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The Effect of Wind on the Performance Natural Draft Dry Cooling Towers in an Inline Arrangement

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Natural draft dry cooling towers (NDDCT) are a favourable cooling system for concentrated solar thermal power (CSP) plants which are often located in arid regions with high solar radiation. However, as the capacity of the CSP plants is increased, additional cooling towers may be required. The geometrical arrangement of the NDDCTs, particularly under windy conditions, could affect the thermo-flow performance of the entire system. Previous studies have discussed the effect of wind on performance of an isolated short cooling tower (Li et al., 2017; Lu et al., 2015) but have not explored the situation of multiple towers on a single site. The aim of this study was to investigate the effect of tower spacing and crosswind velocity on the performance of three short NDDCTs in an inline layout such that there is a windward tower, middle tower, and leeward tower.

Computational fluid dynamics (CFD) modelling was carried out to model the NDDCTs with horizontally arranged heat exchanger bundles at three different tower spacings of 1.8D, 2.6D, and 4.2D (D is the diameter of the tower) and crosswind velocities (0-8 m/s). In doing this a commercial RANS finite volume code was used to carry out these simulations, where the turbulent field was simulated using the realizable k-ε turbulence model. The dimensions of the tower and horizontally arranged heat exchanger paramameters were based on a 20m tall cooling tower operated by the University of Queensland (Li et al., 2015).

It was found that the performance of the NDDCTs depended on the crosswind velocity and tower spacing. More specifically, the combined heat rejection of the NDDCTs was reduced at low tower spacing in the absence of the wind and the heat rejection of the windward tower was lower than the middle and leeward towers for all crosswind velocities and tower spacings. At high crosswind velocities, there was a noticeable performance improvement in the middle tower due to it being protected from the crosswind effect by the windward and leeward towers. As such, it suggests that for a site with a prevailing wind direction, there may be an opportunity to configure additional cooling towers to take advantage of the passive windbreak effect provided by existing towers.

References

Li, X., Guan, Z., Gurgenci, H., Lu, Y., He, S., 2015. Simulation of the UQ Gatton natural draft dry cooling tower. Applied Thermal Engineering.

Li, X., Xia, L., Gurgenci, H., Guan, Z., 2017. Performance enhancement for the natural draft dry cooling tower under crosswind condition by optimizing the water distribution. International Journal of Heat and Mass Transfer 107, 271-280.

Lu, Y., Guan, Z., Gurgenci, H., Hooman, K., He, S., Bharathan, D., 2015. Experimental study of crosswind effects on the performance of small cylindrical natural draft dry cooling towers. Energy Conversion and Management 91, 238-248.