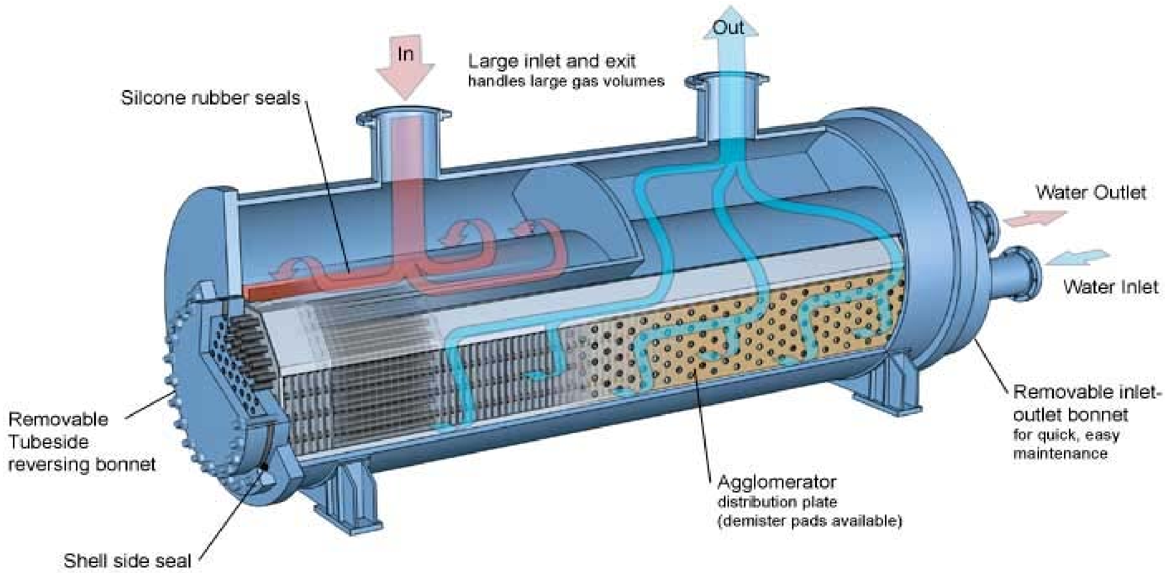
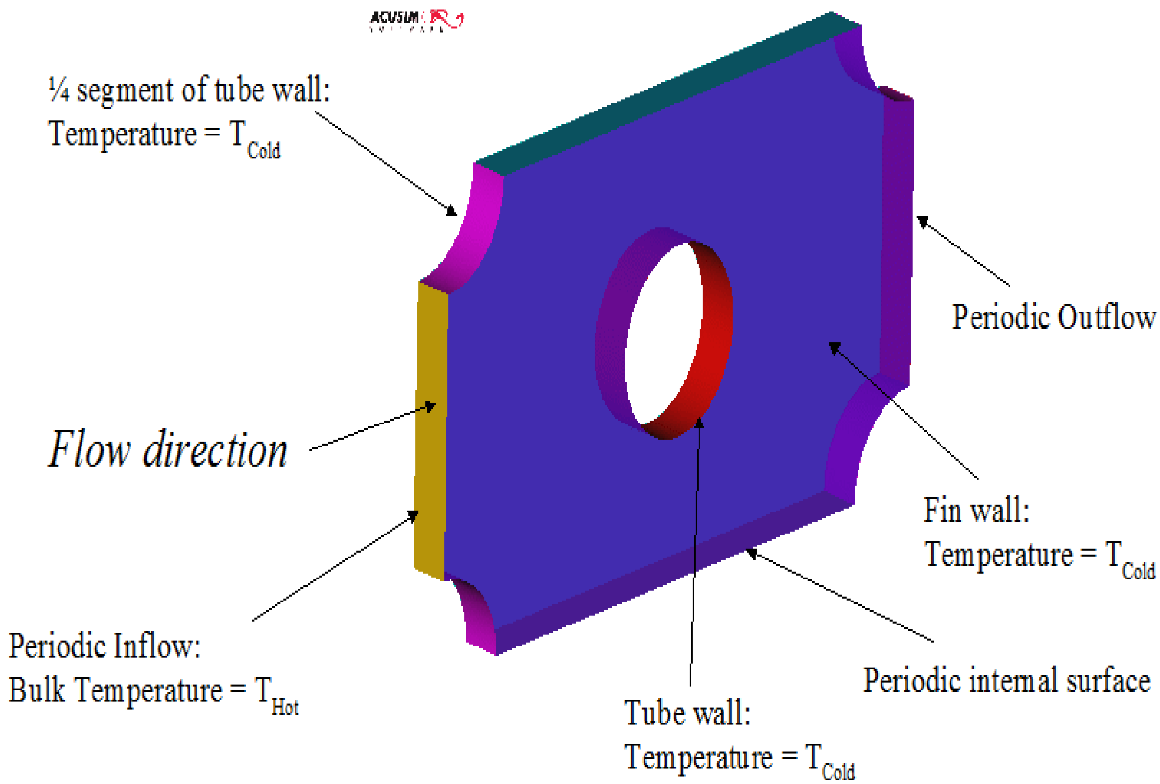
Tube Fin (Plain) Heat Exchanger

Tube fin heat exchangers are extensively used in many engineering devices. One such application is a shell and tube heat exchanger as shown in the figure below.



Cooling of large volumes of air and natural gas between and after compression stages is accomplished in shell and tube heat exchangers having fins external to the tubes. Such heat exchangers are quite large and expensive. The externally mounted fins are tightly spaced to enhance external thermal conductance as much as possible. With ever increasing commodity prices, the manufacturers of such heat exchangers are in constant pursuit to make the devices more compact. It is well established that reducing the size of tubes that flow cooling water and increasing the density of existing fins increase heat transfer efficiency of a given size heat exchanger. However, fins may be chosen that are not simply plain but instead are wavy or have some other features to increase the Nusselt number above that of tube and plain fin combination.

In order to quantify the performance, tests are required in a laboratory that are very expensive. Manufacturers have traditionally relied upon laboratory testing as CFD of the resulting problem is quite difficult. Flow and heat transfer phenomenon for such problems are essentially unsteady for flow rates that are typically encountered in large commercial inter and after coolers. ACUSIM Software Inc. and API Heat Transfer collaborated to demonstrate the viability of solving unsteady flow and heat transfer in staggered tube bundles with external fins. Following state of the art methodology to define a problem for efficient and accurate computations, two cases described in Kays and London have been solved for friction (f) and Colburn (j) factors using AcuSolve. The methodology relies on solving a doubly periodic flow and heat transfer problem in the smallest geometric module that repeats itself between baffles. The periodic domain and the boundary conditions are depicted in the figure below.



The figures below show the calculated f and j factors compared with the experimental data from Kays and London. These are log-log plots with Reynolds number based on the tube diameter plotted on the x-axis.

The established methodology can be easily applied to fins of different configurations like louvered fins, wavy fins etc. To visualize the animations associated with the simulations, please click the icons below.