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STATISTICAL ANALYSIS OF DAMPER SEAL CLEARANCE DIVERGENCE AND IMPACT UPON ROTORDYNAMIC STABILITY (TP076)

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ABSTRACT

Rotordynamic stability in a high-speed, high-pressure centrifugal compressor is achieved through introducing stabilizing forces and managing destabilizing forces. It becomes the original equipment manufacturer's (OEM) responsibility to provide sufficient stabilizing influence to ensure acceptable operational behavior. A variety of mechanisms exist to provide stability: damper bearings, de-swirl elements on seals, shunt holes and damper seals are commonly provided by the compressor manufacturer to combat instability. The application of damper seals provides a significant increase in rotordynamic stability if designed properly. A previous case study (Camatti, *et. al.* [1]) presented the detrimental effect of damper seal clearance divergence and seal gas pre-swirl upon predicted stability. Accurate prediction of rotordynamic stability requires knowledge of the destabilizing influences, and evaluation of the variation possible in the stability promoting elements. In particular, the damper seal can be strongly influenced by the presence of divergence in the seal-to-rotor clearance and can result in unexpected at-load behavior. One approach to ensure stable operation is to perform a “worst case” evaluation. However, this often results in excessive compromise (large seal clearance and impact on aerodynamic performance) to “eliminate” the possibility of unstable operation. A different and new approach is to define an acceptable envelope of probability. This study presents a statistical evaluation of the impact of damper seal clearance divergence, along with other compressor design parameters, and provides a method for ensuring stable operation regardless of manufacturing or operational variation. The logarithmic decrement is evaluated as a function of compressor design values and a statistical response surface is created. From the response surface and defined variation in design values, a measure of probability for instability can be obtained. Allowable parameter variation can be restricted to ensure stable operation. Three case studies will be presented where the potential for instability exists and the risk quantified using this statistical technique. Additionally, in one of these cases, test results are presented to support the analytical work.

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