SECTION 11B

Varying Circulating Water Flow Due to EPA and CWA Regulations and Optimizing Condenser Performance Using PMAX

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Abstract

Many plants are being forced to go to variable speed circulating water (CCW) pumps due to Environmental Protection Agency (EPA) and Clean Water Act (CWA) regulations. Whether it is CWA section 316 (a) and (b) or just monitoring the outlet CCW temperature, these regulations can have a significant impact on plant performance due to condenser performance. This produces a need for a monitoring system that can optimize performance while keeping plants within regulated tolerances. PMAX has been used in the past to examine the effects of circulating water flow on plant performance and would make a great tool to optimize the condenser performance given these regulations.

Introduction

Many plants are being forced to go to variable speed circulating water (CCW) pumps due to Environmental Protection Agency (EPA) and Clean Water Act (CWA) regulations. Whether it is CWA section 316 (a) and (b) or just monitoring the outlet CCW temperature, these regulations can have a significant impact on plant performance due to condenser performance. This produces a need for a monitoring system that can optimize performance while keeping plants within regulated tolerances. PMAX has been used in the past to examine the effects of circulating water flow on plant performance and would make a great tool to optimize the condenser performance given these regulations. The information in this paper describes the basic idea of how the performance is quantified as well as the method for modeling it.

Background

When circulating water flow reduces it increases the condenser backpressure, which in turn reduces generator output. However, when reducing flow either with variable speed pumps or by taking a pump out of service, there is a savings in auxiliary power used to run the pumps. If this savings out weighs the backpressure loss then it is actually better to have less flow. This situation will only occur at low backpressures (i.e. low inlet circulating temperatures) and when LP turbine choking can occur. This is because the MW effect curve illustrated in Figure 1 for back pressure is fairly flat at a back pressure of 1.5 IN HG, and it actually changes slope for back pressures less than 1.5 IN HG because of choking.

During a choked condition, a decrease in backpressure does not decrease exhaust enthalpy (i.e. get more power out of the turbines) and lower backpressures yield lower condensate temperatures entering the lowest pressure feed water heater, which causes an increase in extraction flow. All these effects together cause power generation to decrease. PMAX can inform the user of a choked condition as well as inform them on what CCW flow would be needed to benefit generation the most. In the curve in Figure 1 for backpressures less than 1.5 IN HG, it is actually better to increase backpressure.

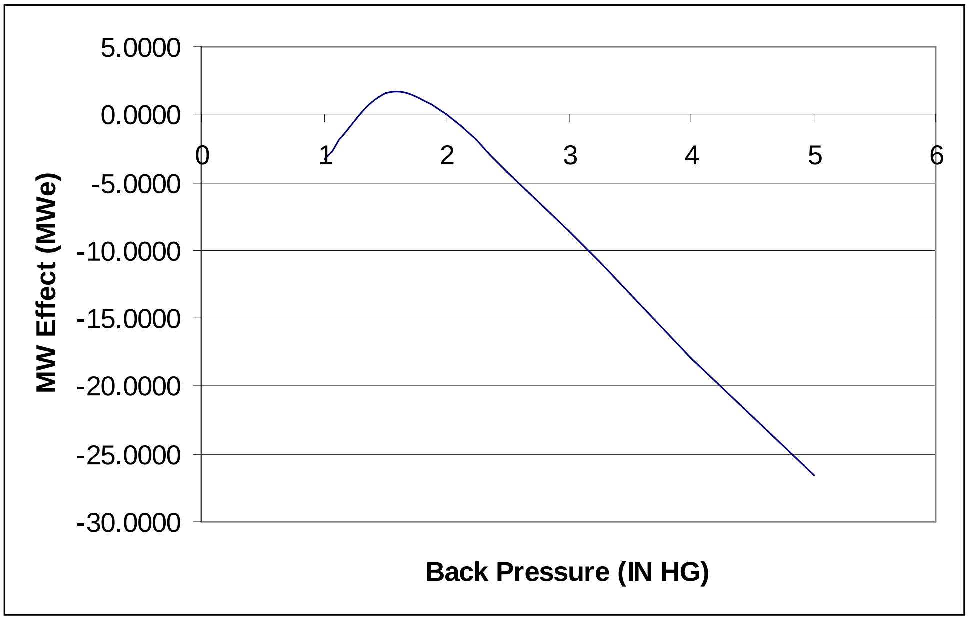

Figure 1: Example Back Pressure MW Effect Curve

Reducing flow can also produce another concern. When flow decreases the delta temperature across the condenser zones has to increase to dissipate the same amount of energy. This causes the outlet CCW temperature to increase. During low temperature seasons, this is not a huge concern, so reducing flow to benefit fish from being sucked into the cooling system as well as increasing power generation during these times is beneficial for everyone. However, during the hot summer months, CCW inlet temperature increases and reducing flow will harm plant performance and higher CCW outlet temperatures could cause plants to have to cut back significantly on generation to meet EPA thermal pollution regulations.

PMAX Optimization

PMAX can be used to optimize plant performance while meeting these regulations. It can be utilized to monitor the flow performance by first calculating the back pressures for all the flow cases that are to be studied and then going into MW Effect curves like the one illustrated in Figure 1 to get an associated MW effect. Then an actual condition MW effect is subtracted from the study case MW effect to get the total effect for reducing or increasing flow. If this total MW effect is positive then the flow change would be beneficial. However, if it is negative then a loss for changing flow would occur. If the loss is due to a reduction in flow then the power loss has to be compared to the power gain associated with cutting back the circulating pumps. If the pump gain is larger than the backpressure loss then the reduction is also beneficial.

PMAX has been used to calculate the MW loss associated with running too much flow during low backpressure time periods and with not running enough flow during increasing backpressure periods. This loss is included in the MW effect advisory display similar to the one in Figure 2. This loss could be associated with either a flow or with the number of pumps running like in Figure 2.

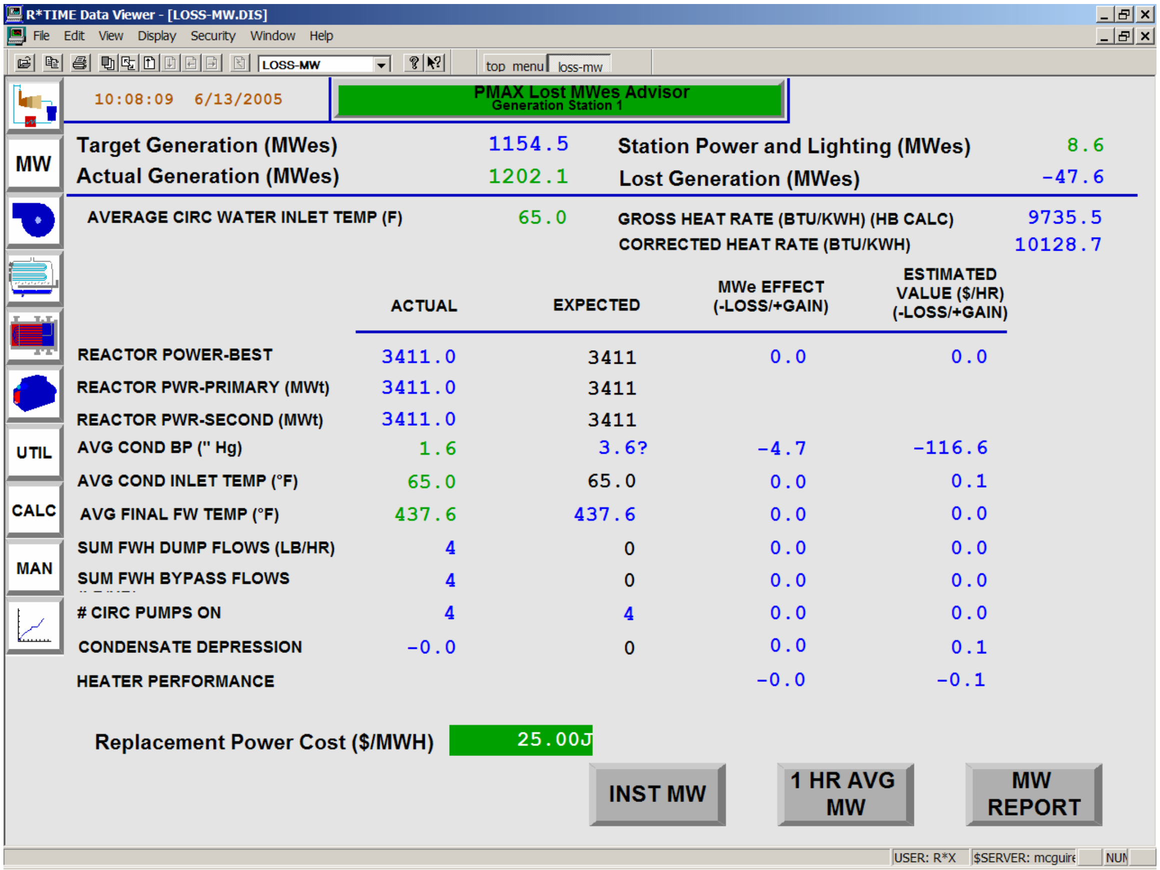

Figure 2: Sample MW Effect Display

PMAX can also be used to predict when the flow should be changed based on circulating water temperature. The display illustrated in Figure 3 is used to manually enter temperatures to see at what temperature the plant should transition from 3 to 4 pumps and visa versa without having a significant change in electrical output.

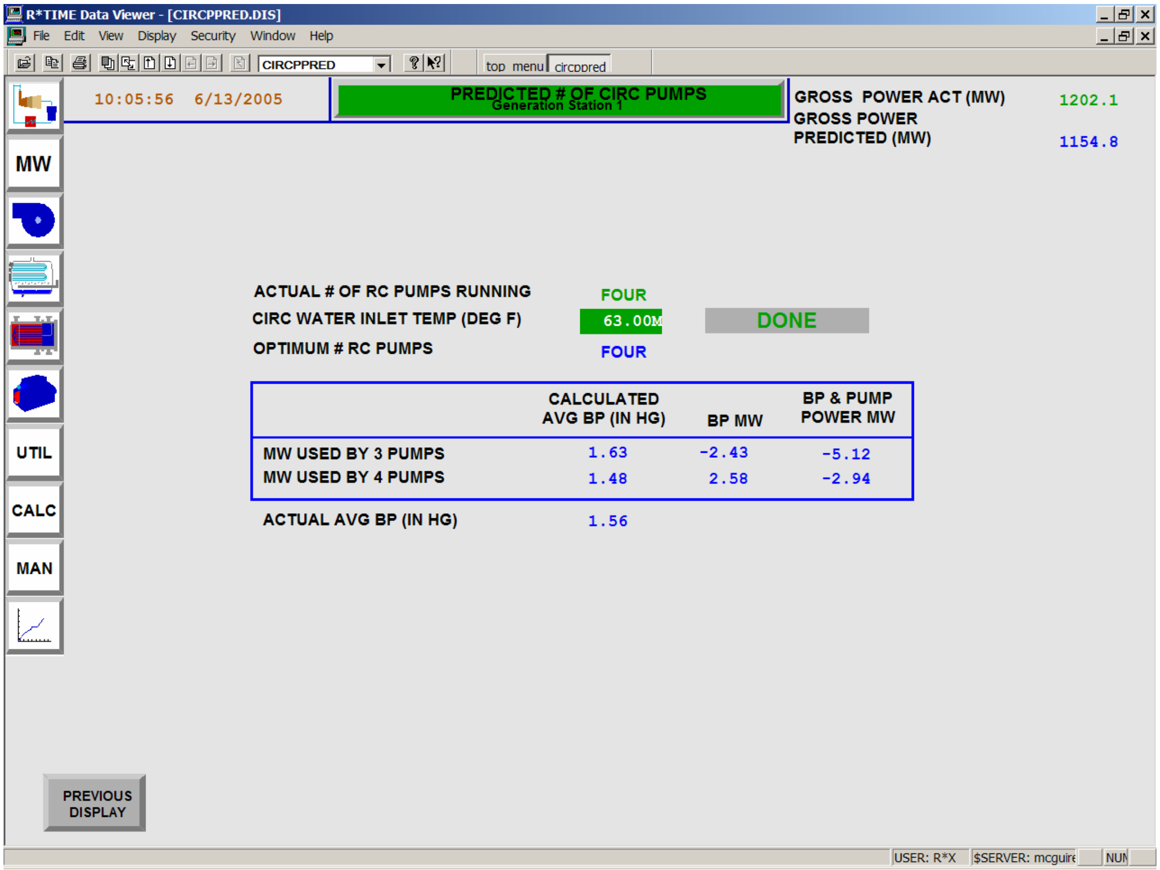

Figure 3: Sample Predictive Display for Circulating Pump Operation

The same principles can be used to regulate inlet flow while getting the most out of condenser performance. PMAX could calculate the optimal flow for maximum performance while taking into account a maximum flow regulation. For example if a plant was to run at a maximum allowable flow all the time then during low temperature seasons, which would produce low back pressures, the plant could actually be loosing MWs because of running too much flow. PMAX could alert the user of this, and the plant could cut back CCW flow even more and produce a gain. During warm seasons running maximum allowable flow would always be optimal, however, CCW outlet temperature could be a concern.

PMAX could be used to predict outlet temperatures based on flow, heat duty, and inlet CCW temperature. It could inform the user of minimum load reductions required to meet regulated outlet temperatures and/or CCW flow changes required to keep CCW outlet temperatures in check. All these predictions and calculations would be automated, and a quick daily display review would inform the user of current condenser performance and help the plant to optimize flows as best they can given EPA guidelines.

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Conclusion

With new regulations coming into play with respect to power generation and cooling water usage, it is imperative that plants have an optimizing system for running variable speed CCW pumps. PMAX is the perfect candidate for handling these optimization situations. It can be used to help engineers and plant operators to achieve optimal condenser performance while residing within EPA guidelines.