CENTRIFUGAL PUMPING SYSTEMS: VIBRATION DESIGN STUDIES

Small Bore Piping Analysis

There are two approaches to assess piping vibration on small bore piping (SBP). The first method (empirical) is a reasonable approach, but less accurate than the second method, finite element analysis (FEA).

1. Empirical – Estimate the natural frequency (using empirical calculations) of small-bore piping near the pump and avoid 1X pump run speed and vane passing frequency (VPF).

2. FEA – Calculate the natural frequency (using ANSYS) of small-bore piping near the pump and avoid 1X pump run speed and vane passing frequency.

Transient Piping Vibration

Conduct a Transient Analysis, to calculate pressure vs. time due to sudden events, such as, the closing of a control valve, an emergency shut-down valve, or a check valve closing. This analysis is focused on piping within Pump Stations.

Option: Forces due to calculated transient pressures and water hammer effects can also be calculated to estimate forces on clamps and stress in piping.

1X Mechanical Excitation Due to Pump Unbalance

Calculate natural frequencies and modes of main process piping, and avoid coincidence with 1X pump run speed. There can be many mechanical natural frequencies (MNF) within ±10% of normal operating speed range. A Forced Response Study will determine if vibrations are a potential problem.

Piping Fatigue Due to Acoustically Induced Vibration (AIV)

Calculate AIV likelihood of failure (LOF) due to pressure reductions using Energy Institute Method to avoid pipe fatigue around recycle, or other valves near the pump.

Shell/Transverse Modal Analysis

Calculate shell mode frequencies of pipe near the pump and transverse acoustic modes in the fluid to avoid coincidence with vane passing frequency. There is a high likelihood of problems if there is an overlap of Acoustical Natural Frequencies (ANF) and MNF at the VPF.

Cavitation/Flashing

Evaluation of pressure near pressure reducing devices.

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