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# 指尖密封动态性能分析与泄漏量计算

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# Analysis of Dynamic Performance and Leakage for Finger Seal

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**摘要** 指尖密封作为一种新型密封技术，不平衡力激励条件产生的动态迟滞泄漏以及动态磨损是制约其性能提高和应用的两个重要因素。为此，对指尖密封动态工作条件下的激励形式和装配过盈进行了技术处理，构建了指尖密封系统的动力学分析模型，获得了指尖密封在转子激励下的位移响应以及动态条件下指尖靴与转子之间的接触压力分布，并根据位移响应结果得到了指尖密封的动态泄漏间隙，建立了指尖密封动态泄漏率计算方法。以某型发动机转子为实际算例进行了分析计算，结果表明：适当设计装配过盈可以降低指尖密封响应幅值，缩小与转子激励的相位差，减小迟滞，提高跟随性，改善密封效果；指尖靴与转子之间的接触压力随转子的激励做周期性变化，无论是过盈量还是密封上下游压差的增加都会增大接触压力，并且使一个运动周期内指尖靴与转子的接触时间变长；转子位移激励的幅值受到支承轴承游隙的约束，当转子达到“特定”转速以后受到轴承游隙的限制而等于游隙。通过与参考文献中试验结果的对比分析验证了计算结果的合理性。

**关键词：** 指尖密封 迟滞 动态泄漏 动力学分析 位移响应

Abstract： The finger seal is a revolutionary new technology in turbine engines. Present research indicates that dynamic hysteresis and contact wear are two key problems in finger seal design. For these reasons, a dynamic analysis model of a finger seal system is presented to study the above two problems. By means of this model, the displacement response for a finger seal and the contact pressure distribution between the finger seal and rotor are obtained. According to the displacement response result, the dynamic leakage clearance for the finger seal is obtained and the leakage is subsequently calculated. The results show preliminarily that: (1) Appropriately designed interference not only reduces the response amplitude of a finger seal but also decreases the phase delay between the finger seal response and displacement excitation. In other words, it enables the response of finger seal to follow the motion of the rotor more closely and therefore reduces the leakage. (2) The contact pressure between the finger seal and the rotor changes periodically with the rotor in motion. (3) The maximum rotor displacement excitation amplitude is approximately equal to the windage after the rotor exceeds a specific speed. This is mainly due to the fact that the rotor displacement excitation amplitude is constrained by the windage of the rotor back up bearing. The above results are validated by a comparison with the test data in references. Therefore, this study may lead to better design of finger seals.

Keywords： finger seal hysteresis dynamic leakage dynamic analysis displacement response

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