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Cooling Tunnel Optimization

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The bulk of the manuscript associated with this thesis contains proprietary information from the company sponsor, and is not available for dissemination to the general public.

If you wish to know more about this thesis, please contact the thesis advisor, Dr. Kline, at the address below. Depending on your needs and interests, parts of this thesis may be available to be released to you for review.

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Executive Summary

The goal of this senior design project was to design an Excel spreadsheet which would model a cooling tunnel at the production facility for Kellogg. This model takes the inputs from the operator, the ambient conditions, and the product going through the model and shows exactly what is happening within the tunnel. Once the model was built, an economic analysis was done based on the normal operations versus the increased efficiency of the cooling tunnel. This economic comparison showed that if the throughput of the cooling tunnel was increased by 17.6%, the cost of running the chiller, which is the biggest energy consumer of the cooling tunnel, would incur minimal increases. According to Kellogg, the cost savings of running the tunnel at the increased efficiency would be much higher than the additional cost to the chiller. The roof chiller could handle this increased load because it is currently operating under capacity. Therefore, it is recommended that Kellogg try to run at the increased efficiency.

The current model uses data logger inputs. In order to build a model that is completely independent of this input, tests need to be run in the Pilot Plant. The tests need to be run in the Pilot Plant, and not in the production facility, so that the air and plate water could be completely turned off. This needs to be done to determine the exact contributions of the cooling air versus the chill plates to the overall cooling of the product. Once these experiments have been run, further correlations between the product temperature drop and plate temperature, plate flow rate, air temperature, and blower input setting would be developed. In order to eliminate assumptions that are in the current model, the mass flow rate of the chiller plates would have to be measured by a flow meter. Other assumptions could be eliminated by having temperature sensors on the inlets and outlets from the air coils. The temperature sensors would eliminate the air reheater and coil efficiency assumptions.

Based on this project, we recommend that Kellogg buy a flow meter for the bottom chill plate water/glycol pipes. It is also recommended that temperature sensors be placed on the inlets and outlets from the air coil and run a couple of trials and record the data to find the reheater and air coil efficiencies. Tests should be run in the Pilot Plant when the air is completely turned off, and once when the chill plates are completely turned off. The throughput should also be increased 17.6% to test the model results.