FINE PRODUCT COOLER UPGRADE

Jace Woods, Khadijah Mirza, Mebin Babu, Cullen Murray
(Group 10)
Supervisor(s): Professor Hussameldin Ibrahim
(Industrial Systems Engineering)

ABSTRACT

Mosaic Potash Belle Plaine is one of the largest solution mines in the world and produces Fine, Standard, Course, Ag Granular, HQ Granular, and special granular MOP (Muriate of Potash). The major engineering problem that is involved with the current Fines Cooler system for Mosaic Potash Belle Plaine is that if the product leaves the cooler too hot and reaches the warehouse at too high temperature, the treatment will be burned off on the product, causing the potash to clump together. The project focusses on achieving the desired product temperature during summertime, which is the worst-case scenario for the product while ensuring the quality of the product and increasing the throughput of the cooling system.

BACKGROUND

- Ambient Air is drawn from the outside atmosphere into a “fine cooler” that cools the temperature of the product allowing it to be stored safely.
- Improvements to focus on the cooler and the cooling process.
- All improvements to be considered during summer months in Saskatchewan as that is considered the “worst-case scenario”.
- Improvement selected to focus on lowering the incoming ambient air temperature entering the fine cooler.

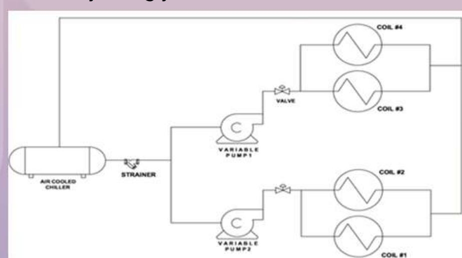
PROJECT GOALS/OBJECTIVES

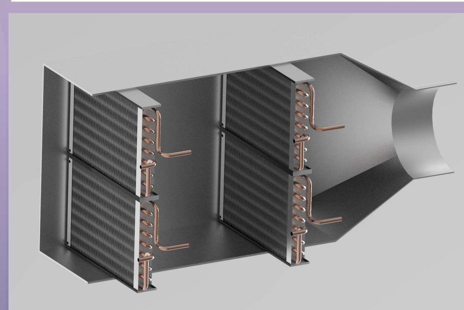
- Design improvements made to the Fine Cooler System to achieve 185.0F product discharge temperature at an operating throughput of 135 short tons/hr.
- System improvements to focus on increasing heat transfer through the cooler and can include internal and/or external modifications to the Fine Cooler System.

Variable	Summer Ambient Air Temperature	Air Flow, (ft^3/min)	Cooler Throughput, short (ton/hr)	Product Inlet Temp, (F)	Product Discharge Temp, (F)
Current	86.0	20,000	110	350	220
Desired	86.0	20,000	135	350	185

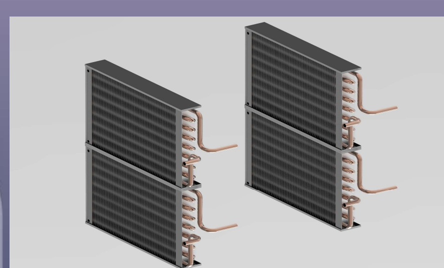
METHODS/PROCESS

- The first step was to understand the terms and all the basic working principles related to a Continuous Fluidized bed Cooler. The ways to control the temperature in a continuous fluidized bed are : ◦ Adiabatic ◦ Solid Circulation ◦ Gas Circulation ◦ Liquid injection ◦ Cooling or heating surfaces in bed ◦ Latent Cooling ◦ Sensible cooling.
- Secondly, the heat transfer and mass transfer related to the current cooling system was determined to iterate the range of temperature which can produce the desired output temperature of the product.
- Lastly, the final design that was selected after several design iterations was a total of four cooling coils that will be placed in two stations, two cooling coils will be stacked on top of one another. The final design also incorporates the removal of the vertical 5-foot diameter pipe located outside of the mill and replacing said pipe with stainless steel ducting that will be able to properly fit the selected cooling coils. The cooling coils will be fed by a variable pump that will pump a 50% mixture of ethylene glycol. The 50% mixture of ethylene glycol was selected because of the antifreeze properties it possesses.





STACKED COILS IN NEWLY DESIGNED DUCT



COIL CONFIGURATION FOR COOLING

RESULTS/OUTCOMES

- Lowered incoming ambient air from 86 F to 34 F.
- Utilized 4 total cooling coils, 2 stacked on top of one another in 2 stations.
- Cooling Coils fed with 50% Ethylene Glycol Mixture.
- Utilized Air Cooled Chiller to cool Ethylene Glycol Mixture.
- Utilized 2 variable pumps to feed Ethylene Glycol mixture to Cooling Coils.

CONCLUSIONS AND RECOMMENDATIONS

There are several ways of cooling the fine product to the desired temperature that was looked into, such as fluid beds, rotary dryers and coolers, and contact column coolers. However, it would have required the team to change the entire system to accomplish the desired temperature, making it highly expensive for the design budget and for Mosaic. Therefore, it was decided by the group to focus on placing the cooling coils with a refrigeration system and install 2 pumps into the already existing system to cool the incoming air, and ideally, placing it before the fan and therefore before the air encountered the fine product. An air-cooled chiller was decided to be installed into the system to output the coolant mixture into 2 pumps through a control valve and be further pumped in 2 cooling coils (stacked on top of one another) per variable pump.

ACKNOWLEDGMENTS

- Tyler Howard and Sean MacDonald – Mosaic Potash corporation
- Hussameldin Ibrahim – Project Supervisor
- Jared Larkson – MacPherson Engineer
- Brad Lulik – Faculty Lab Instructor
- Robert Jones and Adisorn Aroonwalis – Engineering Faculty Professors

REFERENCES

Janna, W. S., & Chhabra, R. P. (2015). *Design of fluid thermal systems*. Australia: Cengage Learning.

McQuinston, F. C., & Parker, J. D. (1994). *Heating, ventilating, and air conditioning: Analysys and design*. New York: J. Wiley and Sons.