Small Punch Test.

Providing direct mechanical properties of in-service equipment.

Background

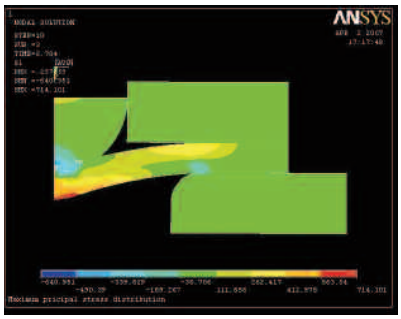
The Small Punch Testing method (SPT) is an innovative technique which has potentials for fitness for purpose analyses and residual life assessment of in-service components. In absence of actual material properties of the component, nominal properties (lower bound, average trends, literature curves or curves given by the constructor for the virgin component) are used. The Small Punch Test technique is a powerful method capable of providing actual values of mechanical properties from actual components.

The method needs only a modest amount of material from the component surface to determine actual mechanical properties. Typical specimen size is 8 mm diameter and 0.5 mm thickness. The test itself is rather simple to perform, but has to be carried out very accurately. Depending on the type of mechanical properties which is needed, results have to be analysed using KEMA developed finite element models.

Encouraged by the ASME standards F1248 and F2183 on small punch test for polyethylene pipe, further work for code acceptance of steels is ongoing. KEMA is member of the European CEN workshop WS 21 and takes part in discussions. Now the European Code of Practice documents are available for both high and low temperature properties, which summarises the international experiences in last 20 years and provides a guide line to small punch test for metallic materials. The Small Punch Test method is increasingly applied and accepted.

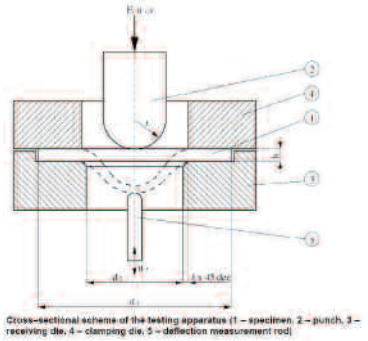
Why using SPT

Determination of actual mechanical properties (yield stress, tensile strength, ductile to brittle transition temperature, fracture toughness and creep properties) of in-service components is necessary for optimization of operating procedures and inspection intervals as well as for repair strategies and residual lifetime assessment.



A second need is the availability of mechanical properties on samples from service-exposed parts for fitness for purpose analysis. Machining the conventional specimens for the standard tests is normally not compatible with the dimensions and shapes of the available parts. For example, a standard Charpy-V test needs about 160 cm^3 material. It is hardly impossible to have this volume available from in-service components without repair or replacement.

Another need is the measurement of miniature samples for assessing local damage. For example, standard specimens cannot be sampled on the gas leading edge of a service-exposed turbine blade, because it is just a few mm thick. The same applies for the properties of the small heat affected zone at a welded joint. Most assessments of welded joints suffer from the limitation that heat affected zone properties can only be presumed, or measured from "simulated heat affected zone" materials.



Cross-sectional scheme of the testing apparatus (1 – specimen, 2 – punch, 3 – receiving die, 4 – clamping die, 5 – deflection measurement rod)

Benefits

Benefits of applying SPT is the reduction of the degree of conservatism. Resulting in a factor, typically as two in residual life, or an increment of about 40% of the allowable crack size in fracture analyses.

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