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加工利用

LNG工厂换热技术的研究进展

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摘要：

对比分析适用于多股流传热的缠绕管式换热器（SWHE）和板翅式换热器（PFHE）的应用效果，指出PFHE具有结构相对紧凑、传热效率较高等特点，但其在可靠性、抗热冲击负荷、浮式LNG的适应性等方面表现较差，国际上存在着PFHE大型化和SWHE小型化的趋势。介绍了新型核状沸腾强化管（GEWA PB）和冷凝强化管（GEWA KS）的应用，论述了采用海水一次通过的直接冷却法的优点：可靠性高、易维护、电耗低、生产稳定性好、安全性高；从全寿命周期的经济性和可靠性角度指出选择钛材作为主制冷剂冷凝器和压缩机级间冷却器具有明显的优势。还介绍了实际混合物制冷剂的冷凝过程及Hammerfest LNG工厂基于实际冷凝过程和机械可靠性对使用的螺旋折流板换热器进行结构改进的措施。最后建议，中国在LNG工厂的换热技术上应着手以下几个方面的研究工作：①开展基于SWHE、处理规模为10^6 m^3/d LNG装置MCHE的研究；②开展基于实际工质下高效冷凝管和蒸发管的传热与流动研究；③系统研究直接冷却法和间接冷却法对LNG装置的影响，加大整个装置范围内材料及设备对海水的适应性研究；④加大钛高效管的研究，结合壳程纵向流动的研究和高效传热元件的利用，开发出具有良好热力性能和机械可靠性的实际混合物制冷剂冷凝器。

关键词： LNG 换热器 SWHE PFHE GEWA PB GEWA KS 直接冷却法 螺旋折流板换热器

Research progress in heat transfer technology in LNG plants

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Abstract:

A comparative analysis is made on the application results of plate fin heat exchangers (PFHE) and spiral wound heat exchangers (SWHE), both of which are adaptable to multiple stream heat transfer. It is pointed out that PFHE are better with compact structure and high heat transfer efficiency but with poor reliability and worse performance in impact heat influx and adaptability of offshore floating LNG terminals. In the global trend, the PFHE are applied on a large scale but the SWHE on a small scale. Then, the application of dual enhanced tubes (GEWA PB and GEWA KS) is introduced and the advantages of the once through seawater cooling system are demonstrated: high reliability, easy maintenance, low electricity consumption, stability in production and high safety. In terms of its life span economy and reliability, titanium is chosen as the preferred dominant refrigerant for the intermediate cooler between a condenser and a compressor. Furthermore, the actual condensing process by use of the mixture refrigerant is introduced, based on that and the mechanical stability, the innovative measures made for the structure of the helical baffle exchangers adopted by the Hammerfest LNG Plant are also presented herein. In the end, this paper puts forward the following proposals for further studies of heat transfer technology in LNG plants in China. (1) The SWHE based main cryogenic heat exchanger (MCHE) with the dealing capacity of 1000000 m^3 per day should be studied. (2) Research of heat transfer and flow should be conducted on the high efficiency condense tubes and evaporating pipes under actual working conditions. (3) A systematic analysis should be made of the impact of direct and indirect cooling methods on an LNG plant and the studies of the adaptability of materials and equipments in the whole plant to sea water should be made as well. (4) The titanium made tubes with high efficiency should be further studied and in combination with the research of shell side longitudinal flow and the utilization of high efficiency heat transfer components, the condenser adopting actual mixture refrigerant with satisfactory thermal performance and mechanical stability should be developed.

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