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Lewis Research Center

Computer Program for Calculating Water and Steam Properties

A computer subprogram, WASP, was developed to calculate the thermodynamic and transport properties of water and steam. The temperature range is from the triple point to 1750 K (2690°F), and the pressure range is from 0.1 to 100 MN/m^2 (1 to 1000 bars) for the thermodynamic properties and to 50 MN/m^2 (500 bars) for thermal conductivity and to 80 MN/m^2 (800 bars) for viscosity. WASP accepts any two of pressure, temperature, and density as input conditions. In addition, pressure and either entropy or enthalpy are also allowable input variables. This flexibility is especially useful in cycle analysis. The properties available in any combination as output include temperature, density, pressure, entropy, enthalpy, specific heats (C_p and C_v), sonic velocity, $(\partial P/\partial \rho)_T$, $(\partial P/\partial T)_\rho$, viscosity, thermal conductivity, surface tension, and the Laplace constant.

Printed tables of water and steam properties have been available to the engineer for many years. Numerous computer codes to interpolate these tables using a variety of curve-fit and interpolation techniques are available. Many are cumbersome or lack the ability to calculate a consistent set of properties for a given point on the fluid surface. Some are designed for specific uses and do not include all the properties. The WASP computer program is comprehensive, flexible, and has an internally consistent computer code for water properties.

The thermodynamic properties are based on calculations using the Helmholtz free-energy equation of Keyes, Keenan, Hill and Moore; the transport properties are calculated by using standard curve fits in regions where these equations exist and are interpolated elsewhere. Temperature and all the other properties can be obtained as a function of pressure and enthalpy (or pressure and entropy). This option is of value in forced-convection studies and cycle analysis.

Notes:

1. WASP is a group of subroutines designed to be used as a subprogram with the user's program. Standard communication between the user's program and WASP is achieved by two FORTRAN statements which contain the symbols representing the input/output parameters and options.
2. The subroutine structure is modular so that the user can choose only those subroutines necessary to his calculations.
3. Mestastable calculations can also be made by using WASP.
4. The program is written in FORTRAN IV for use on an IBM 7094-7044 DCS.
5. The authors adapted the code to fit the following compilers and machines: UNIVAC 1106, 1108, CDC 3600, CDC 6600, IBM 360/67TSS.
6. Inquiries concerning this program should be directed to:

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