Unique technology helps geothermal power plant reduce hydrogen sulfide emissions by 98+%.

NALCO Water
An Ecolab Company

CASE STUDY – POWER
CH-1889

BACKGROUND

Geothermal power plants use heated geothermal fluid (aka brine) from wells thousands of feet deep as their heat source to generate electricity. If the brine has enough enthalpy, it can be flashed off to create steam, which is used to drive a turbine and spin a generator.

This brine fluid in many areas of the world can contain significant levels of hydrogen sulfide, or H_2S (from 20 ppm up to 60 ppm), which is liberated into the steam during the flashing process. The steam is then condensed back to water and about half the H_2S is re-solubilized. The remaining H_2S is removed from the condenser via the air removal section along with other non-condensable gases (NCGs). This condensate from the condenser is then used as make-up water to the cooling tower. The NCGs are normally routed to bio-reactors or fluidized bed reactors to remove the H_2S prior to releasing them directly to the atmosphere.

SITUATION

Hydrogen sulfide exists as a gas and as a compound dissolved in water. As the concentration of the hydrogen sulfide increases in the water, the water reaches saturation and any additional hydrogen sulfide will be emitted as gas. Hydrogen sulfide as a gas is poisonous at elevated concentrations and must be abated to acceptable limits to protect the health of plant workers and surrounding communities.

In the past, the NCGs and H_2S gases were released either directly to the atmosphere or volatilized and stripped from the cooling water as it passed over the cooling tower fill. This release of H_2S gases became an issue for some geothermal power plants from both a worker safety/exposure and an environmental emissions perspective. In 1977, the state of California APCD (Air Pollution Control District) established limits on H_2S emissions from geothermal plants like the Hudson Ranch Power 1, a 49.9 MW power

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Customer Impact	Economic Results
H_2S emissions reduced by about 262 tons/year	$100,000/year in net total cost of operation (TCO)

AIR

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generation facility in Calipatria, CA. These limits were modified in 1999 and again in 2004. The current limit Hudson Ranch is required to meet is 3.8 lb/hr, which translates to a removal rate of the H_2S of at least 90% - 95%.

Normally to achieve this limit the plant would have to install an additional cell on their cooling tower known as an "oxidizer box" to treat the condensate prior to entering the cooling water and install "bio-reactor" to treat the NCGs. Since these treatments were capital intensive, known to be maintenance intensive and unreliable, Hudson Ranch sought a different solution to meeting their H_2S limit.

SOLUTION

Based on a prior relationship with Nalco Water at another area geothermal plant, the Technical Manager at Hudson Ranch asked the local Nalco Water field engineer for options of how best to mitigate the H_2S emissions for the plant's cooling towers in a cost-effective manner. After considering potential solutions and running a pilot plant study, the team devised a unique method of oxidizing the H_2S to sulfate (SO_4), which is highly soluble in cooling water, virtually eliminating H_2S gas emissions. The method, which is patent pending, uses a combination of oxidants, hydrogen peroxide and Nalco Water TowerBrom technology along with specific equipment to oxidize the H_2S gases to sulfur and then to sulfate.

The team determined that the second step of driving the reaction from sulfur to sulfate was critical in that if left in the elemental state (S0) the sulfur quickly forms heavy deposits causing significant operational problems for the cooling tower.

The treatment approach for hydrogen sulfide abatement at Hudson Ranch is a dual approach to remove the hydrogen sulfide in both the NCGs and condensate.

Condensate Treatment: The condensate from the surface condenser is sent to a large reaction tank to be treated. Air from a blower is sparged into the reaction tank through fine bubbling air diffusers that saturate the fluid with oxygen at a concentration of approximately 5-7 mg/l (dissolved oxygen). Prior to entering the reaction tank the condensate fluid is treated with oxidizing chemicals (Nalco Water TowerBrom and hydrogen peroxide). Hydrogen peroxide increases the oxygen level in the tank and is used at concentrations of 45-60 ppm. TowerBrom (trichloroisocyanuric acid) acts as a catalyst in the reaction to convert the hydrogen sulfide to sulfate and is used at concentrations of 10-15 ppm. The treated condensate from the reaction tank overflows into the cooling tower basin to complete the abatement treatment process of any remaining unreacted hydrogen sulfide.

NCG Treatment: The NCGs are sent from the gas extraction system to the cooling tower basin through approximately 1,000 fine air bubble diffusers distributed throughout the cooling tower. The gases being dispersed into small bubbles are critical for the hydrogen sulfide reaction. The cooling tower water is saturated with oxygen through the normal circulation of the cooling water in the tower. Additional TowerBrom is added to the cooling tower basin and acts as a catalyst in the conversion reaction of hydrogen sulfide to sulfate.

RESULTS

The hydrogen sulfide liberated during the geothermal process into the non-condensable gases and condensate is being successfully treated with the process described above. The overall abatement of H_2S in terms of reduction of hydrogen sulfide emissions is greater than 95%, averaging 98.3%. This process was permitted and approved for use at the Hudson Ranch facility in Calipatria Ca, in Imperial County and results in reducing the H_2S emissions into the atmosphere from this facility by about 262 tons/year.

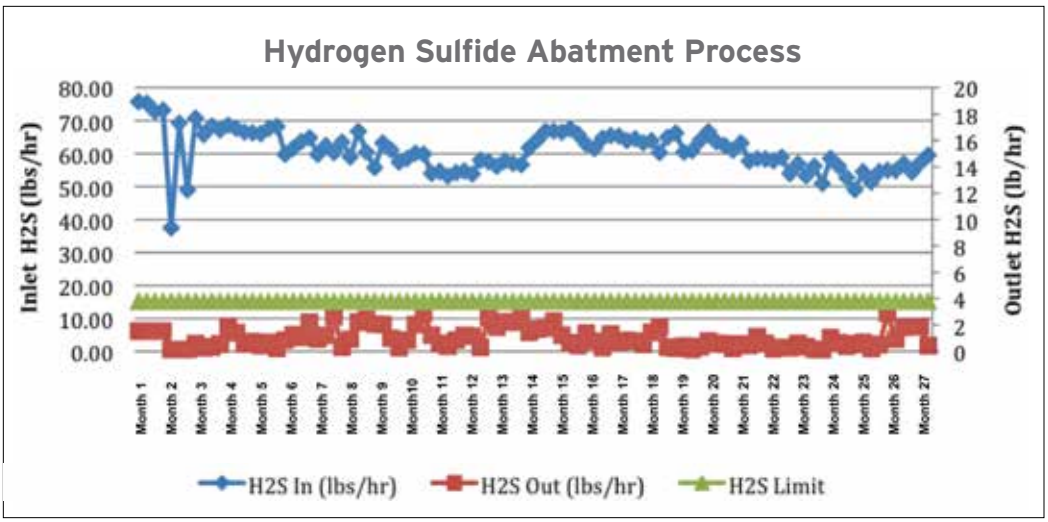

Figure 1

The Figure 1 shows data from a two year time period where the H_2S outlet levels are well below the 3.8 lb/hr limit, averaging 1.03 lb/hr, whereas the inlet H_2S levels averaged 60.9 lb/hr prior to treatment.

This treatment process provides additional benefit in the cooling tower as the oxidants fed to the system are very effective in killing bacteria and other microbial growth, thus reducing the need for additional biocides.

Compared to the previous method of treatment (Oxidizer box + Bio-reactor), the new TowerBrom/ hydrogen peroxide treatment is much more reliable, reducing the risk of environmental violations and is estimated to save the plant $100,000/ yr in net total cost of operation (TCO).

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