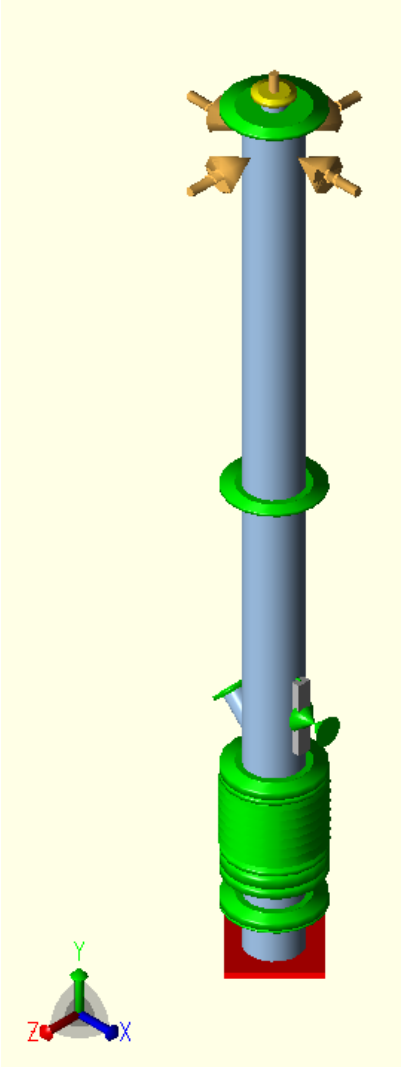
FORCED VIRATION ANALYSIS OF PIPING SYSTEMS

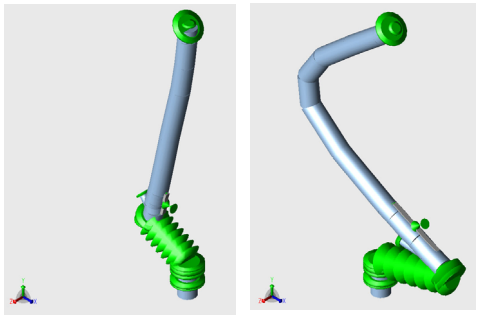
In the pharmaceutical and food industries vibrators are often used to ensure that processed substances do not build up deposits on the inside surfaces of piping or equipment. One such example is a pipe "chute" used to feed powder into a reactor vessel. The chute is hung above the reactor vessel and connected to it via an expansion bellows. The chute is fitted with a vibrator which operates over a known frequency range and develops a known harmonic force.



A vibration analysis of the chute was requested to demonstrate that the chute would not suffer premature failure due to fatigue. On observation the geometry and loading lent itself to a rather novel application for the harmonic analysis capabilities of the Caesar II piping stress analysis software.

The response of the chute to the forced vibration exerted by the vibrator depends to a large degree on the ratio the frequency of the forcing function and its natural frequency. For this reason it is important that model of the chute should be as accurate as possible in regards to its stiffness and mass. It follows that the Caesar II model built includes components that would not have been included in a normal piping model.

The model includes the bolted cover for the chute, the rodding connection, vibrator mount and mass to represent the vibrator itself as well as the clamp connectors and expansion bellows.



The analysis established that first and second modes of vibration of the chute when full of powder were 13.3 and 67.9 Hz with (exaggerated) mode shapes as shown here.

As the vibrator operates over a narrow range of between 30.4 and 37.0 Hz it was concluded that there was little chance of resonance and the chute would not be expected to suffer any significant fatigue damage.

The harmonic analysis, akin to a forced vibration analysis, carried out using Caesar II considered the lateral force of 369N developed by the vibrator at frequencies of between 30.4 and 37.0Hz. The maximum stress amplitude in the chute was found to be only 0.7MPa confirming that no fatigue damage is to be expected.

Further sensitivity analyses were performed with different powder densities and with the chute full to different levels. The conclusions remained unchanged.

The chute has given five years trouble free service since installation.

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