



## Preventing Contamination and Corrosion in Demineralized Water Storage Tanks with Nitrogen Sparging and Blanketing

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Methods for ensuring continuous supplies of near-pure nitrogen are critical.

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Industries ranging from electric power generation to pharmaceuticals rely heavily on demineralized and deionized water to maintain required levels of water purity during process operations. Managing the water supply is critical under normal operating conditions, as well during outages.

For example, under normal operating conditions, power stations used to generate electric power rely on steam generators or boilers to generate electricity. The power stations use the steam from the turbines to run through feedwater heaters. Cooling towers are used to keep the condensers cool, taking the steam that comes out of the turbine and condense it back into water.

While this system ensures, for the most part, a corrosion-free environment, the introduction of make-up water during normal operation and re-filling the boilers with water after an outage can introduce corrosive contaminants. Outages can be



Parker DH Midigas Nitrogen Generator



scheduled or unscheduled and usually revolve around scheduled maintenance or dips in peak demand, such as in the winter when homeowners no longer need their air conditioning and plant utilization is low. When these scheduled or unscheduled downtime outages occur, many boiler and pre-boiler systems are drained. After the outage, they are refilled with aerated water, typically with high concentrations of dissolved carbon dioxide, carbonates and oxygen.

Unfortunately filling the boiler and pre-boiler with aerated water may result in introducing low pH water with dissolved CO<sub>2</sub>, carbonic acid and carbonates.

When aerated water is introduced at startup, corrosion of components takes place, thereby harming the boiler system. Many demineralized water storage tanks are dosed with ammonia and hydrazine to reduce the oxygen content. These mitigation practices, however, increase by about 10 times the concentration of carbonate due to the formation of ammonium carbonate.

## Dynamic Duo: sparging blanketing

In order to prevent corrosion from occurring in boiler feedwater tanks, nitrogen sparging

and blanketing practices need to be put into place. Sparging and blanketing practices, when combined, introduce near-pure nitrogen into the water tanks and maintain a protective layer of nitrogen. In other words, nitrogen sparges the water to remove any dissolved oxygen and CO<sub>2</sub>, and humid air in the head space is replaced by pure, inert nitrogen. This may be maintained by a precise valve-control system that automatically adjusts the nitrogen content to maintain the protective blanket as the tank is filled or emptied or by simply having a continuous purge of low pressure nitrogen.

The nitrogen – when bubbled through water – forces out oxygen and CO<sub>2</sub> dissolved in it. Such gases can eventually lead to corrosion and product degradation, as well as potentially unsafe conditions. Typically when a water tank is sparged, sintered stainless steel plates or rods, called sparging elements, are used to purge the water on a continuous basis.

Advantages of nitrogen sparging and blanketing are many. First and foremost, by filling the boiler and feedwater system with deaerated water with low concentrations of oxygen and carbon dioxide, corrosion, and iron and copper oxide scale are minimized. Furthermore, faster startups are possible

because of less iron and copper holds. These practices also reduce energy costs because they eliminate auxiliary steam for deaerators, and they serve to eliminate storage tank contamination.

### Supplier-sourced or make your own nitrogen on-site?

There are two ways that industrial plants may obtain nitrogen. The nitrogen can be received from a supplier as a gas in high-pressure cylinders or as a liquid in micro-bulk tanks (dewars) and bulk tanks. Relying on an outside supplier, however, is subject to price increases, rental agreements, hazmat fees, surcharges and taxes. Deliveries are made by heavy trucks that contribute to CO<sub>2</sub> emissions and wear and tear on roads and highways. Delivery of gas also requires access to the power plant by a third party, and creates a security issue for the plant to manage.

A cost-effective, energy-efficient alternative to sourcing is to generate the nitrogen on-site via PSA (Pressure Swing Adsorption) nitrogen generators. Payback on such equipment may be accomplished in just two years or less. Nitrogen can be generated for eight to 12 cents per 100 cu. ft., while gas-utility companies charge 50 cents to a dollar or more per 100 cu. ft. Making your own nitrogen uses less energy than traditional manufacturing at an air liquefaction plant. The plant relies on an energy-intensive cryogenic process to cool air to extremely low temperatures to separate the nitrogen from air.

Furthermore, nitrogen generators exceed industry standards. They are capable of producing up to 99.999% pure compressed nitrogen at dewpoints to -70 degrees F (-56 degrees C) from nearly any compressed air supply. The generators are designed to continually transform standard compressed air into nitrogen at safe, regulated pressures without operator attention, thereby eliminating unexpected shutdowns due to "bad" or empty cylinders. Note: in order to be compliant with ASME corrosion prevention specification CRTD-66, systems must generate nitrogen at 99.6%.

Nitrogen generators such as those from Parker use high-efficiency pre-filtration

to remove all contaminants down to 0.01 micron from the compressed air stream. The filters are followed by dual pressure vessels filled with carbon molecular sieves (CMS). In one vessel at operating pressure, the CMS adsorb oxygen, carbon dioxide, and water vapor. The other operating at low pressure, releases the captured oxygen, carbon dioxide, and water. Cycling the pressures in the CMS vessels causes all contaminants to be captured and released while letting the nitrogen pass through. A final sterile-grade filter ensures removal of any microbial contamination. Nitrogen purities can be set with a flow control valve. Reducing the flow, increases purity while increasing flow, decreases purity.

For example, a system that produces a flow of nitrogen as great as 1,530 std. ft<sup>3</sup>/h at 99.9% purity can achieve even higher flow rates - if gas of lower purity is acceptable for that application. A built-in oxygen analyzer measures the oxygen concentration of the nitrogen stream. The system requires a minimum feed pressure of 110 psi and can operate at pressures up to 140 psi. The resulting nitrogen has a dewpoint as low as -40°F (-40°C).

In addition to being precise, on-site nitrogen generators are also compact, thus freeing up valuable floor space. They're typically freestanding, housed in a cabinet, or skid-mounted. They come as complete packages with prefilters, final filters, and a buffer tank. They are also simple to install, maintain and operate. The plant only needs

to connect a standard compressed air line to the inlet of the generator (after ensuring that a sufficient supply of compressed air is available) and attach the outlet to a nitrogen line. Furthermore, such generators serve to eliminate the hassles and safety issues of dangerous high-pressure cylinders.

Nitrogen may also be used for boiler lay up during outages. Proper layout of the boiler is critical. Boilers can be laid up for an indefinite period. If the boilers are cool, then air can infiltrate and cause corrosion and pitting, maintenance issues, startup delays, and water chemistry delays. And it's the near-pure nitrogen that serves as the primary weapon and technology for eliminating such issues because it doesn't introduce foreign chemicals into the boiler.

### Installation

When connecting a generator to a large tank of water, it is important to prevent back-flow of the water into the generator in the event loss of compressed air. A check valve may be used, but a more reliable method is to run a vertical leg above the level of the water overflow pipe (the highest water level in the tank) and then back down again into the nitrogen generator. With this plumbing configuration, if the compressor goes down water in the line would only rise as high as the level of the water in the tank. Therefore, water would not back flow into the generator and cause damage to the generator (See diagram 1).

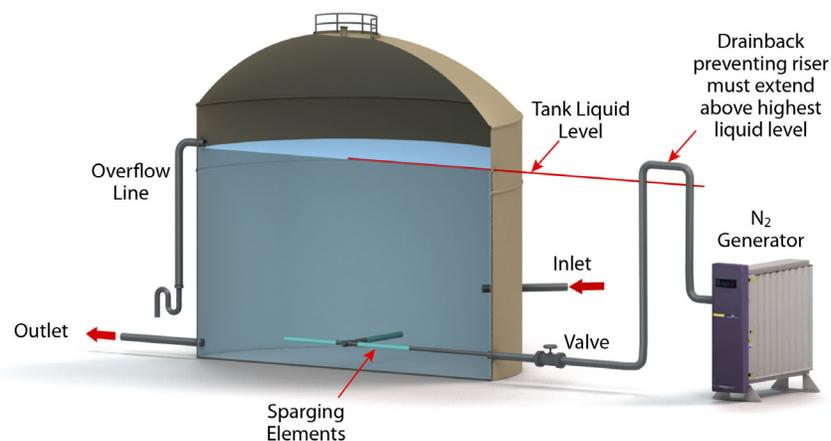


Diagram 1

## Conclusion

Power plants rely on demineralized water for their operations. They must assure the purity of water stored for intermittent needs. Therefore, power plants need to have in place nitrogen sparging and blanketing practices to ensure maintaining high purity demineralized water.

The option of on-site generation of nitrogen versus relying on a gas supplier should be investigated based on the advantages presented here: lower cost nitrogen supply, less energy consumption vs delivered gases, facility and employee safety and elimination of truck delivery miles.

