I. EXPERIMENTAL DEVICE CARAIDAS: AEROSOL DEPLETION BY DROPLETS

In order to comply with experimental device design requirements, different devices have been developped, tested and set up on CARAIDAS (figure 1) :

- experimental enclosure in which representative thermodynamic conditions could be achieved,
- the monosized drops generator, the drops diameter measurements and the drops collector,
- the cesium iodide aerosols generator, concentration and size distribution measurements.

I.I Experimental enclosure

Experimental enclosure is a five meters high cylinder with an inner diameter of 0.6 meter. The vessel is heated up by circulating a thermofluid through the double-wall unit. This system is split into three sections to ensure uniform temperatures overall the vessel height. The vessel has 8 windows (100 mm diameter) and several penetrations (50 mm diameter) for instrumentation purposes.

The thermofluid circuit comprises:
- a pump with a flow rate of 12 m3/h,
- an electric heater (40 kW) using a PID regulation can heat up the thermofluid at a maximum of 160°C. The temperature in the main pipe is monitored by two sensors (Pt100, class A),
- the thermofluid repartition into the three sections is ensured by one valve and one flow meter for each section.

Homogeneous thermodynamic working conditions are obtained by using an air-steam circulation with :
- a varying flow rate fan (0 to 50 m3/h),
- an electric heater (5 kW), using a PID regulation, can heat up air-steam mixture with a temperature range between 20 to 160°C; the temperature is monitored by two Pt100 sensors (class A),
- an absolute pressure PID regulation in the range of 1 to 8 bars is carried out by using two valves(one for pressurized air alimentation and one for release).

The steam saturation rate in the vessel is also controlled by a PID regulator. Steam is produced by an electric generator and injected using a valve controlled by the regulator. Steam saturation rate range is between a few per cent and 95 %. Highest saturation limit is 95 % to avoid condensation particularly on windows.

This air-steam circulation ensures a good mixture in the vesse!. When nominal working conditions (P,T, S) are reached, air-steam circulation is stopped and then the vessel is isolated by two valves.
Several sensors are installed on the vessel to check air-steam mixture homogeneity :
- five gas temperature sensors (Pt100, class A),
- three inner vessel wall sensors (Pt100, class A),
- one pressure transducer (0-10 bars),
- three steam saturation ratio measurements by dew point measurement,
- one steam partial pressure measurement by sampling sorne gas and condensation by cooling.

All of these experimental data are displayed and saved by using a PC supervisor.

I.2. Drops devices

Drops generator is above the experimental enclosure because this device must be at ambienttemperature whatever the enclosure temperature. In order to produce monosized drops, the generator is based on a break-up process of a jet into drops by applying a periodic disturbance. This principle of generation induces a one drop diameter spacing. This small drops spacing is not large enough to avoid drops coalescence, so an electrostatic sorting out drops is set up. A stream of uniformly charged drops is shaped by applying a potential difference between a ring electrode and the feeding tube. When a negative impulsion is applied to the ring electrode, an uncharged drop is produced. The deflection plates placed downstream, which are under electrical potential difference, create an electric field. Charged drops passing through this electrical field are deflected and collected. Uncharged drops are not deflected and they are injected in the experimental enclosure. The rate of injection of uncharged drops is variable from 1 to 1/1000. This device is able to produce monosized water drops with a diameter between 100 and 500 jlm. Drops injection temperature is measured by a Pt100 sensor on the feeding tube. Drops injection temperature can be set between 20°C ta 80°C by a small electric heater.

After injection in the vessel, drops diameter is modified by steam condensation or evaporation as function of thermodynamic conditions. So, three drops diameter measurements are forecast for three falling drops heights: z=0, z=2.51 and z=4.39 meters. These measurements are based on drops shadows axial transmittance. A stroboscopie incoherent light source is placed in front of linear camera (CCD). When a drop cornes in front of the CCD camera, analogie signals from photodiodes are obtained and then numerized. Numerical drop shadow is processing in order to calculate the real drop diameter.

At the end of the fall, drops must be collected ta measure aerosols mass in drops, so a drops collector ensures three functions :

- drops collection,
- dynamic containmnent of drops collection surface,
- sample output.

Drops are collected on fiberglass filters, 80 mm diameter, 1.55 mm thickness and temperature proof under 200°C. These filters can soak up water drops volume (a few milliliters). The collected aerosols mass by drops during fall is dissolved in 10 ml of distilled water and measured by fluorimetric method. Aerosols sedimentation on collection surface is avoided by a dynamic containment : clean air is blown throught collection filter and get back by a circular aspiration on the top of the dynamic containment device not to modify aerosols concentration in the experimental vesse!. Extraction of several samples during test is been able by a pressure thruster which shifts drops collector from experimental vessel to the SAS where it can be brought out and put a new drops collector in place.

I.3. Aerosols devices

Aerosols generation is based on mechanical spraying by a rotative disk, of cesium iodide solutiontagged by soda fluorescein. The rotational device is an air turbine because high rotation speed is needful (3000 rounds per second). The rotation speed is achieved by air pressure at the inlet of the turbine and monitored by an electromagnetic indicator. The spraying disk (8 mm diameter) is fed with cesium iodide solution at a steady state flow rate. The sprayed droplets diameter, which is function of the rotation speed and of the solution flow rate, is about 20 µm. After evaporation, the dry aerosols diameter is function of the cesium iodide concentration.

With this specific generator, it is possible to produce aerosols with temperature (20-160°C) andpressure (1-7 bars). The aerosols diameter range is between 0.5 and 5 µm with a geometric standard deviation lower than 1.7 and the aerosols mass flow rate is roughly 0.1 g/h.

Four aerosols sampling are set up on the experimental enclosure to check homogeneity of concentration and particles size distribution. Aerosols concentrations are measured on fiberglass filters of 25 mm diameter. Each sample is going on one or two minutes with a 1 l/min flow rate. The filtered aerosols mass is measured by fluorimetric method.

The particles size distribution measurements are given by inertial impactors at vessel pressure and temperature conditions. Aerosols are discriminated among eight size ranges corresponding to aerodynamic diameters ranging from 0.35 to 7.5 µm. Data processing is performed by a classical log-probability graph. This method gives aerosols mass median diameter and geometric standard deviation.

This experimental device allows to measure experimental drops diameter evolution and collected aerosols mass by drops as function of different experimental conditions representative of severe accident scenarios.

figure 1: Experimental device scheme