

TESTING CAMPAIGN OF A MARTIAN SPHERICAL WIND SENSOR AT THE AWTSII WIND TUNNEL FACILITY. L. Kowalski, S. Gorreta, M.T. Atienza, V. Jimenez, L. Castañer, M. Dominguez-Pumar, MNT-Group. UPC-Campus Nord, Ed. C4. Jordi Girona 1-3. 08034 Barcelona, SPAIN. manuel.dominguez@upc.edu

Introduction: The purpose of this paper is to present the experimental results obtained with a prototype of a 4-sector spherical anemometer, [1-2], in the Aarhus Wind Tunnel Simulator II (AWTSII) [3] reproducing Martian conditions. The main objective of the experimental campaign has been to measure wind velocity for a wide number of yaw and pitch angles, in an environment in the range of typical Mars conditions. The experimental results indicate that wind speed and angle recovery can be achieved with the proposed spherical sensor. The obtained responses are close to the empirical models found in the literature [4].

Sensor description: The sensor is composed of 4 sectors, conforming a 11 mm diameter sphere, that are placed on two superimposed PCBs, which act as supporting structure and provide signal routing (see Figure 1). A customized silicon die which includes a Pt resistor is attached to each sector in order to sense temperature and dissipate heat. Finally, two additional resistors are placed on the supporting PCBs in order to be able to control the temperature at the core of the sphere, on the PCBs.

The sensor is operated at the same constant temperature in the sectors and core. Conduction losses from the sectors to the supporting structure are minimized, since all parts are at the same temperature. The output signals are the heating powers injected on the 4 resistors within the sectors.



Fig. 1. Photograph of the prototype of the spherical sensor anemometer.

Main result: The paper summarizes the experimental results obtained in a measurement campaign at the AWTSII wind tunnel of the Mars Simulation Laboratory at Aarhus University. The targeted environmental conditions are: CO₂ atmosphere, 7-8 mbar, temperatures from -25°C to -15°C. In order to test the invari-

ability of the results to the operating temperature two constant operating temperatures have been used: $T_{hot}=20^{\circ}\text{C}$ and $T_{hot}=10^{\circ}\text{C}$. The tested wind velocities span the range 0 – 16 m/s, whereas the angle span is 0-360° full yaw rotation, and pitches from -45° to +45°. The pressure and ambient temperature in the chamber were continuously monitored during the experiments.

Figure 2 shows the total heating power in the 4 sectors as a function of wind velocity in two experiments at two different target temperatures ($T_{hot}=20^{\circ}\text{C}$ and 10°C).

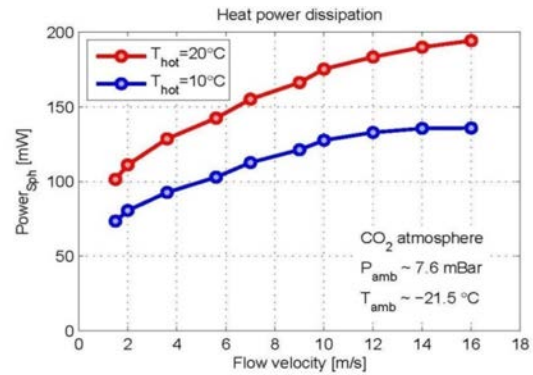


Fig. 2. Total power delivered to the 4 sectors, for different wind velocities, and two operating constant temperatures.

Figure 3 shows the calculated thermal conductance of the whole sphere, taking into account the heating power delivered to the sectors, ambient temperature and pressure variations. Superimposed is the comparison with the model in [4].

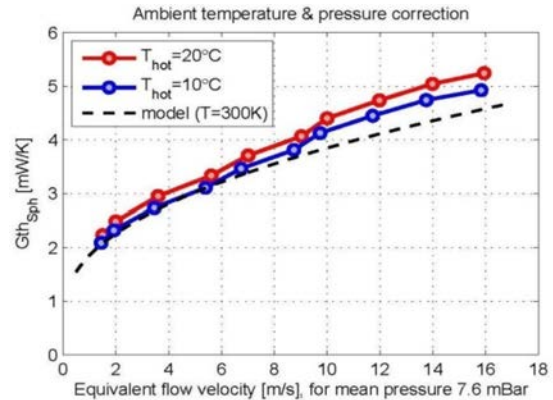


Fig. 3. Thermal conductance in the experiments obtained from the total power in the sectors, ambient temperature and pressure. Comparison with the model in [4].

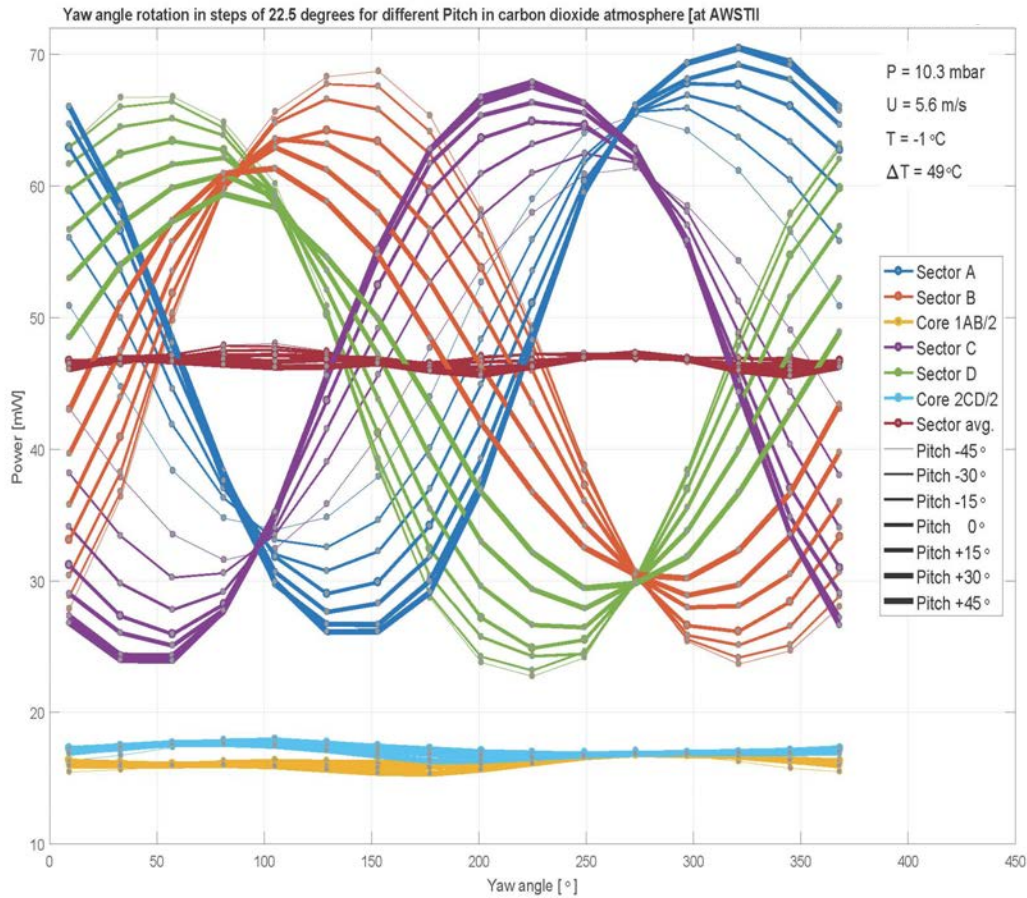


Fig. 4: Power delivered to all Pt resistors (sector A,B,C,D and 2 cores) in a experiment in which 0-360° yaw angles were swept for different pitch angles (-45°, -30°, -15°, 0, 15°, 30° and 45°), at constant wind speed (5.6 m/s)

Finally, Figure 4 shows the powers injected in all resistors for a long-time experiment in which many different yaw and pitch angles were swept. As it can be observed in Figures 3 and 4, wind speed and angle recovery is possible: high individual sector variations for different yaw and pitch angles, whereas the sum of power of four sectors remains constant, and depends only on wind speed.

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