Development of Plate Thermometer (PT) for Heat Flux Measurement

Reactor Design & Development Group

Application:
For Heat Flux Measurement during Thermal Qualification (Open Pool Fire/Furnace tests at 800 Deg.C for 30 mins) specified by AERB/IAEA Transport Regulations for Type-B radioactive material transportation packages.

Advantages over Conventional devices like Schmidt Boelter/Gardon Gauges:
• Economical (Rs.2000 for PT Vs Rs.3 Lakh for Water Cooled) and hence requisite numbers (60-70 Nos for each Pool Fire Experiment) can be deployed
• Easy to Construct, Operate and Calibrate
• Does not need Cumbersome Water Cooling through Extremely Hot Zones of Pool Fire.
• Only Single Temperature Measurement of PT Vs Two Temperature Measurements in addition to one Water Flow Measurement of Conventional gauges

History and Development of Plate Thermometers
• Developed by Wickstrom, in 1980s, for controlling fire resistance furnaces to get harmonized test results.
• Demonstrated by Ingason and Wickstrom, in 2006, for measuring the incident radiant heat flux as an alternative to water cooled heat flux sensors.

Re-engineered and calibrated in the laboratory of IIT- Bombay for large scale deployment in pool fire and furnace tests conducted for package qualification.

Construction of Plate Thermometer
• Thin steel plate of dimensions: 100 mm × 100 mm and 0.7 mm thick
• Coating and Curing of a Paint with High and Known Absorptivity at Measuring side
• An insulating fiber board on one side
• A thermocouple welded to the center of the plate.

Activities conducted during adoption of Plate Thermometer:
• Selection of plate material, backing insulation, the coating used for controlling the surface absorptivity of plate and the thermocouple, as consistency of Heat Flux measurement completely depends upon their thermal characteristics
• Standardization of Coating-Curing methods of High Absorptivity Paint in the temperature range of 30°C to 1200°C, expected during pool fire/furnace tests
• Calibration using Cone Calorimeter to correlate the temperature readings to heat flux values
• Analytical Modeling and Simulation of PT performance for measuring incident radiative heat flux considering the thermal properties of materials, geometry, heat transfer, heat balance and losses including convection that occur during its operation.

Importance of curing method: