



## Research Activities on the Thermodynamic Properties of Water and Steam Report "Research in Progress" 2000

1. Development of backward equations  $p(h,s)$  for water and steam
  - The backward equations  $p(h,s)$  were refitted and successfully tested in process modelling. They can be used in combination with the Industrial Formulation IAPWS-IF97.
  - The Draft of the "Supplementary Release on Backward Equations for Pressure as Function of Enthalpy and Entropy  $p(h,s)$  to the IAPWS Industrial Formulation 1997 for the Thermodynamic Properties of Water and Steam" was formulated and sent to all members of the IAPWS Working Groups "Industrial Calculations" and "Thermophysical Properties of Water and Steam"
2. Preparation of program packages including the Industrial Formulation IAPWS-IF97 for the power industry
  - The Add-In FluidEXL *Graphics* for MS-Excel including graphical representation of the calculated data in thermodynamic charts was improved.
  - The Library FluidMAT for Mathcad 8 and 2000 was completed.
  - The electronic steam table FluidDAT *Graphics* including graphical representation of the calculated data in thermodynamic charts was improved.
  - The property program library for humid air was expanded and improved
3. Implementation of the Industrial Formulation IAPWS-IF97 on pocket calculators
  - The program FluidHP for the model HP 48G of Hewlett Packard was set up.
  - The program FluidTI for the models TI 92 and TI 89 of Texas Instruments was improved.
  - The program FluidCASIO for the model FX 880P of Casio was improved.
4. Program FluidDIA for generating camera ready thermodynamic diagrams for water and steam
  - The program FluidDIA was expanded to calculate and plot
    - oblique angled  $h,s$ -diagrams by Bošnjaković
    - $\log p, h$ - and  $h, p$ -diagrams
    - $h, \log \rho$ -diagrams including Hugoniot-curves
    - $h, x$ -diagrams for humid air for different pressures.

- Five diagrams for water and steam were prepared for the publication "Energietechnische Arbeitsmappe" of the German association of engineers VDI.
5. Property program libraries including the Industrial Formulation IAPWS-IF97 for education
- The Versions for students of the programs
    - Add-In FluidEXL *Graphics* for MS-Excel
    - FluidMAT for Mathcad
    - FluidTI for the pocket calculators TI 92 and TI 89
    - FluidCASIO for the pocket calculator CASIO FX 880P
    - FluidHP for the pocket calculator HP 48G
- were prepared in German and English.

### **Recent Publications**

Wagner, W., Cooper, J.R., Dittmann, A., Kijima, J., Kretzschmar, H.-J., Kruse, A., Mareš, R., Oguchi, K., Sato, H., Stöcker, I., Šifner, O., Tanishita, I., Trübenbach, J., and Willkommen, Th.: The IAPWS Industrial Formulation 1997 for the Thermodynamic Properties of Water and Steam, ASME Journal of Engineering for Gas Turbines and Power, Vol. 122, 2000, p. 150-182.

Kretzschmar, H.-J., Stöcker, I., Knobloch, K., Buchholz, St.:  
Diagrams for Water and Steam in: Energietechnische Arbeitsmappe, ed. by VDI-Energietechnik, Springer Verlag, Berlin, 2000, ISBN 3-540-66704-0

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