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STRESS ASSESSMENT BASED ON OVALITY AND THICKNESS ASYMMETRY FOR AN INTERNALLY PRESSURIZED PIPE ELBOW AT HIGH TEMPERATURE

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ABSTRACT

In this paper the material creep behavior and multiaxial stress state of high temperature pipe elbow were investigated. The stress distribution in the pipe elbow during creep is discussed. The maximum stress area of pipe elbow transfers from inner wall to outer wall during creep. The ovality and the different initial thickness asymmetry of steam pipe elbows subjected to a uniform internal pressure at high temperature are calculated with Finite Element Analysis (FEA). The initial ovality and wall-thickness play a very large role in stress distribution in the elbows, and vary with time during creep. That explains the transfer of stress distribution in the elbows. Based on influence of ovality and thickness an analytical model to calculate equivalent stress of elbow through straight pipe stress is presented.

Keywords: Ovality, Pipe Elbows, Creep, Thickness, FEA

1. INTRODUCTION

The Chinese electric power industry has been developing greatly and rapidly in recent three and four years. In order to reduce air pollutant emission rates and enhance energy efficiency of fossil fired power plants supercritical and ultra supercritical units with the steam temperature and the steam pressure up to 600℃ and 30MPa will become predominate one in the future decade. In such a situation it is necessary to ensure the safety and the reliability of power generation equipment during their operation, especially, for high temperature pipelines connecting the boiler and the steam turbine.

At high temperature an internally pressurized pipe with large diameter used in supercritical and ultrasupercritical unit has shown its viscoelastoplastic material characteristics. In these applications the pipe is subjected to high temperature and high internal pressure, which will produce a tensile stress field in pipe and a complicated multiaxial stress state in its elbow. Aside from third party damage, ductile, brittle rupture and slow nucleation up to crack growth taking place at stress or strain concentrations are the dominating creep failure mechanisms. For high temperature pressure vessels, there exists a requirement for accurate methods of creep life prediction. This is particularly the case for major plant components such as steam pipes and tubes. Furthermore, more attention must be paid to pipe bends or elbows which have initial ovality and thickness asymmetry. At this area, the stress distribution is complicated and varies with time due to creep. The analysis of ovality and thickness asymmetry of pipe elbow plays a key role in studying the stress variation and creep damage proceeding (Hyde，1999).

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