Lateral Rotor dynamic Analysis of a Depletion Centrifugal Compressor for Identification of Critical Speeds

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Abstract

The research work is aimed to identify the reason of applied cap on the study compressor's maximum continuous operating speed MCOS and propose a solution. Methodology followed in this study is the finite element method (FEM) in which the shaft with all attached discs to it where modelled and studied. Timoshenko beam theory is used while developing the matrices of mass, stiffness, damping and force which form the equation of motion (EOM). Shaft and discs material of construction properties are used in the calculation. MATLAB is used to solve the model.

The results of rotor-dynamic analysis are then used to study the nature of the second critical speed (CS) and the severity of response analysis to mass unbalance at the CS. The study identifies that the second CS at two bearing's stiffness conditions; namely Normal Minimum Stiffness and Minimum Stiffness is not critically damped. That is proved by having amplification factor (AF) higher than the maximum allowed by the American Petroleum Institute API in both cases. API standard No. 617 limit is 2.5 and the results show AF of 3.65 for the normal minimum stiffness and 3.78 for the minimum stiffness case. Consequently, the study provides cautionary recommendations that can be applied to avoid running the compressors with the above-mentioned conditions and permanent solutions to push the second CS out of the operating range.

Keywords:
Critical Speed, Depletion Compression, Rotor-dynamic, Timoshenko Beam Theory