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NASA TECH BRIEF

Simple Method for Predicting Viscosity of Gas Mixtures

An approximate method has been developed for predicting viscosities of gas mixtures. The method is derived from the rigorous Chapman-Enskog theory which describes the viscosity behavior of gas mixtures at low-to-moderate pressures. However, the rigorous expression for mixture viscosity is algebraically complex and requires the solution of a system of as many simultaneous equations as there are components in the mixture.

For mixtures of nonpolar gases (gases without dipole moments), only the viscosities and molecular weights of the constituents are required in addition to the mixture composition. With polar gases, the dipole moments, boiling points and liquid boiling point densities are also needed. Certain coefficients which are complicated functions of molecular weight need not be computed since they can be read simply from a chart which has been developed:

$$\eta_{mix} = \sum_{i=1}^{\nu} \frac{x_i \sqrt{\eta_i}}{\frac{x_i}{\sqrt{\eta_i}} + \sum_{\substack{j=1 \\ j \neq i}}^{\nu} \frac{S_{ij} A_{ij}}{\sqrt{\eta_j}} x_j}$$

where η_{mix} is the mixture viscosity while η_i is the viscosity of component i; x_i and x_j are mole fractions that specify the composition. The A_{ij} are obtained from a chart in terms of the molecular weight of the constituents; and S_{ij} are calculated from the boiling points and dipole moments of the constituents.

The method was tested by comparison with experimental data on 25 gas pairs comprising 280 mixtures; the average error was 0.7 percent and the maximum error was 3.7 percent. The Chapman-Enskog theory calculations were available for several of the mixtures and showed comparable errors.

Notes:

1. Errors may be much larger if the method is used for gas mixtures involving ions, free radicals, or valence unsaturated atoms.
2. A similar technique for calculating the thermal conductivities of gas mixtures is presented in I&EC Process Design & Development, vol. 8, pp. 240-253, April 1969.
3. The following documentation may be obtained from:

   Clearinghouse for Federal Scientific and Technical Information
   Springfield, Virginia 22151
   Single document price $3.00
   (or microfiche $0.65)

   Reference:
   NASA-TN-D-4496 (N68-21729),
   Viscosity of Gas Mixtures
4. Technical questions may be directed to:

   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio 44135
   Reference: B70-10361

Patent status:

No patent action is contemplated by NASA.

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Category 04