Solution Note

Honeywell

On-Line Water Chemistry Measurements for Power Plants

Conductivity, pH, Dissolved Oxygen, Measurement Applications

Background

At the heart of every efficient power plant is a good water treatment program. Proper treatment is essential to provide continuous high purity water to preboiler, boiler, steam and condensate systems, as well as nuclear reactor systems utilizing boiling-water reactors (BWR) and pressurized water reactors (PWR). The quality of makeup and feedwater must be monitored continuously to detect upsets, leaks, and carryover, as well as to study gradual trends for prevention of corrosive or scaling conditions. The use of inadequate measuring systems can lead to these conditions, resulting in increased or unplanned maintenance, increased capital equipment expenditures, reduced efficiency of heat transfer surfaces and lost profits caused by downtime. As technology increases the efficiency of a plant, the acceptable limits on water characteristics become tighter, and thus the requirements on measurements become more stringent to assure that the water quality lies in an acceptable operating range.

Improving operating efficiency and maximizing component life has always been critical, but never so much as today. Nearly half of forced power plant shutdowns today can be attributed to impurities and other cycle chemistry problems. With each shutdown costing a plant millions of dollars and competition between utilities increasing continually, ignoring the proper measurements in a water treatment program is not an option. An increased understanding and improved management of these measurements and their applications is one of the most significant methods of improving the water quality in a plant. This in turn will guarantee increased profits, efficient operation, long-term integrity of the materials of construction and improved plant performance.

Basic measurement parameters such as conductivity, pH, dissolved oxygen, and sodium ion are the backbone of any water treatment program.

It is obvious that continuously maintaining and improving these critical measurements should be of utmost importance in the effort to improve system life, plant integrity, and overall efficiency. However, many of the applications where these basic measurements are made as well as the measurements themselves are often misunderstood and neglected. These individual applications include the makeup water, condensate water, feedwater, blowdown, steam, cooling tower water and effluent water.

Measurements

One of the initial difficulties in making pure water measurements such as conductivity, pH and dissolved oxygen is preserving the integrity of the sample. This is especially difficult in power plants, where different sample points vary widely in their respective pressure, temperatures, and flows. Because of its low ionic content, pure water will quickly dissolve traces of contaminants from sample lines, flow chambers, containers and even the atmosphere. It is necessary to rinse new or unused sample lines a surprisingly long period of time before a representative sample can be obtained.

A constant threat of contamination comes from the atmosphere which contains oxygen, O_2, as well as carbon dioxide, CO_2. Oxygen from the air which leaks into the system can cause a perceived high dissolved oxygen reading. Carbon dioxide ionizes in the water to form a weak solution of carbonic acid. Carbon dioxide can cause errors in both pH and conductivity readings. For this reason, all pure water measurements should be made on closed, flowing samples which are free of leaks.

The flow rate of steam and boiler samples should be high enough so that any iron oxide particles or deionizer resins do not become caught in sample lines or flow chambers. The exchange of ionic species with accumulated particles in the sample lines or the electrode flow chamber can cause errors which are often very difficult to troubleshoot. This problem can be minimized by utilizing low volume flow chambers and small sample line diameters which enhance flow velocity.

Conductivity / Resistivity / TDS

Conductivity is the ability of a water sample to carry electrical current. In water, current is carried only by ionic materials - typically mineral contaminants which dissolve into positive and negative ions. Conductivity measurements remain the first line of defense in determining upsets, unacceptable contamination and other corrosive and depositing conditions which may exist. The high reliability, sensitivity and relatively low cost of conductivity instrumentation makes it the primary parameter of any good monitoring program. Many applications are measured in units of resistivity, the inverse of conductivity. Other applications require the measurement of total dissolved solids (TDS), which is related to conductivity by a factor dependent upon the level and type of impurities.

In power plant water applications, conductivity measures contaminants consisting mostly of mineral salts, although carbon dioxide from the air, organic acids from treatment amine decomposition, and other acids or bases are not uncommon. Conductivity is a non-specific measurement in that it responds to the concentration of any conductive material dissolved in the water. It cannot distinguish between materials present, whether they are treatment chemicals or contaminants. However, two types of conductivity measurements - specific and cation - can be made in order to obtain a more accurate determination of the level of contaminants vs. chemicals in a plant.

Specific Conductivity

Direct conductivity measurement of a water or condensed steam sample includes response to treatment chemicals such as ammonia or amines, corrosive mineral contaminants and carbon dioxide. By itself, this specific conductivity cannot distinguish among them because all of the ions will contribute to the overall conductivity of a sample. However, under normal operating conditions, treatment chemicals have the highest ionic concentration and dominate the response. Specific conductivity is therefore used along with pH as a reliable indicator of treatment chemical levels.

Cation Conductivity

Specific conductivity can detect only large amounts of corrosive contaminants, since the conductivity of the treatment chemicals serves to mask out lower levels typically present. To improve sensitivity to these corrosive contaminants, a water sample is passed through a cation exchanger, where two mechanisms are used to increase sensitivity to contaminants.

In the first mechanism, the cation exchanger retains ammonia and amines on the cation resin in the cartridge, effectively removing their large background contribution to conductivity. The second mechanism consists of mineral salts being retained in the exchanger and replaced by acid which actually boosts the conductivity, increasing measurement sensitivity. The overall effect of the cation exchanger is thus to reduce the chemical contribution to conductivity and amplify the contaminant conductivity. Because of this, cation conductivity continues to be the most useful measurement for corrosive contaminant detection.

pH

pH is the measurement of the free acidity or alkalinity of a solution; in this case, the solution is water. The measurement of pH is critical to prevent corrosion processes from occurring. The second leading cause of boiler failure can be attributed to corrosion. However, pH measurement in high purity water can be extremely difficult. Pure water has a high resistance and a high vulnerability to contamination, and often possesses extremely high temperatures in the steam/ water cycle, so pH is often a very challenging measurement which can easily be measured improperly.

It has been argued that pH should not be measured in pure water since a conductivity measurement is simpler and assures high purity. If water treatment systems always produced pure water there would be no need for pH measurement, but treatment systems are never perfect. Conductivity cannot distinguish among contaminants, and therefore pH can be used in conjunction with conductivity to distinguish between contaminants which may lend more to a more acidic or basic pH level. pH has thus proven to be a very useful measurement in diagnosing system problems, such as a condensate leak in the condenser. The level of pH- adjusting ammonia or amine also requires pH measurement in addition to conductivity measurement to assure proper contamination detection.

Dissolved Oxygen (D.O.)

The measure of the amount of dissolved oxygen gas in the water is used to monitor performance of de-aerators, control chemical injection and to detect air leakage into vulnerable parts of the feedwater and condensate system. Oxygen corrosion and the associated corrosion products represent a great expense to power plant water components.

Oxygen pitting is often seen in economizers during operation, while superheaters and reheaters are especially susceptible during standby conditions. All carbon steel components in a system are vulnerable to this type of attack. Copper alloy corrosion in condensate and feedwater systems is a function of oxygen. Oxygen can cause corrosion fatigue of boiler tubes as well as turbine disks and blades.

Totally eliminating oxygen from the water is virtually impossible. Potential sources of oxygen ingress include leaking turbine/condenser expansion joints, low pressure heater flanges and connections, turbine explosion diaphragms, leaking pipe joints, etc. Because the oxygen will always find a way into the system, the oxygen level is constantly monitored and controlled. This is typically done by means of a mechanical de-aerator and/or chemical reaction. Regardless of the type of treatment used, the dissolved oxygen level is always controlled to the parts-per-billion range. Continuous measurement of dissolved oxygen at several points is critical to the long term reliability of critical components, especially the boiler.

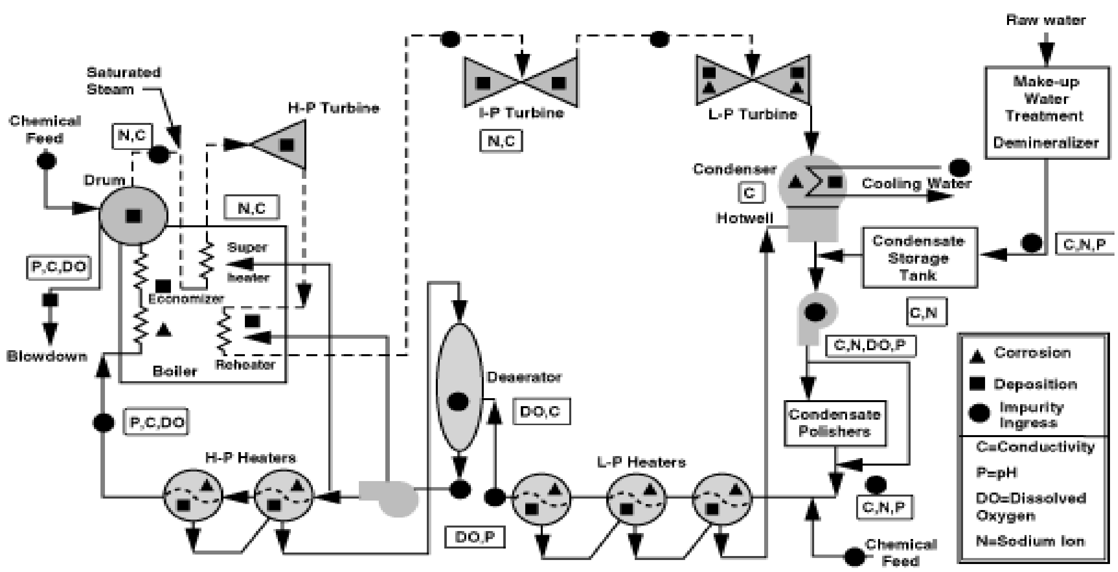

figure 1

Power Plant Applications

In any power plant, there are numerous components that are part of the water treatment system. There are also a wide variety of treatments that are performed on the water from the point it enters the plant (makeup water) to the point it exits (effluent water). Each plant has its own components and treatments based upon the specific requirements of that plant as well as the water that is available to use.

It is a rare occurrence to find two plants exactly alike, since they each can differ in power output, boiler or steam generator type, metallurgy, fuel type, and water supply characteristics. Regardless of whether a plant is fossil-fuel based or nuclear-based, the applications that are most common from plant to plant are the makeup water, condensate water, feedwater, blowdown, steam, cooling tower water and effluent water. Figure 1 is a diagram of a typical fossil-fuel power plant. Figures 2 and 3 are diagrams of typical nuclear-reactor power plants.

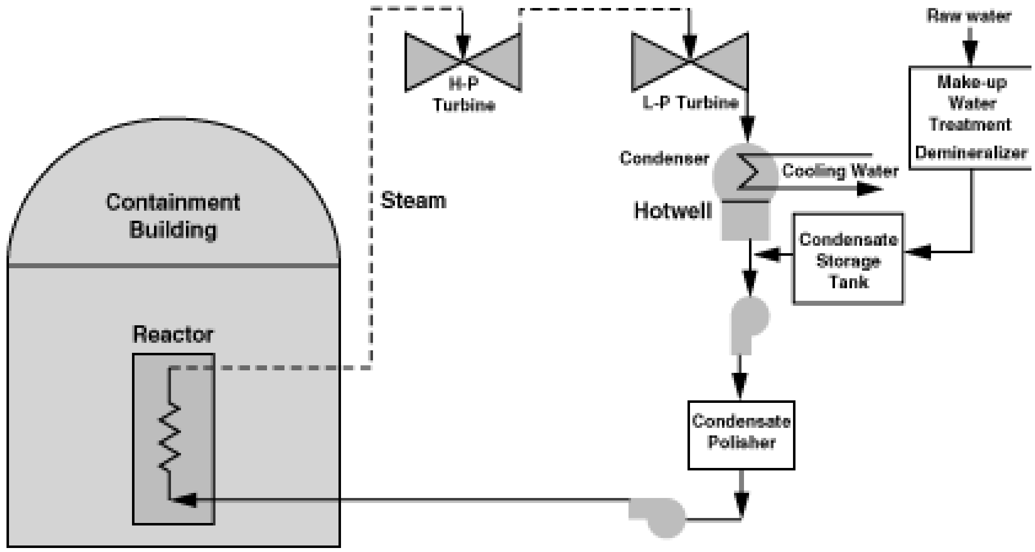

figure 2

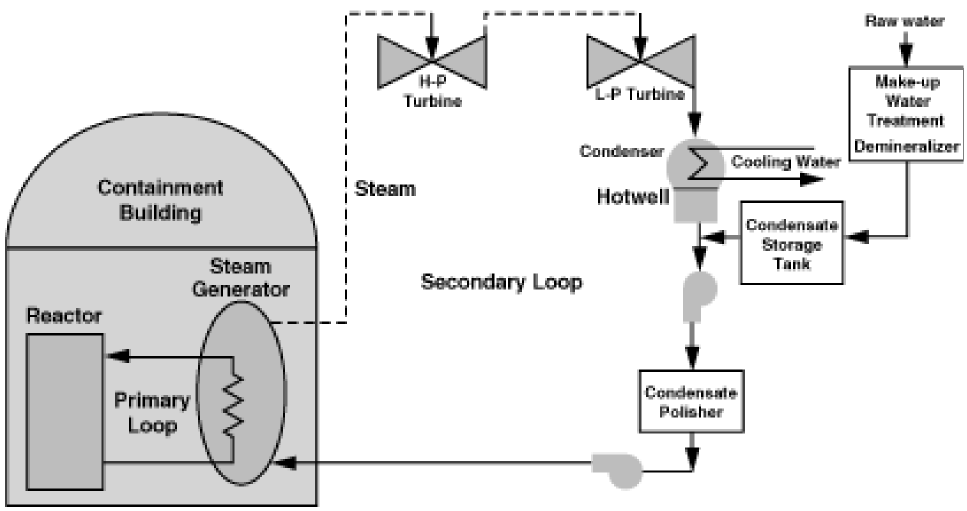

figure 3

Makeup Water

Since there is a constant loss of cycle water for one reason or another, it is always necessary to have a continual source of incoming water. Treating this water is the beginning of the power plant's cycle chemistry. Makeup treatment almost always consists of demineralization to remove dissolved impurities. Other pretreatment equipment consists of softeners, clarifiers, and filters.

On an increasing basis, membrane technology is being used along with ion exchangers for effective demineralization treatment. The overall goal of the demineralization treatment is to yield high purity water for use in the overall feedwater/condensate cycle. Figure 4 illustrates a typical makeup water system.

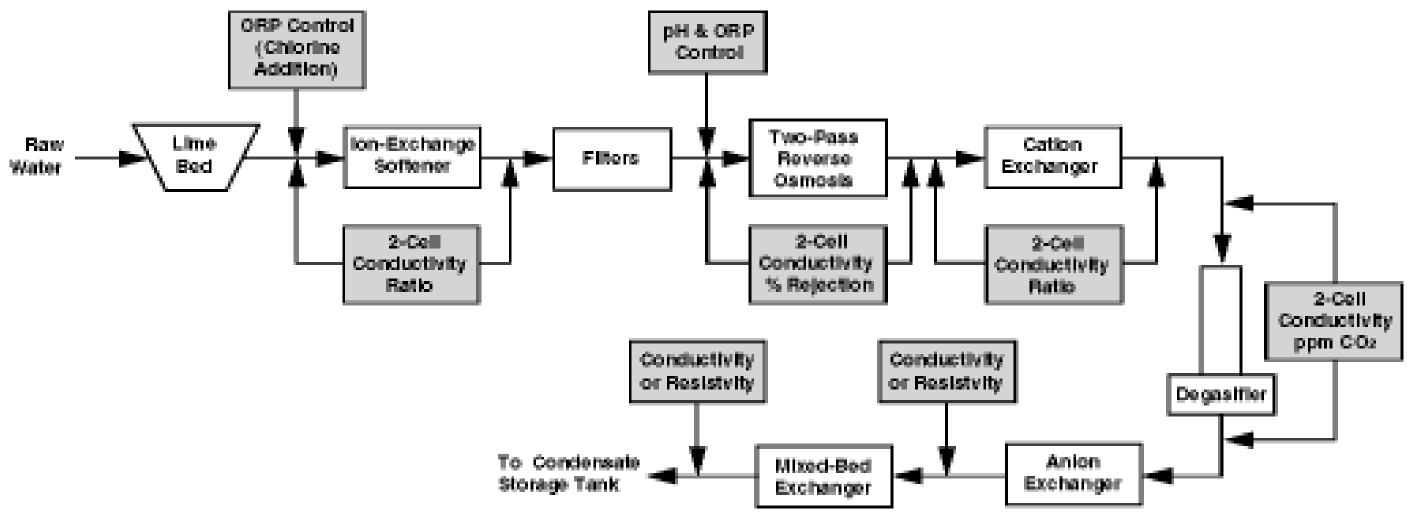

figure 4

Ion exchange treatment will typically involve the use of at least a cation exchanger followed by an anion exchanger. Often times a mixed bed exchanger will follow these, with a vacuum degasifier somewhere in the series. Membrane treatment, either of the reverse osmosis (RO) or electrodialysis (ED) type, is a technique frequently utilized to yield a more efficient demineralizer system. This treatment is often upstream of the ion exchangers to reduce the dissolved solids, thus cutting back the load on the ion exchangers.

Makeup water is usually not directly added to the system; rather, it is stored in the makeup water storage tank, where enough water is available to plant operations for a short period of time if the need should arise. This water is continually monitored to ensure integrity and may be reprocessed through the demineralizers if necessary.

Condensate Water

The condensate portion of the cycle includes the condenser, hotwell, and the condensate polishers. The condenser is cooled by water from the cooling towers in order to condense the steam into water, where it collects in the hotwell. Makeup water is also typically added to the hotwell or condensate storage tank. The mixture of makeup water and condensate is then transferred by a condensate pump to the condensate polisher system for further treatment.

Although the makeup water should be high purity water, the condensate may often contain some water hardness, corrosion products, and impurities, usually resulting from a condenser leak.

The polishing treatment is necessary to prevent these corrosive products and impurities from building up in the cycle and causing problems in the boiler (fossil fuel plants), steam generator (nuclear reactor plants) or turbine.

A polishing treatment system is made up of combinations of filtration and ion exchange, although some nuclear reactor treatments use membrane technology. The filtration system must be adequate to effectively remove insoluble corrosion products. The ion exchange is necessary for removal of dissolved solids, although it can serve as a filter as well. Mixed-resin de-mineralizers are typically used. The system used is dependent upon the water requirements and characteristics.

After water exits the condensate polishers, it is usually delivered to high and low pressure heaters, as well as a mechanical de-aerator. These components increase the temperature substantially and lower the dissolved oxygen to acceptable levels. The water is now called feedwater.

Feedwater

The purpose of feedwater treatment in a power plant is to deliver a minimum level of contaminants and corrosion products to the boiler or nuclear reactor. It is considered to be the most important part of cycle chemistry. The cycle chemistry control of feedwater can vary extensively depending upon the type of boiler or reactor, operating pressure, and water characteristics at a plant.

The boiler's purpose is to convert water into steam. Most power plant boilers, regardless of operating pressure, are catagorized as either once-through or drum-type units. The type of boiler greatly affects the cycle chemistry control. A drum-type boiler has a drum where the water-steam mixture is separated. Since the majority of contaminants are retained in the water, they are removed from the cycle by blowdown. Condensate polishers are not usually used in plants where drum-type boilers are used, although the polishers are beneficial and should be used for optimal cycle chemistry.

Once-through boilers do not have a separating drum, so the steam/water mixture continues out of the boiler directly to a superheater. This allows impurities to affect components downstream of the boiler. Once-through boilers will thus have more stringent cycle chemistry control and will almost always utilize a condensate polisher.

Three separate types of feedwater treatment are typically used, primarily depending upon whether the boiler is a drum-type or a once-through unit, and secondly upon the existing metallurgy. If a drum-type boiler is used, either phosphate or all-volatile treatment is used. In once-through units, all-volatile treatment is utilized. However, a new type of oxygenated treatment is also being employed in both types of boiler units.

In plants where a drum type boiler is present, a coordinated phosphate/pH treatment is often utilized. This treatment is used to precipitate the hardness constituents of water and provide alkaline pH control, which will reduce boiler corrosion. This type of program maintains the sodium-to- phosphate molar ratio within a narrow range of about 2.1 to 2.9. This ratio must be maintained within this established control range to prevent formation of phosphoric acid (ratio below 2.1) or free sodium hydroxide (ratio above 2.9). The pH typically ranges anywhere from 8.4 to 10.6 depending upon the pressure of the boiler. Phosphate treatment offers excellent buffering protection against potentially corrosive contaminants.

The objective of All Volatile Treatment (AVT) is to provide a high pH, high purity, low oxygen environment to minimize the corrosion of metal surfaces. The usual materials of construction in a fossil plant drum or once-through boiler are carbon or low-alloy steel. In high temperature boiler systems (greater than 400o F), a protective metal oxide layer of magnetite (Fe_3O_4) forms on steel surfaces to prevent corrosion.

However, cooler temperature, steel surfaces in the steam/water loop (primarily those in the condensate/feedwater cycle), remain active and vulnerable to corrosion. The AVT objective is accomplished by adding ammonia or morpholine to elevate the pH level to somewhere between 8.8 to 9.6, depending upon the metallurgy. Mechanical de-aerators and an oxygen scavenger such as hydrazine or sodium sulfite are used to lower the dissolved oxygen level to less than 7 ppb.

While elevated pH is the basis of AVT, a new trend in corrosion prevention known as Oxygenated Treatment (OT) uses oxygenated ultrapure water to minimize corrosion in the feedwater train. In plants using OT, oxygen is added to the system to form a protective oxidized layer of hematite (Fe_2O_3) on low temperature steam/water loop surfaces. With OT for once-through units, an oxygen level of 30-150 ppb is monitored across the whole plant cycle. The use of oxygen as a corrosion inhibitor allows satisfactory operation over a large pH range; therefore, a reduction in plant cycle pH down to a level of 8 to 8.5 (once-through boilers), or 9 to 9.5 (drum boilers), is possible. It must be noted that in order to use OT, the system must have all-ferrous metallurgy downstream of the condenser.

In pressurized water reactors (PWR), there are two separate loops, a primary and a secondary. The primary loop water is circulated through the reactor itself to become heated. The heat from the primary loop is then transferred to the secondary loop, which transforms this secondary feedwater into steam. This place where the heat transfer takes place in the PWR is known as the steam generator, and the water chemistry is very similar to that of a drum type boiler. The other type of nuclear reactor, a boiling-water reactor (BWR), has just one loop and the feedwater is converted to steam by contacting the reactor.

Blowdown

When steam is driven off the boiler drum, the chemicals and impurities in the water are left behind. The concentration of solids (scale-forming salts) will increase with every gallon of makeup water, and sludge buildup in the drum will reduce transfer of heat through the drum wall. Also, accumulated concentration of solids increase the danger of carryover into the steam lines. Solid material in the steam can damage steam driven equipment. To prevent (or at least minimize) the concentration of solids in the drum from building up as the steam is driven off, a small amount of water is continuously removed. This is called blowdown. A similar type of blowdown is done in nuclear reactor plants as well.

Since blowdown is typically inadequate, it is usually accompanied by addition of chemicals to control precipitation or condition sludge. Blowdown is wasteful since heated water is being effectively removed from the cycle; therefore, it is important to properly control the cycle chemistry such that blowdown is minimized. Current guidelines allow for operation with a minimum of 1% (100 cycles) of blowdown.

Steam

The ultimate purpose of maintaining a good water chemistry program is to ensure that highest quality steam is produced on a continual basis. Regardless of whether a plant produces steam based on a boiler or a nuclear reactor steam generator, the steam purity is essential. Steam purity for a given system is dependent upon the intended use for the steam. Considerations such as the type of boiler or reactor as well as the type of turbine greatly affect the limits on purity, as do component type and initial water purity.

Once the steam passes from the boiler or steam generator, it usually passes into a superheater where it is heated above the temperature at which it was produced in the boiler. This helps to improve the thermal range of the steam cycle and reduce downstream condensation. The superheated steam is then passed through the first turbine. The steam exiting this high pressure turbine is then usually sent back to a reheat superheater, where the steam is reheated to be sent to lower pressure turbine stages. Usually these lower stages will consist of a single low pressure turbine or a combination of an intermediate turbine followed by a low pressure turbine. After the final stage, the steam enters the condenser, where it changes back to water.

Cooling Towers

In order to provide cooling water for the heat exchangers present in the condenser, sample lines, and other parts of a power plant, a properly maintained cooling tower must be present. Cooling tower cycle chemistry is often misunderstood and thus neglected, although it remains a critical part of a plant's efficiency. Even though the water from the cooling towers is usually completely separate from that in the boiler cycle, proper cycle chemistry is just as vitally important to prevent scaling, corrosion, and microbiological fouling so that heat exchange is as efficient as possible.

Cycle chemistry in a cooling tower is always determined by the makeup water available and the materials of construction.

Each cooling tower will add a variety of chemicals on a continual basis to ensure that heat exchange is kept at a maximum level. In almost all cooling towers, blowdown is done on a cyclical basis. A good cycle chemistry treatment will minimize blowdown and makeup water intake.

Effluent water

Any water that cannot be reused is some part of the plant, typically from the blowdown from the boiler and the cooling tower, will be discharged. Environmental standards must be met for all water released from a plant. Typically the dissolved oxygen must be raised to the partsper-million (ppm) level and the pH must be neutralized to levels somewhere between 6 to 9 pH.

Many plants are being designed for zero discharge. This means that no water will be discharged. The water, whether from boiler or cooling tower blowdown, will in some way be recirculated, usually to the makeup water treatment system for the boiler cycle or occasionally for the cooling tower. If zero discharge is the goal, this recirculated water will also typically be monitored on a continual basis to determine water characteristics.

Application Sampling Points and Measurements

Makeup Water - Conductivity is almost always monitored continuously, as well as pH and ORP, depending upon the components in the makeup treatment system.

- Cation conductivity is measured in the makeup water storage tank to ensure water integrity. Typically this water is at a minimum of 1 megohm-cm of resistivity (1 micromho/cm conductivity), with usual limits being 5 to 10 megohms-cm resistivity.
- ORP may be monitored if some form of chlorination / de-chlorination exists, whether as a monitor of incoming water or as a controlled parameter to protect some types of reverse osmosis or de-ionization resins.
- Specific and cation conductivity is typically measured in various places to determine efficiency of ion exchangers, softeners, and reverse osmosis systems.
- pH or conductivity may be measured as part of the ion exchange regeneration cycle.

Condensate Water - pH, conductivity, and dissolved oxygen are normally measured.

- Specific and cation conductivity are typically continuously monitored at the inlet and outlet to the condensate polisher. These measurements are done to check the total dissolved solids level as well the process efficiency, water purity, and need for regeneration.
- Dissolved oxygen is monitored continuously at the inlet and outlet of the condensate polisher to detect air leaks.
- pH may be monitored continuously or periodically at the inlet and outlet of the condensate polisher to monitor for process leaks and to ensure that a scale-forming pH level does not occur.
- Specific and cation conductivity will be continuously monitored after the condensate pump discharge to determine overall water quality.
- Specific and cation conductivity are continuously measured at the de-aerator inlet to monitor water purity. Conductivity is also usually measured at the inlet and/or outlet of the high and low pressure heaters.
- Dissolved oxygen is measured at the inlet and outlet of the de-aerator to monitor the de-aerator efficiency. It is also typically measured at the inlets and/or outlets of the high and low pressure heaters to detect air leaks.
- Conductivity is typically measured in condenser leak detection trays and/or hotwell zones to ensure that a condenser tube leak is detected significantly earlier than the condensate pump discharge.

Feedwater - Conductivity, pH, sodium ion and dissolved oxygen are measured on a continuous basis to ensure that requirements for water entering the boiler are met. Some of these measurements are also done for feedwater to a boiling-water-reactor (BWR) or pressurized water reactor (PWR).

- Dissolved oxygen is measured in the final feedwater to ensure that no process leaks have occurred, as well as for feedforward control of any oxygen scavenger that may be used to lower the oxygen level further.
- pH is measured in the final feedwater to control the pH level in the boiler, preventing a scaling or corrosive condition.
- Specific and cation conductivity, and occasionally sodium, are continuously measured in the final feedwater to guarantee that the water meets the purity standards required for the boiler cycle.

Blowdown - Conductivity is measured to monitor the periodic or continuous blowdown in the boiler or cooling tower.

- Specific conductivity determines the cycle of concentration, used to determine the need for blowdown.
- pH is often measured to ensure that a scaling or corrosive condition does not exist.
- Dissolved oxygen is often measured in blowdown water to detect corrosive oxygen levels.

Steam - Steam sampling, whether saturated or superheated, is difficult and therefore is often not done by many plants. However, obtaining information about steam purity is useful to detect contamination in steam lines.

- Cation conductivity is often continuously measured in superheated, saturated, cold reheat, and hot reheat steam.
- Sodium ion is continuously monitored in saturated steam to ensure that excess carryover is not occurring.

Cooling Tower Water - pH, conductivity and ORP are normally measured in cooling tower water treatment systems to minimize scale, corrosion and biological growth.

- pH, typically controlled by sulfuric acid addition, should be monitored to control scaling or corrosive conditions.
- ORP will be used to monitor the optimum amount of oxidizing biocides, such as chlorine, bromine, or ozone, which are added to cooling tower water to control microbiological fouling. ORP may also be used to alert personnel of process leaks in the cooling tower heat exchangers.
- Conductivity is used to determine cooling tower blowdown.

Effluent Water - pH and dissolved oxygen should be measured on a continuous basis to ensure that environmental requirements are met.

- Dissolved oxygen is measured to guarantee that oxygen levels in water meet environmental regulations. This may occasionally require some sort of aeration, which may use the dissolved oxygen measurement for control.
- pH should be measured to ensure that levels in the water are safe for discharge. This may require neutralization, so the pH measurement is also used for control of reagent addition.

Honeywell's Analytical Solutions

pH Measurement - UDA2182 and HPW7000

The 7082 pH/ORP Analyzer/Controller offers a wide variety of advanced features in a reliable instrument. The monoplanar front panel incorporates a user-friendly display with specific word messages and offers a clearly labeled keypad with tactile feedback. A solution temperature compensation feature compensates for pH changes in the boiler water, referenced to 25° C. A variety of electrodes and mountings are available, including two types specifically for high purity water measurements.

Features

- Large digital display showing pH, ORP, or temperature
- Specific electrodes and mountings for difficult high purity water measurements
- Up to four alarm relays
- Up to three 4-20 mA outputs
- Unattended, automatic electrode cleaning and calibration
- Controls one or two reagents through current adjusting, pulse frequency, or duration adjusting proportional outputs

Benefits

- Ideal for high purity water measurements where component life and corrosion is dependent upon measurement accuracy
- Temperature compensation for electrode and solution changes

Conductivity / Resistivity / TDS Measurement - UDA2182

Using industry-accepted algorithms, the 7082 analyzer accurately compensates for conductivity changes with temperature, making it ideal for a wide variety of boiler water applications. The superior electronic design ensures reliable signals from the cells over the full display range, allowing separation of cell and analyzer by as much as 1,000 feet without reduction of accuracy. A wide variety of conductivity cells with cell constants specified for individual processes allow reliable, continuous measurements.

Features

- High purity water temperature compensation for neutral salts, cation / acid, ammonia, or morpholine
- Steam purity measurements
- Large digital display showing conductivity/resistivity, temperature, total dissolved solids (TDS), or calculated variables (% passage, % rejection, ratio, difference)
- One or two cell input
- Multiple outputs for transmitting up to three measured or calculated variables
- Up to four relays available
- Withstand pressures up to 250 psig and temperatures up to 285 ° F (140° C)
- Cells specifically designed for boiler processes to ensure maximum accuracy
- Rugged cell body available with various materials of construction, including stainless steel and polyethersulfone (PES), titanium and high density graphite

Benefits

- Temperature compensation specific to high purity water applications for improved accuracy
- Rugged materials of construction, reducing cell costs
- Flexible mounting assemblies, reducing installation costs
- Computing needs are streamlined with automatic computations for improved process results

Dissolved Oxygen Measurement - UDA2182

Honeywell's 7020 series analyzer is unique in both technology and operation. The system combines a patented equilibrium probe - unaffected by inert fouling or changes in flow conditions - with a menu-driven analyzer/controller. Note that Honeywell's equilibrium probe should not be used in BWR water where dissolved hydrogen may be present.

Features

- Unique equilibrium probe technology with no internal maintenance and no flow dependence
- Temperature and pressure compensation
- Extensive probe and analyzer diagnostics, including data storage of dates and times of alarms and diagnostics
- Isolated outputs, alarm relay contacts, and PID control all standard
- Automatic air calibration/cleaning

Benefits

- Heavy-duty membrane - eliminates replacement requirements
- Reduced maintenance costs
- Accurate, reliable dissolved oxygen readings despite fouling and changes in flow rates
- Reduced costs for oxygen scavenger chemicals

More Information
For more information on On-Line Water Chemistry Measurements, visit www.honeywellprocess.com, or contact your Honeywell account manager.

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