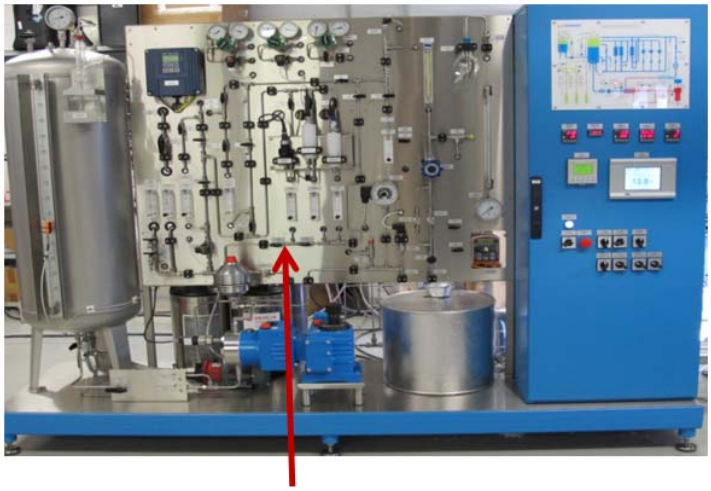
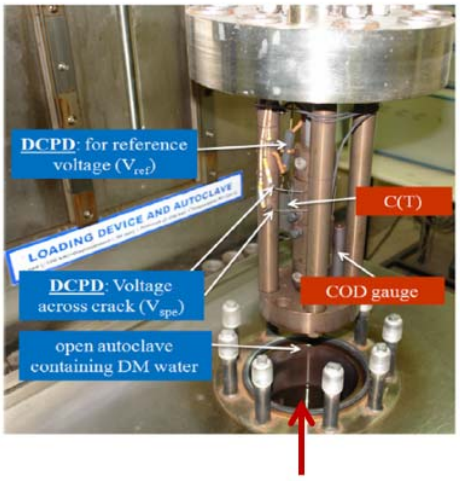
FACILITY FOR MECHANICAL TESTING IN SIMULATED REACTOR COOLANT ENVIRONMENT

Facility Description:

This facility is for testing of material specimens under specified cyclic or monotonic loads, in reactor operating conditions such as temperature up to 325℃, pressure up to 200 bars, and precisely controlled water chemistry parameters like Dissolved Oxygen, Electrolytic Conductivity and pH value. The facility is fully instrumented to measure mechanical parameters like load, displacement, and strain rate and crack growth. The test set up controls dissolved oxygen levels (>20 ppb) and measures electrolytic conductivity and pH values of demineralised water in low pressure and low temperature recirculation loop. This water is fed to high-pressure-high-temperature autoclave, where cracked specimen is subjected to fatigue cycling. The set is aimed at determination of FCGR constants for realistic assessment of fatigue crack growth life of PWR/ AHWR components under reactor coolant conditions.



Recirculation Loop to maintain inlet chemistry

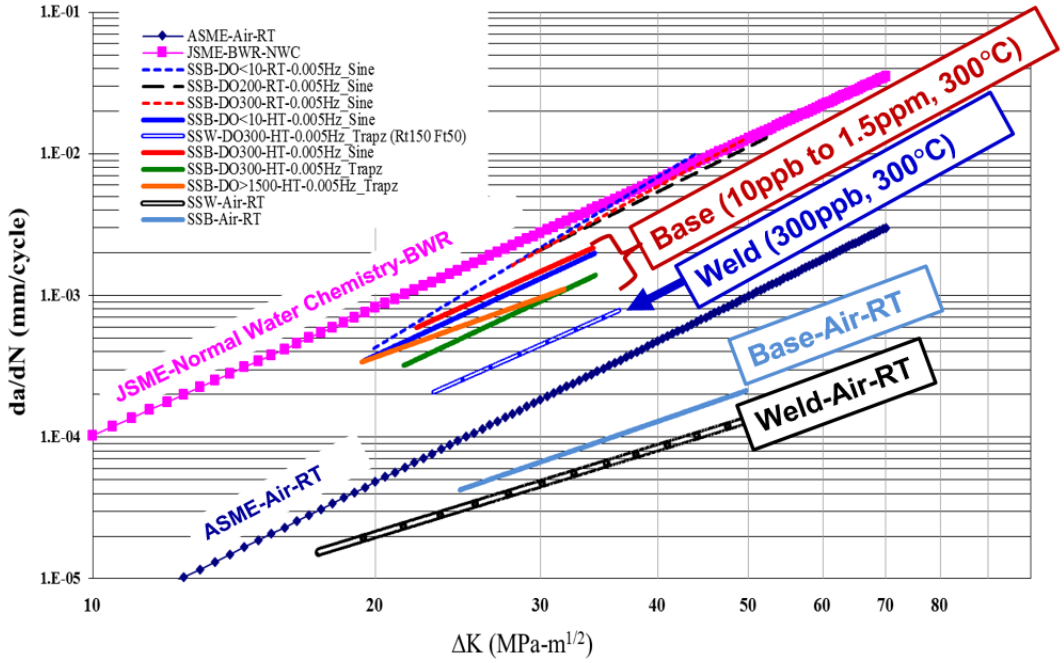


Autoclave with loading frame

Typical Test Results:

Development of Corrosion-Fatigue crack growth (FCG) model / data for AHWR main heat transport material in coolant environment

For the assessment of residual fatigue life of a piping component having flaw, the realistic crack growth constants (Paris Constants) are required under actual reactor coolant environment under operating conditions. These curves are not available in ASME standard for austenitic stainless steel. The use of available constants for air environment would over-predict the fatigue crack growth life in coolant environment due to synergistic material damage effect of corrosion and fatigue. Therefore, tests have been carried out in simulated reactor coolant environment of AHWR. Test variables used in the tests were environment (air and water), base/ weld material, loading frequency, dissolved oxygen level in DM water, loading waveform with varying rise time/ fall time, test temperature (room temperature and 300℃) etc. Results are shown in the figure below.



Fatigue Crack Growth Rate (da/dN)-versus-crack driving force (ΔK) curve for SS 304LN pipe/ weld materials in air and water environment at room temperature and 300 ℃

It was observed that the FCGR in water at 300 ℃ is significantly higher than that in air at RT for both parent and weld. The developed data / model can be uses for realistic crack growth rate assessment of FCG life under coolant water environment.