CHAPTER 15

Condition Control

Introduction

Condition control of water turbines and additional mechanical equipment is the primary basis for organizing and carrying out

- *preventive maintenance* - a continous process which is taking place with certain time intervals and at planned dates.
- *overhauls* - being performed to improve the operation conditions, rectify wear and leakages on the plant according to plans adapting to the plant operation.

If an accident occurs or preventive maintenance and overhauls are not carried out properly, situations requiring repairs may arise. A *repair* is here defined as an unplanned overhaul.

Continous monitoring and condition control is of great importance to all types of turbines. The content of the condition control activities are however, somewhat different from one type to another of the turbines. Therefore, condition control is briefly described specifically for the respective turbine types.

15.1 Activities for Pelton turbines

Turbine guide bearing

The first oil change should be done after 3 - 6 months of operation. The later oil changes are to be done as required by evaluating oil sample tests.

To empty the bearing for oil it has to be done at standstill by pumping through the oil level pipe in the bearing housing.

If babbit metal particles are found in oil samples, the bearing should immediately be dismantled for inspection.

Runner

The runner should be regularly inspected to record possible damages from foreign objects in the water. The time interval between each inspection is dependent on sand content in the water.

The runner inspection is done visually by means of magnaflux and/or dye penetrant. Particular attention should be paid to the area between the buckets.

If minor cracks or defects have been formed, these should be removed by grinding and polishing according to advices from the manufacturer.

The special shape of the runner buckets makes it difficult to detect material defects just below the surface. These defects may penetrate to the surface during the first operation time period. To prevent an extensive crack propagation they must be rectified as soon as possible.

Main injector with needle servo motor

The needle tip and the nozzle should be inspected with respect to cavitation damages and damages from foreign objects. If the water contains fine silt or sand, the needle tips may loose their original shape.

It is of great importance that the nozzle is inspected from the inside.

The needle servomotor should be run to neutral mid position and the oil pressure taken off for safety reasons. The leakage indicators should be regularly inspected.

Seal ring in deflector bearing

Leakage in this seal do not require immediate replacement of the seal ring, but replacement should be done as soon as possible to avoid bearing corrosion. The seal ring must be provided with a spring of stainless material.

Filter

Filter for breaking system control water supply should be checked and cleaned if necessary. It may be cleaned after closing of the valves for this water supply system from the penstock.

15.2 Activities for Francis turbines

Routine inspections

Routine inspections means visual inspection of the complete turbine:

- look for possible leakages
- inspect bolted connections
- drain pumps should be inspected and level switches tested.

RPM shutdown curve

The activity is to record the RPM with 30 seconds intervals from the moment of closed guide vanes to standstill of the unit. The RPM shutdown curve should be drawn from nominal RPM to standstill.

Leakage control of guide vanes

The activity is to record the RPM with the spherical valve open and the guide vanes closed.

Shaft alignment

The activity is to record the shaft misalignment by means of a micrometer dial instrument against the shaft at the turbine bearing top. The misalignment should be recorded at different loads on the unit.

Labyrinth seal water flow

The assessment of wear and control of the labyrinth rings is possible by measuring the labyrinth water flow.

Runner

Visual inspection of the runner is required to record possible cavitation and erosion damages as well as cracks in vanes. The inspection of the inlet is done from the scroll casing. Three of the guide vane arms should be dismantled and the guide vanes rotated by hand to open position. The unit should be rotated manually to enable inspection of the complete runner circumference. The outlet side of the runner should be inspected from the draft tube cone.

Scroll casing and draft tube

The activity is to carry out inspection of painting for possible corrosion and ensure that all manometer connection openings are open and that the manhole cover is drop tight after completed inspection.

Guide vane mechanism

The guide surfaces of the covers should be inspected from the scroll casing and possible wear recorded.

Visual inspection of the surfaces of the guide vanes. The clearances between the guide vanes and the cover surfaces and the clearance between guide vanes should be checked.

Look for possible leakages in the guide vane bearings. Look for slacks in the bearings of the guide vane arms and links.

Check the connection between regulating ring and the servomotor.

Shaft seal box

During operation water will normally not flow over the the shaft seal box. It may however happen during start and stop. If water runs into the upper cover it is removed by a drain pump.

Turbine bearing

The same activities as for Pelton turbines.

15.3 Activities for Kaplan and Bulb turbines

The general principles for condition control are the same as for the Francis turbines. Further considerations are therefore connected only to a few specific details of Kaplan and Bulb turbines.

Runner

The runner should be inspected both from above and below. Particular attention should be given to possible cavitation erosion and scratches on the blades as well as leaks around the blade flange against the hub.

Runner chamber

The narrow gap between runner and the runner chamber should be checked if foreign objects may have passed the gap and made scratches in the chamber.

Guide vane mechanism

For guide vane mechanism with individual vane servomotors on Bulb turbines it should be checked that the vanes have an identical movement.

Shaft seal box

For Bulb turbines at standstill it should be checked that the water does not flow out of the box along the shaft into the turbine bearing.

Generally for Bulb turbines

Special attention should be paid to changes in the sound when the unit is in operation.

References

Kværner Brug: COURSE III, Lecture compendium, Oslo 1986