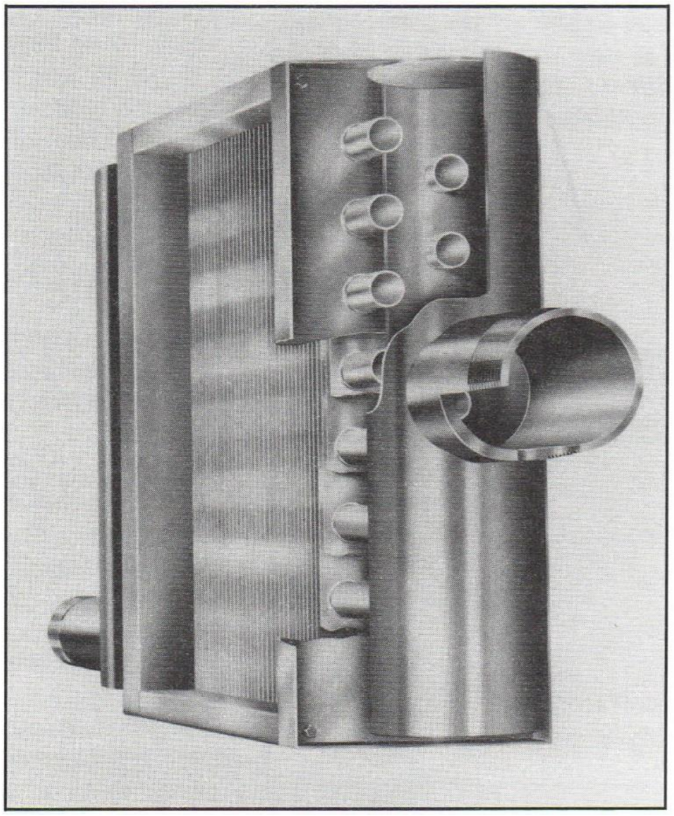

Tech Brief: Coils Series

Temperature/Pressure considerations

Heat Transfer Products Group
The King Company

Tech Brief -Temperature/Pressure Considerations

The operating temperature, either by the fluid flowing thru the tubes or the gas flowing over the fins, is a critical consideration in coil design. Failure to adequately ad- dress the impact of temperature may cause premature coil failure or personnel injury Therefore, it is very important that both the direct and indirect effect of temperature extremes are considered in the coil design.

Table 1: Temperature Limits Of Various Metals	
Copper	400°F.
90/10 Cupro Nickel	600°F.
Red Brass	4500F.
Aluminum	4000F.
Steel	800°F.
304L or 316L SS	800°F.
304 SS or 316 SS	1500°F.
Tube joints brazed with BCuP alloys	300°F.
Tube joints brazed with BAg alloys	4000F.

Table 2: Pressure Ratings of Various Metals

Tube Material	*Min. Tube Wall*	*Header Material*	*Joint Const.*	*Max. Steam Pressure*
Copper	.049"	.083" MIN. Wall Copper	BCuP	50 PSIG
Copper	.049"	Schedule 40 Steel	BAg	200 PSIG
90/10	.035"	Schedule 40 Steel	BAg	230 PSIG
Steel	.049"	Schedule 40 Steel	Welded	250 PSIG
Steel	.109"	Schedule 80 Steel	Welded	400 PSIG
Stainless Steel	.035"	Schedule 40 SS	Welded	250 PSIG
Stainless Steel	.083	Schedule 40 SS	Welded	400 PSIG

MATERIAL SELECTION

The operating temperature is the first consideration in making a material selection for a coil application. Essentially, if a material is suitable for the temperature requirements of the application, the coil can be de- signed to accommodate virtually any pressure requirement. Of course, the practicality and cost of various materials will also have considerable impact on material selection.

The temperature limits that are applied to various materials are based on metallurgical considerations that affect primarily stress values. Although the temperature limits in Table 1 are somewhat subjective, they should be useful in most applications for tube and fin materials.

STEAM COILS

With steam coils, the steam temperature is the highest temperature the coil is exposed to. Therefore, ratings are based on steam temperatures. Because the steam temperature is dictated by the steam pressure (at saturated steam conditions), most manufacturers use steam pressure to rate coils because it is more convenient. Caution must be exercised, however, when super-heated steam is used. Under those circumstances it is then possible to have steam temperatures that exceed maximum recommendations for the metals being considered.

Table 2 shows recommended steam pressures for some coil constructions manufactured by The King Company. The table considers the temperature considerations noted above, as well as some practical considerations, such as mechanical stresses imposed by the system, cost and obtaining reasonable coil life.

CIRCULATING FLUID COILS

Circulating fluid coils are usually subjected to the warmest temperatures via the fluid circulating thru the tubes in various heating applications. Usually the heating medium is water.

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at 212° F. or less. Pressurized water systems and systems using various heat transfer flu- ids can utilize fluid temperatures up to 400°F. or more. Table 3 shows general recommended temperature/pressure limits for various circulating fluid coils manufactured by The King Company.

Aside from the tube side media, the gas (usually air) passing over the fins also needs to be considered in coil applications. A flue gas heat recover coil, for example, is often ex- posed to temperatures well into the range that would cause many coil designs to fail prematurely. In applications like this, where the gas side media is the extreme temperature, it is advisable to base the tube material selection on the gas temperature and not on the fact that the tube temperature will be much cooler because the fluid circulating thru it is cooler. Sooner or later the fluid flow will be cut off for maintenance of equipment failure and the coil tubing will be subjected to whatever the gas temperature is. The fin temperature should not exceed that shown on Table 1.

TUBE TO HEADER JOINTS

It is noteworthy that in the case of copper tube coils, the temperature limits are imposed more times than not by one of the two general types of braze alloys in use today. The BCuP group of braze alloys generally have between 0% and 6% silver, 6% to 8% phosphorus and the balance copper. This group of braze alloys are the simplest and least expensive to use but have a maximum, recommended temperature limit of 300° F. based on ASME codes.

On the other hand, the BAg group of alloys have a significantly increased silver content, as well as some zinc, copper and depending on the specific alloy, other trace elements. These alloys can tolerate temperatures to 400° F. and are commonly used to braze coils with steel or stainless-steel headers to cop- per or copper alloy tubes. Because of their higher temperature resistance and better ductility, the BAg alloys are recommended for most heavy duty and some process coil applications.

Table 3: Circulating Fluids Pressure/Temperature Limits - PSIG

		Tube Material											
		Copper	**Copper**	**Copper**	**Admiralty Brass**	**90/10 Cupro Nickel**	**90/10 Cupro Nickel**	**Aluminum 1100**	**Steel**	**Steel**	**304L SS**	**304L SS**	**316L SS**
Minimum Tube Wall		.020"	.049"	.049"	.049"	.035"	.035"	.049"	.049"	.109"	.035"	.OBJ"	.035"
Header Material		Type L Copper	Type L Copper	Sch40 Steel	90/10 Cupro Nickel	90/10 Cupro Nickel	90/10 Cupro Nickel	Sco40 Aluminum Pipe	Sch40 Steel	Sch40 Steel Pipe	Sch40 304L SS	Sch40 304L SS	Sch40 316L SS
Joint Construction		BCuP	BCuP	BAg	BAg	BAg	Welded	Welded	Welded	Welded	Welded	Welded	Welded
en ::::::1 u en a: Q.. w en ::!!: a: I– ::::l en ::::l w — Q.. a:	JQQOf.	150	150	250	250	250	250	250	250	400	250	400	250
		50	120	250	250	250	250	200	250	400	250	400	250
	350°F.	—	—	200	250	250	250	150	250	400	250	400	250
	400°F.	—	—	200	230	230	250	50	250	400	250	400	250
	500°F.	—	—	—	—	—	150	—	250	400	250	400	250
	600°F.	—	—	—	—	—	50	—	200	300	250	400	250
	800°F.	—	—	—	—	—	—	—	150	200	250	400	250
	1000°F.	—	—	—	—	—	—	—	—	—	250	300	250
	1200°F.	—	—	—	—	—	—	—	—	—	200	200	200
	1500°f.	—	—	—	—	—	—	—	—	—	100	100	100

* Above 800°F, the "L" grade designation is not applicable.

** -30°F to 250°F

Note: Higher pressures are available with special test procedures for some material combinations.

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Welded joints (as opposed to brazed joints) are the most desirable joint construction and are normally suitable for the same temperatures as the materials being joined. Welded joints are commonly available on steel tube, stainless steel tube, aluminum tube and cu-pro nickel tube coils.

INCREASED STRESSES

Higher temperatures also have an indirect impact on coil systems. Since coils and piping systems are fabricated at ambient conditions, provisions must be made when actual temperatures encountered in the operation of the coil substantially exceed ambient temperature. Steam coils or high temperature water coils above 150°F. for example need to be piped in such a manner as to allow for the thermal expansion of the piping to the coil and the coil itself. The use of swing joints or flexible couplings are the most common means of providing relief for the expansion and contraction in the piping system. Otherwise damaging stresses may be applied to the tube/header or header/connection joint on the coil causing premature failure of the system. The same is also true for low temperature systems (below 20°F.).

INCREASED CORROSION RATES

The effect of temperature on corrosion rates is also an important concern when temperatures begin to approach or exceed 120°F. Tests have indicated, for example, that corrosion rates of steel can double for every 60°F. temperature increase in environments containing Co2 and O2. At higher temperatures most forms of corrosion increase significantly. Some corrosion mechanisms, like stress corrosion cracking, are only possible at temperatures above 120°F. Unfortunately, the specific impact of temperature from a corrosion standpoint is virtually impossible to predict with any degree of accuracy.

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