Practice and Analysis of a Flushing Method for Lubricating Oil System of Thermal Power Unit

Junfeng-Qi*, Yuzhu-Zhao¹, Maosong-Wu¹ and Zhengfeng-Wu¹

¹Huadian Electric Power Research Institute Co., LTD. Hangzhou, Zhejiang, 310000, China
¹*Corresponding author’s e-mail: junfeng-qi@chder.com

Abstract. Lubricating oil system is an important auxiliary system of thermal power unit. The equipment and pipes in the system may have foreign impurities in the process of manufacture, transportation and installation. In order to discharge foreign impurities from the system, it is particularly important to flush the lubricating oil before the unit is officially operated to ensure that the key components such as bearing bush, journal, are not damaged and affected in operation. This paper combines the optimization of the original flushing scheme of the lubricating oil system of a 1000MW unit in China, and introduces the optimized flushing methods and measures. By introducing the establishment of good working practice and experience feedback, it facilitates the follow-up similar work, and also provides a good guarantee for the safe and reliable operation of the unit, and brings good economic benefits.

1. Introduction

Lubricating oil system is an important auxiliary system of thermal power unit. Its main function is to provide qualified lubricating oil to bearings, Jacking oil pump and turning gear of turbo-generator, and to provide high-pressure oil to the turbo-generator manual and overspeed trip circuits associated with the electric hydraulic fluid system. In addition, it also provides stable and reliable initial oil source and standby oil to generator sealing oil system[1].

The purpose of flushing the lubricating oil system is to remove iron filings, welding slag and other impurities in oil pipeline during manufacture and installation, so as to ensure that components such as turbine bearing are not damaged and affected during unit operation and to realize safe, effective and stable operation of unit. Therefore, the cleanliness of the lubricating oil system is an important guarantee for the safe and reliable operation of the unit.

Therefore, the new or overhauled units have to flush the lubricating oil system of the steam turbine to ensure cleanliness, and the choice of flushing method determines the time and effect of the flushing. In this paper, the scheme optimization is carried out on the basis of the original flushing scheme of the lubricating oil system of a 1000MW unit to ensure that the quality of the lubricating oil is quickly qualified. The popularization value of this flushing method in other units is discussed and analyzed.

2. Problems existing in the original flushing scheme of lubricating oil system of this unit

2.1. Brief introduction of original scheme

The original scheme is simple and conventional. It divides the flushing of the lubricating oil system into two stages. The first stage is that the lubricating oil does not flush the external pipeline of the bearing box. It uses temporary large flow oil pump and some temporary pipeline to implement the
flushing. The second stage is the internal circulation flushing after the restoration of all the formal lubricating oil system pipeline, i.e. the temporary pipeline of the system are dismantled and restored to the state of the formal operation system. The pumps in the system are put into operation to flush the system[2].

2.2. Difficulties in the original scheme
For the first stage flushing of this unit, due to the complexity of the oil pipeline, the volume and velocity inside the oil pipeline of the system vary greatly. Some pipeline need large flow volume and velocity, while some have low flow volume and velocity. Therefore, it is necessary to use a certain amount of temporary pipeline to establish temporary measures to achieve a better flushing effect.

Secondly, the internal flushing of the system is carried out in stages. Some equipment or pipeline need to wait until the final stage of flushing to enter oil. Therefore, the optimization of these flushing pipeline should also take into account that not too many pipeline changes can be made. Otherwise, the system will not only recover time-consuming after flushing, but also easily cause secondary pollution, and increase investment costs in disguised form[3].

Also, the lubricating oil system flushing acceptance standard of the unit is relatively strict. On the basis of the NAS grade sampling test, the impurities collected at the main oil tank and each bearing box inlet filter are also subjected to weighing acceptance. The high standard requires strict challenges for flushing. How to improve the flushing effect and efficiency to shorten the flushing time is a key issue in the installation, commissioning and subsequent operation management for this unit. Considering the overall working arrangement of this unit, the flushing method of lubrication system of this unit should be optimized.

3. Introduction of the optimized flushing scheme
The optimized flushing scheme can solve two key problems pertinently: first, it can make the impurities adhering to the inner wall of the pipeline and manufacturing residues completely peel off; second, it can make the impurities completely removed from the pipeline system to meet the acceptance criteria.

3.1. Highlights of Optimized Scheme
The optimization scheme of the specific flushing method is embodied in:

1) Pre-purging with compressed air before flushing lubricating oil. After the equipment and pipeline are welded, the cleanliness is difficult to meet the requirement. In addition, the lubricating oil in the return pipeline of the lubricating oil system is not satisfied with the pipeline in the flushing stage or the formal operation stage, and there is uncertainty in the falling off of the flocculent or welding slag attached to the wall, which increases the difficulty of flushing acceptance, while installing the pipeline and using compressed air pre-blowing at the same time. This measure can solve the problem very well.

2) Bypass the oil cooler. Horizontal oil cooler with shell and tube structure is adopted in this unit. Complex internal structure is difficult to remove impurities. Once the impurities enter the unit, the flushing time will increase. On the one hand, the bypass of the oil cooler will reduce the flushing resistance, increase the flow rate and improve the carrying capacity of impurities, on the other hand, it is also a protection of the oil cooler.
3) The confluence row at each bearing box are installed. Aiming at the layout characteristics of lubricating oil system pipeline of this unit, the confluence row is installed on the inlet pipeline of each bearing box, and the isolation valve is installed on each pipeline of the confluence row. This can flush the pipeline by different combination of flushing paths, which can solve the problem of poor flushing effect of some pipeline caused by different flow velocity of pipeline.

4) Two pumps operate simultaneously. After the formal system is restored after the first stage of flushing, on the basis of reliability analysis with designers, motor manufacturers and batteries, the system is flushed by turning oil pump running alone at night, and by turning oil pump and direct current lubricating oil pump flushing at regular intervals in the daytime. The instantaneous large flow impact of the system is carried out to improve the flushing effect.

5) Keep flushing at variable temperature. According to the characteristics of lubricating oil viscosity changing with temperature, the oil temperature is controlled by electric heating device in the main oil tank and large flow device in two stages before flushing, and the cooling water temperature is adjusted after the formal system is restored in the later stage to flush with variable temperature, so as to achieve the purpose of flushing with variable temperature[4].
6) Magnetic rods are placed inside the main oil tank. Because the main oil tank oil return filter material is stainless steel material, does not have magnetic absorption capacity, so consider the main oil tank near the oil return filter placed magnetic rods, using magnetic adsorption to collect the remaining magnetic impurities suspended in the lubricating oil pipeline, effectively avoid being sucked into the system again by the pump [5].

![Magnetic rods are placed in the oil tank](image)

**Figure 4. Magnetic rods are placed in the oil tank**

3.2. *Implementation of the Optimized Scheme*

The optimization measures mentioned above are integrated into the process of flushing on this unit. The specific steps of flushing operation are as follows:

1) Installation, inspection and acceptance of temporary pipeline system and purging with compressed air.

2) Flush the lubricating oil storage, transportation and purification system. Flush the main oil tank, the dirty oil storage tank, the clean oil storage tank and the related pipelines by starting the oil supply pump and purifying device.

3) Large-flow flushing, temporary flushing measures were established. The first stage of flushing was carried out by bypass the oil cooler, bearing box and removal of throttle orifice plate in the system. The first stage of flushing was carried out by using large-flow devices such as electric heating, use of confluence row and manual hammering. According to the sampling results, impurities were collected and analyzed every 2-3 days, and the system was restored after qualified.

![Flush the flushing and conveying and purifying system](image)

**Figure 5. Flush the flushing and conveying and purifying system**
4) After the first stage of flushing, all temporary measures used for flushing are removed and the system pipeline is restored to the normal operation state. In this stage, the flushing is carried out by two pumps running at the same time and the oil temperature is adjusted by cooling water. When the impurity sampling is qualified, the temporary filter will be removed and the system will be in normal operation condition, as shown in the following figure 6 and 7.

![Figure 6. NAS grade sampling result](image)

![Figure 7. Impurity weighing results](image)

4. Analysis of the effect and characteristics of the optimization method

4.1. Flushing Effect Analysis
From the point of view of the actual flushing effect of the unit and the overall start-up of the follow-up unit, it has significant advantages in terms of the flushing time and the effect of the flushing results.

1) In terms of flushing time: plan ahead from the installation stage, intervene in the whole process of lubricating oil flushing, enter flushing phase quickly after installation, significantly shorten the flushing time of the first stage of lubricating oil pipeline system, speed up the whole flushing cycle of lubricating oil system, improve the time for the unit to enter a full set of commissioning, and shorten the overall commissioning work of the unit.

2) As for the flushing results, from the acceptance results of several consecutive times, each evaluation index is excellent and meets the acceptance criteria.

4.2. Advantages of Flushing Scheme
Through the actual application of pipeline flushing in lubricating oil system of this 1000MW thermal
power unit, the method has the following advantages:

1) Because the pipeline is thoroughly flushed, all the indicators meet the acceptance criteria, so the flushing effect is good.

2) Save the flushing time, shorten the commissioning period of the whole unit, and contribute to the subsequent overall start-up and operation of the unit.

5. Conclusion
On the basis of fully considering that the acceptance standard of this unit is obviously higher than that of other types of units, the optimization scheme is arranged and planned in advance, the flushing method is optimized, the specific optimization scheme and the implementation steps are elaborated, and the engineering application is carried out in the process of the capital construction and commissioning of a 1000MW thermal power unit. The results show that the scheme has the advantages of saving time and good flushing effect, so it can be used as a successful case. The subsequent start-up and production operation of the unit provide a strong safety guarantee, and also provide a good reference for the lubricating oil flushing work of the same type of newly built units.

Reference
[1] ZHAO-zhengqing.(2017)Cause Analysis and Treatment on Long Flushing Period of an AP1000 Lubricating Oil System.POWER EQUIPMENT,Vol.31,No.6:416-417.
[2] PAN-kejian.(2016)New Method for Lubricant System Flushing of Steam Turbine Generator. GUANGDONG ELECTRIC POWER,Vol.29 No.9:23-24.
[3] ZHAO-qifang.(2009)Discussion of Imported 660MW Turbogenerator Type of Oil System Flush. Anhui Electric Power,26:25-26.
[4] Huang-houdong(2010)Disscussion on the Turbine Oil System Washing Process in Power Plant. Value Engineering,23:231.
[5] LU-rufei.(2011)Cleanliness Control of Oil System for 1000MW Power Turbines. POWER EQUIPMENT,Vol.25,No.3:191-192.