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Harvesting industrial fog and in situ removal of organic pollutants from collected water

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Industrial make-up water accounts for about 95% of the overall fresh water consumption globally, and an efficient fog water harvesting will provide a relief to the increasing fresh water stress. Like the atmospheric fog harvesting, industrial fog harvesting, i.e. tapping fog water from industrial cooling tower (CT) plumes or circulating water outlet, can be a viable alternative source of freshwater. Industrial fog harvesting from vertical cooling tower plumes offer a few additional challenges over the traditional atmospheric fog harvesting because of the relative orientation of the fog nets with the fog plume, CT fan rotation and gravity. We used stainless steel wire meshes in different frame sizes with varying pore density (shade coefficients) and surface wettability. Fog collection is characterized under different angles of orientation of the fog nets with the upward moving fog stream. Factors influencing the aerodynamic, deposition and drainage efficiencies are identified and recommendations for improvement of fog capture efficiencies are made. Making the surface superhydrophobic is found to minimize mesh clogging, but it also increases premature dripping of water from the mesh. Superhydrophilic surfaces are found to offer more clogging than their superhydrophobic counterparts. The dimension and shape of the fog nets are also found to influence the collection efficiency.

Besides the CTs, large loads of industrial fog are also found to appear in several industrial premises, e.g., in paper mills or other process plants where evaporative removal of process water needs to be performed as a process protocol. Large amount of fog are produced in such plants, which are often loaded with pollutants like volatile organic compounds (VOCs). Harvesting this industrial fog (e.g., from the exhaust hoods of the plant sheds) and re-using of the collected water requires that the collected water is freed from the pollutants. We demonstrate the use of an advanced mesh design that, besides capturing the fog, also degrades the VOCs present in the fog. We use stainless steel meshes, electrophoretically coated with TiO_2 nanoparticles that act as catalyst to degrade the VOCs in the fog water. Methylene blue (MB) particles are seeded in the fog as a surrogate of VOCs for characterizing the performance of the mesh. The organic molecules degrade in presence of weak UV light or very low visible light sources (395nm-405nm) as the fog deposits on the mesh. MB concentration recorded from the collected water shows in situ degradation of MB. Once the meshes are UV-activated, the VOC-breakdown continues (albeit at a reduced magnitude) for several hours even after the removal of the UV light. The research shows avenues of collection and purification of water from industrial fog.