Exploring the removal characteristics of heavy metals employing Nanofiltration (NF) technique

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Heavy metals are serious environmental concern in recent industrial era, release from different industrial process. These are non-degradable, persistent, highly toxic and tendency of bioaccumulation into body tissues of organism, which causes several health consequences. Various technologies have been reported to develop so far in the removal of these contaminants which primarily include adsorption, chemical precipitation, and phytoremediation. These are conventional techniques of treatment process, which have several disadvantages such as high treatment cost, generation of sludge in bulk and requirement of large amount of adsorbent. From last few decades, usage of nanofiltration membrane (NF) during treatment process has gained significant attention in chemical processing, biotechnology and desalination industries. Recently, nanofiltration technique has been reported to be employed for the treatment of heavy metals in electroplating industries, due to its high efficiency, less energy consumption and minimum generation of toxic sludge. Therefore, a synergistic approach has been explored for the removal of concerned metals in combination with the electrocoagulation technique.

In present study, synthetic waste water was formulated containing different concentration of Zn, Cu and Ni metal ions for the treatment process. A central composite design was explored to study the effect of variable such as pH, concentration, pressure temperature ranges from the value of 4.5-9.5, 10-20 bar, 10-25 ppm and 15-35-degree C, respectively. A set of 30 experimental runs was examined for the removal. Further, the Response Surface Methodology (RSM) was adopted to optimize the removal percentage (maximize) by minimizing the pressure and maximizing the concentration. The experiments were also performed at the optimize conditions which have shown significant co-relation with the predicted values.

The removal percentage (%) of 99.96, 99.82 and 99.93 was observed at temperature of 15 -degree C for Cu, Ni and Zn metal ions, respectively. At low pH, high copper removal was observed as compared to those nickel and zinc ions. The high removal of copper occurred due to the formation of its precipitates at lower pH. The results show that the value of pH and metal concentration are not significantly affected the flux while pressure and temperature increase flux increase. This can be attributed to the fact that increased temperature decreased the viscosity and increase in the diffusion rate of solute through the membrane. The effect of pH and concentration on removal efficiency shows that the removal efficiency increases as pH increases while it decreases with the increased concentration. At desirability 0.993, the maximum removal of Zn, Ni, Cu were observed to be 101.53, 97.81 and 102.48, respectively. The maximum flux 225.88 was achieved at ambient temperature of 25-degree C. A good correlation of 0.9823 was observed for the experimental outcomes among the optimised experimental runs and predicted values.

Keywords: Nanofiltration, Response Surface Methodology (RSM), Electroplating Industry

