

激光诱导荧光测量横掠管束流动标量混合系数

摘要

螺旋管式换热器通常被选用作高温气冷堆（HTGRs）的主要换热器。为了提高热效率，设计者追求尽可能高的运行温度，这几乎接近镍基合金的极限温度。管束中的温度峰值会使部分传热管的工作温度高于设计值，并可能在管头处引起较大的热应力。湍流脉动、流束分离和再汇以及管后尾迹摆动等现象有助于管束内温度峰值的混合和展平。佩克莱数（ Pe ）可以描述管束内温度分布的有效混合效果。在本研究中，通过在水洞中测量罗丹明 6G 的浓度场，研究了横流过管束的标量混合过程。通过比较不同流向位置的拟合曲线得到 Pe 。测试的管束为管间距与直径比（ P/D ）为 1.58 的直管束。雷诺数（ Re ）范围为 10000~40000。当 Re 从 10000 增加到 40000 时， Pe 先下降，然后保持稳定。

关键词

横掠管束、标量混合、激光诱导荧光

Abstract

Helical tube bundles are usually used for the main heat exchangers of High Temperature Gas-cooled Reactors (HTGRs). In order to improve the thermal efficiency, the designers pursue as high as possible operating temperature, which almost reaches the limited temperature of nickel based alloys. Temperature peaks in tube bundles will additionally make some of the tubes work at temperature higher than the design value, and may induce large thermal stress in the tube header. The phenomenon of turbulence fluctuation, splitting-rejoining flow and swinging wakes can help mixing and flattening the temperature peaks in tube bundles. Peclet number (Pe) can describe the effective mixing effect on temperature distribution in tube bundles. In the current investigation, the concentration field of Rhodamine 6G is measured to investigate scalar mixing process in cross flow over a tube bundle in a water tunnel. Pe is obtained by comparing fitting curves at different streamwise locations. The tested tube bundle is a straight tube bundle with tube pitch to diameter ratio (P/D) of 1.58. The Reynolds number (Re) range is 10000 ~ 40000. Pe first declines and then maintains stable when increasing Re from 10000 to 40000.

Keywords

cross flow over tube bundle, scalar mixing, laser induced fluorescence

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