FINNED TUBE HEAT EXCHANGER PRIMER

Second Law Of Thermodynamics – Heat moves only from a warm body (heat source) to a cold body (heat sink), never vise-versa, and it stops when both bodies reach the same temperature (equilibrium).

A finned tube heat exchanger ("coil") does not create heating or cooling but acts as a "conduit", allowing heat to be transferred away from a hot medium to be absorbed by a cold medium, while keeping both mediums from mixing together.

Heat Source ⟶ Conduit (Coil) ⟶ Heat Sink

First Law of Thermodynamics - Energy cannot be created or destroyed, only changed from one form to another.

This means the amount of heat absorbed by the heat sink has to be the same as that given up by the heat source (the amount of heat transferred has to balance). Following is an example of a dry air-to-water heat transfer:

(Hot Air)		(Coil)		(Chilled Water)
1.085 x SCFM x |EAT- LAT|	⟶	UAΔT	⟶	500 x GPM x |EWT – LWT|
= Q		= Q (BTU/Hr.)		= Q

Heat given up by heat source = Heat transferred through the conduit = Heat absorbed by heat sink

The <u>amount</u> of heat that can be transferred from the heat source to the heat sink over a period of <u>time</u> is dependent on:

1. The temperature difference between the hot medium to the cold medium (ΔT). This is the <u>driving force</u> that makes heat <u>want</u> to move from one place to another (See the "Second Law" above). The <u>wider</u> this temperature difference, the more heat (BTU's) that gets transferred in the same amount of time (Hour).

2. The mass flow rate of the fluids to provide a heat source and a heat sink, and their heat retention properties (C_p).

3. How efficient the thermal conduit (coil) is between the heat source and heat sink. This depends on;
   - How the fluid flow pattern is designed in a coil to <u>assist</u> (not create) in maximizing the temperature difference (ΔT) between the two fluids.
   - The thermal conductivity of the coil materials, how the coil tubes and fins are physically configured to enhance conductivity, the thermal properties of the fluids, and the velocity of the fluids going through the coil (U).
   - The amount of the coil's heat transfer surface area that is exposed to the fluids (A).

These factors have an interdependent effect on achieving one of the main design criteria - the least expensive coil.

- The smallest coil will be the least expensive by having less material and labor costs. To achieve this, <u>first</u> there has to be a temperature difference between the fluids, otherwise even the most thermal conductive coil will have no effect.

- To maximize the temperature difference between the fluids, operate at the MAXIMUM fluid flow rates that the system can provide to the coil. Also higher flow rates increases fluid velocity through the coil, improving the coil's efficiency.

- To take advantage of the increased fluid velocity, the coil is designed to the MAXIMUM pressure losses that the system can tolerate of the fluids going through the coil. This may include the use of enhancements to thermal sur-faces (raising the coil's efficiency), and pressure losses. By knowing the MAXIMUM allowed pressure losses, the coil can be made smaller (increasing fluid velocity and fluid pressure drop) until this maximum is reached.

- To further decrease the cost of the coil, the coil size needs to be kept short in the more expensive coil dimensional planes (fin height and rows deep) and made longer in the less expensive dimensional plane (finned length). This is done by knowing the MAXIMUM available space for the coil, the air flow direction (horizontal or vertical), and location of the piping connections in relation to the direction of air flow (coil hand). Air flow direction and coil hand also play a critical role in <u>assuring</u> that the maximum ΔT between the fluids is achieved in the coil design.

- Additional options to reduce the final coil cost:

  - Use better thermal conductive materials (copper and aluminum in lieu of carbon and stainless steel) whenever possible.
  - Eliminate unnecessary and excessive amounts of additives in the fluids (i.e. using 40% EG when 10% EG is acceptable) which degrade the fluid's thermal properties, requiring a larger coil to compensate.

Q=Heat Load SCFM =Std. Cu Ft / Min. EAT/LAT=Entering/Leaving Air Temp.^{o}F GPM=Gal/ Min. EWT/LWT=Entering/Leaving Water Temp. ^{o}F | |=Absolute Value
C_p=Specific Heat Btu/Lb - ^{o}F EG = Ethylene Glycol