Mechanical Solutions, Inc.
Rotating Machinery Analysis, Test & Troubleshooting

Case History:
CO_2 Absorber Column Vibration Problem Resolution

MSI was contracted by a customer to investigate the source of high displacement vibration at the top of the absorber column (220 feet tall and 13 feet diameter) at low frequency (6 inches displacement peak-peak). This high vibration caused the following losses:

- Efficiency reduction.
- Damage to internal components, such as downcomers, chimneys, trays, etc.
- Additional maintenance costs during every turnaround adding approximately 10 days of production lost.

The purpose of the test and analysis was to determine the stresses at the nozzles and lower portion of the column. Our plan was to minimize the vibration by detuning its natural frequency.

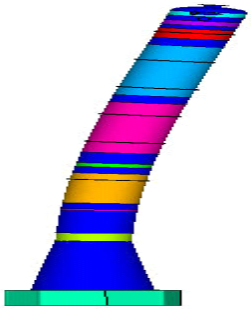


Figure 1. 3D model of the 220 foot tall column, together with the main piping and foundation.

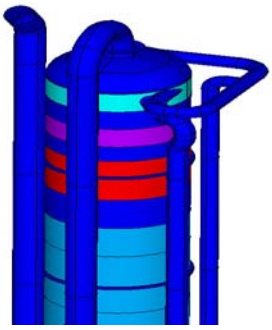
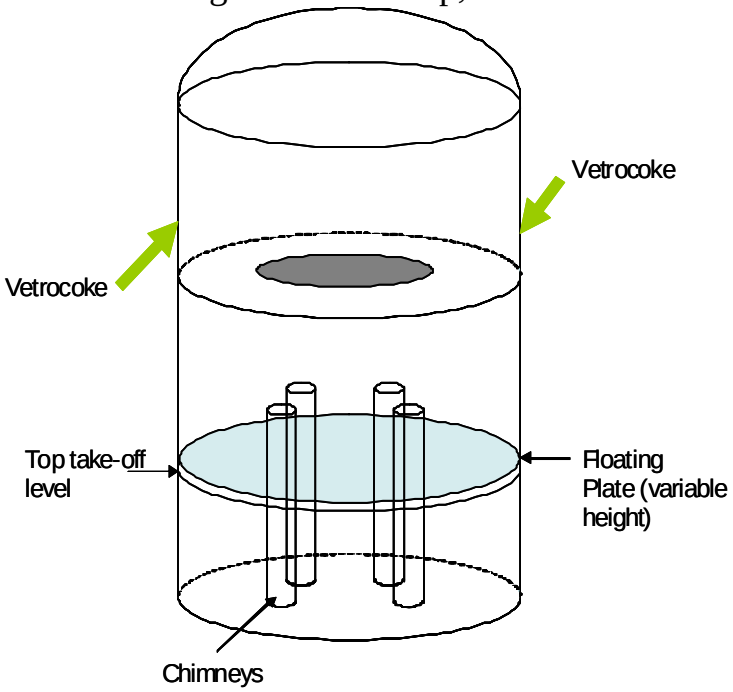


Figure 2. First bending mode of column 0.78 to 0.81 Hz in computer model. Test data was used to validate or anchor the model before potential solutions were modeled.

The ODS (Operating Deflection Shape) and modal impact test were performed on the column in order to determine behavior of the unit at different frequencies. MSI performed a detailed finite element analysis (FEA) to determine the overall natural frequencies and mode shapes, by creating a 3-D model of the column, together with the main piping and foundation (Figure

1). The real world test data and analysis results were overlaid and indicated a similar natural frequency about 0.78 to 0.81 Hz corresponding to the first bending mode (Figure 2).

Trends in the process were reviewed versus column vibration trends. There was a close correlation between the level changes at the top tray of the column, and the vibration levels. Every time the level in this tray hit a range between 80-97% full, the vibration increased. Assuming a cylindrical storage vessel within the top take-off tray, the natural frequency of the internal waves, based on the main geometry, was predicted to be about 0.50 Hz, which was in the neighborhood of the 1st natural frequency of the column. The complete geometry of the top take-off section, including the gas pipes, downcomers, and the contribution of tangential motion of the solution coming from the top, results in the wave's natural frequency increasing to 0.78 Hz when filled to the 80-97% range. Therefore, MSI recommended the installation of a floating" plate as a "wave breaker" at the top take-off tray section in order to detune wave's natural frequency away from to the column 1st natural frequency at 0.78 Hz (Figure 3).



The cost of MSI's troubleshooting and the repair is insignificant when compared to the production increase and reduction in maintenance costs.

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