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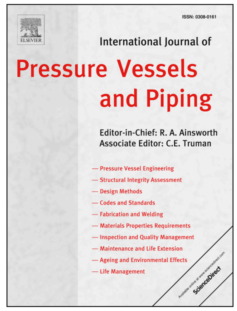


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# Residual Stresses Due to Cladding, Buttering and Dissimilar Welding of the Main Feed Water Nozzle in a Power Plant Reactor

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## Abstract

A 100MW AP1000 Reactor was considered and welding processes were employed in joining of the main feed water nozzle, in primary circuit of nuclear reactors were simulated by means of finite element method. Distribution and magnitude of the residual stresses created by thermal processes including cladding inside the nozzle, buttering prior to dissimilar welding, heat treatment and dissimilar welding of the safe-end austenitic stainless steel to the nozzle ferritic steel were investigated. Norton-Bailey creep model was used for heat treatment simulations. Experimental results obtained in previous studies and residual stress measurements were applied for verification of the developed model. It was revealed that residual stresses after cladding were approximately equal to yield strength of the materials. Also, buttering led to reduction of residual stresses in the nozzle free end. Heat treatment decreased residual stresses in the base metal significantly; whereas, it had minor effects on those in the cladding layer. Besides, circumferential residual stresses were invariably tensile at inner and outer surfaces of the joint. Further discussions were provided to explain the obtained result.

**Keywords**: Finite element, Residual stresses, Cladding, Buttering, Heat treatment, Nozzle Dissimilar welding.

## 1. Introduction

Dissimilar metal welding (DMW) is widely used in nuclear power plants structures to join ferritic carbon and austenitic stainless steel components. The manufacture process in nuclear power plants comprises several thermal procedures including cladding, buttering and heat treatment. Prediction of residual stresses in the dissimilar metal weld joints is an important challenge due to their effects on the performance of structure as well as the complexity of manufacturing process [1].

Ferritic steel nozzles or pipes of pressure vessels such as reactor vessels, steam generators and pressurizers are joined to a safe end which is made of austenitic stainless steel in primary circuit systems of nuclear power plants. Appropriate welding techniques have to be employed in order to provide this type of dissimilar weld joints. Generally, nickel based super alloys such as Inconel 82/182 are used as the filler metal in welding of ferritic and austenitic stainless steel components. The super alloy specifically makes a delay in diffusion of carbon

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