ABSTRACT

Growing concern about the effect of emitted air pollutants from the industry on environment, abatement of those pollutants is now a very serious issue. This study is not only focused on the industrial emitted pollutants, also deals with the abatement of one of the major fission product iodine due to accidental discharge from the nuclear power plant. Nowadays, filtered containment venting system (FCVS) is an essential safety technology in nuclear power plant. Venturi scrubber is major part of FCVS system. For developing the highly efficient FCVS system, modification can be made in venturi scrubber. In present research, a forced feed venturi scrubber has been designed for the removal of iodine. Hydrodynamic study has been done in this forced feed venturi scrubber for getting the detailed information about flow characterization. Maximum pressure drop 372.54 Pa was found at throat gas velocity of 22 m/s and liquid flow rate of 0.033 kg/s. The minimum pressure drop, 33.41 Pa was obtained at throat gas velocity of 6 m/s and liquid flow rate of 0.008 kg/s. CFD simulation was also carried out to validate the experimental results. Furthermore performance study was conducted for iodine removal in forced feed venturi scrubber using water and potassium iodide (KI) solution as scrubbing liquid. Maximum iodine removal, 82.32% was obtained at 3×10^{-3} kmol/m^3 KI solution, throat gas velocity of 18 m/s and liquid flow rate of 0.033 kg/s with iodine inlet concentration of 0.39 kg/m^3. On the other hand, a self priming venturi scrubber has been designed for the removal of HCl gas and fly ash. Experiments were conducted at non-submerged and submerged condition. Where, 0.4 m and 0.5 m liquid level was as non-submerged condition and 0.67 m and 0.77 m was as submerged condition. From hydrodynamic study, maximum pressure drop, 8619.31 Pa was obtained at throat gas velocity of 72 m/s and 0.77 m of liquid level and lowest pressure drop, 2427.97 Pa was at 36 m/s throat gas velocity and 0.4 m of liquid level. From performance study, 92.54% as maximum HCl removal efficiency was achieved with 0.005N NaOH as scrubbing liquid at throat gas velocity of 60 m/s, inlet HCl loading of 500 ppm and liquid level of 0.77 m. Maximum fly ash removal, 99.89% was obtained at same throat gas velocity and liquid level and inlet fly ash concentration of $0.3x10^{-3}$ kg/Nm^3. It is also noticed that submerged condition gives better efficiency than the non-submerged condition. Simultaneous removal of HCl gas and fly ash in self priming venturi scrubber gives maximum HCl removal, 98.3% at 60 m/s of throat gas velocity, 0.77 m of water height, 500 ppm of inlet HCl concentration and $0.3x10^{-3}$ kg/$Nm^3$of inlet fly ash concentration. For industrial application, this study is also deals on modelling and optimization of HCl gas in self priming venturi scrubber using response surface methodology. Optimum conditions were found as 55.18 m/s of throat gas velocity, 405.10 ppm of inlet HCl concentration and 0.0038 N of NaOH concentration in scrubbing liquid at 90.80%, maximum removal efficiency of HCl.

Keywords: Air pollution control; venturi scrubber; self priming; wet scrubbing; iodine removal; HCl gas; CFD; particulate matter; hydrodynamics; optimization.