Computer Code Abstract

STP

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1. Program Name and Title: STP-FORTRAN Library Routines for Steam Table Properties.

2. Problem Solved: The STP library of subroutines[1] calculates a set of thermodynamic properties of water including temperature, pressure, specific volume, specific enthalpy, specific entropy, specific internal energy, quality, constant pressure specific heat, isothermal compressibility, coefficient of volume expansion, sound speed, dynamic viscosity, and thermal conductivity. The properties are provided in either SI or U.S. customary units.

3. Method of Solution: The thermodynamic properties exclusive of transport properties are calculated with the fundamental equation of Keenan et al.[2] The dynamic viscosity and thermal conductivity are calculated with the latest interpolating equations recommended by the International Association for the Properties of Steam.[3-5] Density and temperature are the independent properties for the Keenan fundamental equation. Hence a state may be evaluated directly (explicitly) if density and temperature are specified. The evaluation of properties for states specified by pressure and enthalpy, pressure and entropy, or pressure and temperature is done by solving either one nonlinear equation in one unknown or two nonlinear equations in two unknowns. Saturation states are evaluated by specifying either temperature or pressure. The nonlinear equations are solved using state-of-the-art mathematical software based upon variations of Brent's algorithm.[6-8]

4. Restrictions: Pressure range for all routines is $6.097 \times 10^{-4} \rightarrow 100.0$ MPa. Temperature range for routines exclusive of transport properties is $0 \rightarrow 1300$°C. Temperature range for transport property routines is $0 \rightarrow 800$°C.

5. Unusual Features of the Program: The STP library has been designed for general use. Accuracy and user convenience are the major design criteria. The STP library uses the true saturation envelope of the Keenan fundamental equation. This envelope, along with other design features, imparts an exceptionally high degree of thermodynamic and mathematical consistency to the STP library, even at the critical point. Accuracy and smoothness, library self-consistency, and designed user convenience make the STP library a reliable and versatile water property package. User conveniences include extensive input checking, diagnostic messages, and the option of specifying either SI or U.S. customary units. Also the user does not need to specify the phase of the input state.

   The STP library is modular in structure. This allows the easy modification of the general purpose library routines for special applications to gain improvements in execution statistics and storage. Also the library may be easily expanded to enable the user to specify input states with property pairs other than that now provided.

6. Relationship to Other Programs: None.

7. Other Programming, Restrictions, or Operating Information: None.

8. Computer and Language(s): CYBER 171, CYBER 750, CDC 7600, FORTRAN.

9. Typical Running Time: Varies depending on whether the state evaluation is direct (density and temperature are input) or requires the solution of nonlinear equations to determine the corresponding density-temperature pair. On the CDC 7600, a state evaluation requires from 0.03 to 2.3 central processing unit milliseconds. However, all thermodynamic properties exclusive of transport properties are evaluated simultaneously with a single call.

10. Operating System: CYBER 171 NOS-BE, CYBER 750 NOS, CDC 7600 SCOPE 2.1.5.

11. Machine Requirements: The entire library requires ~11 000 octal storage locations. Individual subroutines may be used, thus reducing the required storage.

12. Availability: Available through Babcock & Wilcox Computer Services.

13. Status: Production.

14. *References*:

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