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Air Cooled Condenser Coil Leaks

Some years ago it was common for air-cooled condensers to develop leaks, resulting in unpredictable shorter service life. By studying the causes of the problem, it's possible to come up with solutions. As we studied the problem it became obvious that vibration was the major culprit, and thermal expansion/contraction creates some specific problems where the hot gas first enters the coil. To discuss this, we'll look first at leaks at the tube sheets caused by vibration – by far the major culprit – them leaks at the discharge header, a result of either vibration or thermal expansion/contraction or both.

Vibration Caused Leaks at Intermediate Tube Sheets

The most frequently reported leaks have been at the intermediate tube sheets. While all leaks are problems, these are particularly troublesome since they are almost impossible to repair. As you'll see in the specific examples discussed later, these are all caused by vibration! If they were caused by thermal expansion/contraction they would appear in the top row since that's where the greatest changes in temperature occur (the hot discharge gases enter the coil here and the majority of all heat loss, or exchange, occurs in the top row). However, almost totally, leaks are reported in the bottom row of tubes where the temperature is the most stable. Let's look at the two types of leaks in more detail.

1. The most common type of leak occurs on the bottom of the tube where it passes through the tube sheet. These do not occur when the tube is expanded to a tight fit but when there is a clearance between the expanded tube and its matching through-hole in the tube sheet. Studies show that it does not matter whether the tube sheet is steel or aluminum, or the holds formed with collars, clean punched or even fitted with bushings. With vertical vibration, the tubes "bounce" on the tube sheet holes and start to work harder at the point of contact. When the vibration is strong enough and lasts long enough, stress cracks develop and become leaks. But there is very little wearing on the tubes. These most often happen on the bottom row of a coil. This bottom row carries the greatest weight (the refrigerant is now liquid). This bottom row is also where the flexing of the corrugated fins allows the tubes to make greatest contact with the tube sheet during bouncing. These failures happen at the intermediate tube sheets since these carry twice the weight of end sheets.

Condenser Coils -Did You Know?

Did you know?

USA Coil & Air has replaced condenser coils in a myriad of systems in the United States and abroad. Most times just the unit model number and manufacturer is all that is needed. We have never had a performance issue with our alternative condenser coils vs. going back to the OEM.

Did You know ?

Many manufacturers do not exist anymore and replacement condenser coils then becomes a seek and find mission by the owner and installer. You have a one stop shop with USA Coil & Air. Simply, if you need a condenser coil then USA can fabricate for you.

Did You know?

USA Coil & Air has professional field personnel that can evaluate systematic conditions that may be affecting performance or coil longevity and then also measure coils so they fit perfectly in your existing unit.

(Continued)

2. A second cause of leaks is due to flexing of the coil bundle when vibration is present. The possibility of this happening is magnified by having fewer rows of tubes and/or a wide span between supports. Engineering figures show that a 25% reduction in rows (4 rows to 3 rows) results in about a 60% increase in flexing. Similarly, a 15% increase in span (from 48 to 55 inches for example) results in about a 50% increase in flexing. This type of leak shows up as a fatigue crack across the top of the tube at the support point and can eventually result in the tube totally breaking off at the tube sheet.

Leaks in the Discharge Header

There are generally three causes of leaks in the area of the discharge header: (1) thermal expansion/contraction of the tubes in contact with the tube sheet, (2) the discharge header itself expands/contracts bending the tubes and creating fatigue, and (3) improper support of field piping amplifies vibration.

- 1. Leaks can occur if the tube sheet makes contact with the tubes that are attached to the discharge header. Thermal expansion/contraction of the tubes causes wear. Most manufactures have solved this problem by having clearance holes in the tube sheet at these locations (essentially the top row).
- 2. Leaks can be caused by the thermal expansion/contraction of the discharge header itself. Because the expansion coefficient is linear, a long header expands more than a short header. The outermost tubes connected to the header will therefore bend the most. Headers over 4 feet long can cause fatiguing of the outermost tubes. In actual application field manifolding should be configured so that some of the expansion/contraction can be absorbed at the manifolds.
- 3. Leaks also result from improper support of field piping connected to either the discharge or liquid headers. Piping with multiple bends very quickly amplifies compressor pulsations or any other vibrations. The resulting stress is concentrated at the core tubes that tie into the header, right at the point where these tubes pass into the core bundle. Small circuits with only 1, 2 or 3 tubes into the header are particularly susceptible to leaks from this cause.

Causes of Vibration

As you can see, most leaks result from vibration. There are many sources of vibration, most out of the control of the condenser manufacturer. Examples include:

- 1. Over-the road shipping vibration
- 2. Compressor pulsation
- 3. Motor bearing failure
- 4. Bent, broken or dirty fan blade
- 5. Dirty condenser

- 6. 6. Broken motor mounts
- 7. Loose bolts
- 8. Fan cycling
- 9. Blocked or frozen dampers

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Did you Know ?

We fabricate condenser coils in our standard 4 to 5 weeks year-round and then also offer our 5 and 10 working day shipment program. We can also build coils in 2 or 3 working days as well as expedite coatings for environmental condition.

Did you know ?

Call USA engineering anytime to discuss problems you are having with condenser coils and systems. We can many times pinpoint the problem and offer simple solutions. We have found many manufacturer's original chiller or condenser designs that can in itself cause premature failures of condenser coils. We have also found original installations that also have caused problems with condenser coils.

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Designing the Replacement Coil

There is one specific design criteria that must be reviewed on almost every change-out with propeller type condensers. Prop. fans are low resistance type fans and have usually been selected (along with motor) very close to the condenser CFM vs. pressure design. It is therefore imperative that the new coil have the same resistance as the old one.

The following are potential solutions to some of the problems that have already been reviewed.

- 1. Reduce fins per inch from 12 or 16 to 8 or 10 FPI. You will probably have to increase the rows. Overall cleanability will be much better and coil air pressure drop will be stabilized over a much longer period of time.
- 2. Construct condenser coil(s) with slightly oversized holes in tube sheets and tube supports so that coil tubes can float within casing. This will alleviate most of the problems related to tube sheet piercing holes in tubes. Installer/Engineer can also isolate condenser coil from structures by putting a flexible connection on the connections and also by putting heavier duty vibration isolators under compressor.
- 3. Use copper fins and stainless steel casings for bad, salt laden atmospheres, especially when fins per inch can't be reduced below 12 fins per inch. Stainless steel casing prevents corrosion where casing (tube sheet) and tubes meet. Use USA Coil & Air coating on condenser coils that can be reduced to 10 fins per inch or less. This coating is a baked-on type and must be dipped. Spray-on types are absolutely inadequate since the coating must reach in between fins and tubes. Copper fins with stainless steel casing are twice as expensive as an aluminum fin coil when comparing coils at 12 fins per inch or more. It also almost totally eliminates corrosion from salt laden atmospheres. Coating may only increase price 35 to 50%, but won't last as long as the more expensive copper fin/stainless steel casing additions. If properly applied, it should more than double the life.
- 4. Heavier Fin Material When Corrosive Agents May Be Present. The heavier fin material allows high pressure cleaning without destroying fins. Get rid of the by-products/ corrosive agent off the surface of the coil as quickly as possible.
- 5. Phosphorous Free Brazing Material Should be used for those types of systems that have the joints being attacked. USA can recommend brazing material(s) if corrosive agent can be identified.
- 6. Industrial By-Product Corrosion is a problem that must be dealt with based on what is attacking the coil. Chlorine is different from sulfur, etc. Use of cupro-nickel or stainless steel is a possibility in a new coil design but some type of coating must be based on an existing system since special materials normally cause more rows and fins per inch and therefore more resistance. Refer to USA Coil & Air catalogs for information on corrosion resistance of different materials and coatings.

USA Coil & Air is the largest and oldest replacement coil company in our industry. Over the years, we have developed other great lines of HVAC equipment to include direct drive and belt drive fan coil units, central station units with emphasis on the replacement market and also replacement chillers, water cooled condensers and tube bundles as well.

Every one of our lines is specific to the quick shipment and requirements of the replacement market. You will find that we make this process simple and easy. We have stocking and expedited schedules for all of our equipment and know how to deal with existing facilities and the problems related to shipment and delivery. We also pride ourselves with great application engineering so that you don't replace equipment without having a true understanding of why the original might have failed and what can be provided in replacement to increase longevity.

Many of you may already be USA Coil & Air customers and we thank you for your current and past business. If you are not a customer yet, we hope you will be in the very near future. We believe that this newsletter will give you keen insight into our equipment, typical applications and will answer service questions as well. We hope you enjoy.



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Tom Jacobs - President USA Coil & Air, Inc.

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Thank you for allowing us to share with you. We'd be happy to answer any questions you may have from the services we offer to general product info.

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