AME 30334

Special Project

Spring 2013

Heat Exchanger for Regasification of

Liquefied Natural Gas (LNG)

Problems 11.69 and 11.70 deal with a shell-and-tube heat exchanger (single shell and single-pass tube bundle) used to gasify LNG for delivery to a land-based pipeline. LNG routed through the shell is gasified by heat transfer from sea water routed through the tubes. You are to work with the operating conditions prescribed in the problem statement. The LNG, which is degasified at a rate of 150 kg/s, enters the heat exchanger as a liquid at – 155°C and leaves as a gas at 8°C, while the sea water enters at 20°C and exits at 10°C. You are also to use the fluid properties and overall heat transfer coefficients provided in the problem statement.

The heat exchanger must be designed to meet the foregoing requirements, and your first task is to determine whether it should be operated in parallel or counter flow. Having determined the surface area requirement for the preferred flow mode, your next task is to specify the tubing and the design of the tube bundle, including the number and length of the tubes. Your selection of tube wall material, diameter and thickness should be consistent with standard manufacturer specifications and should consider related costs. Assume that the surface area and overall coefficients are based on the outer tube diameter. Values of 1,020 kg/m^3 and 1.05×10^{-6} may be assumed for the density and kinematic viscosity of sea water.

 While optimizing the design is beyond the scope of the project, you should seek features that favor lower capital and operating costs. You may also want to consider the effect of variability in the prescribed sea water inlet and outlet temperatures.

Project reports are due on **Monday, April 8.** The report should begin with an executive summary, not to exceed three double-spaced pages, in which you provide salient results and conclusions. Subsequent sections should be in the form of appendices providing details of your mathematical model and parametric calculations, including numerical results presented in tabular and/or graphical form. Reports will be judged on the basis of technical content, clarity and neatness.

Note that the *Tools* menu in the *Advanced* version of IHT includes a *Heat Exchanger* module that provides ε-NTU equations in formats suitable for either design or performance calculations.

This project provides a good learning experience on a subject that is very much in today's news. Unlike oil and coal, natural gas is not a globally traded commodity and its market price is not set by international supply and demand. To a large degree, natural gas is what economists would call a *stranded commodity*, with transport in many regions, including North America, limited to land-based pipelines. This restriction lowers prices in regions where production exceeds demand, as in North America, and raises them where the inverse is true. Today, the price of natural gas in the U.S. (about $3 per million BTUs) is about one-fifth the price in Europe and Asia. To level prices on a global scale, infrastructure must be developed to transport large amounts of gas across oceans, as done today for oil and coal. Regasification facilities are an important component of this infrastructure.

The student submitting the best project report will receive the Jerome L. Novotny Design Award in Heat Transfer, established in memory of a deceased AME faculty member. The award includes a plaque and $100 to be presented at the AME graduation ceremonies.