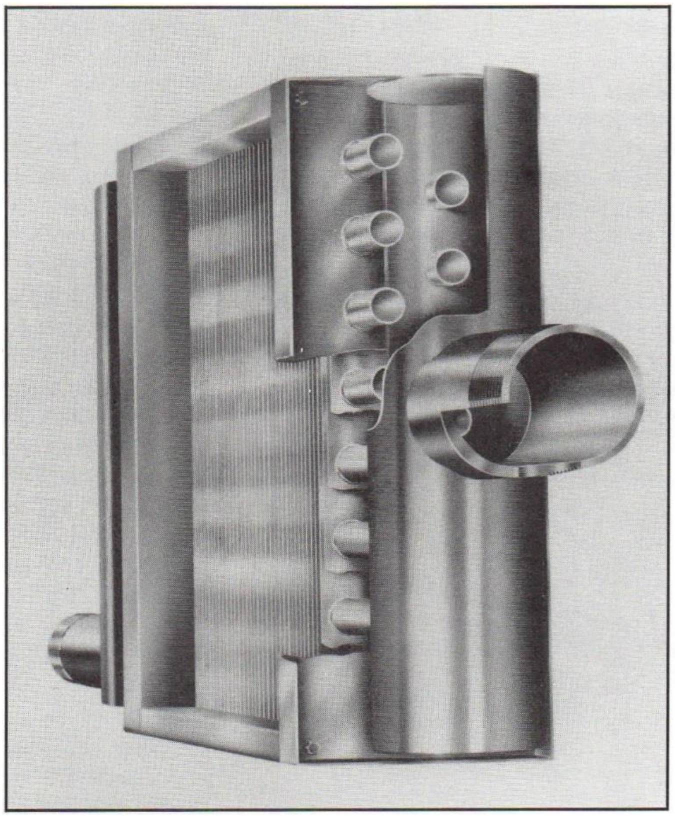
Tech Brief - Fin Designs



Tech Brief: Coil series

Fin Designs

Heat Transfer Products Group

The King Company

Tech Brief - Fin Designs

There are currently several fin designs available for the engineer, contractor, or end user to choose from. Which design is best? Unfortunately, there is no easy answer. Each design has its own merits and no single design is ideally suited to all applications.

In this tech brief we will try to identify the attributes of the various fin designs and point out limitations that should be considered. The selection of fin design is one of the most important criteria in coil construction. A poor choice could result in a loss of thermal performance or unmanageable maintenance problems due to air side fouling tendencies.

There are fundamentally 3 types of fin designs predominantly in use today; a spiral fin, an integral fin, and a plate fin. Within these groupings there are important variations that may have a significant impact on its application.

Figure 1:
Tension Edge Wound Fin

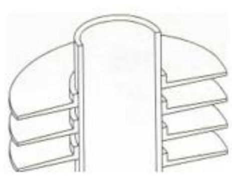


Figure 2:
Tension Wound "L.:' Foot Design

Figure 3:
Imbedded Fin Design

SPIRAL FIN COILS

Spiral fin coils are individually finned tubes which are assembled in a predetermined pattern to make up a coil. The basic method of manufacturing the finned tube is by wrapping a ribbon of fin material onto the tube. The wrappings can be spaced to accommodate a variety of fin spacings.

There are many variations of spiral fins. Some of the most common are listed below. In all cases, the differences in the fin designs are related to the method of attaching the fin to the tube. Tube diameters are normally .375, .625, .75, or 1.0". The thickness of fins range from .01O to .020". Fin OD's are usually 1.75 to 2.25 times the tube diameter.

Tension Edge Wound

This fin design depends on tightly wrapping the fin ribbon onto the tube to achieve its thermal efficiency (see Figure 1). Since the contact sur- face is only as thick as the fin, there is no margin of error either in terms of its manufacturing or applicational conditions (such as corrosion films between the fin and tube). In new condition, this fin design has a minimal contact pressure between the fin and tube. In fact, the fins can usually be moved easily on the tube. This is a low-cost fin design and is used primarily on light duty applications.

Tension Wound "L" Foot

This fin design is similar to the edge wound f in except that the base of the fin is formed into a collar where it contacts the tube (see Figure 2). This design increases the contact surface against the tube.

Tension Wound Double "L" Foot

This fin design is the same as the "L'' foot except that the foot of the fin is extended and overlaps the adjacent fin foot. The objective of this design is to provide more protection to the tube in corrosive conditions. There are significant limitations to this protection, however, since small cracks and crevices, which would occur with this fin de- sign, can lead to conditions which are actually more corrosive than exposed tube. Additionally, the tube ends (unfinned) would require some measure of protection.

Imbedded

This fin design (see Figure 3) is manufactured by wrapping the fin in a groove that has been pre- cut into the tube. Once the fin has been installed, the displaced metal from the tube is peened back against the fin.

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This fin design works very well in higher temperature applications using aluminum fins since the fins, due to increased rates of thermal expansion, can't expand away from the tube as it can with some other designs.

However, it also is important to recognize that the groove cut into the tube substantially reduces the effective tube wall. Consequently, with this design, a heavier tube wall needs to be specified. There is also some concern that the process of grooving the tubes may create stress risers which may initiate fatigue failures or stress corrosion in some applications.

Welded/Brazed

This fin design is manufactured by wrapping the fin onto the tube and then continuously brazing or welding it to the tube. This design offers an excellent fin/tube bond under virtually any temperature range. The construction requires, however, that the fin and tube are compatible from a weld/braze perspective. This construction is also quite expensive compared to other designs.

This process should not be confused with a solder coated fin. Soldered fins ·have a low operating temperature. Within those temperature limits, however, a good fin/tube bond is achieved.

INTEGRAL FIN COI LS

These are also individually finned tubes which are assembled together in a predetermined pat tern to make up a coil. However, unlike the spiral fin design where a ribbon of fin material is wrapped onto the tube, the fins on the integral finned tube are continuously extruded radially onto the tubes (see Figure 4).

This fin design provides an excellent fin/tube bond and works well with moderately high temperatures. The fin materials on the integral fin design are limited to aluminum or copper. Since the fins are extruded onto the tube, there are no "breaks" in the fin so the tube is totally isolated from the environment.

PLATE FIN COILS

Unlike the spiral or integral fin designs which are individually finned tubes, plate fin coils are constructed as a core.

A core is made up of a group of identical fins stacked together. Each fin is made with a series of collared holes arranged in a predetermined pattern. Tubes are pushed into the collared holes and then expanded to a dimension slightly larger than the inside dimension of the collared hole, creating an "interference fit" between the fin and tube. This fin bond works well over a wide range of conditions. Temperature limitations depend on the fin material.

Tube diameters are normally .375 through 1.125" in diameter. Fin thickness usually is .006 through .025" thick. Tubes can be arranged in an inline or staggered pattern (see Figure 5). Tubes are frequently spaced 2.25 to 2.5 times the tube diameter apart.

Flat Plate Fins

This design usually offers the lowest air pressure drop of the common fin designs. It also is the easiest to clean and is the least likely to foul with airborne particulate (see Figure 6)

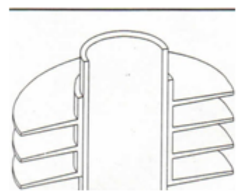


Figure 4:
Integral Fin Coll Design

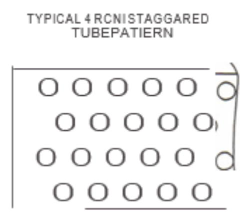
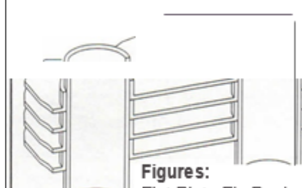
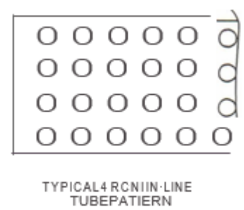


Figure 5: (above & below)
Plate Fin Coll Patterns



Figures:
Flat Plate Fin Design



OPERATING TEMPERATURE LIMITS OF VARIOUS FIN DESIGNS

FIN STYLE	Max. Operating Temp.			
	Alum Fins	Copper Fins	C. Steel Fins	S. Steel Fins
Tension Edge Wound	300°F 149°C	300°F 149°C	300°F 149°C	300°F 149°C
Tension Wound ("L" Foot)	350°F 177°C	350°F 177°C	400°F 204°C	400°F 204°C
Spiral Wound-Imbedded	600°F 316°C	600°F 316°C	800°F 427°C	800°F 427°C
Spiral Wound-Brazed	NA	NA	800°F 427°C	800°F 427°C
Extruded	500°F 204°C	500°F 204°C	NA	NA
Flat Plate	400°F 204°C	400°F 204°C	800°F 427°C	800°F 427°C
Corrugated Plate	400°F 204°C	400°F 204°C	NA	NA

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Corrugated Fins

These are plate fins that have corrugations added to improve their thermal efficiency Consequently, fewer rows are required to achieve the same capacity as found in similar spiral, integral, or flat plate fins.

However, the corrugations also increase the air side resistance which increases the fan horse- power required to move air through it. Also, the corrugations tend to "catch" airborne particulate and make the coils very difficult to clean. Corrugated fins are usually light gauge and only avail- able in aluminum or copper.

FIN SELECTION

OTHER CONSIDERATIONS

Resistance To Fouling

Aside from maximizing the space between the f ins, which is advantageous in any dirty environment, fin design is the next most critical consideration in minimizing fouling. This is particularly true in applications that involve fibrous airborne particulate which has the ability to "bridge" fins.

In applications where fouling is a concern, plate fins may offer a significant advantage. The reason for this is obvious if an existing coil that has been fouled is examined, in which case it would be noted that most of the particulate clings to the leading fin edge. With a flat plate fin design, most of the particulate that gets past the leading fin edge will pass through the coil (see Figure 7).

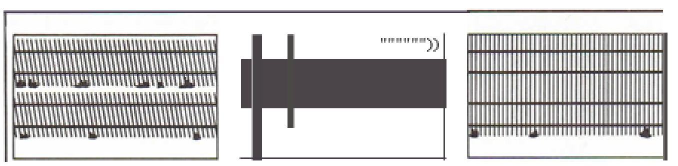

Figure 7:
These three illustrations demonstrate how and where airborne particulate tends to accumulate on spiral wound, corrugated and flat plate fin types.

On spiral or integral fins, the particulate that gets past the leading edges of the finned tube can get c aught in each successive row. With a corrugated plate fin, the particulate will become lodged in the core.

Cleanability

The cleanability of a coil depends, in large part, on how rigid the fins are. The fins must be sufficiently rigid to withstand the force of spray systems. Rigidity is primarily dependent on the fin material, its temper, and the thickness.

However, rigidity is only one factor. Cleanability also depends on how easily particulate can be washed through the coil. The ability to wash particulate through a coil, is greatly influenced by the fin design itself.

A flat plate fin, for example, allows particulate to be washed through the coil much easier than spiral or corrugated plate fins.

FREE TECHNICAL SERIES

This is just one in an ongoing series of techni- cal reports which deal with standard and spe- cialty industrial coils published by the King Company.

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And of course, if our engineers can be of any other technical assistance, please don't hesi- tate to call.

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