to measure the temperature of the insulation shell of the sealpot in the Teluk Sirih Power Plant (PLTU) in order to prepare the procurement documents for the bidding process of refractory repair work on the sealpot of the Teluk Sirih PLTU, according to the standards and specifications outlined in the procurement documents for goods and services for the refractory repair work on the sealpot of the Teluk Sirih PLTU. This will help ensure that the repair work is carried out properly and effectively to address the issues of excessive temperature and hotspots that have been identified.

Research methods

The Teluk Sirih Power Plant (PLTU) utilizes a Boiler Circulating Fluidized Bed (CFB) system that can use various types of solid fuels, including coal and biomass. This system generates clean, reliable, and efficient energy while helping to reduce emissions of fossil fuels and CO2 by utilizing locally available renewable alternative fuels.

In this system, the fuel is burned in a separate furnace from the boiler. The hot gases produced then enter a cyclone separator before entering the boiler. Solid particles and partially burned coal are recirculated back into the furnace. To redirect the hot gases back to the furnace, a discharge duct or seal pot is used as an intermediary between the cyclone separator and the furnace, containing the high-temperature gas.

At the Teluk Sirih Power Plant, the component that requires repair is the seal pot (Figure 1), which is the conduit between the particle separator (cyclone separator) and the combustion chamber. There are two seal pots, namely seal pot A and seal pot B. Currently, the seal pots are experiencing issues with the formation of hotspots (areas with excessively high temperatures) at certain locations. To prepare the procurement documents for the seal pot repair project, surface temperature measurements of the outer casing of the seal pots are being conducted to detect hotspots and undesirable temperature increases.

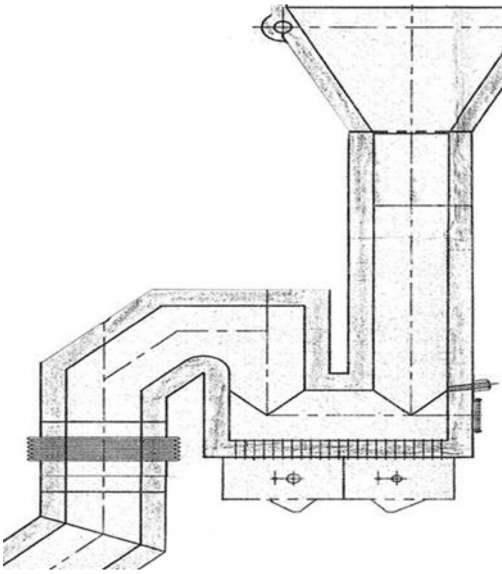

Figure 1 Seal spot for Unit 1 PLTU Teluk Sirih

The Teluk Sirih Power Plant consists of two units, and this research focuses on measurements conducted at Unit 1. The measurements are performed using a thermal imaging camera, specifically the FLIR camera. This camera is capable of detecting and measuring the infrared energy emitted by objects. The infrared data is then transformed into an electronic image that displays the surface temperature of the measured objects. By utilizing an infrared sensor composed of thousands of pixels, the camera generates a color-coded temperature map of the objects. Each temperature value is assigned a different color. FLIR is also compliant with the NFPA 1801-202 standard and has the capability to identify heat signatures, detect hotspots, and quickly identify hazardous areas.

Work Results and Analysis

Hotspots refer to areas that experience significantly high temperature increases in equipment or structures. This often indicates that the refractory is not functioning effectively and can lead to refractory failures. Such incidents are commonly observed in furnaces, boilers, and refractories. If not accurately diagnosed, hotspots can be highly dangerous and result in damage, leaks, or even fires. When a hot spot is identified, immediate repairs are necessary on the affected seal pot to address the hotspots and ensure the refractory operates effectively.

Temperature measurements and hotspot monitoring were conducted from February to May 2022 (Table 1). This approach aimed to identify any damage and the formation of hotspots on the casing of the seal pots. Thus, the temperature measurement results can be utilized as the basis for the procurement documents, which will serve as the foundation for the procurement project aimed at repairing the seal pots and addressing the detected hotspots.

The involvement of a second party, namely the engineering team from the power plant, is necessary for this project and their participation in the bidding process is required. The procurement documents for the seal pot repair typically incorporate information based on the observed damage or service life, as well as findings from the engineering team within the boiler system, as the basis for the procurement request of goods/services. The procurement documents are prepared to include the temperature excess measurements on the seal pot and the identification of hotspots in the seal pot area, leading to shell temperatures exceeding 200°C.

Out of the 44 measurement points conducted in Unit 1 on the two seal pots of the boiler, only 6 points were found to be in normal condition, while the remaining 5 points experienced hotspots. This condition is highly dangerous as the temperature exceeds 200°C, and the abnormal conditions at those points need to be addressed promptly. High temperature deviations can damage the refractory material and potentially lead to the formation of new hotspots.

In this regard, it is crucial to take immediate corrective action. The repairs should involve restoring the normal conditions at the points experiencing excessive temperatures and addressing the formed hotspots. By performing precise and effective repairs, it is expected to restore temperature stability in the seal pots and prevent further damage to the refractory material. These repairs need to be carried out with the assistance of an experienced technical team that specializes in refractory issues and excessive temperatures in boiler systems. The

Table 1 Results of Thermography Measurements from February to May 2022

Peralatan	Posisi	Titik	Februari (oC)	Maret (oC)	Mei (oC)	Standar (oC)
SEALPOT A	SISI WTP	A	**176**	**178,6**	**150,5**	110
		B	**183**	**167,1**	**177,2**	110
		C		**105,9**	**95,6**	110
		D	**121**	**112,6**	**112,1**	110

	SISI ASB SILO	E	214	182,2	174,4	110
		F	274	320,1	257,2	110
		G		109,9	106,6	110
		H	135	125,3	124,2	110
SEALPOT B	SISI WTP	A	175	175,7	161,5	110
		B	113	156,7	131,1	110
		C		90	78,3	110
		D	104	140,8	130,8	110
	SISI ASB SILO	E	194	222,6	186,1	110
		F	149	169,1	141,8	110
		G		93	84,3	110
		H	176	129,1	129,1	110

Normal
Warning
Dangerous

team can conduct a thorough evaluation of the seal pots' conditions, identify the causes of hotspot formation, and take the necessary steps to rectify the situation.

FLIR is a thermal imaging camera used for temperature measurement. It operates based on the principle that every object emits infrared energy, known as its thermal signature. An infrared camera, also known as a thermal imager, detects and measures the infrared energy of objects. The camera converts the infrared data into an electronic image that displays the surface temperature of the measured object.

Inside the camera, there is an optical system that focuses the infrared energy onto a specialized detector chip (sensor array) containing thousands of individual detector pixels arranged in a grid. Each pixel in the sensor array responds to the focused infrared energy and generates an electronic signal. The camera's processor collects the signals from each pixel and applies mathematical calculations to create a color map of the visible object's temperature. Each temperature value is assigned a different color. The resulting color matrix is sent to the camera's memory and display as a thermal image of the object.

FLIR, in accordance with NFPA 1801-202 standards, has the capability to determine heat signatures, detect hotspots, and swiftly identify life-threatening situations and hazardous areas. Based on these capabilities, temperature measurements on the seal pot's surface can be trusted and used as supporting evidence in the procurement document for the acquisition of goods and services to repair Unit 1's seal pot in PLTU Teluk Sirih.

Several documented cases of hotspots on the inner walls of the Unit 1 seal pot at PLTU Teluk Sirih can be observed in Table 2.

Table 2 Documentation of failure of the refractory seal pot unit 1 of PLTU Teluk Sirih

Sealpot A			
			
Seal Pot B			
			

Based on the images in Table 2, it is evident that the surface of the seal pot has experienced damage. Certain areas of the surface have undergone degradation and cracking. The thinning and cracking of the surface will result in hotspots on the seal pot's shell..

Conclusion

1. Hotspots occur as a result of previous refractory damage, which may have occurred due to either reaching the end of its service life or premature damage caused by operational errors in the power plant.
2. The temperature measurements conducted on the surface of the seal pot revealed that only 13% (6 measurement points) were operating normally below 110°C, while the remaining points were in a hazardous

condition. Furthermore, 5 points (11%) were identified as hotspots.

3. It is imperative to promptly repair the refractory of the seal pot as the presence of hotspots alone can potentially lead to fires.
4. With the completion of the seal pot temperature measurements, the resulting data can be utilized as technical information to prepare procurement documents. This includes technical specifications, project timelines, contract requirements, and supplier/contractor evaluation criteria.

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