Dehumidification With Extra Bite

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GlaxoSmithKline is a well-known global leader in prescription medicines, vaccines, consumer health care, and dermatology. The company's mission statement is simple, yet ambitious: improve the quality of human life by enabling people to do more, feel better, and live longer.

To fulfill this mission, GlaxoSmithKline operates facilities that produce pharmaceutical and health care products, many of which demand precise environmental conditions. In one recent HVAC facility upgrade, where low humidity was required to ensure flawless manufacturing, GlaxoSmithKline showed that its creative ability is not limited just to medicines and consumer goods. The company installed an innovative passive dehumidification heat pipe system that brought remarkable energy savings, a quick return-on-investment (with ongoing savings) and a direct and indirect CO_2 savings of 164 metric tons/yr.

The 225,000-sq-ft manufacturing facility in question uses roll compaction as part of the manufacturing process for Polident® denture tablets. The facility cooling load is served by a 1,000-ton chilled water loop consisting of two 300-ton York centrifugal chillers, and one 400-ton Carrier chiller. The 2,000-sq-ft roll compaction process area requires a maximum relative humidity of 50% or less at

72°. If the humidity requirements are not strictly maintained, the consistency of the powder used to create the final product potentially thickens and operations must shut down until the environmental conditions are corrected. Shutdowns obviously lead to major losses in both time and money.

To maintain the required humidity level, GlaxoSmithKline has to extract an extraordinary amount of moisture from the ambient air, which was initially accomplished by lowering the temperature of their 1,000-ton facility chiller loop to a setpoint of 39°. Additional dehumidification was obtained by overcooling the supply air and then reheating it, as necessary. This process is not very energy-efficient. Several potential solutions were investigated as part of the site's overall energy reduction efforts.

EXPERIENCE PAID OFF

GlaxoSmithKline quickly recognized that a 39° chilled-water setpoint was overly expensive to operate and maintain. In an effort to cut costs, prevent potential manufacturing shutdowns, and reduce overall energy consumption, the company sought an alternative method to achieve the required dehumidification while also raising the chilled water temperature setpoint. Raising the chilled water plant to a more industry standard 42° would save an estimated 185,000 kWh/yr, a substantial energy savings.

The company agreed to undertake a preliminary analysis of heat pipes for passive dehumidification as a potential alternative solution. The facilities manager at GlaxoSmithKline had successfully used heat pipes with one of his previous employers, another well-known pharmaceutical manufacturer, where similar levels of dehumidification were required. The facilities manager stated that the heat pipes worked well at providing additional dehumidification and attested to the cost and energy savings.

For its analysis, GlaxoSmithKline brought in Heat Pipe Technology, a Berkshire Hathaway company, and Computer Environment, Heat Pipe's Memphis-based representative, to engage in an appraisal that included precision computer modeling of before-and-after heat pipe implementation scenarios using proprietary software from Heat Pipe Technology. Heat Pipe Technology software accepts inputs of AHU coil dimensions, airflow rates, and entering and leaving air conditions. From there, models can be run with heat-pipe designs made up of various number of coil rows and fins-per-in. to determine an optimum configuration that achieves the desired dehumidification level and final leaving air conditions. These performance data are then used to project the energy savings, which can be used as a comparison tool when plotted against the overall cost of the installation.

HOW HEAT PIPES WORK

A properly-sized passive dehumidification heat-pipe solution is a remarkably simple approach to achieving lower humidity levels, while avoiding the need to overcool and reheat. Passive dehumidification heat pipe systems are practically maintenance-free and have no moving parts, hence the passive designation in their name. Heat pipes work on a simple theory of energy redistribution. A wraparound heat pipe system occupies a place on both sides of the AHU cooling coil: the warm side (for precooling incoming air) and the cold side (for reheating air that has now been over-cooled for dehumidification). The heat pipe system physically surrounds, or wraps around the cooling coil of the air handler. (Figure 1).

Heat pipes work through a closed system of copper tubes, arranged in circuits, which transfer refrigerant from one side of the cooling coil to the other, in a traditional evaporation and condensing (phase change) cycle without the use of a compressor. The transfer of the refrigerant extracts heat from the incoming air and circumvents the coil to use that same heat to warm the overly cool air leaving the cooling coil.

Adding to the list of benefits, a passive dehumidification heat pipe system is internal to the air handler with no moving parts, so it does not require additional footprint space. A heat pipe system can be used in any air handler that has dehumidification requirements that are challenging to meet with chilled water alone.

Technology behind the heat pipe design was originally researched and developed by NASA, because its satellites have dramatic temperature differentials between hot and cold sides of the vessel, as one side faces the sun and the other side faces the deep cold from dark space. Heat pipes allow satellites to achieve a more uniform heat signature.

SPECIFYING THE SOLUTION

Heat pipe systems are sized to match the coil face area of the AHU, and they use different combinations of tubing thickness, number of coil rows, and number of fins-per-in. Heat Pipe Technology’s modeling software can be used to quickly do performance runs on multiple scenarios to determine how much additional moisture can be extracted at a given set of air conditions. Iterations are performed until a solution is obtained that achieves the client’s dehumidification goals.

The software can also be utilized to generate a single matrix of performance data at many different temperatures to show how the system will perform in different seasons of the year. At the GlaxoSmithKline site, a three-row system was utilized, but heat pipes can have as many as six or even ten rows. The two main things that have to be carefully taken into consideration are: increased coil pressure drop, and coil cleanability.

The turn-key, three-row system for the GlaxoSmithKline facility cost around $40,000. After the energy modeling, analysis, and decision-making processes were finished and the decision was made to implement a heat pipe system, the project was manufactured and installed into the existing unit in under 12 weeks. The actual installation took just three days once the materials and work crew were onsite.

GLAXOSMITHKLINE HEAT PIPE RESULTS

This GlaxoSmithKline project was successful in reducing the humidity levels for the processing area, and the heat pipe system is working as designed, producing an additional 9° of precooling and reheat. The ongoing temperatures are continuously monitored and verified with new averaging temperature sensors that were installed before and after the heat pipe sections.

Financial savings: According to project’s financial analysis model, the GlaxoSmithKline site enjoys energy savings of approximately $26,000/yr. This savings comprises both reheat cost avoidance as well as additional energy savings from raising the chilled water setpoint by an additional 3°.

Carbon savings: The direct CO_2 reduction is estimated at 65 metric tons per year, with direct and indirect CO_2 reduction of 164 metric tons.

Payback period: Direct payback of the three-row heat pipe was estimated by GlaxoSmithKline at 1.6 years. The ongoing measurement process proves that the system is indeed on track to meet these preliminary estimates. ES

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