

# Effects of Rust Particle Deposition at the Axial Seal Pin Between Two Blades

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## GAS TURBINE NEEDS

One source of particulate matter in land-based engines is rust particles from piping, casings, and rotor hardware. During engine startup, rust particles deposit in various engine locations, significantly reducing leakage and cooling flow areas.

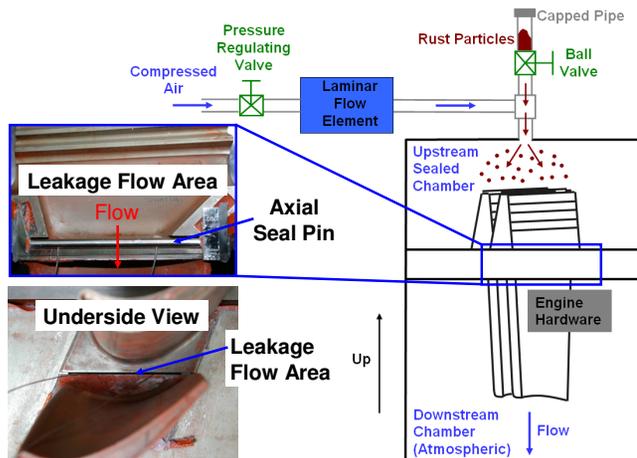
## OBJECTIVES

Characterize effects of temperature and centrifugal acceleration on iron oxide particles

Determine coolant blockage from injection of rust particles through engine hardware

## PROJECT APPROACH

Slugs of rust particles were injected into engine hardware through a gravity feed system



Flow blockage was measured in terms of a reduction in dimensional flow function

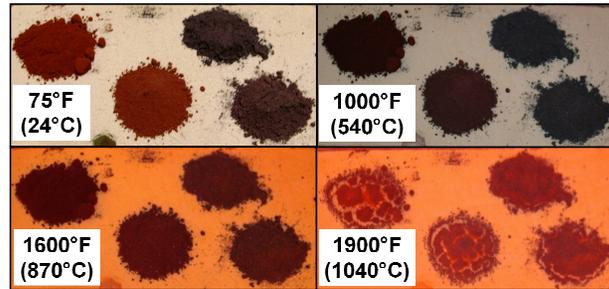
$$FF = \frac{\dot{m} \cdot \sqrt{T_0}}{P_0} \quad [m \cdot s \cdot K^{1/2}]$$

$$\%RFF = 100 \cdot \left(1 - \frac{FF_{\text{blocked}}}{FF_{\text{clean}}}\right)$$

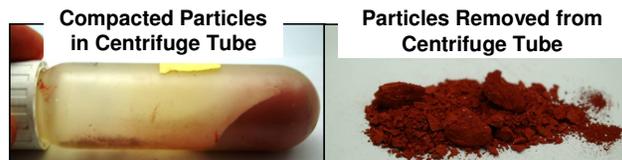
## RUST CHARACTERIZATION

The effect of centrifugal acceleration was dominant over the effect of elevated temperature

In separate experiments, rust particles were heated in a kiln and spun in a centrifuge to assess effects of temperature and centrifugal acceleration.



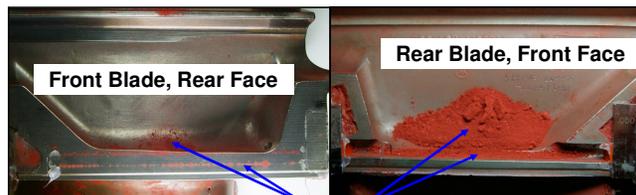
Rust particles conglomerated into larger chunks when heated above a typical engine coolant temperature



Rust particles compacted to twice their loose bulk density after spinning in a centrifuge at engine representative rotating conditions

## PARTICLE DEPOSITION

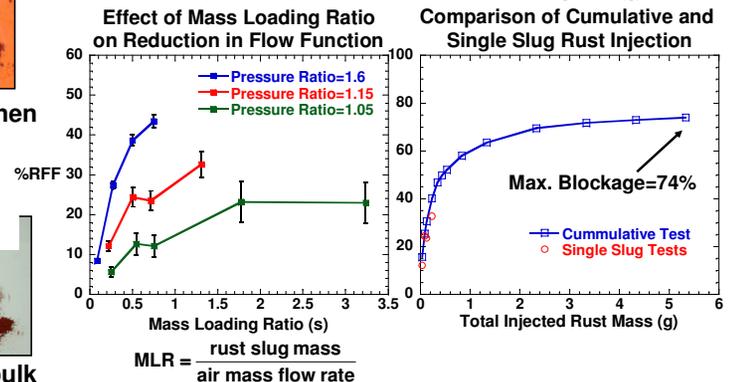
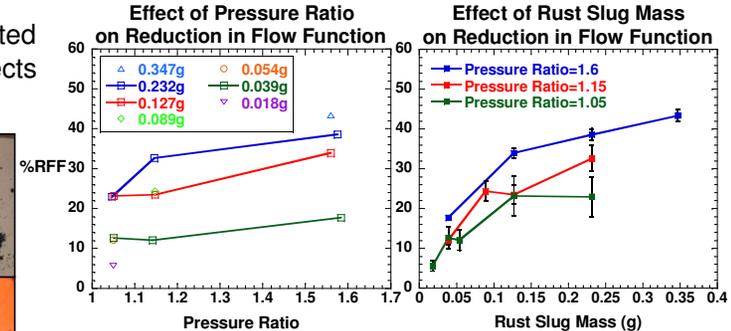
Rust particles were deposited in the seal pin slot and upstream on the blade platforms



Rust Particle Depositions

## FLOW BLOCKAGE

Injecting rust yielded reductions in flow ranging from 5% to 74%



## SUMMARY AND CONCLUSIONS

Flow blockage at the axial seal pin depended on the quantity of rust injected and the pressure ratio

Rust particles deposited primarily on the rear blade in the seal pin slot and above the seal pin. The increase in blockage with pressure ratio agrees with the results of Cardwell et al. and is a result of ballistic particle behavior that caused more particles to impinge and deposit on the blade surfaces.

## REFERENCES/PUBLICATIONS

Cardwell, N.D., K.A. Thole, S.W. Burd., 2008, "Investigation of Sand Blocking within Impingement and Film Cooling Holes," in *ASME Turbo Expo 2008*, pp. 1147-1159.