

动力机械与工程

转子轴向碰摩非线性流固耦合动力学特性全自由度分析

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摘要: 基于Jeffcott转子模型,用六自由度方法研究了考虑涡轮非线性流固耦合力的转子轴向碰摩动力学特性。通过响应分叉图、波形图、频谱图、轴心轨迹和Poincare图分析了在涡轮非线性流固耦合力作用下转子轴向碰摩的动力学表现。分析表明,非线性涡轮叶尖间隙流体激励力对转子轴向碰摩的非线性特性影响不很明显,只是在低转速时轴向振动碰摩响应中会出现更高阶的偶数倍频的超谐波成分。在高转速情况下,碰摩响应的波形和频谱不能明显反映具有弱非线性的涡轮叶尖间隙流体激励力对轴向碰摩非线性动力学特性的影响,而轴心轨迹和Poincare图则能反映这种影响,反映出碰摩响应中出现的轻微混沌。

关键词: 转子动力学 轴向碰摩 动力学分析 全自由度 涡轮 非线性流固耦合

Dynamic Analysis in Full Degrees of Freedom of Rotor's Axial Rub-impact With Consideration of Nonlinear Fluid-structure Interaction Forces

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Abstract: Based on a Jeffcott rotor, dynamic characteristics of rotor's axial rub-impact with the consideration of turborotor's nonlinear fluid-structure interaction forces were studied in six degree-of-freedom of the rotor. Dynamic behaviors of the system were analyzed with bifurcation diagrams, waveforms, frequency spectrums, orbits and Poincare maps. Following conclusions were reached. The influences of the nonlinear clearance-excitation fluid force of turborotor on the dynamic behaviors of rotor's axial rub-impact are insignificant. The only effect is the appearances, in the axial response, of the higher order superharmonic components of even-time working frequency at low rotating speeds. At high rotating speeds, the waveforms and frequency spectrums cannot reflect significantly the influences of the weakly-nonlinear clearance-excitation fluid force of turborotor on the dynamic behaviors of rotor's axial rub-impact. But the orbits and Poincare maps can clearly show the influences represented by the slight chaos in the responses.

Keywords: rotordynamics axial rub-impact dynamic analysis full degrees of freedom turborotor nonlinear fluid-structure interaction

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