

STABILITY LIMITS OF A SELF-EXCITED TORSIONAL VIBRATION SYSTEM

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ABSTRACT

Self-excited vibrations may be encountered in drive trains when friction loads decrease with an increasing sliding velocity present in the system. Such non-linear phenomena are known as stick-slip effects in drive trains. Furthermore, there are certain types of machines used in process plants, which generate self-exciting frictional torques and may cause violent torsional vibrations. Mixers, separators and conveyor drums are among these equipments where such friction-induced vibrations may occur.

This contribution deals with a mechanical system that can be reduced to a minimal torsional vibration model of three degrees of freedom. The self-excitation mechanism is acting between two masses of this model and can be linearized by a viscous damping element with negative coefficient. Depending on the level and location of positive damping present, the system may behave stable or unstable.

To investigate the system a suitable linearized model is established and a damped eigenvalue analysis is carried out to decide on the stability of the torsional vibration behavior. This numerical approach is extended and stability maps are calculated for ranges of various system parameters. Different configurations are investigated to study the effectiveness of measures to prevent the system from becoming unstable. A sensitivity analysis provides information on the robustness of an optimised configuration. Finally, numerical simulation is employed to analyse the non-linear system and confirm the results obtained from the linearized analysis.

Keywords: Stability analysis, self-excited vibrations, torsional vibration system