Cooling tower operation in extreme cold

General

Proper operation of a cooling tower in extreme cold environment depends to a great extent on constant monitoring and tracking of the cooling tower and the effects of the weather on its components, such as mechanical system, water distribution system, and areas in the cooling tower that have a tendency to ice up, such as louvers, basin and fill.

When the ambient temperature dips to 7.2°C, regular operations halt, and winter protocol is implemented. (winterization operation mode)

Cooling tower operation in harsh winter weather

Operating a cooling tower in extreme cold

Operating principles

- The water temperature must be monitored and must not dip below 10° C. (if the industrial process demands another minimum, preventative actions must be adjusted).
- As high a thermal load as possible must be maintained, i.e., the process water should enter the tower at as high a temperature as possible. If heat load is partial, a hot water bypass should be operated at full capacity directly into the pool.
- Maximum water supply to the tower must be ensured such that all distribution pipes are operating, and the hot water reaches every place continuously and efficiently. Ensure that the nozzles in the main and secondary distribution pipes are clean and in working order.

Actions

- Physical monitoring of critical tower parts daily
- Reducing of fan revolutions as per water temperature (if a VFD is in use) is the most efficient way of controlling ice formation in areas where the water temperature is minimal. In multi-cell towers, ensure that the revolution speed decreases simultaneously in all cells so as to prevent a situation wherein some cells are operating at higher speeds, as ice can form therein.

- Activate hot water bypass – In the event that the fan stops rotating completely and the pool water temperature continues to drop, activating hot water bypass will send all of the hot water directly to the pool without it passing through the fill. In the event that the operator wishes to activate the bypass in one cell only, ascertain that that cell can be hydraulically isolated from the others to prevent a situation wherein water supply to neighboring cells drops and increases the likelihood of ice forming.

Restart the cooling tower after Shutdown in extreme cold

Principles

- Design of the tower such that no water remains during long-term shutdown: self- drained basin, efficient and thoroughly drained distribution system, sealable air entryway
- Proper tower maintenance during shutdown by means of cleaning and clearing ice and snow from the fan, fan deck, and air entryway.
- Activating measures to maintain minimal heat during periodic stoppages: heated pool and internal electrical heating for the motors and speed-reducers.

Reactivation post shutdown

- Prepare the tower for activation: physical inspection of the various system; clearing snow and ice from the critical parts
- Channel hot water through the bypass into the pool, then shut off the bypass and start regular operation.
- Turn on the fan in reverse to force hot air into the fill and the louvers and melt any ice therein. Leave it on for as long as needed, or about 20 minutes.
- After turning the fan off, allow the tower to “rest” for 20-25 minutes before activating the fan in its regular working direction. Use this rest time to clean melted ice from the louvers, as well as ice that likely formed on the fan during its reverse operation.
- From this point, operation and overall monitoring of the fan revolution speed, as well as use of the bypass, should be as set forth in the previous section.

Recommended special measures and equipment to be installed in a tower that will operate in extreme cold

- Adjustable louvers and those that can be closed completely
- Dedicated panels for closing the air entryways
- Hot water bypass directly into the pool
- VFD for the fan revolution speed
- Gear appropriate to extreme cold: reverse mode option, synthetic lubricant, thermostat, oil heaters, sump heaters. The gear can work in reverse mode up to half of the regular gear speed of 875 rpm.

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- Motor appropriate to extreme cold: fitted with internal heaters – anti-thickening agents in the coils; order the motor with synthetic lubricant for the bearings to prevent the oil from freezing during shutdowns / stoppages.
- drip edge for reducing the droplets reaching the louvers (should be standard pre-installed in cooling towers).
- Heaters in the cold-water basin.
- Temperature sensors in various locations.
- Dams for regulating the flow in the hot water basin (required in cross flow towers)
- Reinforced fill and louver infrastructure (due to the weight of the ice)
- Control valves at the cooling tower inlet and hydraulic separation between various cells

Types of towers and their appropriateness to operation in extreme cold

When comparing counterflow and crossflow towers, there is not a big difference in their abilities to withstand extreme cold, yet it may be the case that a crossflow tower has some advantages in this respect due to its structure and mode of operation:

- Due to the fact that the height from which the water falls from the fill into the pool is minimal, there is less spray onto the other tower parts, and thus the likelihood of ice forming is lower.
- Because water distribution is carried out from the hot water basin on the top of the cooling tower, the hot water can be directed such that it better rinses the fill parts close to the tower's exterior, which is exposed to outside temperatures. This continuous rinsing of the fill, including the louvers, in hot water, reduces the likelihood of ice forming. The water distribution from the hot water basin can be regulated by temporary dams or by increasing the nozzles' diameters on the sides closest to the tower's air inlet points.
- Running the fan in reverse to thaw ice is the most effective in crossflow towers, due to the hot water distribution's being via the fill. As a result, melting ice is easier done in these towers, as it is done using both hot water and hot air. In counterflow towers, the hot water distribution is less efficient in the fill on the exterior, due to the fact that thawing is based mostly on hot air from the fan via the fill, without the "aid" of hot water.
- One drawback of a crossflow cooling towers is the possibility of the hot water basin's overflowing, as water leaking/dripping therefrom will freeze much faster in cold weather, thus the criticalness of preventing such leakage.

While neither tower type – cross- or counterflow – has an absolute advantage in cold weather, it is clear that the least recommended configuration is that of a tower fitted with a forced-air fan. This is because due to pressure differences between the air entryway and air exit, recirculation of humid air is produced between the exitway to the entryway, where the motor and fan are located. This flow of humid air in extreme cold necessarily increases the likelihood of ice forming on the motor and fan.

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Summary

Cooling towers' robustness in extreme cold depends to a great extent on frequent inspection and monitoring of the tower's condition. Aids to preventing ice forming include mainly reducing the fan revolutions using VFD; hot water bypass directly into the basin to maintain the pool temperature above freezing, various heaters for the mechanical parts, and various additions that assist in accumulation and/or directing of heat to frozen areas. Crossflow towers have an advantage over counterflow towers due to the former's structure and nature of operation.

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