

Case History	Self-Excited Vibration Caused by Trapped Liquid inside Diaphragm Coupling	Rotating machinery (turbine & generator)
Self-Excited Vibration		

Object Machine

Turbine generator with double reduction gearing that reduces the rotation speed of the high speed (100,000 rpm) turbine and generates power at 3,600 rpm. See the block diagram shown in Fig.1.

Observed Phenomena

The turbine and the single reduction gear shaft are connected with a diaphragm coupling. The single reduction gear shaft rotating smoothly at 100,000 rpm suddenly experienced one day the occurrence of unstable vibrations as shown in Fig.2 above 80,000 rpm. Their components were larger than unbalance vibrations, which prevented further acceleration. On the turbine side, no unstable vibration was observed.

Cause Estimation

Since it was unlikely that internal damping of the mechanical components was the cause, considering the fact that the reduction gear shaft was rotating smoothly at 100,000 rpm and that the system has no shrink fit, design drawings were reviewed to check for any possibility to allow fluid to enter the interior. In addition, literature search was conducted on the characteristics of vibrations caused by internal fluid. As a result, it has been revealed that the fluid is most likely the cause because the fluid could penetrate inside the hollow diaphragm coupling and that the phenomenon is repeatable with frequencies and amplitudes varying in accordance with the rotating speeds.

Countermeasures and Results

As expected, overhauling of the diaphragm coupling indicated the presence of lubrication oil on the single reduction gear shaft side. After removing the oil and resuming operation, it was confirmed that no unstable vibration occurred. Although a path to allow for the entry of lubrication oil has not been identified, it is assumed that the diaphragm coupling experienced a high temperature during operation but was cooled down during standstill, which reduced internal pressure, thus leading to the situation where vaporized lubrication oil was introduced inside due to pressure difference during standstill and condensed.

Lesson Learned

Since high speed rotating machinery has many unstable elements including internal friction, it is essential to include an adequate safety allowance at the design stage, and also to fully eliminate possible elements to cause such phenomena. However, it is impossible to completely prevent them. Thus, upon occurrence of an abnormal phenomenon, it is required to carefully observe the phenomenon and investigate all the factors on an assumption of several causes. "Do not give the benefit of the doubt."

Keyword

Self-excited vibration, internal fluid, diaphragm coupling

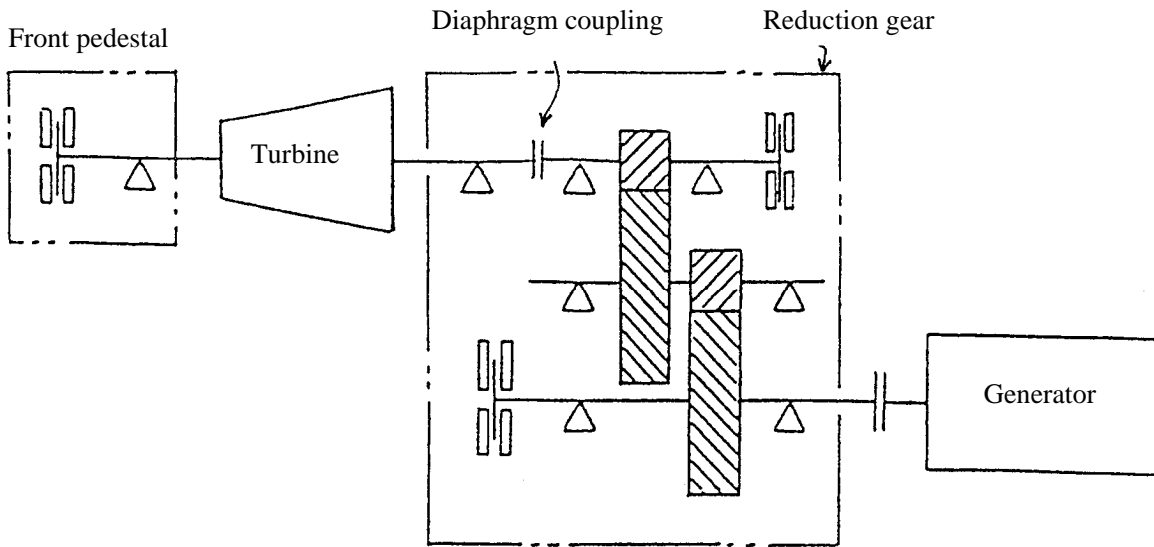


Fig.1: Block diagram of turbine generator

★ Entry of oil into the hollow diaphragm coupling allowed unstable vibration due to oscillation of internal liquid to occur.

