

PRESSURE SENSITIVE PAINT (PSP) MEASUREMENTS IN S2MA

PSP objectives at up to transonic speeds

PSP is a weakly intrusive measurement technique that provides the local pressure distribution on the surface of a model. The higher data density provided by PSP compared to the sparse information from pressure taps, allows the integration of pressure loads on movable devices (flaps ...). In addition, the model cost and lead-time are reduced.

PSP methodology

The ONERA PSP system is based on the intensity method. The model is painted with 2-components paint with low temperature sensitivity, which has been in-house developed.

During the test, the model surface is illuminated with UV lamps. The intensity of light reemitted in the visible spectrum is measured with high-sensitivity cameras and is related to the surface pressure after an appropriate calibration procedure. Up to five 16-bit cameras can be used concurrently on a test rig among three 2048×2048 and four 1024×1024 pixel resolution.

PSP measurements are available over the entire operating envelope of the wind tunnel.

Preparation

A surface mesh of the model is required 3 weeks before the test. Model must be equipped with a minimal number of pressure taps and temperature sensors: e.g. 2 sections of 10 pressure taps and 3 PT100 for a wing to characterize the temperature gradients.

An extra preparation time of approximately 2 weeks is required outside the tunnel. It includes the painting of the model by Onera staff, the calibration of the paint (determination of pressure and temperature sensitivity), pixel to pixel calibration of the model in the calibration tank.

Final preparation inside the test section takes about 2 to 3 hours per camera (set up and calibration of cameras and UV lights).

Testing

The PSP system has its own independent data acquisition system. PSP measurements have to be performed in pitch pause mode: a PSP data point lasts about 1 minute depending on the numbers of cameras. Wind-off images must be taken before and after the run for several incidence and sideslip positions.

Our PSP technique is validated for hinge moment measurements, assuming a few pressure taps are available on the measured surface.

360°PSP is available in S2MA.

Results

Data reduction of a pressure distribution over a wing is available at the end of the run. Integration of a pressure distribution or gathering of PSP data coming from different cameras on the model grid requires additional data processing time after the test.

Accuracy

Repeatability/deviation from pressure tap data: +/- 0.02 in C_p

Extra cost to the customer

Preparation: fixed costs 46 k€, variable costs 13 k€ per camera

Test performance: 2.2 k€ per day

Limitations

Paint has to be applied behind the transition trip to avoid preliminary tripping. Our recommendation is to perform PSP measurements at the start of the test.