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基于浴盆曲线故障率函数的FFOP预计方法

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FFOP Prediction Method Based on Bathtub-shaped Failure Rate Function

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摘要 与传统可靠性指标中假设产品的随机失效不可避免不同,无故障工作期(FFOP)内产品不会发生任何故障(即零故障)。首先阐述了FFOP的概念内涵、与平均故障间隔时间(MTBF)的区别和联系,提出了一种FFOP的预计方法。该方法假设产品的故障率函数具有浴盆曲线特征、故障发生过程为泊松过程、产品具有固定的免维修工作期。然后以一种改进的Weibull分布函数描述具有浴盆曲线函数特征产品的故障率。基于泊松过程理论,给出了FFOP的预计算法、流程和仿真验证手段。最后以某型无人机舵机为案例对研究方法的可用性进行了验证。结果表明:FFOP与免维修工作期(MFOP)、置信度水平密切相关,及时维修的产品能够保证较长的FFOP。在工程应用时,FFOP的确定应综合考虑运行维护费用进行权衡。

关键词： 无故障工作期 免维修工作期 泊松过程 浴盆曲线 可靠性 舵机

Abstract： Failure free operating period (FFOP) is defined as a period during which no failures resulting in a loss of system functionality occur. First, the concept of FFOP and the difference between FFOP and mean time between failures (MTBF) are introduced. Three hypotheses are held as the preconditions of the presented methodology. First, the fault event is a Possion process. Second, the failure rate function is shaped like a bathtub curve. Third, constant interval scheduled maintenance is permitted during which the product must maintain trouble-free function. A modified Weibull distribution function is used to model the bathtub-shaped failure rate function. Furthermore, based on the probability and stochastic processes theory, FFOP prediction algorithm and procedure are developed, whose accuracy is verified through simulation. Finally, an actuator is selected as the sample case to validate the feasibility of the proposed method. The result shows the FFOP is correlated with maintenance free operating period (MFOP) and the predefined confidence coefficient. Shorter MFOP will deliver both higher maintenance and operating costs and longer FFOP. In engineering practice, a tradeoff between FFOP and maintenance and operation cost should be considered.

Keywords： failure free operating period maintenance free operating period Possion process bathtub curve reliability actuators

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