Detection of Steady Crack Growth on Rotating Shafts

[1]Gómez-Mancilla J., [2]García-Illescas R, [1]Nosov V.
[1]Laboratorio de Vibratrónica & Rotodinamica ESIME, Edif. 5, 3er Piso,
Instituto Politécnico Nacional, Zacatenco, México D.F., MÉXICO, jcgomez@ipn.mx

[2]Gerencia de Turbomaquinaria, Instituto de Investigaciones Eléctricas,
Av. Reforma 113, Edif. 32, Palmira, Temixco, Morelos, MÉXICO

ABSTRACT

An upgraded model for an extended Jeffcott rotor supported on two journal bearings having a mid-span crack, with two possible imbalance locations and vibrating around nontrivial equilibrium positions is used. This nontrivial equilibrium approach yields periodic responses with multi-frequency power spectrums, similar to experimentally obtained plots for simple configurations, and due to its high sensitivity to cracks it is suitable for qualitative behavioral analysis.
Stability analysis become useless of as far as early crack detection is concerned [1,2]. Recalling that mass imbalance and misalignment effects are always present in rotating machinery and dominate vibration response, interaction of imbalance and a growing mid-span crack is here considered and analyzed. Existence of several Local Resonances facilitate the detection using run up/down Bode plots. Oppositely at fix speed, depending on the phase angle between imbalance and crack orientation vectors, synchronous vibration amplitudes can decrease even if the crack grows; non-synchronous frequency responses are less influenced by such phase angle.
Therefore for steady speed operation uncertainty on location, magnitude and direction of the residual imbalance vector prevents an adequate and pertinent crack detection; at least with current detection methods based on vibration monitoring. The previous is concluded after studying the numerically obtained trend polar plots for several frequency components as used in the Acceptance Region Method [3].

1. Gómez-Mancilla J., García-Illescas R., Nosov V., New Modeling Approach for Detection & Behavioural Characterization of Cracked Rotating Shafts, *9th. International Symposium on Transport Phenomena and Dynamics of Rotating Machinery*, *ISROMAC-9***,** Honolulu, Hawaii, U.S.A., (2002).
2. García-Illescas R., Gómez-Mancilla J., Nosov V., Vibration Analysis in the Characterization of the Dynamic Behaviour of Cracked Rotating Shafts, *International Conference on Rotating Machinery*, *IFToMM***,** Sydney, Australia, (2002).
3. Bently D, Shaft Crack Detection Using the Acceptance Region, *Orbit*, August 1987.