Water solubility of solid solution of phenanthrene and anthracene mixture

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ABSTRACT

The solubility of polycyclic aromatic hydrocarbons (PAHs) in water is of fundamental importance in understanding the leaching behavior of PAHs from landfills, contaminated soils, and waste treatment plants. Although a lot of investigators have measured the water solubilities of pure PAHs, the solubility data of binary or multicomponent PAHs mixtures are rarely available. Such data are more useful for understanding details of the leaching behavior. Generally, aqueous phase composition at saturation of binary solutes is the invariant point according to Gibbs' phase-rule, or independent of the mixing ratio of the solutes. If a binary solute mixture forms a solid solution, however, the water solubility of each solute depends on the composition of the solid. It is well-known that a mixture of phenanthrene and anthracene forms the solid solution within the whole composition range. Therefore, the water solubilities of their solid solutions corresponding to various solid compositions should be measured when predicting the leaching behaviors of those compounds from solidified materials of liquid PAHs mixture such as solidified tar pitch or creosote.

In this work, the water solubility of solid solution form of phenanthrene and anthracene, namely the saturation concentrations of these compounds in water, and the influence of solid composition on the solubility were investigated. Prior to solubility measurement, first, the solid-liquid equilibrium for this binary mixture was measured with a differential scanning calorimeter to prepare solid solution crystals with the solid composition of interest. The solid solution sample was prepared by melting a solid mixture of phenanthrene and anthracene to a homogenous liquid over the melting point and then quenching the liquid to crystallize. The water solubilities of the solid solutions with different compositions between 283 K and 308 K were measured by the shake flask method. The present experimental results showed that the solid composition had a significant effect on the water solubility of the solid solution as follows: The saturation concentration of a solute decreased with an increase in the amount of the other in solid phase. In addition, the temperature dependence of water solubility of each solute was affected by the solid composition. Finally, we tried to develop a numerical equation to represent the solubility behavior.