Paper No. 27

INSTANTANEOUS ENERGY AND CIRCULAR STATISTICS APPLIED ON ULTRASONIC SIGNALS FOR VERY LOW SPEED BEARING FAULT DIAGNOSIS

MOUSTAFA Wael[a,b], COUSINARD Olivier[a,b], BOLAERS Fabrice[a], AIT SGHIR Khalid[a], DRON Jean Paul[a]

a Université de Reims Champagne-Ardenne, GRESPI / Faculté des Sciences PB1039, 51687 Reims, France
b AltéAd Industries Est,11 Rue Colonel Charbonneaux, 51100 Reims, France

ABSTRACT

Low speed machines' fault diagnosis and prognosis has been and still a challenge for the research community and engineers working in condition monitoring field since these machines have generally high inertia supporting heavy loads and are considered as critical machines in the production process. The shortcoming of conventional vibration analysis applied on low speed bearings is due to the fact that vibrations generated by the faulty rotating element has very low energy and can be lost into the noise generated by the other components of the machine. Therefore, Acoustic Emission (AE) and Ultrasonic based analysis have been introduced to overcome some of these shortcoming and proved its effectiveness in many previous works and applications despite its high amount of acquisition data required to perform it. In this work, we deal with ultrasonic signals containing very low speed faulty bearing signature buried in machine noise. In order to extract the faulty signature, the ultrasonic signal is first decomposed into intrinsic mode functions (IMF) using the Ensemble Empirical Mode decomposition (EEMD), a data driven and adaptive signal processing technique. Afterwards, using Hilbert transform, the instantaneous energy density is calculated to locate repetitive high energy zones in the IMFs induced by rolling element impact on a seeded outer race fault. finally circular statistics is introduced to study the distribution of high energy density in respect with shaft revolutions. The proposed method presents more efficient low speed bearing fault diagnosis in comparison with conventional signal processing technics which failed to diagnose a faulty signature burried in machine noise and a better sensitivity to fault size.