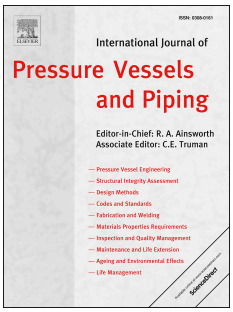
Accepted Manuscript



Thermo-mechanical behavior during encapsulation of glass in a steel vessel

S. Nakhodchi, D.J. Smith, B.G. Thomas

PII: S0308-0161(15)30085-5

DOI: 10.1016/j.ijpvp.2016.07.001

Reference: IPVP 3545

To appear in: *International Journal of Pressure Vessels and Piping*

Received Date: 2 October 2015

Revised Date: 3 June 2016

Accepted Date: 3 July 2016

Please cite this article as: Nakhodchi S, Smith DJ, Thomas BG, Thermo-mechanical behavior during encapsulation of glass in a steel vessel, *International Journal of Pressure Vessels and Piping* (2016), doi: 10.1016/j.ijpvp.2016.07.001.

THERMO-MECHANICAL BEHAVIOR DURING ENCAPSULATION OF GLASS IN A STEEL VESSEL

S.Nakhodchi[1*], D.J.Smith[2], B.G.Thomas[3]

[1]*Corresponding author, Assistant Professor at the Faculty of Mechanical Engineering, K. N. Toosi University of Technology, Tehran, Iran - Previously at the University of Bristol, UK

[2]Professor, Department of Mechanical Engineering, University of Bristol, UK

[3]Professor, Department of Mechanical and Industrial Engineering, University of Illinois at Urbana-Champaign, USA

Abstract

Quantitative numerical simulations and qualitative evaluations are conducted to elucidate thermo-mechanical behaviour during pouring and solidification of molten glass into a stainless-steel cylindrical container. Residual stress and structural integrity in this casting / vitrification process is important because it can be used for long-term storage of high-level nuclear wastes. The predicted temperature and stress distributions in the glass and container agree well with previous measurements of the temperature histories and residual stresses. Three different thermal-stress models are developed using the finite-element method and compared. Two simple slice models were developed based on the generalized plane strain assumption as well as a detailed two-dimensional axi-symmetric model that adds elements according to the stages of pouring glass into the stainless steel container. The results reveal that mechanical interaction between the glass and the wall of the stainless steel container generates residual tensile stresses that approach the yield strength of the steel. Together, these results reveal important insights into the mechanism of stress generation in the process, the structural integrity of the product, and accuracy of the modelling-tool predictions.

Keywords: Thermo-mechanical process, finite element, residual stress