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Original Research Article

An estimation of the high-pressure pipe residual life ☆

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ABSTRACT

The paper presents an estimation of the residual life of the power plant high-pressure pipe, which has been in exploitation for years. A crack was noticed in the pipe, thus it was necessary to estimate the pipe material residual life until its eventual failure. The combined methodology for residual life estimation, which consists of experimental and numerical investigations, was developed. The samples were taken directly from the real high pressure pipe and material properties were determined experimentally, both at room and elevated (operational) temperature. The experimental results also served for the verification of the developed numerical methodologies. The FEM and the X-FEM methods were used for the residual life numerical estimation of the high pressure pipe. The stress and strain fields, used for the estimate, were obtained by application of the Paris' law. The final verification of numerical results was realized by comparing the critical crack length to the experimentally obtained value.

1. Introduction

An estimate of integrity and the residual life of the vital structural parts, which were in the prolonged exploitation, represents the final objective of the application of damage mechanics, fracture and fatigue mechanics. To realize the complex procedure, which assumes the estimate of structural integrity, comprehensive activities are necessary. In this paper the combined methodology for the structural integrity estimate is presented. The development of this methodology is based on the application of numerical, theoretical and experimental techniques of fracture mechanics.

Numerical methods, which were used and developed here, are based on the application of conventional finite elements, as well as on contemporary numerical approaches, like eXtended Finite Element method X-FEM [1,2]. Our preference for the application and implementation of the X-FEM method into the software is justified by the fact that this method enables the simulation of the crack propagation without reformulation of the finite elements mesh. The crack

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