POWER ENGINEERING

Retrofit Decreases Dissolved Oxygen at Low Load

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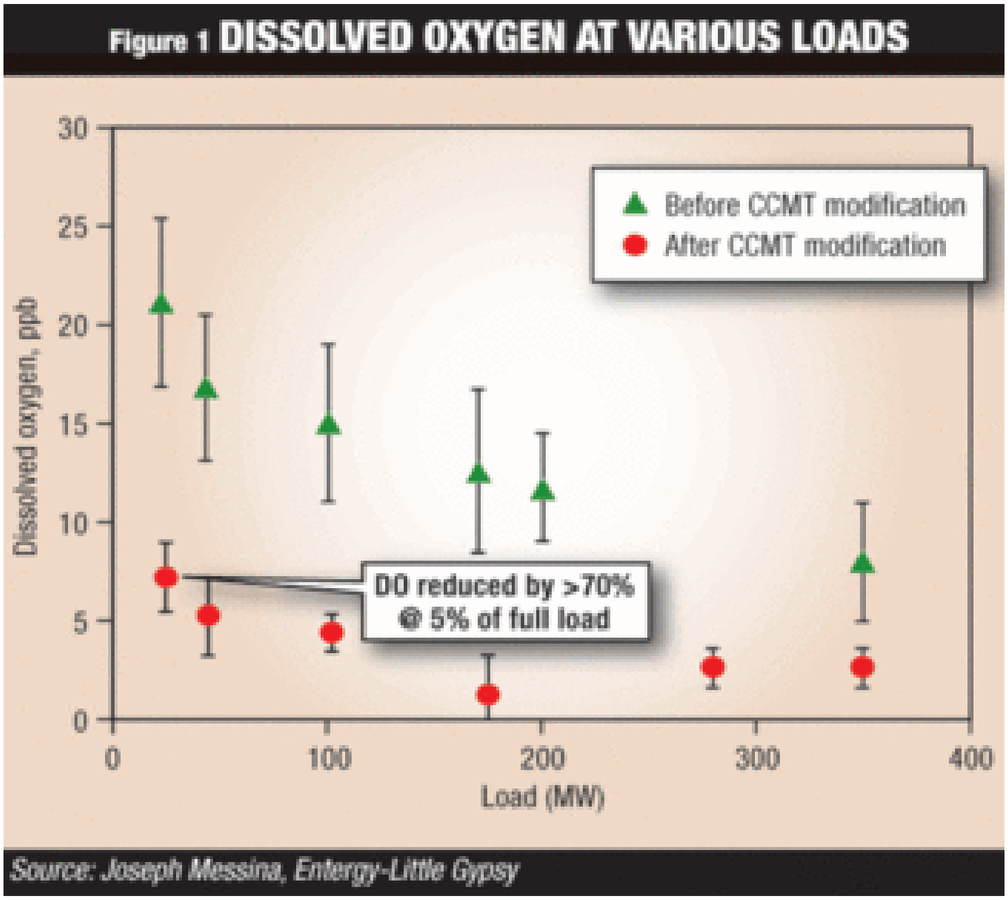
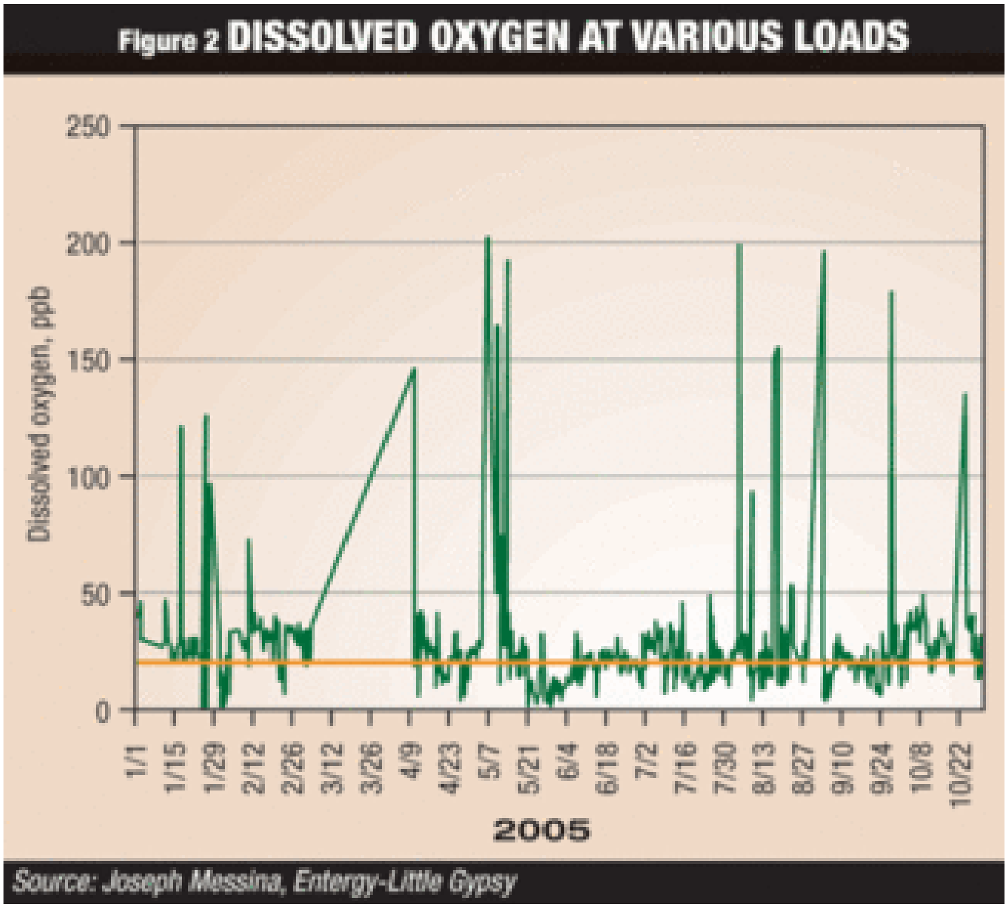
Entergy's Little Gypsy Unit 2 is a 450 MW gas-fired (with an oil alternative) thermal power plant originally designed for base load operation. Since changing over to peaking power operation, the plant has had problems with excessive dissolved oxygen (DO), especially during periods of low load. Entergy hired Intek Inc. to use a nontraditional condenser modeling program and methodology to identify and modify design configuration issues that led to the high DO. The result was a 75 percent reduction in DO at only 5 percent of full load.



When operating at full load, DO levels at Little Gypsy were acceptable. When operating at lower load, DO was considerably higher (Figure 1). Being a peaking plant, Little Gypsy ran at an idle power of 20 to 40 MW half the time. At this low operating level, DO reached high levels that were unacceptable to plant owner, Entergy Corp., and proved problematic for the plant (Figure 2).



The plant staff made numerous attempts at lowering the DO through repairs and operating procedure changes. Even though air in-leakage was measured at only 4 to 8 standard cubic feet per minute (SCFM), plant personnel made several fruitless searches for leaks. The staff also made many minor repairs, but they had little or no effect on DO. Little Gypsy engineers experimented with different combinations of vacuum pumps and cleaned the vacuum pump seal water heat exchangers; however, DO remained at unacceptable levels. Plant personnel even went so far as to build a dam to flood the standby condensate pump seals, leading to the replacement of both seals, yet DO refused to budge.

The Solution

Joseph Messina, Little Gypsy's chemistry supervisor, contacted Intek Inc., with which Entergy's Little Gypsy established a relationship in 1998 when the plant began using Intek's RheoVac system. The RheoVac system measures air in-leakage and other indicators of overall condenser health.

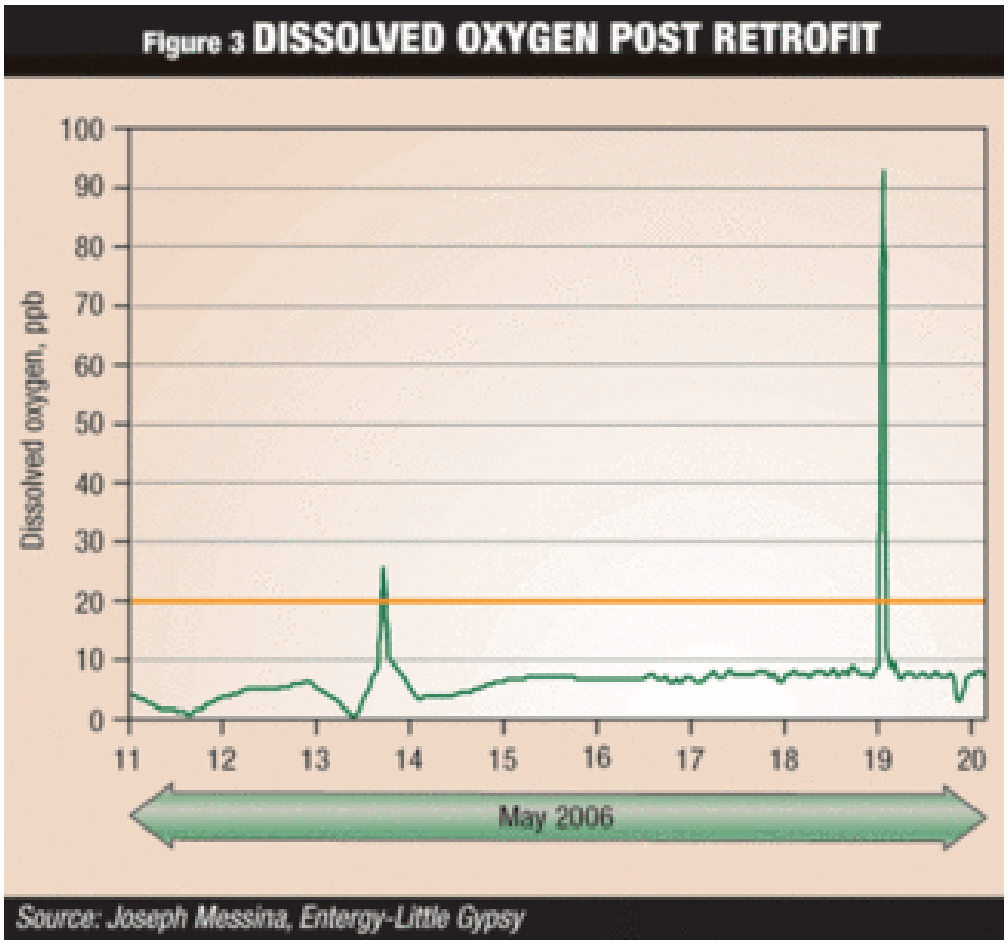
In 1994, Intek began collecting operating data from condensers around the world and observing the operations and behavior of various condenser configurations. Dr. Joseph Harpster, Intek's president, spent several years researching and understanding the causes and solutions for shell-side condenser-related problems. The data he collected and his observations led Dr. Harpster to develop the Comprehensive Condenser Model and Theory (CCMT). The CCMT is verifiable because it mirrors and predicts the condenser behavior observed by Intek and power producers over the years. The CCMT differs from traditional condenser modeling programs, such as those that use computational fluid dynamics and finite element analysis exclusively, because it explains steam and air flow within the condenser, including the air removal section.

To understand Little Gypsy's problems, Intek used its four-step condenser analysis program. To identify the design problems, Intek studied Little Gypsy's available condenser drawings and operating plant data to locate suspected trouble areas. Once the problems were identified, Intek verified the information by performing a condenser inspection and analysis. Using the CCMT, Intek determined the extent of the condenser problem and identified methods that could be used to improve performance.

During this stage, Intek also considered the amount of time available for the fix, in this case a two-week outage. The last step involved delivering drawings and obtaining a license to use the patented methods on this specific unit. Little Gypsy then contracted with an outside firm to perform the work. The work included modifications to a flawed air removal section and a circulating water tube bundle subsection to better accommodate high and low load. Work included configurations to correct conditions that contributed to excessive sub-cooled condensate and to increase deaeration. Intek inspected the work and acted as technical advisor.

Resolution

High DO is often thought to be a necessary evil of low load operation. At lower loads, condenser pressure is lower, moving the vacuum further up the annulus of the turbine, exposing more valves, ports and openings, leading to higher air in-leakage. The higher air in-leakage increases the opportunity for the gases to dissolve. Intek's efforts show that plants operating at lower loads do not need to endure high levels of DO.



After the retrofit was completed and the unit was returned to operation last spring, the results were immediate and dramatic (Figure 3). At 22 MW, DO decreased from 22 parts per billion (ppb) to 7 ppb and at 180 MW DO decreased from 13 ppb to 2 ppb. The guaranteed projection level was 10 ppb. Intek's unique understanding of condenser dynamics was a key to the program's success.