Droplet separators for evaporative towers: efficiency estimation by PDA

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Abstract

A PDA system has been set up to characterize the behavior of different arrangements of static panels that are used as drift eliminators to intercept and remove residual water droplets entrained in the hot air flow released by an evaporative tower. The tested tower has a square section of 60x60 cm, that is the standard size for modular separation filters; it was tested while working with or without the droplet separators to allow comparisons. The residual water droplets entrained by the air flow and expulsed by the tower are measured few centimeters above the tower exhaust and characterized by the PDA system; the droplet population main parameters (number, velocity, mean diameters) can be calculated. The top chart on the right shows the droplet distribution measured over the whole exit section, binned per diameter classes. The percentage of droplets contained in each bin is calculated both respect to the total number and to the total volume of the detected droplet. The velocity-diameter plot of the same droplets shows other aspect of the population. The velocity spread reflect the high turbulence of the exhaust air flow. Larger droplet have smaller velocity, since the gravitational downward force is not negligible compared to the aerodynamic upward drag from the air flow. Few very large droplets have negative velocity: they are interpreted as droplet that after expulsion, are falling back downward. The use of an LDV-PDA allows to detect such droplets and to discard them from the efficiency calculations. The separation efficiency can be calculated by direct comparison of the number of water droplets that are detected in the exhaust air flow, both globally and for specific classes of droplet diameters. Global results can be calculated on the basis of the number or of the volume of the droplet. The test can be repeated with different arrangements; in the chart on the right it is reported the effect of using up to three layer of droplet separators to increase the separation efficiency. The accuracy of the efficiency estimation is also studied. Two main aspects are considered. The first is that the PDA measurement volume dimension changes with the detected droplet size: it should have negligible effect on the result per classes of diameters, but the effect on the global efficiency is present and will be discussed. The second aspect is the presence of droplet that are falling downward in the upward air flow: their presence should be considered and corrected for. The results of this paper are useful when comparing them to other measurements obtained with techniques that are not able to detect the droplet velocity.