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Research on Lubricating Oil System used in 300 MW Thermal Power Plant in Viet Nam

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ABSTRACT: The lubricating oil is still used as the main lubricant for all types of machinery. It has become an indispensable and important role for all machinery in general and in the electricity industry in particular.

For all types of machinery, when the surface contacts are working, the contact position between the surfaces of the moving parts and the other one move relative to each other will generate frictional forces and wear. In this paper explore the role of lubrification oil for reducing the friction, wear etc. and discussing some case study in 300 MW Thermal power in Viet Nam.

KEYWORDS: Thermal power plant, bearing, lubricating oil system, friction, wear

I. INTRODUCTION

The lubrication oil is very important to reduce friction and wear in a contact between two surfaces. The study of lubrication oil system in Thermal power plant can increase the life of rotor, shaft, bearing by 2-8 times. Moreover, it contributes to avoiding incidents that lead to stopping the unit. Machine parts lubricated will have:
- Reduce friction coefficient means increasing machine performance and machine parts.
- Reduce the wear of machine parts.
- To cool machine parts due to heat caused by friction.
- Protects machine parts from rust.
- Ensure tightness of contact area parts.

In this article, we will discuss a lubricating oil system in a power plant, its problems and solutions.

II. PRINCIPLES OF LUBRIFICATION OIL CONDITIONS IN THERMAL POWER PLANTS

Each type of lubricating oil is evaluated according to two criteria:
- Physical and chemical properties (viscosity, ignition temperature, freezing point, sulfur content, coke, ash, acidity). These properties are standardized.
- Usage properties, such as load-bearing properties, anti-friction properties, anti-wear properties, anti-stick properties.

It is impossible to operate and preserve machines and machine parts for a long time without lubrication. Perfect lubrication is the cheapest and fastest method to increase machine life.

In addition to the main functions above, lubricating oil must also satisfy some other requirements:
- Ensures the ability to work in a wide range of temperatures, pressures and sliding speeds.
- Fill in the surface undulations.
- Creates the largest resistance in the direction perpendicular to the friction surface and the smallest in the tangential direction.
- Does not cause explosion or fire.
- Does not cause harmful effects to detailed materials.
- Ensures lubrication and minimum amount of oil.
- Does not change properties during transportation, storage or supply.
- Does not create dangerous and harmful deposits (metal wear particles).
- Does not produce foam.
- Does not form emulsions.

2.1. DESCRIPTION OF TURBINE LUBRIFICATION SYSTEM OF 300 MW THERMAL POWER PLANTS

The turbine of thermal power plant with a rated capacity of 300MW is a steam turbine. This steam turbine consists of 3 parts: high pressure, intermediate pressure, and low pressure. In particular, the high-pressure turbine is installed on the same axis as the intermediate pressure turbine to reduce axial force and steam compression, and the low-pressure

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turbine divides the flow in half to reduce blade height and eliminate axial force (steam flow move to in opposite directions).

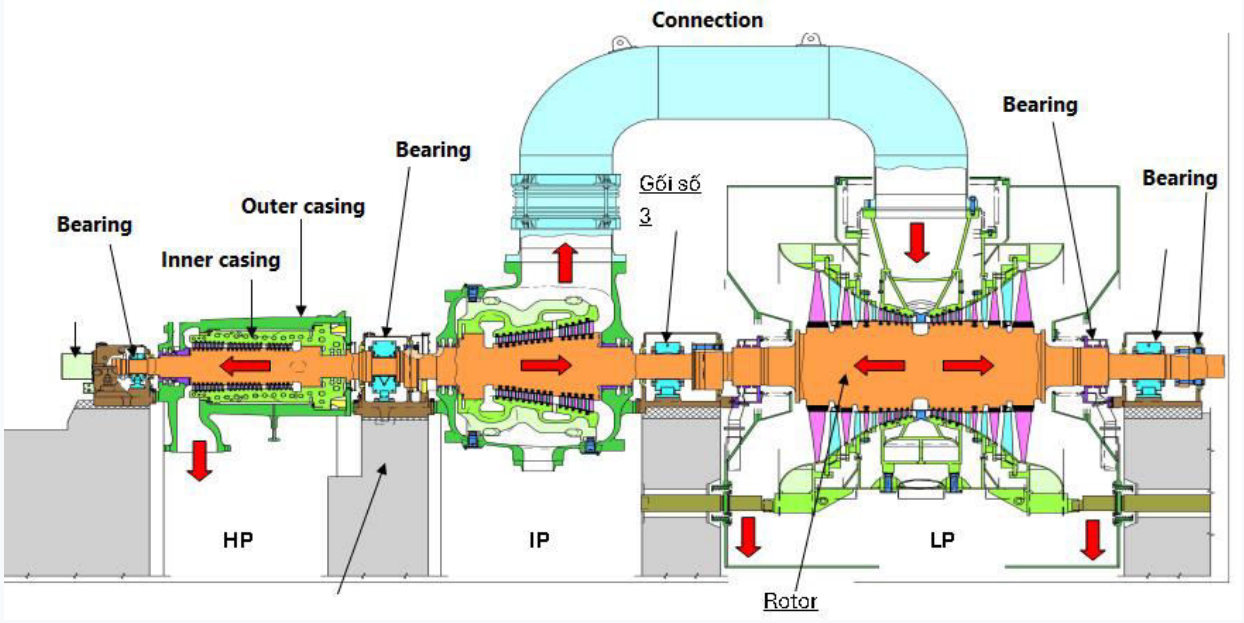

Figure 1: Diagram of 300MW thermal power turbine

Turbine shaft bearings are the most important parts that must be paid attention to in the lubrication process. This Thermal Power Plant turbine has 4 shaft bearings, bearing numbers 1, 3 and 4 are bearings; bearing number 2 is satisfied with both the supporting - blocking task. The bearing has be supporting the rotor of turbine, the support-block bearing has the effect of supporting and blocking the rotor from moving due to the force of the steam flow.

Turbine support is an important part, it is responsible for supporting and blocking the rotor. Metals for manufacturing bearings include:

- Body of bearing usually made from high quality cast iron СЧ21-40.
- Supporting bearings are usually made from low-carbon steel (10-15% carbon steel) with a carbon content not greater than 15% and annealed at high temperatures of 800^{o}C -900^{o}C
- The part of the bearing in contact with the shaft is coated with a layer of 3-metal Б-83 at the two ends are coated with a brass. The lower back of is fitted with 3 self-adjusting lugs in contact with the bearing, the upper back has 1 other lug.
- The bearing No 1 has a special structure that both supports and blocks and has an intermediate support ring. The intermediate support ring has 3 lugs, and the bottom also has 3 lugs.
- The two ends of the bearing are fitted with 4-tab brass. This gap with the shaft is more than 0.4mm that will easily cause oil splashing, loss of oil and causing oil fire. The steam insert rim or gasket is intended to prevent steam getting out. It will pass through the oil seal into the bearing, causing the oil to degrade and lose its lubrication and cooling ability.

2.1.1. Function of turbine lubrication system

Continuously supply oil to each bearing at any time because if the supply is stopped, the bearings will be seriously damaged. The mainly functions are:

- Reduce friction coefficient
- Lubricate turbine shaft bearings
- Cooling and cleaning the turbine shaft bearing
- Create a layer of oil to lift up the turbine shaft
- Damping

Detailed descriptions of the main functions are as follows:

- Friction coefficient reduction

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When the oil layer is continuous, the friction of the lubrification oil replaces the surface friction of the metal against each other. When the shaft rotates, a layer of oil will help resist physical impacts on the bearing. It acts as a cushion between moving parts, preventing contact between metal surfaces and reducing vibrations.

- Lubricate the turbine shaft bearings

Oil is moved to the bearings to lubricate the shaft. This reduces friction coefficient with the equipment in contact with it.

- Cooling and cleaning

Oil cools internal parts by absorbing heat. It then carries this heat out of the system through the oil cooling system to remove the heat and bring the oil to the appropriate temperature. As it passes through parts of the system it picks up impurities and carries them through the oil cycle to the sump. Here impurities are filtered and removed.

- Forms a lubricated layer of sealing.

Shaft are located between the moving and stationary parts. And there is always a certain amount of space that exists. This space will be filled with lubricating oil.

The thin film of oil between the surfaces forms a very good leak-proof air cushion. To ensure functionality, the oil must meet the following requirements: viscosity and cleanliness.

- Damping

2.1.2. Working principle of the lubrification system

During normal operation, oil from the oil tank is transported by the main oil pump in turn through the oil cooler (ensuring the oil temperature is within the allowable range 35°C), oil filter (ensuring the oil is not mixed with impurities) and then move to lubricate the turbine bearings. At the main oil pump's discharge end, a pressure compensation tank is installed to stabilize oil pressure during operation.

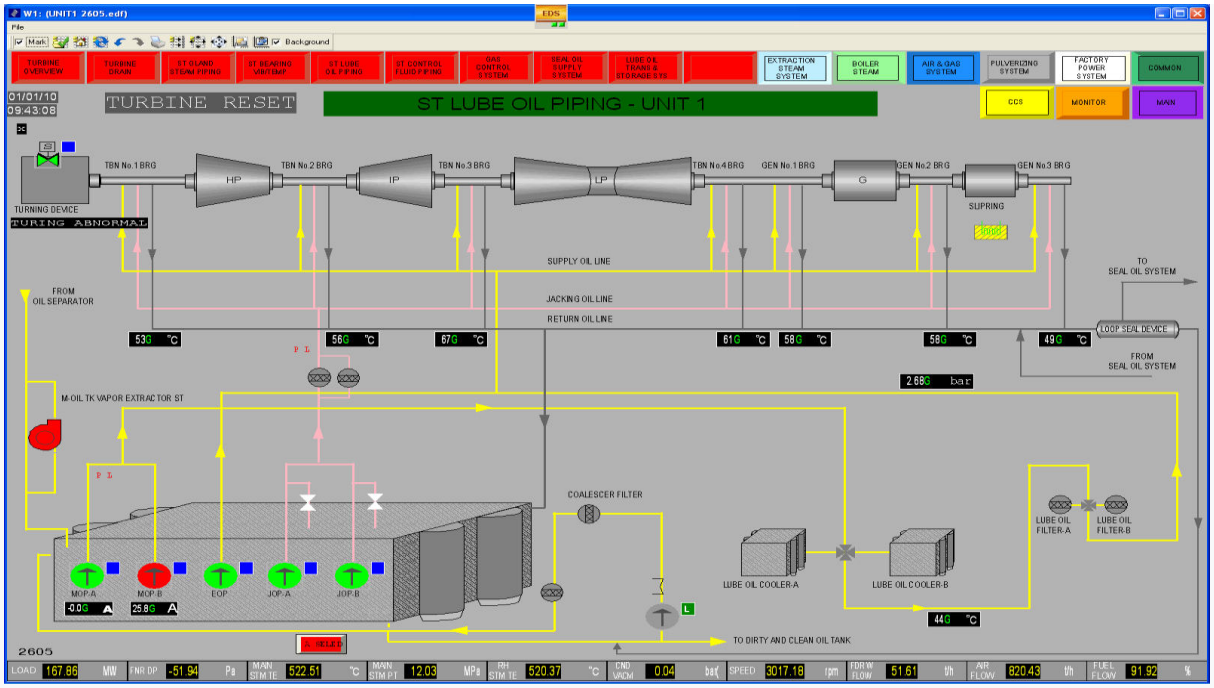

Figure 2: Diagram of lubrification system of 300MW thermal power plant

On each oil line, before entering the bearings, there is a throttle valve installed to adjust the oil flow into the bearings.

- Oil from the oil tank is pumped to the turbine and generator shaft bearings thanks to the oil pumps. When the turbine starts up, one of the two shaft lift oil pumps (JOP) operates to supply oil to the shaft bearings and shaft rotation device, the remaining pump is in interlock backup mode.

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- After entering the bearings, the lubricating oil is returned to the oil tank. There is an oil cleaning device at the oil tank. This device works periodically (from 24 ~ 36 hours/week). Oil returned to the tank is often mixed with air, oil vapor and water vapor. This gas mixture is sucked away by the oil tank exhaust fan to improve the quality of lubricating oil.

During the process of starting up or stopping the turbine, the shaft lifting oil pump will come into operation, high pressure oil is supplied by the shaft lifting pump to the bearings to lift the turbine shaft. Oil from the oil tank is transported by the shaft lift pump through the shaft lift oil filter and then to the bearings.

During operation, if the lubricating oil pressure drops to a low level or the AC power which is lost, the emergency oil pump will automatically start working. Oil from the oil tank is sent directly to the bearings by the emergency oil pump without going through filters and coolers.

2.1.3. System lubrification specifications

a) Oil tank

- Capacity (when operating normally): 12,500 liters
- Number of installation: 01.

b) Main Oil Pump (MOP - Main Oil Pump)

- Type: Vertical centrifugal AC pump
- Normal pressure: 5.5 bar
- Number of installation: 02 (including backup pump)

c) Emergency Oil Pump (EOP - Emergency Oil Pump)

- Type: Vertical centrifugal one-way pump
- Push head pressure: 2.2 bar
- Number of installation: 01.

d) Jacking Oil Pump (JOP - Jacking Oil Pump)

- Type: Rotary piston AC pump
- Push head pressure: 147 bar
- Number of installation: 02

e) Oil type:

ISO VG 32 (According to viscosity standard level 32).

2.2. COMMON PROBLEMS AND SOLUTIONS IN LUBRICATION SYSTEMS

The risk of bearing injury increases due to many reasons and we will discuss in case of lubrification systems as follows: Normally the lubricating oil system works very well and effectively, however during operation there are still some problems that occur. Here we will indicate some problems that occur with the lubricating oil system.

2.2.1 Low lubricating oil tank level

During the working process, the oil is transported in a closed pipeline system. However, during operation process, there may be subjective or objective errors as follows, causing the oil to leak to the outside and leading to the following phenomenon such as low lubricating oil tank level warning symbol or at the local water tube showing low oil tank level

- The oil tank bottom valve is not closed tightly;
- Oil leak on the lubricating oil pipeline returning to the tank;
- Oil leak in heat exchanger with closed cooling water;
- Error measuring, displaying, and warning equipment are not accurate.

After detecting a low oil tank level warning and finding the cause of the low oil tank level warning, we take the following corrective measures.

- Check and close the oil tank bottom draining valve;
- Check and detect lubricating oil leaks, request immediate repair as soon as possible. If there is a lot of leakage, stop the turbine and stop the system according to the procedure and then request repair.
- Request C&I to check and fix errors in measurement and control equipment.

2.2.2 High lubricating oil tank level

During operation, the lubricating oil tank level is always kept at the working oil level (0mm and 914mm from the top of the tank), however, during the operation process, the lubricating oil tank level warning on the DCS may be high. Lubrication in the water tube mounted very high in the lubricating oil tank. The cause of the high lubricating oil tank level warning can be due to one of the following reasons:

- The system to separate water from the oil does not work effectively, leading to the oil containing a lot of water.
- Coolant leaking into the oil line in the cooler.
- Error measuring equipment, display, and alarm are not accurate.

After finding the cause of the high lubricating oil tank level warning, we proceed to take corrective measures according to the following steps, in order to bring the oil tank level to normal working level:

- Check and operate the oil filtration system to filter out all water mixed in the oil. Make sure the oil tank air suction system operates normally.

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- Request C&I to check and fix errors in measurement and control equipment.

2.2.3 Poor quality of lubricating oil

During the operation of the lubricating oil system that provides lubricating oil to the turbine - generator shaft bearings, there is a phenomenon of increased oil temperature, high return oil level, turbine - generator shaft bearing temperature is higher than the normal temperature. Normally, we have to carry out some tests of the lubricating oil and the results show that the oil quality is not guaranteed or when operating there is a high pressure differential warning in the push head filter. We can assume that the quality of lubricating oil is bad and not guaranteed.

From the above phenomena, we can give some of the following causes that can lead to bad lubricating oil quality:

- There is water mixed in the lubrification oil.
- There are new impurities mixed into the lubricating oil;
- It's time to replace the lubricating oil but don't change it.

After finding the cause of the bad oil quality, we take the following corrective measures to improve the quality of lubricating oil to ensure the operation of the system as well as the turbine – generator. Try to do in the best way:

- Check and operate the oil filtration system to filter out all water and impurities mixed in the oil. Make sure the oil tank air suction system operates normally.
- Replace lubricating oil according to regulations.

2.2.4 Lubricating oil temperature after cooler is high

During the operation of the lubricating oil system that provides lubricating oil to the turbine - generator shaft bearings, there is a phenomenon of increased oil temperature, high return oil level, turbine - generator shaft bearing temperature is higher than the normal temperature, normal, accompanied by a display of high lubricating oil temperature after the cooler.

Based on the above phenomena, we can point out some causes leading to high turbine-generator lubricating oil temperatures:

- Faulty lubricating oil temperature regulation valve leads to low lubricating oil cooling water flow;
- The heat exchanger plate at the lubricating oil cooler is dirty, leading to poor heat exchange performance

After checking and determining the cause of the high lubricating oil temperature problem, we proceed to take corrective measures to make the lubricating oil system back to normal working state according to the following steps:

- Check and switch the lubricating oil temperature adjustment valve to “MAN” mode to keep the lubricating oil temperature at a normal value.
- Change the lubricating oil cooler; isolate, take safety measures and require repair, clean of heat exchanger plates.

2.2.5. Low lubricating oil pressure

During normal operation, the lubricating oil system's lubricating oil pressure is always kept at a fixed level to ensure the supply of lubricating oil to the turbine - generator bearings, however, pressure may occur. Low and full lubricating oil is one of the particularly dangerous incidents with the following phenomena: low lubricating oil pressure; the backup pump is interlocked to work when the pressure is lower than 4.48bar or the emergency oil pump is interlocked to work when the lubricating oil pressure behind the adjusting valve is lower than 2.35bar.

The problem of low lubricating oil pressure is one of the particularly dangerous problems, so it must be quickly discovered that it may be due to one of the following causes:

- Lubricating oil mixed with impurities leads to high differential pressure in the oil filter;
- Error in the lubricating oil pressure regulating valve;
- Error of lubricating oil pump;
- Errors in measuring and control equipment;

This is one of the dangerous incidents, after finding the cause, we must quickly take corrective measures according to the following steps:

- Check and operate the oil filtration system to filter impurities mixed in the oil, change the lubricating oil filter.
- With the error of the lubricating oil pressure regulating valve, the remedy is to stop the turbine and the lubricating oil system according to the correct operating procedures; take safety measures, request repair of the lubricating oil pressure regulating valve.
- Check that the lubricating oil pump has just started working automatically; Request to check the electrical part of the lubricating oil pump that has just broken down. If it is a mechanical error that requires repair, check and fix it when the system has stopped working.
- Request C&I to check and fix errors in measurement and control equipment.

III. CONCLUSION

In conclusion, the analysis briefly describes important operational parameters that need to be monitored during the turbine Bearing Lubrication System and precautions to be taken during turbine lubrication. Many improvements are

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going on to adjust operations or make emergency stops when the parameters exceed the limit. These studies will reduce incidents and help the Thermal power plant increase the number of continuous working hours of the units. It is also the basis for further research on the tribology and lubrication for the high-capacity turbine that will reduce the friction, wear and will increase the application life.

REFERENCES

1. Pham L.T: Steam Turbine: Theory and Structures. Polytechnique Press, 2005 (in Vietnamese).
2. Pham L.T: Steam Turbine equipment: some common problems. Science and technology Press, 2005 (in Vietnamese).
3. P.N. Sliakhin, Steam and gaz Turbine, Leningrade energy press, 1966;
4. Alfred Holn: les paliers des turbogroupes à vapeurs, revue Brown Boveri, No 3, 1975.
5. Pham LT: some basics problems of modern steam turbines in thermal power plant, Polytechnique Press, 2016 (in Vietnamese)
6. Nguyen DY. Tribology, wear and lubrification. Construction Press, 2005 (in Vietnamese)
7. Operation process for 300 MW thermal power plant.

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