MICROSTRUCTURAL EVALUATION WITH TYPE I HOT CORROSION DEGRADATION OF GAS TURBINE ALLOYS DURING BURNER-RIG TESTING

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The hot corrosion resistance of selected gas turbine alloys was evaluated, as a baseline for assessing candidate new hot-section materials. The alloys were tested under burner rig exposures, using ASTM standard seawater for the salt contaminant and combustion conditions that provide representative materials evolution and degradation behavior relative to what is observed with marine gas turbines under service environments. Modern characterization techniques were utilized to evaluate the hot corrosion behavior and resistance of the evaluated material systems, to observe the degradation of the alloys and to study the underlying degradation mechanisms active during hot corrosion attack.

The burner rig test protocols were used to accurately simulate exposure conditions and materials evolution under extended service conditions in marine turbines. The burner rig test protocols achieve the following desired properties:

- Combustion by-products of shipboard and aero-turbine fuels
- Constant flow of contaminants, such as salt water
- Thermal cycling aimed to duplicate engine cycles.
- Accurate sample characterization.

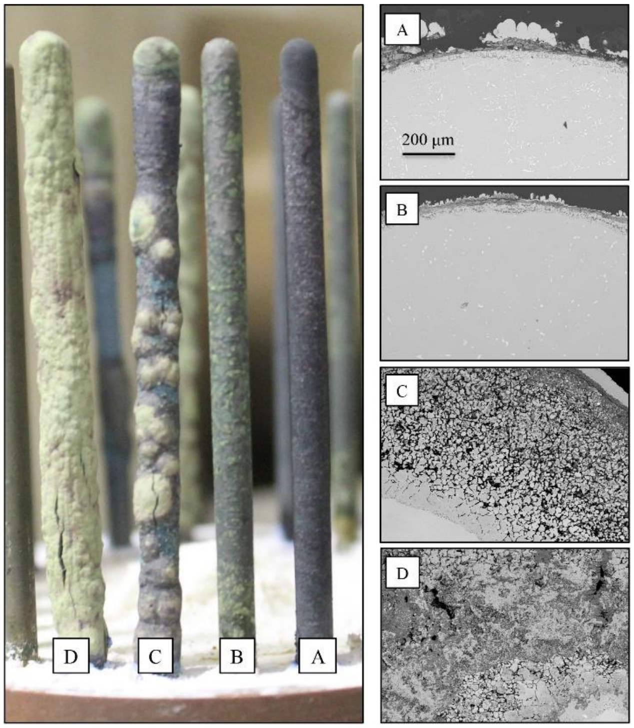

Figure 1 – The pins after 500 hrs at 900°C in burner rig test and the cross section view of the pins.

The extent of attack was distinctly different in the alloys. Figure 1 shows 4 different marine alloys after 500 hours of burner rig testing at 900°C. Presence or formation of carbides and second phases close to the surface, affect the corrosion mechanism in different ways.

After the test, CrS was observed at the reaction front in all alloys. The sulfide reacts with oxygen when the partial pressure of oxygen increases. The sulfur that is released from the sulfides by the oxidation reaction penetrates the material in front of the oxide, even if no additional sulfur is supplied. Subsequently, healing of the oxide scale is no longer possible.

Alloys A and B have higher Cr content (>15W%) compared to alloys C and D (~6W%). Overall the alloys with higher Cr content underwent milder hot corrosion attack. In these alloys, the high Cr phases, especially chromium carbides, seem to be the fist region to face S attack.

Alloy C is a single crystal alloy with regular γ/γ' arrangement within the whole volume of the crystal, while in alloy D the shapes and sizes of the γ' precipitates are highly irregular, and distinct carbides are formed in different regions. The excessive different extend of attack in alloys C and D, despite the similar composition, illustrates the microstructural dependence of hot corrosion resistance of the alloys