Application 2048

Performance evaluation of the XEN-5310 sensor and PCB connexion in an academic free jet/plume of helium in air.

Sander Van Herwaarden

Xensor Integration, Delfgauw

Context :

Xensor is an independant high-tech company of approximately 10 persons and has been operating out of Delft since 1988. Xensor is focusing on custom design, prototyping, production of micro sensors, micro systems and sensor signal conditioning electronics.

Xensor's product range consists of thermal sensors and related products. Depending on the application, Xensor can offer a range of reliable standard products or may opt for custom development of nano calorimeters, gas type / vacuum sensors and sensor signal conditioning electronics.

Xensor has provided gas sensors to different companies (CEA, Air Liquide, JRC ....), in the field of experimental programs to evaluate the dispersion of gas in the frame of Hydrogen safety. Within the frame of the H2FC infrastructure project, Xensor wants to demonstrate the interest of recent improvements added to their sensors (XEN-5310) and also connecting lines (PCB instead of wires) for jet releases measurements:

- Reduced size lowering impact on turbulence measurements
- Improved time response of the sensors

The CEA Floreal infrastructure is particularly adapted for that purpose and several preliminary experiments have already been performed on jet release, in the context of European projects connected with fuel cells safe use. CEA is also familiar with Xensor technology.

CEA Floreal set-up

The Floreal infrastructure is composed of 3 experimental platforms dedicated to gas release characteristics measurements. Around 7 persons are working on:

- GARAGE (a 30 sq.m garage room, with a 3D helium concentration sensors mesh)
- GAMELAN and grand GAMELAN a 1 sq.m and a 2 sq.m box with helium concentration sensors located on 3 vertical lines of 5 sensors
- Mistra, a more than 100 sq.m able to withstand pressure load.

CEA activity consists in performing experiments of helium release in various cavities with very well controlled experimental conditions (temperatures, leakage etc…). These

experimental installations can be operated with closed or opened (with apertures) cavities, with or without forced ventilation. Concentration distributions of helium vs time are accurately measured as well as its velocity with 3D velocity components PIV systems. Flow visualization is also possible with boss techniques.

It is worth noting that CEA can easily integrate new Xensor sensors to test their performance since CEA is already equipped with Xensor technology.

Why helium

CEA is using helium for two reasons: it is safer to use than hydrogen, but its characteristic in term of buoyancy and dispersion are quite close and correlations obtained with helium can be easily extrapolated to hydrogen.

CEA expertise

CEA has published between 10 and 20 articles on the sole GAMELAN and GARAGE set-up in international journals. CEA collaborates strongly with EDF on hydrogen safety of nuclear plants and with air liquide, INERIS and other companies/institutes in the scope of hydrogen safety.

Objectives:

The objectives are multiple and challenging:

- Access to CEA facility in order to test Helium sensors improvements
- Perform helium injection in well known jet configuration and validate concentration measurements: spatial distribution, time averaged but also fluctuating quantities.
- Analyse the improvements made compared to standard product that can be summarized in two points: 1) reduction of the sensors alimentation and data cable via use of special PCB devices, 2) improvement of time reactivity of the sensors with new aperture design of the sensor casing.
- Check the possibility to measure the entrainment coefficient with horizontal distribution of C and velocity PIV measurements at small distances from injection.

Time requested:

The time access request is of 25 days. It is decomposed in the following way:

- Reception, set-up of the sensors (on the data acquisition system), set-up of the sensors on the experiment – 5 days
- First data acquisition, tests and data processing of the first experiments. Determine the closest distance possible to the injection for the sensors. Determine minimum flow rate for significant concentration measurement. Build up of the final experimental plan – 5 days
- Experimental campain: 5 flow configurations. 10 days.
- Post processing of the data and deliverable (data file and word document describing the experiments) : 5 days

Experimental approach:

The objectives will be achieved thanks to the following approach:

- Perform a series of 5 experiments in GARAGE :
- Jet from a 10mm nozzle : 5 varying flow rates.
- “free” environment : no side walls, styrodur to protect from Delta T
- Measurement along jet axis and across jet axis. 10 sensors minimum.
- Measure as close as possible from injection z/D < 10
- Check velocity fields with PIV to evaluate perturbation generated by sensors.
- One person during 25 days at CEA.
- Tests will be done on new Xensor XEN-5310 sensors with PCB flat connexions.

Detailed experimental program

The set-up

The program consists in testing the sensors response in a well controlled environment and on an academic type of flow: a vertical free jet of a light gas (helium). Such a flow is very well described at large distance from the injection (above a hundred diameter from injection). Therefore we can easily validate the accuracy of the sensors and quantify their performance improvement in term of flow perturbation (due to a smaller size and an improved connexion system without any cables).

Visualisation

CEA will also provide PIV laser measurements to measure velocities around the sensors and have an even better estimation of the perturbation created by the sensors in the flow path.

Publications

Tests performed in the past by CEA on old design sensors showed that measurements can be achieved down to a distance of 10 diameters from injection with less than 10% of perturbations on measurements. We can expect a better performance which could lead to publications of concentration and velocity profiles to distances smaller than 10 diameters to the injections. Those results could lead to strong improvements on the knowledge of the entrainment coefficient which controls the injection gas mixing with air. Those results would be strong results to publish in international reviews.

Travels:

Travels of Xensor (Delft):

- 2 travels of 3 days at beginning and at end of the program for 1 person from Xensor are foreseen.