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Experimental validation of impact energy model for the rub–impact assessment in a rotor system

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ABSTRACT

An experimental setup which can simulate the rotor-to-stator rub in a rotor system is installed. A rub screw is used to simulate the condition of local rub–impact fault. Based on the theory of elastic collision and energy conservation, an Impact Energy Model (*IEM*) is proposed to evaluate the probability or severity of rub–impact fault. To prove this model, the paper conducts the experiment in two steps i.e. hammer test and rub–impact fault validation. The wave signal, spectrum and axis orbit are used to analyze the severity of the rub–impact fault when it occurs. The analysis result shows that the proposed Impact Energy Model (*IEM*) is effective in the assessment of rub–impact fault. Furthermore, the proposed *IEM* can also provide a reference for the design and operation of a rotor system.

1. Introduction

Rotating machinery such as turbines and compressors are the key equipments in oil refineries, power plants and chemical engineering plants [1]. In modern industry areas, the machinery is becoming more and more precise with the increasing development of science and technology. The faults of these machinery are also becoming difficult to be identified [2]. Because vibration signals carry a great deal of information representing mechanical equipment condition, the vibration analysis is an effective and widely used way to diagnose the rotating machinery faults [3].

Rotor-to-stator rub is one of serious malfunctions in rotating machinery which will often cause catastrophic failure and subsequent economic loss [4]. Most of the system instabilities may be caused by rub–impact fault and it will also generate very complicated vibration in the rotor system. When the rub–impact fault occurs, severe vibration will be induced in the equipments. What is worse, it will lead to the permanent bow to the shaft and even damage the whole shaft system. There are a lot of performance analysis for rub–impact faults. Choy and Podavan [5] analyzed the effects of different system parameters on rubbing forces and transient responses of a run-impact rotor system. Ehrich [6] studied the cases of the rub-impact between the shaft and the bearing and the rub–impact between the rotor and the stator near supports at two ends of the Jeffcott rotor system. Zhang et al. [7] analyzed the rub–impact fault caused by geometric asymmetry between the rotor and stator, and discussed the grazing phenomenon of the single point rubbing in detail. Zhang and Meng [8–16] give a series of researches on the nonlinear Micro-Electro Mechanical Systems (MEMS), including stability, bifurcation and chaos. Also they do a number of detail researches on the influence of several nonlinear parameters to rotor systems.

As pointed out above, most of the researches for the nonlinear rub–impact phenomenon are focused on the stability and chaos analysis. In this paper, we propose a new mathematic analysis model (Impact Energy Model) to discuss the

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