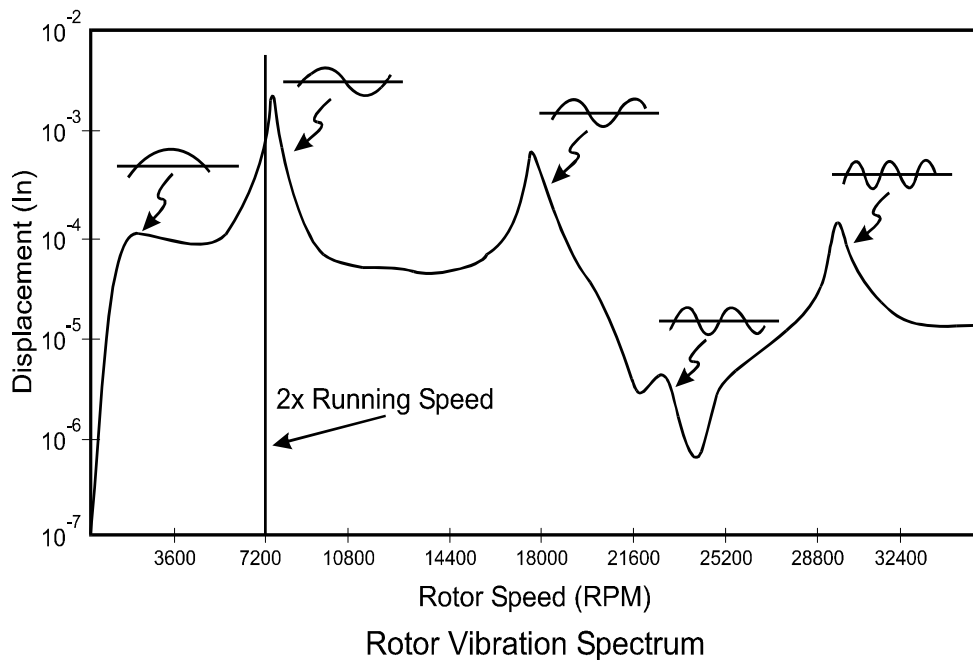


Case History: Hydro-cracking Pump Rotor Failures

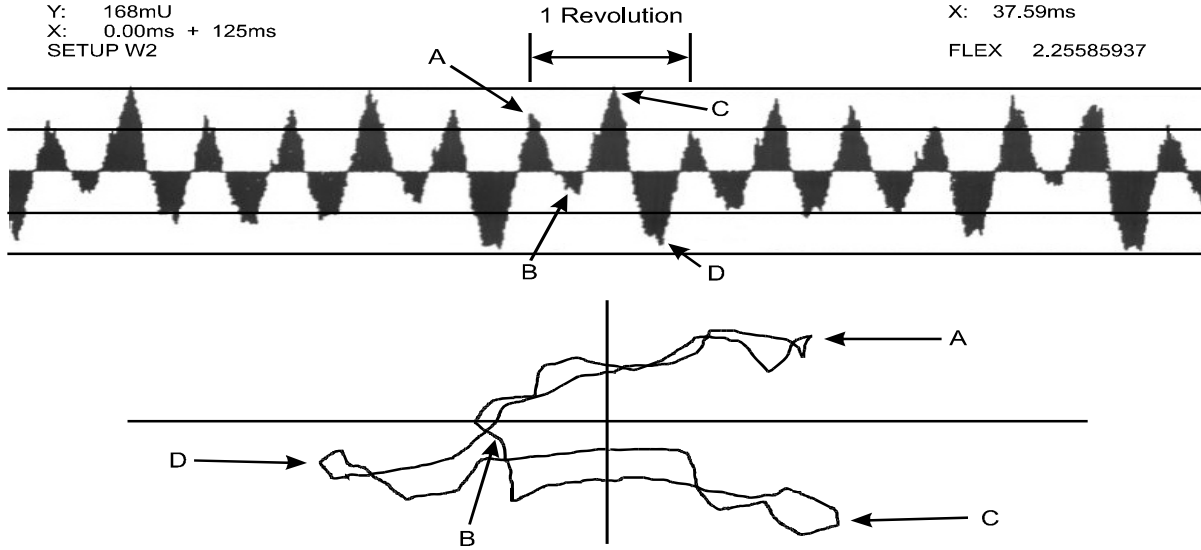
Impact testing was used to determine the reasons for three failures of a hydrocarbon cracking pump which was critical to a diesel fuel production process at a major California refinery. Each failure closed down or severely curtailed fuel production at the refinery, at an average cost of about \$3/4 million per day. Vibration testing was used to determine the shaft critical speeds while the pump was operating at various loads and with various product densities and viscosities. This allowed a rotor dynamics analysis of the 11 stage flexible shaft pump to be calibrated by the test results, so that the analysis could then be used to accurately predict why certain operations in the process might have caused pump failure, and whether proposed rotor changes would avoid future problems.



The testing found the critical speeds of the operating pump, and the combined testing and analysis showed that the main reason for past failures was a poorly damped backward precessional rotordynamic critical speed, which was located at a lower speed than expected. The critical speed would be excited operationally at 2x running speed during a rub of the balance piston. This was possible when pumping product with excessively low specific gravity, because of flashing of the liquid at the exit of the balance drum causing loss of a liquid film between the rotor and stator. A time-averaged pulsing

W5 TIME CH. A IMAG
Y: 168mU
X: 0.00ms + 125ms
SETUP W2

HARM Y: 144mU
X: 37.59ms
FLEX 2.25585937



Orbit of Outboard Shaft

(TAP™) test performed by Msi's engineers clearly showed that a shaft "second bending" mode was near 2x running speed, and proximity probe traces showed that the orbit was made up of primarily 2x running speed vibration when the pump experienced the operational difficulties. The rotor design was changed to make this mode more difficult to excite, and the minimum permitted specific gravity was increased by the plant to a level that would avoid flashing. The pump, which had been failing roughly every three months, has now run for three years without further difficulty.

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