ABSTRACT

Design characteristics of circular stepped cascade pump (CSCP) aerator were studied to optimize the geometric parameters of the cascade, to develop detailed, scaleable and predictive model equations for evaluation of aeration performance and to fabricate prototype CSCP aerators and test their performance. Aeration experiments were conducted with various designs of circular stepped cascades in brick masonry tanks of dimensions 4 × 4 × 1.5 m^3 and 5 × 5 × 1.5 m^3 to study the effect of geometric and dynamic variables on aeration process based on dimensional analysis. Optimum values for the non-dimensional geometric parameters were established by conducting experiments on the basis of response surface methodology (RSM) by adopting a three factor, five level central composite rotatable design (CCRD) using the software "Design Expert" keeping non-dimensional dynamic parameters constants. The effects of different dynamic conditions on geometrically similar circular stepped cascades were ascertained by performing aeration experiments with different sizes of cascades operated at different pump discharges. Simulation equations for oxygen transfer and power consumption based on Froude (Fr) criterion were developed subject to $0.0014 \leq Fr \leq 0.0144$. SAE of the developed prototype CSCP aerators based on estimated brake power ranges between 2.16 to 2.70 kg O_2/kWh.

Keywords: Cascade aerator, circular stepped cascade, aeration performance, aeration efficiency, dimensional analysis, similarity criteria, response surface methodology.