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Optimization of Artificial Neural Network Model in Scaling Factor Determination Method

Sang Chul Lee, Ki Ha Hwang, Sang Hee Kang, Kun Jai Lee
Korea Advanced Institute of Science and Technology, 373-1, Gusong-dong, Yuseong-gu, Daejeon

Final disposal of radioactive waste generated from Nuclear Power Plant (NPP) requires the detailed information about the characteristics and the quantities of radionuclides in waste package. Most radionuclides are difficult to measure and expensive to assay. Thus it is suggested to the indirect method by which the concentration of the Difficult-to-Measure (DTM) nuclide is estimated using the correlations of concentration-it is called the scaling factor-between Easy-to-Measure (Key) nuclides and DTM nuclides with the measured concentration of the Key nuclide. In general, the scaling factor is determined by the log mean average (LMA) method and the regression method. However, these methods are inadequate to apply to fission product nuclides and some activation product nuclides such as ^{14}C. To improve this conventional SF determination method-the LMA method and the regression method, the artificial neural network (ANN) method can be used. To apply the adequate ANN model in SF determination, it is important to determine the adequate size of hidden layers of the ANN model. In this study, to determine the optimum size of hidden layers of ANN models, the ANN models having the various hidden layers and nodes are assessed by the root mean squared errors (RMSE) in two parts divided by a training part and a validation part. The arithmetic mean values of the RMSEs for each ANN model make little difference. However, the dispersions of the RMSEs depend on the number of hidden layers and the number of hidden nodes. Sometimes the ANN models having 12 or less hidden nodes in one hidden layer and those having 8x7 or less hidden nodes in two hidden layers make very poor predicted values of the activities of DTM nuclides. In case of a poor case, the RMSE is larger than those in a general case. Therefore, the RMSEs of the ANN model which sometimes makes poor cases are dispersed widely and those of the ANN model which never makes poor cases are dispersed narrowly. It is concluded that the ANN model having 14 or more hidden nodes in one hidden layer and those having 10x9 or more hidden nodes in two hidden layers are suitable for SF determination method.