

APS Diagnostics Correlation Study

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Gas Turbine Need

Properties of Atmospheric Plasma Sprayed (APS) Thermal Barrier Coatings (TBC) are dependent on the temperature and velocity of sprayed particles. Accurate diagnostic sensors are used to determine spray conditions by measuring in-flight particle temperature and velocity

Project Objectives

- To determine measurement correlation between SprayWatch® and Accuraspray® diagnostic sensors, for 8wt% Yttria stabilized Zirconia (8YSZ) with F4MB torch.

Background

- APS is a thermal spraying process where a primary and secondary gas (Ar and H₂ in our case) is electrically excited between an anode and cathode, to generate a high temperature plasma

- To this plasma, a powder is injected where it is heated to a molten or semi-molten state and accelerated in to a target substrate generating a coating.

•Diagnostics overview:

	SprayWatch	Accuraspray
Temperature measurement	Two color pyrometry (low & high ranges)	Two color pyrometry (>1300°C)
Velocity measurement	Shutter speed of a CCD camera to measure particle streak (±10m/s resolution)	Two optical fibers and measures time shift between signals (±12m/s resolution)
Measuring volume	20mm x 16mm x 14mm (whole plume)	3mm DIA x 25mm (Center plume)
Type of measurement	Average particle temperature and velocity	mean particle temperature and velocity

Experimental Setup



- Primary gas: Ar

- Secondary gas: H₂

- Spray distance: 100mm

- Two sensors were available to the study: Spraywatch® (Oseir Ltd.), Accuraspray® (Tecnar).

- Commercially available Sulzer metco 204-NS 8at% YSZ (125µm cut) powder was used for all tests.

- Sulzer metco F4-MB® torch, 6mm nozzle, 0° injector, was used for all tests.

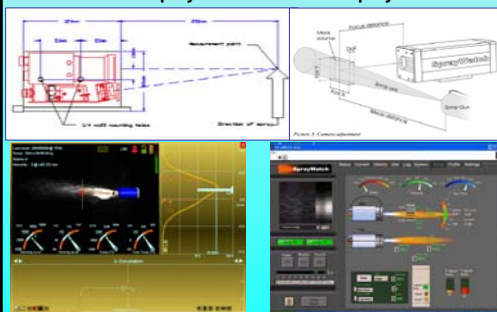
- Torch position were set to factory positioning settings for each sensor and run.

- Runs were conducted by altering between high and low currents, primary and secondary gas flow rates, table 1.

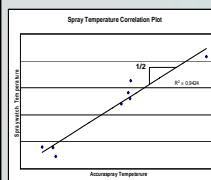
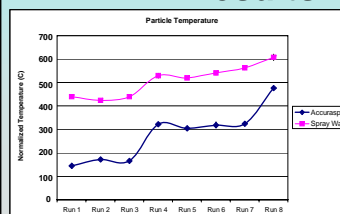
	Current	Primary SCFH	Secondary SCFH
		Ar	H ₂
Run 1	400	50	5
Run 2	400	100	5
Run 3	400	50	20
Run 4	400	100	20
Run 5	600	50	5
Run 6	600	100	5
Run 7	600	50	20
Run 8	600	100	20

Accuraspray

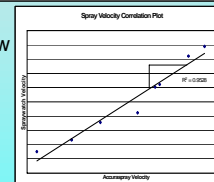
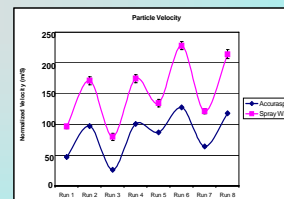
Spraywatch



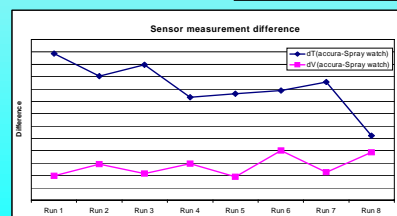
Results



- Temperature measurements from both sensors show the same over all trend,
- The correlation plot shows this trend to be linear



- Velocity measurements from both sensors also show the same over all trend,
- The correlation plot shows this trend to also be linear



Discussion

- Accurate positioning of the torch to the sensor head is critical to accurate diagnostics measurements,
- Spray watch the whole plume profile is averaged using inner and outer particles in measurement,
- Accuraspray uses only the inner plume particles for mean measurements,
- The discrepancy in the measurements between sensors due to sensor differences, could result from:
 - Different measurement volumes, averaging more particles increasing the value of plume temperature and velocity,
 - Small positioning errors in the torch-sensor alignment,
 - Observations of small movements of the torch showed large fluctuations of both temperature and velocity for spray watch but not accuraspray
- Discrepancies in sensor measurement with respect to run parameters show:
 - Temperature difference decreases with higher plume temperature and primary gas flow,
 - Velocity shows only dependence on primary gas flow and current,
- By examining the trends of temperature and velocity, the major source of measurement discrepancy is most likely a sensor calibration and acquisition difference,
- To better understand discrepancies, a follow up study needs to be conducted to examine sensitivities of the sensors to changes in internal calibration settings.

Acknowledgements



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