Steam Tables

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GLOSSARY

Critical point For a pure substance, the upper limit of the vapor–liquid saturation curve where the equilibrium vapor and liquid phases become identical and the compressibility of the fluid becomes infinite. For water, the critical point occurs at a temperature of approximately 374°C and a pressure of approximately 22 MPa.

Formulation A mathematical equation or set of equations from which a desired quantity or set of quantities (such as the thermodynamic properties of water) can be calculated.

Saturation A condition where two phases of a substance (in most common usage, the vapor and the liquid) are in thermodynamic equilibrium. Some thermodynamic variables, such as the temperature and pressure, have identical values in the two phases at saturation; other properties, such as density and enthalpy, have different values in each phase.

Skeleton tables Accepted values of properties presented at specific values (usually round numbers) of temperature and pressure. These are based on analysis and interpolation of data at nearby conditions, and an estimate of the uncertainty of each value at each point is usually included.

STEAM TABLES is the traditional name for tabulations of the thermodynamic properties of water in both its vapor (steam) and liquid states. This information is of particular importance for the steam power-generation industry, but many other industrial processes make use of water in some form and therefore need reliable values of its properties. In addition, water is widely used in research, and some of these uses require highly accurate representations of its properties. Modern "steam tables" are for the most part no longer printed tables, but are mathematical formulations implemented in computer programs.

I. INTRODUCTION

The need for standardized representation of properties of water and steam is most apparent in the power industry, where electricity is generated by passing large amounts of steam through turbines. The thermodynamic properties of water and steam are vital to the design of equipment and to the evaluation of its performance. Small differences in the properties used will produce small changes in calculated quantities such as thermal efficiencies; however, because of the magnitude of the steam flows, these differences can translate into millions of dollars. It is therefore essential that all parties in the steam power industry, particularly bidders and purchasers in contracts, use a uniform set of properties in order to prevent any party from having an unfair advantage.

For other industries, such as petroleum refining and chemical manufacturing, standardization of water properties is less important, but there is still a need for reliable thermodynamic values for process design, optimization, and operation. In some cases, the complexity of the formulation is an issue, because the properties must be evaluated within iterative calculations. Thus, there is an incentive to keep the formulations as simple as possible without sacrificing significant accuracy or consistency.

Scientific and engineering research also requires highly accurate values for properties of water. This is not only for work where water is used directly, but also because of the widespread use of water as a calibration fluid.

In this article, we review the historical development of steam tables and then describe the current international standards as maintained by the International Association for the Properties of Water and Steam (IAPWS). While the primary focus of steam tables (and therefore of this article) is thermodynamic properties (density, enthalpy, entropy, etc.), other properties (such as viscosity, thermal conductivity, and dielectric constant) are also of some importance and will be mentioned briefly.

II. EARLY HISTORY OF STEAM POWER AND STEAM TABLES

About 2000 years ago, a figure showing a workable steam reaction turbine was included in a book by Hero of Alexandria. He showed other ways in which steam, or other hot gases, could be used to do mechanical work, and used the boiler, valve, and piston (basic components of a steam engine) at various places in his book. In spite of this promising start, the use of steam for power never advanced significantly in antiquity; it remained for later generations to develop its potential.

Although early engines of Papin, Savery, and Newcomen paved the way, it was James Watt in the late 1700s who made steam power an industrial success. Watt greatly improved the design of steam engines and took advantage of the improved metal-working techniques then available. Early in his career, Watt measured the temperature and pressure of saturated steam and constructed a curve through the points to permit interpolation. In a sense this curve was the first steam table; however, the science of Watt's day was inadequate to make much use of such data.

In the 1840s, V. Regnault (with some assistance from a young William Thomson, who later became Lord Kelvin) produced a set of careful measurements of the properties of steam. These data and others from Regnault's laboratory provided a foundation for the development and application of the new science of thermodynamics by Thomson, Clausius, and Rankine. By the late 19th century, steam tables based on Regnault's data began to appear, and in 1900 Callendar devised a thermodynamically consistent set of equations for treating steam data. Further steam tables soon appeared based on Callendar's equations; Mollier published the first steam tables in modern form.

The proliferation of steam tables soon became a problem, because different tables used different data. The differences between tables were particularly serious at high temperatures and pressures, where industrial interest was concentrated in the quest for increased thermodynamic efficiency. In addition to uncertainties in design, the different tables made it difficult to compare designs from different manufacturers. It became clear that international standardization was necessary in order to put all parties in the industry on a fair, consistent, and physically sound basis.

III. INTERNATIONAL STANDARDIZATION

The first conference directed at producing international agreement on steam tables was held in London in 1929. After a second (Berlin, 1930) and a third (New York, 1934) conference, agreement was reached on a set of "skeleton tables." These tables consisted of a rectangular grid of temperatures and pressures, with values of specific volume and enthalpy determined at each point by interpolation of the surrounding data. Values were similarly determined along the vapor–liquid saturation curve. An estimated uncertainty was assigned to each value at each point. These tables and their supporting data were the basis for the widely used steam tables book of J. H. Keenan and F. G. Keyes, published in 1936, which became the *de facto* standard for engineering calculations for many years.

After World War II, international standardization efforts resumed. Improvements in power-generation technology required reliable properties at pressures and temperatures beyond the range covered by Keenan and Keyes, and new data (notably from laboratories in the Soviet Union) became available. At the Sixth International Conference on the Properties of Steam (New York, 1963), a new set of skeleton tables was approved, covering an expanded range of pressures and temperatures.

By 1963, it was recognized that the growing use of computers for engineering calculations made it desirable to represent the properties of water and steam by equations in addition to skeleton tables. An International Formulation Committee (IFC) was appointed to develop a consistent set of equations that reproduced the 1963 skeleton table values within their tolerances. The main product of this effort was "The 1967 IFC Formulation for Industrial Use" (known as IFC-67). This formulation, and the printed steam tables based on it, replaced the Keenan and Keyes tables as the standard for industrial calculations for the next 30 years. Because of its association with the book of the same name, it is sometimes called the 1967 "ASME Steam Tables" formulation, although the American Society of Mechanical Engineers was only one of several participants in the international effort, and steam tables based on IFC-67 were published in several countries in addition to the United States.

At about the same time, the need was recognized for a permanent organization to manage the international conferences and the maintenance and improvement of property standards. In 1968, the International Association for the Properties of Steam (IAPS) was established; in 1989 the name was changed to the International Association for the Properties of Water and Steam (IAPWS). IAPWS, which now has 11 member countries, continues to work to improve international standards for water and steam properties for use in science and industry. It meets annually, and sponsors an International Conference on the Properties of Water and Steam every five years. Some of the activities of IAPWS are discussed in the following sections.

IV. STANDARDS FOR GENERAL AND SCIENTIFIC USE

There are actually two different audiences for steam tables. The steam power industry, which historically provided the impetus for standardized steam tables, needs a formulation that can be calculated relatively quickly by computer for use in iterative design calculations. It also needs a standard that is fixed for many years, because switching from one property formulation to another involves much adjustment of software that uses steam properties and impacts areas such as contracting and testing of equipment where large sums of money are at stake. Once the accuracy attains a level sufficient for most engineering purposes, the industry is willing to forego additional accuracy for the sake of speed and stability.

However, there are other users in industry for whom speed and stability are not significant issues. In addition, researchers need to have the most accurate properties available for their work. IAPWS therefore has two separate tracks of standards. Formulations "for industrial use," such as IFC-67, are designed for computational speed and are intended to remain the standard for use in the power industry for decades. In contrast, formulations "for general and scientific use" are intended to be kept at the state of the art, giving the best possible representation of the best experimental data in conjunction with theoretical constraints regardless of how complicated they must be or how frequently they are updated.

The first thermodynamic property formulation for general and scientific use was adopted in 1968, but was never widely used. In 1984, IAPS replaced it with a formulation developed by L. Haar, J. S. Gallagher, and G. S. Kell. The Haar–Gallagher–Kell (HGK) formulation, codified in the *NBS/NRC Steam Tables*, saw widespread use as a standard for scientific work and for some engineering applications. It used a single thermodynamic function (the Helmholtz energy as a function of temperature and density) to cover a wide range of temperatures and pressures. This guarantees thermodynamic consistency and prevents the discontinuities inherent in formulations that use different equations for different pressure/temperature regions. While the HGK formulation was not the first to take this approach, it was the first such approach to be adopted as an international standard.

As better data became available and small flaws were found in the HGK formulation, IAPWS in the early 1990s began an organized effort to produce a replacement. A task group, led by W. Wagner, evaluated the available experimental data and worked on producing an improved formulation; others tested the formulation exhaustively. The final result was the "IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use," which we shall refer to as IAPWS-95.

The structure of IAPWS-95 is a single equation for the Helmholtz energy as a function of temperature and density. All thermodynamic properties can be obtained in a consistent manner from differentiation and manipulation of that equation. The equation was also forced to meet certain theoretical constraints such as a correct approach to the ideal-gas limit at low densities, and it closely approximates the correct behavior as water's critical point is approached.

IAPWS-95 is now the state of the art and the international standard for representing water's thermodynamic properties at temperatures from its freezing point to 1000°C and at pressures up to 1000 MPa. It also extrapolates in a physically meaningful manner outside this range, including the supercooled liquid water region. The uncertainties in the properties produced by IAPWS-95 are comparable to those of the best available experimental data; this is quite accurate in some cases (for example, relative uncertainty of 10^{-6} for liquid densities at atmospheric pressure and near-ambient temperatures) and less so where the data are less certain (for example, relative uncertainty of 2×10^{-3} for most vapor heat capacities). Values of properties for saturation states and the property change upon vaporization, as generated by IAPWS-95, are shown in a typical steam tables format in Table I.

Formulations for general and scientific use have also been adopted for other properties of water. The most industrially important of these are probably the viscosity and the thermal conductivity, although some other properties such as the static dielectric constant and the refractive index are important in research. There are also IAPWS formulations for some properties of heavy water (deuterium oxide, D_2O).

Table II shows all the properties for which IAPWS has thus far adopted official formulations (known as "releases"). Copies of specific IAPWS releases may be obtained at no charge from www.iapws.org or by requesting them from the Executive Secretary of IAPWS. Currently, the Executive Secretary is:

Dr. R. B. Dooley
Electric Power Research Institute
3412 Hillview Avenue
Palo Alto, California 94304

V. STANDARDS FOR INDUSTRIAL USE

As mentioned earlier, the steam power industry requires a standard formulation that is both stable (in the sense of not changing for tens of years) and computationally fast. For 30 years, the IFC-67 formulation mentioned in Section III fulfilled that need. Through the years, however, some deficiencies in IFC-67 became apparent. Probably the worst problems related to inconsistencies at the boundaries between the regions of pressure–temperature space in which different equations defined the formulation. These inconsistencies can cause problems in iterative calculations near the boundaries. Also, with improvements in optimization methods and computer technology, it was believed that the computational speed of IFC-67 could be surpassed. In addition, there was a desire (driven by the increasing use of combustion turbines) to add standard properties for steam at temperatures higher than the upper limit of 800°C for IFC-67.

Therefore, in parallel to (and slightly behind) the development of the IAPWS-95 standard for general and scientific use, IAPWS undertook an effort to develop a new formulation for industrial use that would replace IFC-67. This effort, led by a development task group chaired by W. Wagner and a testing task group chaired by K. Miyagawa, resulted in the adoption of a new standard in 1997 called "IAPWS Industrial Formulation 1997 for the Thermodynamic Properties of Water and Steam" (abbreviated IAPWS-IF97).

The structure of IAPWS-IF97 is shown in Fig. 1. It consists of five regions defined in terms of pressure and temperature. The heavy solid line (Region 4) is the vapor–liquid saturation curve, represented by a single equation giving the saturation pressure as a function of temperature (and vice versa). The compressed liquid (Region 1) and the superheated vapor (Region 2) are represented by equations giving the Gibbs energy as a function of pressure and temperature (the most convenient independent variables for typical power-industry calculations). Other thermodynamic functions are obtained by appropriate differentiation of the Gibbs energy function. A Gibbs energy equation is also used in Region 5, which covers the high-temperature range needed for combustion turbines. In Region 3, which includes the area around the critical point, a Helmholtz energy function is used with density and temperature as independent variables (because pressure and temperature do not work well as independent variables near the critical point). Careful efforts were made to ensure that the values of the thermodynamic properties at either side of the region boundaries matched within tight tolerances.

Figure 1 also indicates the so-called "backward" equations in Regions 1 and 2, which allow the temperature to be obtained directly from pressure and enthalpy, or pressure and entropy, without iteration. The backward equations were made to reproduce the results from iterative solution of the "forward" equations (which have p and T as independent variables) within close tolerances. The backward equations in IAPWS-IF97 provide a great increase in speed for calculations (common in the power industry) where pressure is known in combination with either entropy or enthalpy. The backward equations necessarily introduce some inconsistency compared to exact solution of the forward equations, but this is negligible for most purposes. If greater consistency is desired at the expense of speed, the backward equations can be used as initial guesses for iterative solution of the forward equations to the required precision.

The accuracy of IAPWS-IF97 is for the most part only slightly less than that of the IAPWS-95 formulation for general and scientific use. In fact, rather than being fitted to experimental data, IAPWS-IF97 was fitted to the IAPWS-95 formulation and therefore agrees with it closely.

For industrial users, switching from IFC-67 to IAPWS-IF97 can be a major effort. Especially in the design and testing of large power-generation equipment, the relatively small changes in properties can produce numbers sufficiently different to have a large economic impact. Other aspects of the design and testing process, including software, which have been "tuned" to give the right results for IFC-67 properties, must therefore be readjusted to be

TABLE I Thermodynamic Properties of Water in Saturated Liquid and Vapor States as Calculated from the IAPWS-95 Formulation

t (°C)	Pressure MPa	Volume, cm^3/g			Enthalpy, kJ/kg			Entropy, kJ/(kg·K)			t (°C)
		v_L	Δv	v_V	h_L	Δh	h_V	s_L	Δs	s_V	
0.01	0.000 612	1.0002	205 990	205 991	0.00	2500.9	2500.9	0.0000	9.1555	9.1555	0.01
5	0.000 873	1.0001	147 010	147 011	21.02	2489.0	2510.1	0.0763	8.9486	9.0248	5
10	0.001 228	1.0003	106 302	106 303	42.02	2477.2	2519.2	0.1511	8.7487	8.8998	10
15	0.001 706	1.0009	77 874	77 875	62.98	2465.4	2528.3	0.2245	8.5558	8.7803	15
20	0.002 339	1.0018	57 756	57 757	83.91	2453.5	2537.4	0.2965	8.3695	8.6660	20
25	0.003 170	1.0030	43 336	43 337	104.83	2441.7	2546.5	0.3672	8.1894	8.5566	25
30	0.004 247	1.0044	32 877	32 878	125.73	2429.8	2555.5	0.4368	8.0152	8.4520	30
35	0.005 629	1.0060	25 204	25 205	146.63	2417.9	2564.5	0.5051	7.8466	8.3517	35
40	0.007 385	1.0079	19 514	19 515	167.53	2406.0	2573.5	0.5724	7.6831	8.2555	40
45	0.009 595	1.0099	15 251	15 252	188.43	2394.0	2582.4	0.6386	7.5247	8.1633	45
50	0.012 352	1.0121	12 026	12 027	209.3	2381.9	2591.3	0.7038	7.3710	8.0748	50
60	0.019 946	1.0171	7666.2	7667.2	251.2	2357.7	2608.8	0.8313	7.0769	7.9081	60
70	0.031 201	1.0228	5038.5	5039.5	293.1	2333.0	2626.1	0.9551	6.7989	7.7540	70
80	0.047 414	1.0291	3404.1	3405.2	335.0	2308.0	2643.0	1.0756	6.5355	7.6111	80
90	0.070 182	1.0360	2358.0	2359.1	377.0	2282.5	2659.5	1.1929	6.2853	7.4781	90
100	0.101 42	1.0435	1670.7	1671.8	419.2	2256.4	2675.6	1.3072	6.0469	7.3541	100
110	0.143 38	1.0516	1208.2	1209.3	461.4	2229.6	2691.1	1.4188	5.8193	7.2381	110
120	0.198 67	1.0603	890.15	891.21	503.8	2202.1	2705.9	1.5279	5.6012	7.1291	120
130	0.270 28	1.0697	666.93	668.00	546.4	2173.7	2720.1	1.6346	5.3918	7.0264	130
140	0.361 54	1.0798	507.37	508.45	589.2	2144.3	2733.4	1.7392	5.1901	6.9293	140
150	0.476 16	1.0905	391.36	392.45	632.2	2113.7	2745.9	1.8418	4.9953	6.8371	150
160	0.618 23	1.1020	305.68	306.78	675.5	2082.0	2757.4	1.9426	4.8066	6.7491	160
170	0.792 19	1.1143	241.48	242.59	719.1	2048.8	2767.9	2.0417	4.6233	6.6650	170
180	1.0028	1.1274	192.71	193.84	763.1	2014.2	2777.2	2.1392	4.4448	6.5840	180
190	1.2552	1.1415	155.22	156.36	807.4	1977.9	2785.3	2.2355	4.2704	6.5059	190
200	1.5549	1.1565	126.05	127.21	852.3	1939.7	2792.0	2.3305	4.0996	6.4302	200
210	1.9077	1.1727	103.12	104.29	897.6	1899.6	2797.3	2.4245	3.9318	6.3563	210
220	2.3196	1.1902	84.902	86.092	943.6	1857.4	2800.9	2.5177	3.7663	6.2840	220
230	2.7971	1.2090	70.294	71.503	990.2	1812.7	2802.9	2.6101	3.6027	6.2128	230
240	3.3469	1.2295	58.476	59.705	1037.6	1765.4	2803.0	2.7020	3.4403	6.1423	240
250	3.9762	1.2517	48.831	50.083	1085.8	1715.2	2800.9	2.7935	3.2785	6.0721	250
260	4.6923	1.2761	40.897	42.173	1135.0	1661.6	2796.6	2.8849	3.1167	6.0016	260
270	5.5030	1.3030	34.318	35.621	1185.3	1604.4	2789.7	2.9765	2.9539	5.9304	270
280	6.4166	1.3328	28.820	30.153	1236.9	1543.0	2779.9	3.0685	2.7894	5.8579	280
290	7.4418	1.3663	24.189	25.555	1290.0	1476.7	2766.7	3.1612	2.6222	5.7834	290
300	8.5879	1.4042	20.256	21.660	1345.0	1404.6	2749.6	3.2552	2.4507	5.7059	300
310	9.8651	1.4479	16.887	18.335	1402.2	1325.7	2727.9	3.3510	2.2734	5.6244	310
320	11.284	1.4990	13.972	15.471	1462.2	1238.4	2700.6	3.4494	2.0878	5.5372	320
330	12.858	1.5606	11.418	12.979	1525.9	1140.2	2666.0	3.5518	1.8903	5.4422	330
340	14.601	1.6376	9.143	10.781	1594.5	1027.3	2621.8	3.6601	1.6755	5.3356	340
350	16.529	1.7400	7.062	8.802	1670.9	892.7	2563.6	3.7784	1.4326	5.2110	350
360	18.666	1.8954	5.054	6.949	1761.7	719.8	2481.5	3.9167	1.1369	5.0536	360
370	21.044	2.215	2.739	4.954	1890.7	443.8	2334.5	4.1112	0.6901	4.8012	370
t_c[a]	22.064	3.106	0	3.106	2084.3	0	2084.3	4.4070	0	4.4070	t_c

[a] $t_c = 373.946°C$.

TABLE II IAPWS Releases for Calculating Properties of Water and Heavy Water[a]

Property	Date of latest version
Thermal conductivity[b]	1998
Viscosity[b]	1997
Refractive Index	1997
Static dielectric constant	1997
Thermodynamic properties (industrial use)	1997
Thermodynamic properties (general and scientific use)	1996
Surface tension	1994
Surface tension (D_2O)	1994
Melting and sublimation pressures	1993
Critical point properties	1992
Thermodynamic properties (D_2O)	1984
Viscosity and thermal conductivity (D_2O)	1984
Ion product	1980

[a] Copies of IAPWS Releases may be obtained by writing to the IAPWS Executive Secretary: Dr. R. B. Dooley, Electric Power Research Institute, 3412 Hillview Ave., Palo Alto, CA 94304.

[b] These releases contain formulations both for industrial use and for general and scientific use.

consistent with IAPWS-IF97. IAPWS, upon adopting the formulation, recommended a waiting period (which expired at the beginning of 1999) in which IAPWS-IF97 should not be used for contractual specifications, in order to allow users time to adjust. Similar adjustments and therefore a similar waiting period will likely be required whenever a successor to IAPWS-IF97 is adopted; however, the intention is for IAPWS-IF97 to remain the standard in the power industry for at least 20 years.

Property formulations for industrial use have also been generated for the viscosity and the thermal conductivity, as mentioned in Table II.

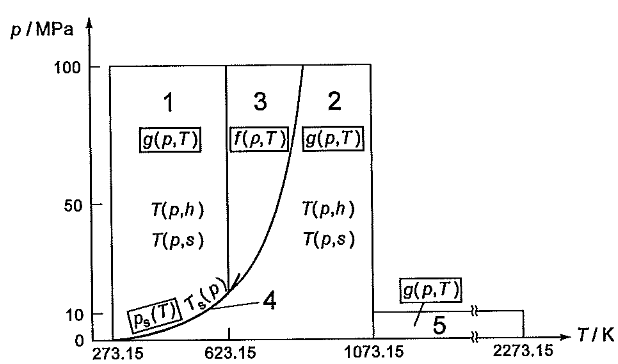

FIGURE 1 Regions of the IAPWS-IF97 standard for thermodynamic properties of water and steam for industrial use.

A final question to be addressed is when it is appropriate to use the industrial formulation (IAPWS-IF97), as opposed to the formulation for general and scientific use (IAPWS-95). In general, since IAPWS-95 is the state of the art, it (or any formulation for general and scientific use that might replace it in the future) should be used in all cases except those where IAPWS-IF97 is specifically required or preferable. IAPWS-IF97 is preferred in two cases:

- In the steam power industry, the industrial formulation (now IAPWS-IF97) is the industry standard for contracting and testing purposes. It therefore makes sense to use IAPWS-IF97 for calculations in all facets of the power industry.
- In any application where computing time is at a premium (and where the calculation of water properties consumes most of that time), IAPWS-IF97 may be preferred because of its much faster computing speed. An example would be finite-element calculations of steam flow in a turbine. In some cases, even IAPWS-IF97 might be too slow; an alternative in such cases (especially if the calculations are confined to a narrow range of conditions) is to generate a table of properties in advance and then use a table interpolation algorithm in the computations.

VI. FUTURE DIRECTIONS

Probably the most notable current direction for steam tables is the migration from printed tables to computer software. Most engineering design and research now uses computer-generated properties. Printed tables and charts formerly had to be detailed enough to permit interpolation with an accuracy suitable for design; now they are mostly relegated to the role of an auxiliary to be used for quick estimates when the computer is not handy, and therefore can be much less detailed. With the increased use of computers, it has become increasingly important to present water property standards in user-friendly software, either for standalone calculations or as something to be plugged into a spreadsheet or other application. There is also demand for implementations of steam property formulations in computer languages other than the traditional FORTRAN and for access to properties via the World Wide Web. Figure 2 shows a window from some modern "steam tables" software.

As new data are obtained and new theoretical understanding is gained, work will continue to improve the existing formulations for the properties of water and steam. Much of this work is organized by IAPWS. Current areas of focus include improvement of the formulations

1: L/V sat. T=300.0 to 500.0 [K]

	Temperature [K]	Pressure [MPa]	Density (L) [kg/m³]	Density (V) [kg/m³]	Enthalpy (L) [kJ/kg]	Enthalpy (V) [kJ/kg]
1	300.0	0.003537	996.5	0.02559	112.6	2550
2	320.0	0.01055	989.4	0.07166	196.2	2586
3	340.0	0.02719	979.5	0.1744	279.9	2621
4	360.0	0.06219	967.4	0.3786	363.8	2654
5	380.0	0.1289	953.3	0.7483	448.1	2686
6	400.0	0.2458	937.5	1.369	533.0	2716
7	420.0	0.4373	919.9	2.352	618.6	2742
8	440.0	0.7337	900.6	3.833	705.3	2765
9	460.0	1.171	879.6	5.983	793.4	2783
10	480.0	1.790	856.5	9.014	883.3	2796
11	500.0	2.639	831.3	13.20	975.4	2802

FIGURE 2 Sample screen from a modern "steam tables" database implementing the IAPWS-95 formulation (From A. H. Harvey, A. P. Peskin, and S. A. Klein, "NIST/ASME Steam Properties," NIST Standard Reference Database 10, Standard Reference Data Office, NIST, Gaithersburg, MD 20899; information also available at srdata@nist.gov or http://www.nist.gov/srd/nist10.htm).

for viscosity and thermal conductivity, and representation of water's thermodynamic behavior in accordance with theoretical constraints in the vicinity of its critical point.

IAPWS is also increasing its activities in application areas where water properties play a role. In the physical chemistry of aqueous solutions, efforts are devoted not only to those properties of pure water (such as the dielectric constant and ionization constant) that are important for solution chemistry, but also to the description of key properties of aqueous mixtures. Areas of interest include the partitioning of solutes between liquid water and steam and the properties of water/ammonia mixtures. In power-plant chemistry, IAPWS seeks to help industrial users apply fundamental knowledge and identifies key areas requiring further research. Documents called IAPWS Certified Research Needs (ICRN's) describe these needs; these documents are intended to serve as evidence to those who set research priorities that work in an area would be of significant use to industry. More information on current ICRN's may be obtained from the IAPWS Executive Secretary (see Section IV) or on the IAPWS Website (see following).

New data, new scientific capabilities, and new industrial needs will continue to shape the international steam properties community (and specifically IAPWS) as it seeks to maintain its core mission of developing steam tables and other water property standards while expanding into related areas to meet the needs of the power industry and of others who require accurate knowledge of the properties of water and aqueous mixtures. Up-to-date information on the activities of IAPWS may be found on its Website at www.iapws.org.

SEE ALSO THE FOLLOWING ARTICLES

Critical Data in Physics and Chemistry • Thermodynamics • Thermometry • Water Conditioning, Industrial

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