Turbine, Generator & Auxiliaries - Course 334

THE TURNING GEAR

In the time it takes for a turbine to come to a complete stop following shutdown, the casing and rotor hardly cool down at all. One hour after steam is shut off, the turbine is essentially at the same temperature as it was when operating. As the turbine slowly cools, cool steam and air tend to settle to the bottom of the casing and warm steam and air rise to the top of the casing. This temperature gradient from the top to the bottom of the casing causes the bottom of the rotor to cool faster than the top of the rotor. This results in a greater contraction of the bottom of the rotor than the top.

The differential contraction results in an upward bowing of the rotor called shaft hog. For a large turbine, the temperature gradient necessary to hog the shaft beyond acceptable limits in only 3 - 4°C.

There are few phenomena as reliable as shaft log. If a hot turbine rotor is allowed to come to a complete stop prior to cooling, the shaft will, almost without exception, develop a permanent bow. Although very minor hogging can occasionally be removed by rotating the shaft within the casing, this is generally an uncertain cure at best. Failing in this, the rotor must be removed from the turbine and sent to the manufacturer for heat treatment or replacement.

To overcome this problem on shutdown, the shaft is kept slowly turning until cool. The turning gear assembly consists of an electric motor which drives the shaft through a reduction gear. Depending on the station, the turbine shaft is rotated at a speed between 10 and 30 rpm. The turbine is normally kept on the turning gear for 24 hours or until the turbine is cooled below 100°C, whichever takes longer.

If the turbine is to be shutdown for maintenance, the unit must be kept in a condition which will allow operation of the turning gear for about 24 hours. After this time, the turbine may be stopped and disassembled.

Another condition which can cause permanent bending of the shaft is warming of the shaft by applying gland sealing steam when the shaft is stationary. Whenever gland seal steam is applied, the shaft must be rotated either by the turning gear or with steam, or distortion is likely to occur.

When cold, the shaft can sag under its own weight if left stationary for a prolonged period of time. The requirements for unacceptable shaft sag are not so clear cut as for shaft hog. Rotating the shaft on the turning gear for one hour per day is usually more than sufficient to prevent sagging. Longer periods of non-rotation may occasionally be necessary, particularly during major overhaul when the lubricating oil system, turning gear and bearings may be disassembled. When the turning gear is disassembled, the shaft can be hand barred or rotated with a crane. In these cases, sound engineering judgement on the part of senior station personnel must be used to determine the maximum period the shaft may safely remain stationary.

On selecting the turning gear motor to start, the following sequence of events should occur:

1. Lube oil should be established at the bearings.

2. The jacking-oil pump should start.

3. Seal oil should be established.

On completion of these items, the turning-gear motor should start and engage shaft drive.

A speed of approximately 3 rpm would be enough to prevent shaft distortion, but speeds up to 30 rpm are generally used to create turbulence within the cylinder and thus cool the cylinder and shaft uniformly. Also running at this speed ensures that an oil film is maintained in the joined bearings.

On initial engagement of the turning gear, a close watch should be kept on the eccentricity and vibration indicators. The shaft should be run in this mode until the eccentricity and vibration are within acceptable limits.

On startup, after running on turning gear as outlined above, steam may be admitted to the turbine. As the speed increases above turning gear speed, the gears will disengage, the turning gear motor will continue to run until the turbine speed is greater than 100 rpm to ensure that if a run back is necessary, that the drive will be taken up immediately by the turning gear as soon as the shaft speed is less than 30 rpm.

It is now becoming general practice on shutdown that as soon as the turbine speed falls to 100 rpm, the turning gear motor will start and as soon as the turbine speed falls below 30 rpm, the turning gear drive will automatically engage on the turbine shaft. At the same time as the turning gear motor starts, the jacking oil pump starts. Both shutdown at the same time as well.

ASSIGNMENT

1. Why does a turbine shaft hog?

2. How is hogging prevented?

3. What action would you take if the turning gear failed to start on shutdown?

4. Why is it necessary to run the turning gear before admitting steam to the turbine?

5. What is shaft sag, and when is it likely to occur?

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