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Method of Estimating Absolute Entropy of Municipal Solid Waste

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Abstract : Entropy, as an outcome of the second law of thermodynamics, measures the level of irreversibility associated with any process. The identification and reduction of irreversibility in the energy conversion process helps to improve the efficiency of the system. The entropy of pure substances known as absolute entropy is determined at an absolute reference point and is useful in the thermodynamic analysis of chemical reactions; however, municipal solid waste (MSW) is a structurally complicated material with unknown absolute entropy. In this work, an empirical model to calculate the absolute entropy of MSW based on the content of carbon, hydrogen, oxygen, nitrogen, sulphur, and chlorine on a dry ash free basis (daf) is presented. The proposed model was derived from 117 relevant organic substances which represent the main constituents in MSW with known standard entropies using statistical analysis. The substances were divided into different waste fractions; namely, food, wood/paper, textiles/rubber and plastics waste and the standard entropies of each waste fraction and for the complete mixture were calculated. The correlation of the standard entropy of the complete waste mixture derived was found to be s^o_{msw}= 0.0101C + 0.0630H + 0.0106O + 0.0108N + 0.0155S + 0.0084Cl (kJ.K⁻¹.kg) and the present correlation can be used for estimating the absolute entropy of MSW by using the elemental compositions of the fuel within the range of 10.3% ≤ C ≤ 95.1%, 0.0% ≤ H ≤ 14.3%, 0.0% ≤ O ≤ 71.1%, 0.0 ≤ N ≤ 66.7%, 0.0% ≤ S ≤ 42.1%, 0.0% ≤ Cl ≤ 89.7%. The model is also applicable for the efficient modelling of a combustion system in a waste-to-energy plant.

Keywords : absolute entropy, irreversibility, municipal solid waste, waste-to-energy
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