Thermal conductivity prediction of nano enhanced phase change materials: A comparative machine learning approach

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ABSTRACT

Thermal conductivity is one of the crucial properties of nano enhanced phase change materials (NEPCM). Then, in this study three different machine learning methods namely MARS (Multivariate Adaptive Regression Spline), CART (Classification and Regression Tree) and ANN (Artificial Neural Network) is applied to estimate the thermal conductivity of NEPCMs. To develop these models, the information of the different types of NEPCM were collected from 25 studies. The nano particle includes CNF, h-BN, CBNP, GNP, MWCNT, TiO_2, SiC, GO, CuO, ZrO_2, EG and the PCMs were Paraffin, Polyethylene glycol, Dimethylformamide, Myristic acid, High Density Polyethylene, Phenol, Stearic acid, Erythritol, Eicosane, Palmitic acid and n-octadecane. The total number of samples were more than 911 data to train, test and validate the models. The input parameters for the model were thermal conductivity of nano particle and PCM (W/m.K), phase of NEPCM (solid or liquid), temperature of NEPCM (°C) and concentration of nano material (wt%) and the output of the models was the thermal conductivity of the NEPCM (W/m.K). The results of the study showed the thermal conductivity of PCM is main effective parameter on the thermal conductivity prediction of NEPCM in all three models. Moreover, the accuracy of the predicted values by ANN model has shown the ability of the ANN to find relationship between dependent and independent variables complex problem and R^2 for MARS, CART and ANN model were 0.93, 0.93 and 0.96, respectively. Furthermore, the phase of the NEPCM, which has been used first time uniquely as a predictor in this study, has been second important variable in the developed models. Then, the developed ANN model in this study, as the first general ANN model for prediction of the thermal conductivity of NEPCM for carbon, metal and metal oxide nano particles combined with different types of PCM, can be used to estimate thermal conductivity of various type of NEPCM.

KEYWORDS

ANN; CART; MARS; PCM; Thermal conductivity; Nano

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