VIBRATION AND WEAR OF LOOSELY SUPPORTED HEAT EXCHANGER TUBES

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Heat exchanger tubes must be loosely supported to allow for thermal expansion and ease of construction. Consequently the tubes are not fully restrained at their supports and they may rattle, impact and slide producing wear. A further problem is that the loose supports may not prevent low frequency vibration and this makes the tubes particularly susceptible to flow excitation.

A support can be fully effective if the friction force between the tube and its supports prevents any sliding motion. This however requires a large static force to press the tube against its supports. This paper will consider what static force is necessary in order to prevent any sliding motion. The factors the designer must manipulate to achieve an effective support are the magnitude of the fluid loading, the tolerance in construction and the location of the supports. This paper considers these factors.

If the friction force is not sufficient to prevent motion, then the tube will slide until its motion is limited by impacting against a support. This situation is much more difficult to analyse but theoretical and experimental considerations show that very low frequencies of vibration are possible. Recent work which investigates the natural frequencies an damping of loosely supported tubes is described. This work includes theoretical simulations of the vibration of an impacting tube and experimental measurements of loose tube motion.

In summary, this paper examines the link between the excitation forces which cause a tube to vibrate and the wear mechanisms which cause damage.

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FLOW INDUCED VIBRATION IN LMFBRs

Development Work in Support of the UK Programme

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1. INTRODUCTION

Techniques for the assessment and avoidance of flow induced vibration problems employed for the Dounreay Fast Reactor (now closed down) and the Prototype Fast Reactor PFR are being continued for development of the Civil Demonstration Fast Reactor (CDFR) and are also being used for components of SPX2 and SNR2. It is usual to assess (theoretically initially) flow distribution, fluid forcing functions, structural response and the potential for wear or other harmful effects. Prediction of resonance or instability is required at an early stage in design. Endorsement tests have been carried out to confirm theoretical approach or to provide realistic simulation of vibration in cases where available data or techniques are insufficient to give reliable results.

Design aspects are discussed by Bolton(1) in a separate paper, to be presented alongside this one.

The $1.5m^3/s$ water loop at Risley Nuclear Laboratories has been extensively used to generate basic data and for endorsement tests on large prototypic models.

Considerable effort has been devoted to understanding flow interaction in tube bundles as these feature prominently in heat exchangers (Steam Generator Unit, SGU and Intermediate Heat Exchanger, IHX) also in CDFR core support and above-core structure. Excitation data has been obtained at Reynolds Numbers Re $0.4\text{-}4\times10^5$ for a range of triangle pitch geometries appropriate to heat exchangers and at Re up to 2×10^6 for above core structure.