Leak Detection "Ins" and "Outs"

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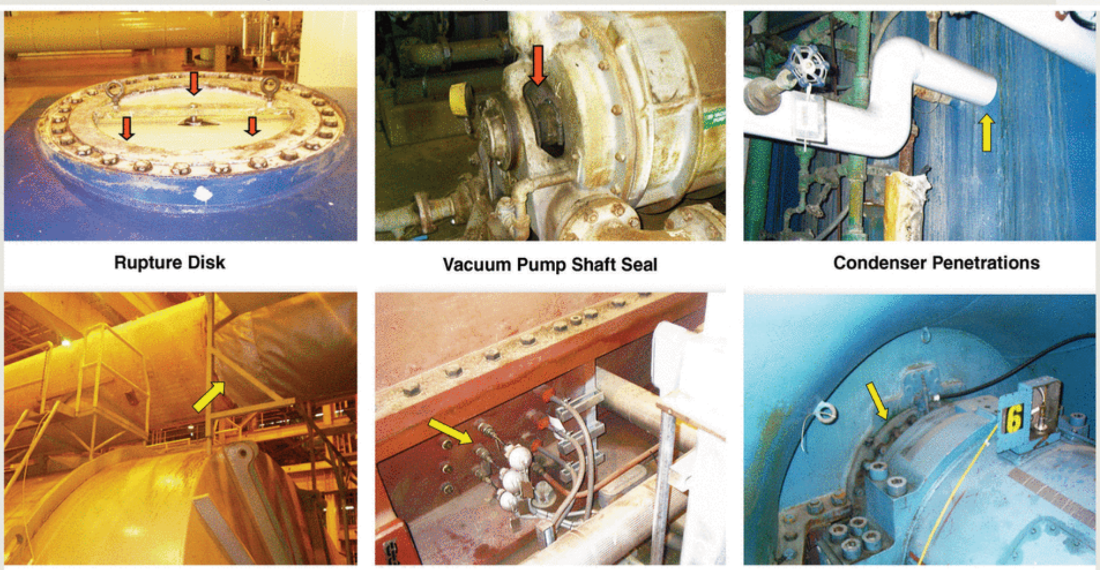
When considering the damaging and costly effects resulting from condenser air inleakage and water leakage, we must also consider methods to avoid these conditions and maintain condenser reliability. Effective cleaning and testing strategies will maximize megawatt output while minimizing condenser-related outages during normal operating cycles. Properly performed, your results can be quantified, permitting an accurate calculation of return-on-investment.

To achieve maximum condenser performance, we must consider the combined efforts of cleaning, leak detection and testing. Many plants have an established cleaning regimen, usually annually, as well as an eddy current testing regimen that could take place up to every few years, depending on the age and condition of the condenser. However, many of the leak detection programs occur on an as-needed basis. By combining proactive cleaning, leak detection and eddy current testing, the result will be improved total performance of your condenser and condenser components.

Condensers are designed with air removal systems to handle a certain amount of air inleakage and keep the unit running at peak efficiency. Whenever you have a leak that exceeds the capability of the air removal system, the efficiency of the condenser is adversely affected. An increased plant heat rate will certainly give you an indication that there is a problem that could be traced to a leak. You might also experience a need for more frequent maintenance of equipment that could lead to increased risk to turbine components. Also, high levels of dissolved O_2 in the feedwater will cause increased corrosion and deterioration of your boiler and feed systems.

All plants need to test for leaks, but the test can be either reactive or proactive. When it's reactive, the condenser is telling you when to test. Emergency inspections are performed as a result of catastrophic failure or because inleakage has exceeded the capability of your air removal system. Waiting for an emergency situation can be very costly and result in damage to ancillary equipment. With proactive testing,

Technician Checking For Air In-Leakage Around Valves 1



Rupture Disk | Vacuum Pump Shaft Seal | Condenser Penetrations

Crossover Bellows | Test Probe Penetrations | LP Turbine Shaft Seal

Photo courtesy: Conco

routine inspection is scheduled to let you understand where potential failures will occur. By doing this before a scheduled outage, components in need of repair can be scheduled for those repairs. After undergoing an outage is also a good time to schedule testing to make sure all repairs were made successfully.

One of the indicators of air inleakage is climbing condenser backpressure. While other factors, such as fouled condenser tubes, can contribute to increased backpressure, an air inleakage inspection should be the first option since it can be performed online and at minimal cost. Your systems engineer or maintenance personnel should be able, based on past condenser performance, to tell you whether a fouled tube or air inleakage scenario is most likely the culprit. An increased level of dissolved 0_2 is another indicator and should be routinely monitored, as should any change in water chemistry, especially an increased use of phosphates.

Because there are many sources of air inleakage, it is important to have an experienced crew come in to do the inspection, to keep their time on site, and therefore costs, at a minimum. Air inleakage can be related to the shell, rupture discs, shaft seals, man ways, vacuum pumps, flanges, and one or more of the many bolt holes in your equipment. Let's not forget test probe penetrations, as well. With today's technology, there are more sensors tapped into the system than ever before. Any time there is a penetration of a test probe, there is the potential for a leak.

There are also many sources of water leakage, such as water box flanges, leaking hot well components, through-wall penetrations and tube-to-tubesheet joints. Faulty tube plugs are another source. There may be temporary plugs that have been left in too long and loosened up over time, or permanent plugs that were put in incorrectly and are permitting leakage. Last but not least, the condenser tubes themselves. Fouling may have resulted in corrosion that is now causing tube failure. An experienced crew will be able to test quickly and accurately to determine the cause, or causes, of water leakage.

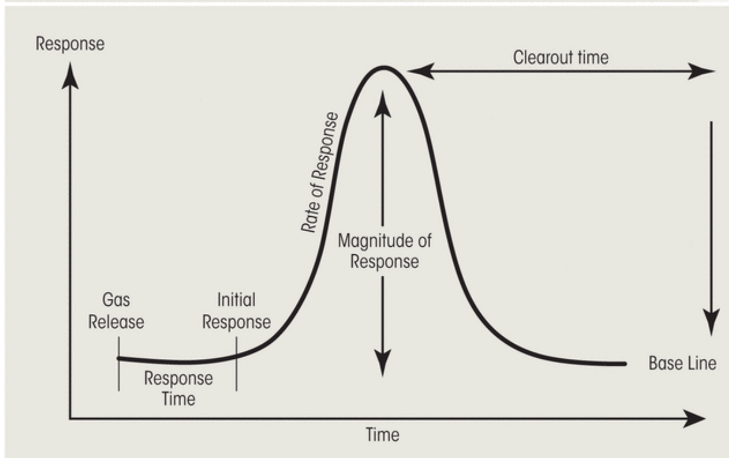
Some of the old methods of leak detection that are still used today, especially in under-the-gun circumstances include smoke, shaving cream, plastic wrap, and dependency on sight and sound. However, these methods are often inaccurate and certainly not easy to replicate. What we have come to rely on today are tracer gases, helium and sulfur hexafluoride (SF_6). Choosing the most appropriate tracer gas for your site-specific conditions is important. While some contractors may only have experience with one type of gas, it is important to choose a contractor that has extensive experience since the less ideal tracer will cost you time and money.

When it comes to air inleakage, it is important to determine the total amount of that leakage and whether it has happened over a length of time or perhaps it is a sudden increase. If you have the appropriate sensor on your system, it will provide you with the answer that you can pass on to your contractor. It would be helpful for your contractor to know the characteristics of a specific leakage, such as location below the water line or association with a tube or a bellows. Dissolved oxygen occurs below the water line and that would be a clue to your contractor's crew as to where the leakage exists and where they need to concentrate their efforts to resolve the situation.

With water leakage, the condenser tubes themselves may be leaking, so online injections may be needed. You may have two or more boxes in your system, so it is important to determine which box on which to concentrate. An on-line injection will give you that information. Once inside the box, a tubesheet inspection using helium is performed. One technician at the condenser with another at the analyzer will pinpoint the leaking tube. Again, we look at the leak characteristics, determining whether it is a large or small leak, whether in the tube, or perhaps a tube-to-tubesheet leak.

The helium mass spectrometer was developed during World War II to find extremely small leaks in the gas diffusion process in the Manhattan Project. Later, it was found to be effective in many other applications, including finding leaks in power plants. Helium is quick, reliable, non-toxic and non-hazardous. Very sensitive, detection range is in parts-per-million, so only a few puffs are needed to

Chart Recording of a Typical Leak Response



determine where the leak is. Helium is plentiful enough to have a supply always on hand. It is suitable for detecting up to 90% of leaks with an experienced crew.

Sulfur Hexafluoride (SF_6) was used as recently as 1976 as an airborne tracer gas to track plume migration and the Electric Power Research Institute (EPRI) explored its use as a tracer in power plant leak detection. SF_6 is inert, odorless and incombustible. Very sensitive, it has a detection range measured in parts-per-billion, making it suitable for small or hard to locate leaks. Non-reactive to H_2O, it is the ideal gas to inject below the water line to identify which bundle is the problem. It is important to use a contractor who is familiar with the use of both helium and SF_6, can analyze the problem and work with you to determine which gas should be used and how much is needed in your particular case. In most cases, helium will be suitable, but in those 10 percent of instances when SF_6 is required, it is always preferable to have an experienced crew who knows how to and how much to use. Comparing the two systems, they are very similar. A mass spectrometer is for helium and a Fluorotracer™ analyzer is for SF_6, while the air monitor, desiccant dryer and strip chart recorder are basically the same for both. The difference is in the analyzer itself and the experienced technicians who know how to use it.

At the point where you know you have a leak, you understand some of the leak's characteristics and have determined an area you want to inspect, there is something you must provide the contractor. That is some amount of power. A minimum of 15% turbine power is required for successful leak detection. It is the steam that drives the gas down through the system. Without this steam, the gas will just float in pockets and may never reach the leak, especially if it is downstream. Also with steam, you get fewer false reads and much quicker response time. Without steam flow, the tracer gas background will continue to rise, making isolation of the leak virtually impossible.

When it comes to the crew's equipment, the strip chart recorder is essential. There is a technician out in the field, either in the tube sheet box, or going around the plant, releasing puffs of tracer gas in suspect areas to determine where the air inleakage is. There is also a technician back at the analyzer and the strip chart recorder that will tell him when the field technician has located a leak. They are in constant contact. The rate of response may be very gradual, telling them they are close to the leak, but not quite there. The time between the gas release and the initial response has been already told to the field technician, who will move along the system to determine exactly where the leak is. As he moves closer to the leak, the rate of response increases and the strip chart recorder tells when the field technician is right at the leak. There is now a dedicated report that gives you and the technician the ability to see where the leak is and whether it is occurring, for example, at a valve's packing or the valve itself, or some other area.

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Condenser tube leak detection is a little different. There is the same technician in the field at the condenser and the technician watching the strip chart, but when you get into the condenser itself, after identifying the proper bundle, plenums are used. Plenums range in size from one by two feet down to four by four inches. A "gun" is used, once the problem has been narrowed down to a single tube. Starting at one section of the tubesheet, say the upper left corner, a shot of helium is sent down the tubes. Once there is a "hit," smaller and small plenums are used as the problem area is narrowed down. The crew has now determined which specific tubes are leaking. If no tubes are indicating leaks at this point, it is pretty certain that the problem is actually tube-to-tubesheet and the situation can be properly addressed.

The properties of SF_6 tracer gas allows it to be injected online into water boxes under full load to determine the leaking bundle. While a Fluorotracer™ analyzer is sampling the off-gas, a SF_6 cylinder is connected to an injection point below the waterline. Gas is then injected into circulating water. Using SF_6, leaks as small as 1 gallon-per-day can be identified.

When summarizing leak detection technology, it's important to understand that air inleakage and water leakage continue to cost the power generators hundreds of thousands to millions of dollars each year from lost megawatts, to emergency repair costs, to wear and tear on equipment if you get 0_2 into your system. Realize, too, that condenser tube leaks cause more than 6,000 forced outages annually and rank as one of the highest concerns among plant chemists. In addition to reactive leak detection, a proactive regimen of testing will keep total air inleakage in check and ROI for leak detection maintenance dollars spent is usually in the 1,000%+ range. While this discourse on leak detection has been limited to water-cooled systems, an experienced contractor will also be able to handle leakage problems in air-cooled condensers as well. The important message here is to get into a routine of proactive testing and not let emergencies control your action. pe