

## Property Libraries for Water and Steam and Related Mixtures for Calculating Heat Cycles, Turbines, Heat Pumps, and Refrigeration Processes

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The program libraries developed for calculating the thermophysical properties of water and steam and mixtures with water and steam are designed for very practical use by engineers who routinely calculate heat cycles, steam or gas turbines, boilers, heat pumps, or other thermal or refrigeration processes. Thermodynamic properties, transport properties, thermodynamic derivatives and inverse functions can be calculated. The electronic steam table library *LibIF97* has been set up to facilitate the modelling of heat cycles, boilers, and steam turbines. It calculates the properties of water and steam from the Industrial Formulation IAPWS-IF97 including all supplementary backward equations of IAPWS-IF97-S01, -S03rev, -S04 and -S05. Today, gas turbines are being developed for ever higher temperatures and pressures. The calculation of the combustion gases as ideal gas mixtures will, however, be inaccurate at high pressures. For this reason, the property library *LibHuGas* has been developed for humid combustion gases calculated as ideal mixtures of real fluids. The pointing effect of the saturation pressure of water in a gas atmosphere under pressure and the influence of the dissociation of the components at high temperatures have been taken into consideration. At present, processes using humid air as a working fluid are designed for pressures up to 10 MPa and, conceivably, higher. For example, the advanced adiabatic compressed air energy storage technology requires very accurate algorithms for the thermodynamic and transport properties of humid air at low temperatures and high pressures. At these parameters, humid air cannot be calculated as an ideal gas mixture. For this reason, the property library *LibHuAir* has been developed. It comprises the calculation of humid air as an ideal mixture of real fluids. Again, the pointing effect and dissociation are taken into consideration. The property library *LibAmWa* for ammonia/water mixtures can be used for calculating the Kalina process. This library and the property library *LibWaLi* for water/lithium bromide mixtures are also suitable for modelling absorption-refrigeration processes. The following software solutions will be presented: Property libraries for applications in user-specific programs written in Fortran, Pascal (Delphi), C++, or Visual Basic for use with the operating systems Windows<sup>®</sup>, Unix<sup>®</sup>/Linux<sup>®</sup>, Mac OS<sup>®</sup>, DLLs for Windows<sup>®</sup> applications, Add-In *FluidEXL* for Excel<sup>®</sup>, Add-On *FluidLAB* for MATLAB<sup>®</sup>, Add-On *FluidMAT* for Mathcad<sup>®</sup>, Add-On *FluidEES* for the Engineering Equation Solver<sup>®</sup>, the Program *FluidDIA* for calculating and plotting large and camera-ready thermodynamic charts, as well as programs for Texas Instruments, Hewlett Packard, and Casio pocket calculators. Student versions of all libraries and programs are available.

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