ABSTRACT

Modern machinery and manufacturing systems are expected to be more accurate and efficient, which in turn requires a perfect maintenance system. Maintenance strategies has many tasks of which vibration control is one of the indispensable and challenging one, especially in rotating machineries like gears, sprockets, pulleys etc. This research work deals about evaluating and control of spur gear vibration. The main focus of the present investigation is to obtain quantitative information on the various parameters in different approaches of vibration control in spur gear operation. Three distinct approaches have been adopted in this study. The first one is the Geometry modification, the second is the usage of different material in the web of meshing gears and the third approach is the functional coating of gears.

In the first approach i.e. in Geometry modification, a groove has been provided at the bottom land of the gear in order to increase the thickness and height of the gear tooth at the root. Due to this, the stiffness of the gear tooth at the bottom land of the gear is made increase which in turn reduces the amplitude of vibration of the gear.

In the second approach, the material in the web portion of the steel spur gear is ridged out and packed with a different material on both sides of the gear in order to provide effective vibration control. In this
approach, three different materials have been chosen for three pairs of gears for the above purpose. They are

i) Glass Fiber Reinforced Polymer (GFRP) composite having unidirectional fiber with bidirectional lamination.

ii) GFRP Composite having bidirectional fiber with normal lamination.

iii) Acetal Homopolymer

The third approach used in this study is the functional coating of gears. In this approach, two different coating have been done for the analysis. They are

i) Molybdenum Di-Sulphide (MoS$_2$) coated gear pairs and

ii) Xylan coated gear pairs.

Totally seven gear pairs are used in this study. All the gear pairs are tested experimentally for the vibration study. Experimental studies are conducted by meshing the same type of a gears only (i.e.) grooved gear against grooved gear and xylan coated gear against xylan coated gear. These studies have been carried out with two different load conditions and with three different speeds for each load.

A finite element method has also been adopted for analyzing the amplitude of vibration under frequency response. But this method is being
utilized for the Geometry modified and material replaced gear pairs alone, and not for the coated gear pairs due to the complexity in computational and may not be effective for vibration analysis, which may be more erroneous and unpredictable.

From the results, it is concluded that the Geometry modification in the bottom land can reduce the velocity of vibration to an average of 23% at various operating frequencies. It is found that the material replacement has a major role in vibration control at higher meshing frequencies. Among the three different materials, the BD Fiber Laminate packed gear reduces the magnitude of vibration considerably and the acetal homopolymer packed gear reduces the vibration by almost 40%. The coated gears are found to have effectiveness in reducing the vibration. Among those two coating techniques adopted in this study, xylan coating is more effective in reducing the vibration than MoS2. It is concluded that all the above method shows their effectiveness in the vibration reduction of a spur gear power transmission system.