



第六章 重大设备的失效分析

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6.1 核电装置的失效分析

6.1.1 典型案例分析

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3. 核电厂汽轮机EH系统油动机密封圈意外泄漏的失效分析
4. 核电厂乏燃料储存水闸门减速器异常断裂的失效分析
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7. 核电厂汽轮机系统凝升泵角接触滚子轴承的失效分析
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11. 核岛用聚合物电缆材料辐照损伤的老化寿命评估
12. 核岛主泵冷却回路换热管爆裂的失效分析及治理方案
13. 不同辐照剂量对核电用电缆材料的性能影响分析

6.1 核电装置的失效分析



6.1.2 主要参考文献

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6.2 火电装置的失效分析

6.2.1 典型案例分析

1. 超超临界1000MW机组循环水泵异常断裂的失效分析和解决对策
2. T91钢异种钢焊接工艺评定及寿命评估分析
3. 超超临界机组T92/HR3C异种钢焊接蠕变寿命评定
4. 超超临界机组T92/Super304异种钢焊接性能评定
5. 锅炉二次过热器后屏炉管的腐蚀失效分析
6. 600MW电动机SKF滚动轴承的失效分析
7. EH系统油动机螺栓断裂的失效分析

6.2.2 主要参考文献

1. Yue-Yue Ma, Shi Yan, Zhen-Guo Yang*, Guo-Shui Qi, Xin-You He. Failure analysis on circulating water pump of duplex stainless steel in 1000 MW ultra-supercritical thermal power. *Engineering Failure Analysis*, 2015, 47: 162-177.

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5. Jian Cao, Yi Gong, Kai Zhu, Zhen-Guo Yang*, Xiao-Ming Luo, Fu-Ming Gu. Microstructure and mechanical properties of dissimilar materials joints between T92 martensitic and S304H austenitic steels. *Materials and Design*, 2011, 32(5): 2763-2770.
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6.2 火电装置的失效分析



8. **Yi Gong, Zhen-Guo Yang*. Corrosion Evaluation of One Dry Desulfurization Equipment — Circulating Fluidized Bed Boiler. *Materials and Design*, 2011, 32(1): 671-681.**
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6.3 风电设备的失效分析

6.3.1 典型案例分析

1. 海上4MW风电设备变压器超温燃烧的失效分析
2. 1.5MW风电设备齿轮箱轴承异常磨损的失效分析

6.3.2 主要参考文献

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6.4 石化装置的失效分析

6.4.1 典型案例分析

1. 年产109万吨聚乙烯装置急冷油/稀释蒸汽换热器管子的腐蚀失效分析
2. 高压聚乙烯装置循环气体冷却器爆裂的腐蚀失效分析
3. PTA聚酯装置干燥器的失效分析及其解决对策
4. 加氢精制PTA聚酯装置的失效分析及治理方案
5. 大型萃取塔MMA内壁异常磨损的失效分析
6. 受火损伤后石化设备HDPE管道的试验分析与寿命评定

6.4 石化装置的失效分析



6.4.2 主要参考文献

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6.4.2 主要參考文獻

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6.5 化工设备的失效分析

6.5.1 典型案例分析

1. 废热锅炉系统低温省煤器腐蚀泄漏的失效分析与治理方案
2. 氨气蒸发器热交换管异常减薄的失效分析
3. 高硫含量循环流化床锅炉设备的腐蚀失效分析
4. 腐蚀条件下设备防腐蚀材料的制备与分析
6. 化工厂蒸汽系统管配件冲刷与腐蚀的失效分析

6.5.2 主要参考文献

1. Qun Ding, Xiao-Feng Tang, Zhen-Guo Yang*. Failure analysis on abnormal corrosion of economizer tubes in a waste heat boiler. *Engineering Failure Analysis*, 2017, 73: 129-138.
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6.6 冶金设备的失效分析

6.6.1 典型案例分析

1. 高炉炼焦气燃气轮机叶片的腐蚀断裂分析
2. 蠕变温度下耐热钢的碳化物析出表征及老化分析
3. 二次过热器炉管的腐蚀失效分析与评价

6.6.2 主要参考资料

1. Zheng-Fei Hu, Zhen-Guo Yang *. Identification of the precipitates by TEM and EDS in X20CrMoV12.1 for long-term service at elevated temperature. *Journal of Materials Engineering and Performance*, 2003, 12 (1): 106-111.
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6.7 汽车部件的失效分析

6.7.1 典型案例分析

1. 轿车踏板用纤维增强复合材料部件的失效分析
2. 汽车密封件用纤维增强复合材料密封填片的力学性能分析

6.7.2 主要参考文献

1. Yi Gong, Zhen-Guo Yang*. Fracture failure analysis of automotive accelerator pedal arms with polymer matrix composite material . Composites B, 2013, 53: 103-111.
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6.8 电子电路的失效分析

6.8.1 典型案例分析

1. 芯片引线框架高速电镀不锈钢钢带的失效分析
2. 手机用BGA焊点及盲孔开裂的失效分析

6.8.2 主要参考文献

1. Yun-Song Gu, Yi Gong, Zhen-Guo Yang*. Hydrogen Embrittlement on High-speed Stainless Steel Belts Used for Tin Plating Chip Lead Frame. *Journal of Failure Analysis and Prevention*, 2010, 10(5): 399-407.
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6.8 电子电路的失效分析

6.8.3 典型案例分析

1. 高密度PCB电镀铜互连盲孔的失效分析
2. PCB表面处理ENIG未浸润的失效分析
3. PCB 引线键合及钎焊电镀镍金表面处理的失效分析
4. 高端智能手机用PCB及PCBA的失效分析

6.8.4 主要参考文献

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3. Shi Yan, Fei-Jun Chen, Yue-Yue Ma, Zhen-Guo Yang*. Failure analysis of un-wetting for the surface finish on the ENIG. *Journal of Failure Analysis and Prevention*, 2013, 13(2): 194-201.
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6.9 城市管网的失效分析

6.9.1 典型案例分析

1. 地铁附近埋地Dn1000管线异常泄漏的腐蚀失效分析
2. 冲刷腐蚀工况下不同管道的失效机理与预防方法

6.9.2 主要参考文献

1. Tong-Wei Ni, Tong-Tong Bi, Zhen-Guo Yang*. Failure analysis on abnormal perforation of super large diameter buried gas pipeline nearby metro. *Engineering Failure Analysis*, 2019, 103: 32-43.
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第六章 思考题



1. 概述一下核电装置RCW热交换器传热钛管失效案例分析的主要步骤。你认为该复杂失效案例中哪些方法应用得比较成功？
2. 在对超超临界1000MW火电机组进口循环水泵的失效分析案例中，应该吸取什么样的经验教训？
3. 从石化装置PTA干燥器的失效案例分析中，简述一下在检验、维护及管理等环节应注意什么？
4. 化工装置常有腐蚀与磨损的交互作用工况，试从管道失效分析角度论述如何选材，以及采用什么方法可以缓和这类腐蚀的严重性？
5. 在冶炼设备的失效案例分析中，哪些因素会导致燃气轮机叶片发生过早失效？
6. 通过对汽车踏板开展失效分析，你认为这类复合材料结构件可能发生哪些失效机理？产生原因主要有哪些？
7. 微电子元器件都要进行表面处理，从芯片电镀高速钢带到引线键合的失效案例中，电镀质量改善一般需要控制哪些因素？
8. 印制电路板是层状复合材料，试从高密度互连PCB的失效案例中，概述一般有哪些失效机理？应该如何改进？
9. 从风电设备的两个失效案例分析中，你认为应该吸取哪些教训。