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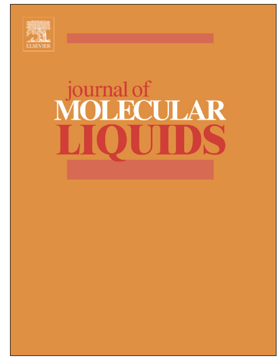

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Accurate Prediction of Water Dewpoint Temperature in Natural Gas Dehydrators Using Gene Expression Programming Approach

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Abstract

Triethylene Glycol (TEG) is one of the most frequently applied liquid desiccants in natural gas dehydration. For this purpose, minimum concentration of TEG is necessary to achieve the outlet gas water dewpoint specification. Several empirical models have been developed to predict the equilibrium established between water vapor and TEG; however, the existing models requires numerous input parameters needing to longer and more complicated calculations. Thus, in present study, the most recent and powerful mathematical strategy known as, Gene Expression Programming (GEP), was applied to develop an easy-to-use and a simple mathematical expression for prognostication equilibrium water dewpoint temperature as a function of contactor temperature and TEG purity in water. For absolute pressures up to 10300 kpa (10.3 MPa), equilibrium water dewpoint temperature is nearly independent of operating pressure. For this, 167 datapoints were collected from the open literature, then the database was divided into the two sets of training (about 80% of the databank) and test (about 20% of the databank). Comprehensive error analysis and diverse graphical illustration were employed to show the performance of the developed empirically derived correlation in this study. The results of the GEP model was also compared with the previously published correlation available in literature, which leads to this consequence that the proposed model in this study is a more efficient approach with higher simplicity than the prementioned literature correlation. GEP-based model gives an acceptable agreement with experimental databank reported in the open literature in terms of determination coefficient (R^2) of 0.9820 and Root Mean Square Error (RMSE) of 3.5018. With respect to cumulative frequency analysis, it is understood that about 80% of the whole databank used in this study have estimation error equal or less than 0.2. The results of sensitivity analysis approved that the TEG purity is the most affecting variable on the natural gas dehydration. At last, it can be concluded that the suggested GEP-based empirically-derived correlation is an efficient tool for experts working in gas industry to have a quick check on equilibrium water dewpoint temperature at various TEG concentrations and temperatures.

Keywords: Natural gas dehydration; Triethylene glycol; Equilibrium water dewpoint temperature; Gene expression programming; Correlation; Error analysis.