Contents lists available at ScienceDirect

Process Safety and Environmental Protection

journal homepage: www.elsevier.com/locate/psep

Development of SVR-based model and comparative analysis with MLR and ANN models for predicting the sorption capacity of Cr(VI)

Nusrat Parveen, Sadaf Zaidi, Mohammad Danish*

Department of Chemical Engineering, Aligarh Muslim University, India

ARTICLE INFO

Article history:
Received 6 December 2016
Received in revised form 27 February 2017
Accepted 1 March 2017
Available online 12 March 2017

Keywords:
Biosorption
Low cost biosorbent
Support vector regression (SVR)
Multiple linear regression (MLR)
Artificial neural networks (ANN)
Heavy metals removal

ABSTRACT

Environmental pollution due to heavy metals has become a global concern. Among all existing processes such as chemical precipitation, electro-dialysis etc., biosorption has been recognized as an efficient treatment for the wastewater containing heavy metals like Cr(VI). In this study, the soft computing technique support vector regression (SVR), has been used for predicting the sorption capacity of Cr(VI) with the independent parameters including contact time, initial sorbate concentration, pH of the medium and temperature using agricultural waste 'maize bran' as a low cost biosorbent. The developed SVR-based model has been compared with multiple linear regression (MLR) and artificial neural network (ANN) in terms of statistical evaluation parameters. The correlation coefficient (R) for the SVR, ANN and MLR model are 0.9986, 0.9331, 0.8955 while the average absolute relative error (AARE) are obtained as 1.30%, 9.52% and 13.16% respectively. The SVR model is found to be superior than the MLR and ANN models for predicting the sorption capacity of Cr(VI). Furthermore, the effects of the input parameters on the sorption capacity of Cr(VI) employing the MLR, ANN and SVR-based models have been simulated and the obtained results revealed that the SVR-based model is the most accurate, precise, and highly generalized.

1. Introduction

Presence of organic pollutants and heavy metals like Cr(VI) in water has become a major issue in many countries. Organic pollutants can be pesticides, fertilizers, hydrocarbons, phenols, dyes, plasticizers, biphenyls, detergents, oils, greases, pharmaceuticals, surfactants, alcohol, proteins and carbohydrates. The main sources of organic pollutants are domestic sewage (raw or treated), urban runoff, industrial (trade) effluents and farm wastes. The large amount of organic material in the form of sewage effluents is found in the freshwater. 99.9% water is present in raw sewage and only 0.1% is solids in which 70% is organic containing 65% proteins, 25% carbohydrates, 10% fats. Large quantities of suspended solids are also present in organic effluents which hinder the light available to photosynthetic organisms. Moreover, organic wastes coming from humans and animals might contain disease causing pathogens. Adsorption offers a good solution for the removal of these organic pollutants (Rashed, 2013; Ali et al., 2012; Mateen et al., 2016).

Of greater concern is the damage being caused by the concentration of heavy metals far exceeding the permissible standards. These heavy metals are non-biodegradable and also toxic. They are a threat to both the environment and human life.

Some recent experimental studies based on ion-exchange and adsorption have been reported in literature. Naushad and ALOthman (2015) and Naushad et al. (2015b), have reported the separation of toxic Pb^{2+} metal ion from aqueous solution using strongly acidic cation-exchange resin. Mittal et al. (2016), have reported the fabrication of MWCNTs/ThO_2 nanocomposite and its adsorption behavior for the removal of Pb(II) metal from aqueous medium. Bushra et al. (2015) have reported the use of polyaniline supported nanocomposite cation exchanger for the efficient removal of Pb^{2+} ion from aqueous medium. Naushad et al. (2015a), have discussed the adsorption kinet-

* *Corresponding author.*
E-mail addresses: nusratalig@gmail.com (N. Parveen), sadaf63in@yahoo.com (S. Zaidi), mdanish@rediffmail.com (M. Danish).
http://dx.doi.org/10.1016/j.psep.2017.03.007