3.8. PREMIX - Premixing phase of melt-coolant interaction

Objective of the facility

The PREMIX experiments have been performed to study the premixing of sizable amounts of very hot oxidic melts with water when being released as a jet in a reasonably characterized way and with full optical access. Alumina at 2600 K from a thermite reaction was used to simulate the corium melt. A technique has been developed to retain the molten iron in the source so that the contribution of iron to the melt is well below 10 %. PREMIX involves the full physics of the mixing process including jet break-up and melt drop fragmentation. But, of course, on the other hand, the initial and boundary conditions are more difficult to control and to vary compared to experiments with solid spheres such as QUEOS.

Parameters of the facility

The test facility consists of a slender cylinder with an effective inner diameter of 0.66 m bearing plane glass windows in the front and back sides. The upper part is occupied by the melt generator which leaves a 0.14 m wide annular space for the steam flow. The facility is entirely closed except for four large venting pipes (4 m long, each with a cross section of 90 cm2) which were also closed in two tests. The space below the melt generator is about 2.2 m high but for the processes to be studied, the actual height of the test water pool was determined by a concave debris catcher that could be mounted at different heights. The test rig was placed inside a large (220 m3) pressure vessel providing a safety barrier and the possibility to perform tests at elevated ambient pressure.

Instrumentation and measurements

The tests were recorded visually by video and high-speed cameras, and the pressures inside and outside the test vessel were measured. The initial increase of the water level was recorded by level meters. Furthermore, the water temperature and the distribution of water and void within the test vessel were measured by thermocouples and local void probes, respectively. (Sometimes the destruction of a thermocouple indicated the arrival of melt.) In the open tests, the steam velocity in the vent pipes was measured. After the tests, the size distribution of the debris was determined.
The ideal test result would be the spatial distribution of the volume fractions of melt, liquid water and gas within the test vessel. But from the movies one can at least obtain the shape of the mixing zone as well as rough estimates of its volume and of mean volume fractions within it. The void probes give time resolved information about the volume fractions of water and steam at the locations in which they are installed (in arrays of 8 probes distributed radially). Besides that, pressures and steam flow rate give (indirect) evidence of heat transfer.
A total number of 18 experiments have been performed from 1994 to 1999. After test PM11 the test rig had to be rebuilt since it was destroyed by a steam explosion. It was slightly modified to have geometrical conditions as close as possible to FARO. In only one test (PM11) the single melt nozzle was replaced by three nozzles in a triangular array. All tests but PM17 and 18 were open to a constant pressure surrounding via the vent pipes. Duration of the melt release was typically 0.5...2.0 sec. In test PM16, with the largest melt mass, it was 6 sec. In this test, the outside pressure increased on the long run.
PREMIX was a task in the EU-MFCI-Project within the Fourth Framework Programme.

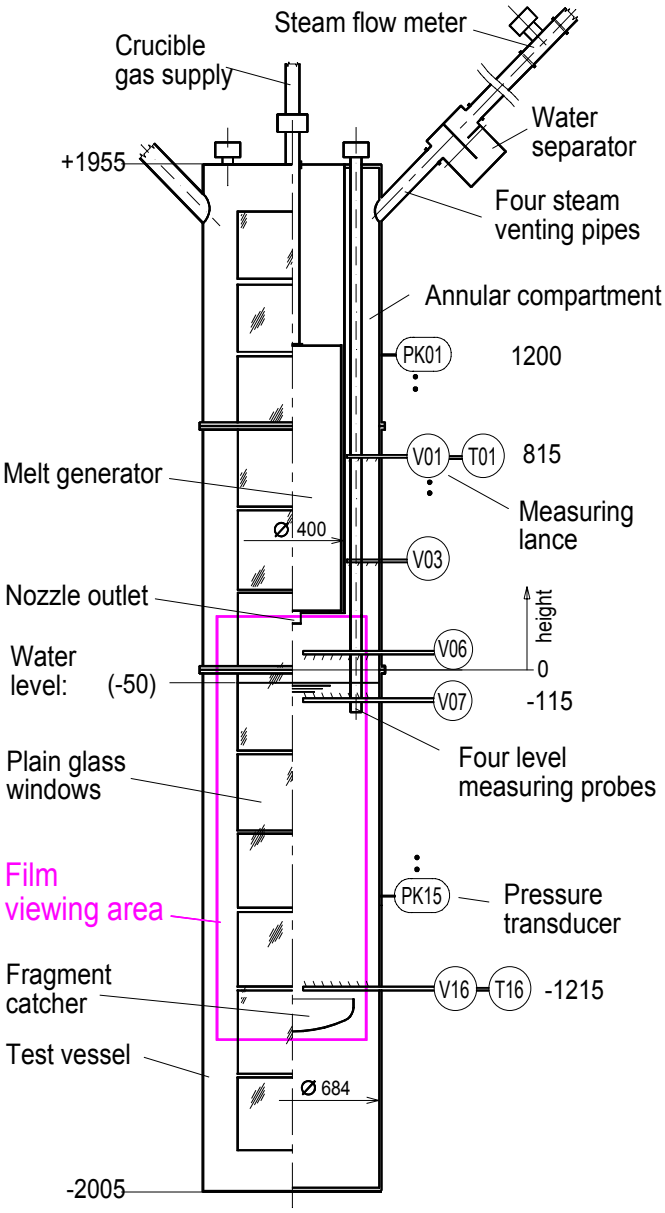

Fig. 8-1 Scheme of the PREMIX facility

Table 8.1 Premix test matrix

Exp. ID	Date	Type (characteristics)
PM1	27.07.94	- melt: 9.3 kg discharged, nozzle d=45 mm, - driving pressure 0.08 MPa -falling height: 200 mm - pool: h=1.6 m, subcooling 2 K - system pressure: 0.1 MPa
PM2	05.10.94	Main parameters similar to PM1
PM3	14.12.94	Main parameters similar to PM1
PM4	07.02.95	Main parameters similar to PM1
PM5	10.04.95	Main parameters similar to PM1
PM6	09.06.95	- melt: 20.2 kg discharged, nozzle d=60 mm. - other parameters similar to PM1
PM7	11.10.95	- melt: 9.6 kg discharged, nozzle d=40 mm. - driving pressure 0.39 MPa - saturated water
PM8	09.01.96	- melt: 10 kg discharged, nozzle d=45 mm. - driving pressure 0.08 MPa - falling height 0 - pool: h=0.5 m, saturated.
PM9	21.03.96	- melt: 21.8 kg discharged, nozzle d=60 mm - driving pressure 0.95 MPa - falling height 0 - pool: h=0.9 m, saturated
PM10	03.07.96	- melt: 27.3 kg discharged, nozzle d=60 mm - pool: h=0.5 m, saturated - other parameters similar to PM9.
PM11	21.08.96	- first and only test with triple-jet. - melt: 20 kg discharged, nozzle 3 x 35 mm. - driving pressure 0.07 MPa - other parameters similar to PM10 - facility was destroyed by steam explosion
PM12	26.06.97	- facility was rebuilt with some modifications - melt: 29 kg discharged, nozzle d=60 mm. - driving pressure 0.046 MPa - falling height 193 mm - pool: h=1.36 m, subcooling 1 K
PM13	13.10.97	- melt: 23.8 kg discharged, nozzle d=60 mm. - driving pressure 0.05 MPa - falling height 213 mm - pool: h=1.34 m, subcooling 1 K - system pressure 0.1 MPa - standard test of second test series
PM14	10.03.98	- main parameters similar to PM13 - reproducibility test
PM15	16.09.98	- melt: 23.1 kg discharged, nozzle d=60 mm.

		- driving pressure 0.03 MPa - falling height 323 mm - pool: h=1.23 m, subcooling 8 K - elevated system pressure 0.5 MPa

PM16	03.02.99	- melt: 60.4 kg discharged, nozzle d=48 mm. - driving pressure 0.01 MPa - falling height 223 mm - pool: h=1.33 m, subcooling 5 K - elevated system pressure 0.5 MPa - parameters adjusted to FARO-L28
PM17	20.04.99	- melt: 16.0 kg discharged, nozzle d=48 mm. - driving pressure 0.01 MPa - falling height 223 mm - pool: h=1.23 m, subcooling 104 K - elevated system pressure 0.22 MPa - steam venting pipes closed - parameters adjusted to FARO-L31
PM18	07.07.99	- melt: 14.6 kg discharged, nozzle d=48 mm - pool subcooling 30 K - other parameters similar to PM17

Table 8.2 Premix Documentation

EDR	A. Kaiser, W. Schütz, H. Will - PREMIX experiments PM12-PM18 to investigate the mixing of a hot melt with water, Wissenschaftliche Berichte, FZKA-6380 (Juli 2001)	FZKA-Bericht 6380.pdf	3 Mb