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Numerical study of longitudinal inclination effect on a tubular BOG heat exchanger

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This work proceeds a numerical study of inclination effect on the heat transfer performance of a tubular heat exchanger. This equipment is widely used in the gasification process of a floating liquefied natural gas system (FLNG) to exploit cold energy from boiled-off liquefied natural gas (BOG). The inclination comes from the FLNG floating in an ocean environment. The finite volume computational fluid dynamics method and the k-ω based shear stress transport model are applied to simulate the heat transfer between BOG and refrigerant. As known from the previous study, the major inclination effect is associated with the inclination in long-axis plane. Therefore, this work focuses on the longitudinal inclination with different angle and mass flow conditions. The simulation result was verified by comparing with the engineering specification data from its supplier - Salof Refrigeration Company in New Braunfels, Texas. The numerical analysis reveals that, in a high mass flow condition (2448kg/h) of shell-side ethylene glycol, the shell-side outlet temperature is relatively more stable than lower mass flow situation. The entire variation range is only 1.3K from inclination -30° to 30°, but 21.3 K in lower mass flow situation. Hence, maintaining higher mass flow of shell-side is an effective way to reduce the inclination effect on shell temperature shift. In addition, outlet temperature of tube side BOG also changes with the inclination angle. There are two approximately linear relations with different variation range between inclination angle and outlet temperature of BOG. The temperature range is 2.9K in higher shell-side mass flow but 6.9 K in lower mass flow. So higher mass flow condition is recommended to achieve a smaller inclination effect on tubular heat exchanger and the outlet temperature of BOG can be predicted by the fitting function of inclination angle.

Primary authors: Dr YAN, Yan (Southeast University); Prof. NI, Zhonghua (Southeast University)

Co-authors: Mr YIN, Jingsong (Furui Special Equipment Co., Ltd.); Prof. LIU, Xiaojun (Southeast University)

Presenter: Dr YAN, Yan (Southeast University)

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