

Degradation of the materials used in the energetic systems and the ways to prolong their operation time

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Outline

Energy sources
Power Plants
Materials issue

Kinds of materials
Types of degradation
Ways of problem solution

Conclusion







Energy sources available today

- Hydro-electrostations
- Wind plants
- Nuclear power generators
- Solar power plants
- Steam power plants
- o SOFC
- 0







Solar power stations



The mirrors concentrate the solar radiation in a vacuum insulated absorber tube at their focus, heating the thermal oil in the tube to ~400°C. The oil passes through a heat exchanger generating steam which drives the electricity-generating turbines.





Steam power plant



A steam power station is a power plant in which the prime mover is steam driven. Water is heated, turns into steam and spins a steam turbine which drives an electrical generator







Steam power plant (schematic)









Siemens Steam Turbine 5000







Assembly of a low pressure turbine rotor in a power station



Under the working severe conditions the lifetime requirement of the blades is









Corroded turbine blades









What is SOFC ?

•It is a power generation system with high electricity generation efficiency

 SOFC's are still in the development

and improvement process which is evident still in searching of new (long term stable, more efficient) materials for its different components stack









Solid Oxide Fuel Cells (SOFC)



The biggest fuel cell of 60 planar cells (13.3kWt) constructed in FZ Jülich







What is interconnect?

- This is a part of SOFC which provides electrical connection between the cathode of one cell and of the anode of the neighboring one.
- Or a layer between each individual cell



repeating unit







Materials being used for interconnects (substrates)

• Still materials problem:

- There a number of ceramic (La chromite base) and metallic materials (Ni,Co,Fe base alloys) which potentially could be used for this purpose.
- Crofer22 APU is the material used for the interconnects showed

 No alumina forming alloys are applicable!







SOFC in FZJ

- In FZJ the works on SOFC's count about 15 years, which are rather successful according to the obtained valuable results and citation ratio of the papers published under the FZJ name
- The FZJ works covered all the steps preceding to the final stack production (materials, modeling, manufact., testing...)







The ways of problem solution

- There could be only two possible ways:
 - Apply the coating protection system
 - Improve the buck material properties through the modification of the existed materials or elaboration new ones.







Types of degradation

 According to the above mentioned the materials working under high temperatures besides could be affected by the high concentration of O₂, H₂O, S, C and N rich ambient, depending on the power system and its nature







Alternative application field of high temperature materials



Honeycomb carrier (Aluchrom) is most important component in a catalytic converters used in automobile engines exhaust system





Fe-Cr-Al system alloys

Commercial alloys

Model alloy

The weight gain vs. oxidation time dependence data received during cyclic oxidation of three specimens oxidized at 1100°C in laboratory air during 2000 hours







Fe-Cr-Al system alloys



The fracture cross section of the scales formed on the investigated specimens oxidized cyclically in the laboratory air during 2000 hours at 1100°C





Conclusions

- Unfortunately materials used in the power plants in the high temperature unites are tend to degrade
- In order to extend the life time of the turbine system the development of the existed or even new materials is important
- High temperature materials are widely applied in the automotive field
- Improvement of their working parameters is also crucial







Conclusions

- High chromium content model alloy showed better oxidation resistance comparatively to the commercial AluchromYHf widely use in the catalytic converters for the modern automobiles
- Further studies are required for the better understanding of the oxidation mechanism in the alloys under our investigation







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Thank you for the attention !

Now questions ©



