CASE STUDY

DRY AIR PROTECTION FOR A SCHEDULED OUTAGE

BACKGROUND

Equipment installed at this plant is a Foster-Wheeler design with a capacity of 500 MW and a drum-type, natural-circulation coal-fired boiler. The unit was brought on line in the early 1970s.

In 1993, the unit was taken off line for a nine-month scheduled outage. The main purpose of the outage was to increase the size of the precipitator, which improves particulate removal and complies with future clean air legislation.

The operating utility had experimented with dry air layup during operational outages, and had encountered problems. In contrast to the earlier project, this long-term layup was carried out with comprehensive support from Munters, which improved the results.

GENERAL APPROACH

Following the guidance in EPRI Report No. CS-5112, the plant lab technicians planned a dry air protection system for the water/steam side, the air/gas side and for the penthouse. Later, as the unit came off line, it became apparent that the generator housing was collecting condensation, so the dry air system was adapted to protect the generator as well.

Budgeting and financial arrangements were simplified because Munters provides equipment for rental as well as for purchase. So the plant was able to use funding sources from both operational and capital equipment accounts. Half of the dehumidifiers were purchased, since they will be used in the future for normal plant maintenance operations. The remainder were rented, as they were only needed for the period of the outage.

Above: Equipment in a southeastern power plant was protected by a combination of rented and purchased desiccant dehumidifiers provided by Munters.

WATER/STEAM SIDE

A single desiccant dehumidifier protects the water/steam side of the unit. Dry air is circulated throughout the system in a closed loop. A slight positive air pressure is maintained inside the system to avoid any leakage of humid air into the system.

The dehumidifier injects dry air into the system at the hotwell of the condenser. Dry air proceeds through each piece of equipment including the turbines, reheater tubs, boiler tube walls and feed pumps. The air eventually returns to the dehumidifier through flexible ducts attached to three parts of the system: the discharge side of the condensate pumps, the suction side of the heater drain pump and the ten headers of the waterwall tubes.

The layup procedure was well-planned in advance of shutdown. For best results, it is critical to remove all liquid water from the system. As the unit came off line, the crew began draining the boiler when pressure dropped to 300 PSI. After the pressure fell to 60 PSI, the plant staff applied nitrogen and continued draining water. The nitrogen eliminated any oxygen infiltration, protecting components while water and condensate remained in the hot system.

A Munters dehumidifier injects dry air into the hotwell of the condenser. From there, the air flows back through the water/steam side, eventually returning to the dehumidifier via the condensate pumps.

After the water was completely drained, the boiler was fired by oil to maintain a temperature of 450°F at the gas probes. This fire was maintained until there was no perceptible vapor emerging from vents in either the superheater or the steam drum.

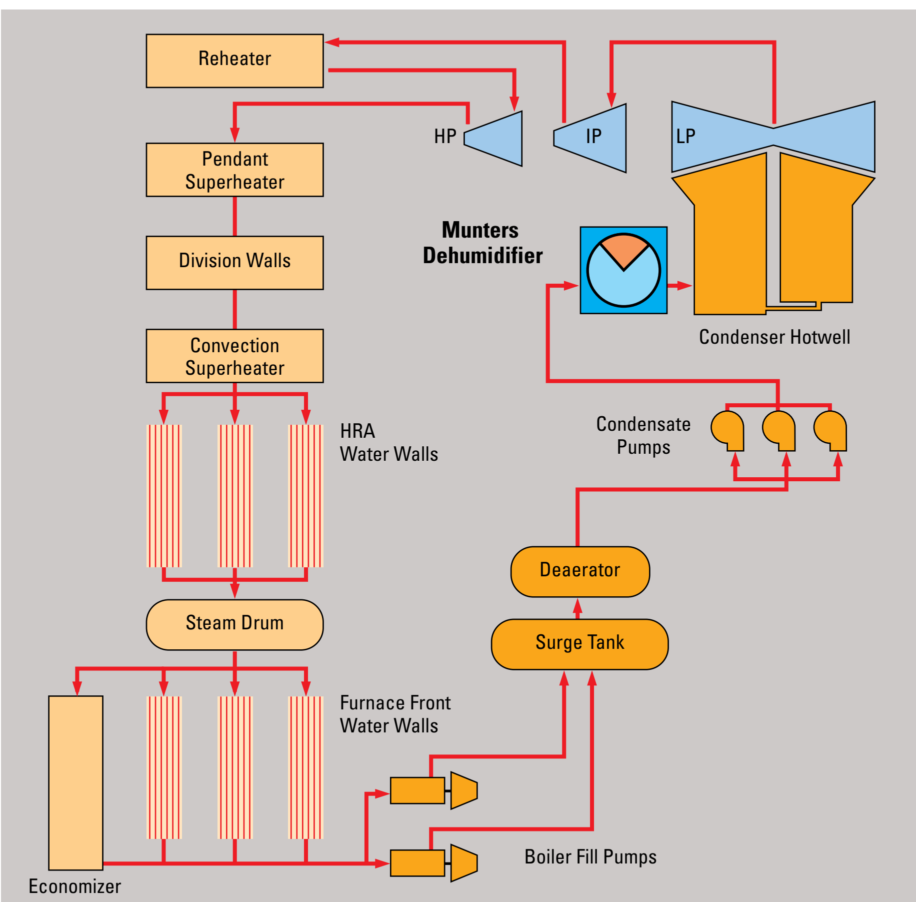
With the boiler dry, the crew proceeded to drain each system, vacuuming and mopping water as each low point was drained. Most of the systems could be drained without disassembling components, but in a few cases, pipe sections were removed to allow all water to flow out. This phase is especially important. Although dry air will remove water vapor which diffuses from wet points, the diffusion process is slow, and corrosion can occur at the "waterline" if pools of liquid remain in low spots.

After all systems were drained, each valve was set in the full open or full closed position, depending on which was required to force dry air though all parts of the system in roughly equal proportions. Check valves were forced open if they were welded into the lines. Where they could be removed, the check valves were pulled and the internal workings were taken out so air could flow through the lines smoothly.

To verify that air was moving through each section, the plant staff opened inspection ports, feeling for air movement before re-sealing the port and moving to the next. In some cases, valve positions were adjusted to correct for low airflow.

After the dehumidifier was started and airflow validated throughout the system, the staff continued regular monitoring, including:

- Regular humidity readings at 14 points in the system
- Weekly equipment rotation
- Monthly changes of the filter which precedes the desiccant dehumidifier
- Semiannual lubrication of desiccant wheel drive system.



The Water/Steam Side of the unit is protected by a single dehumidifier in a closed-loop system.

AIR/GAS SIDE

On the air/gas side of the unit, layup included the boiler and the secondary air heaters. The system downstream of the heaters was under construction, so the dry air was kept in the boiler by blanking plates in the ductwork downstream of the air heaters.

After the unit came off line and the water fully drained, the boiler was cleaned of all slag, and washed down. After the wash water was removed by vacuum, the boiler was neutralized with a solution of sodium carbonate.

Dry air from two 2250 scfm Munters dehumidifiers was injected into the system at one inlet of the air heaters. The air then flowed through the other side of the heat exchangers and up through the reheat section, entering the boiler at the top and falling to the ash pit, where it was returned to the dehumidifiers through the inspection doors. Dry air was also allowed to enter and protect the pulverizer, although there was no forced circulation through that equipment.

PENTHOUSE

Above the boiler, the penthouse – which shelters the superheat section – was also placed under dry air protection. The goal was to eliminate any external corrosion of the tubes and support structure.

After the penthouse was vacuumed to remove particulate, the insulation in the walls and ceiling was repaired and openings in the siding were sealed to minimize humid air infiltration.

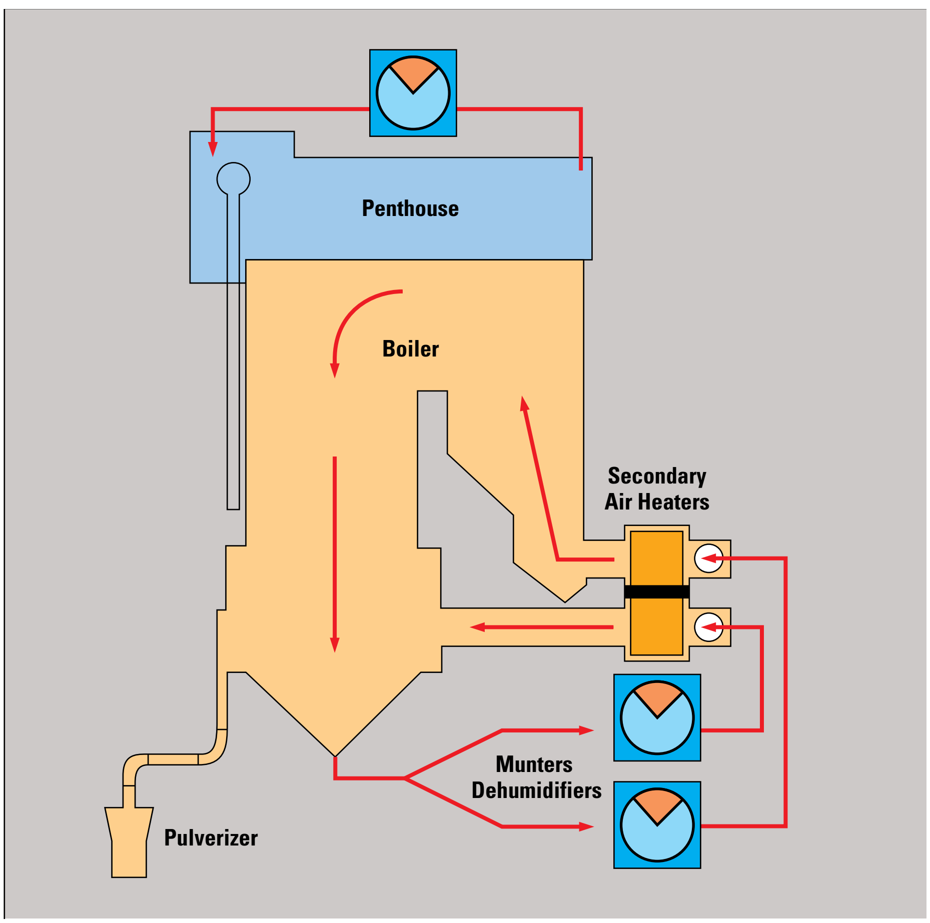
A Munters dehumidifier with 1125 scfm capacity was arranged so it supplied dry air through the west wall of the penthouse. Air returned to the dehumidifier through a duct placed along the east wall, so the dry air swept evenly through the space.

GENERATOR

Originally, the plant staff planned to protect the generator with nitrogen, as suggested by the manufacturer. However, after the unit came off line, the plant staff noted that condensation had accumulated rapidly, leaving as much as a gallon of water in the housing through condensation.

After the liquid was removed, the staff decided to circulate dry air through the housing to accelerate removal of humidity from the housing and from the insulation of the windings. A small, flexible air duct was connected to the generator from the low pressure turbine. Dry air "purged" the housing, flowing through the generator and eventually leaving through the vent and the rotor seals. The airflow is controlled by a damper in the duct coming from the turbine, so that only a small amount was lost from the system through the generator.

This procedure avoided the cost and the cumbersome safety procedures associated with nitrogen, and ensured continuous moisture removal for the duration of the outage.



On the air/gas side, Munters dehumidifiers circulate dry air through the entire system, beginning at the secondary air heaters.

Two dehumidifiers are used to protect the boiler and the air heaters. One of these units was rented, reducing the required capital expenditure for the project. The penthouse is protected by a separate system.

BENEFITS

- **Access—**
  Since the purpose of the outage was to repair, expand and replace components, easy access during construction was essential. Using dry air rather than a nitrogen blanket or wet layup allowed easy access to all parts of the unit for maintenance as well as component replacement.
- **Low Capital Cost—**
  Because Munters offers units for rent as well as units for sale, operational funds could be used to obtain the dehumidifiers needed for the project without increasing the capital equipment budget.
- **Safety—**
  Given the need to access all components freely, using nitrogen would have presented a significant safety risk, which would have slowed the maintenance procedures to an unacceptable pace. Using dry air rather than inert gas eliminated that risk, and also avoided the need for toxic or carcinogenic compounds used in wet layup. Such chemicals can present a safety risk and also require a rather costly and cumbersome disposal procedure.
- **Benefits Ensured by Complete Technical Support—**
  While dry air layup provides the benefits described above, the process must be accomplished correctly to achieve the benefits. With full support from both the rental division and the application engineering professionals at Munters, the plant staff achieved the benefits and avoided the problems encountered on earlier projects where in-depth technical support was not available.

As the unit came off line, the generator housing began to collect condensation. The system was modified to protect the generator by pulling a small amount of dry air from the low pressure turbine through the flexible hose shown here.

Munters technical support personnel worked in partnership with the plant staff to plan and execute the dry air system. Full support through the end of the outage was essential, because equipment had to be relocated and readjusted as construction proceeded through different parts of the unit.

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