

A survey of designated users, that is people who initially receive the departmental profile, revealed an average of three people see each departmental copy. Of 42 respondents to the survey, 36 spent 30 min or less each week reviewing their group profile. The number of "hits" varied. Chemical research personnel, for example, found an average of three pertinent patents each week per profile, while chemical marketing/commercial development and food research personnel averaged one per profile during that period. With 10 chemical research profiles, that group now sees approximately 30 patents pertinent to their activities each week. At that rate, this group of 75 professionals should see over 1500 patents of specific interest to their research annually.

#### USER REACTIONS

Of the 42 respondents to the survey, 83% found their current profile satisfactory. When asked the greatest benefits of the program, they voted this way:

- 14 Broader patent coverage
- 14 Less time spent on patent awareness
- 12 More timely coverage

Delay in obtaining foreign patents and the lack of translations for these patents are the principal irritants. A few respondents said that they thought the abstracts from the alerting bulletins

did not contain sufficient information for their purposes, thus making purchase of the complete specification necessary, even when a foreign language was involved.

#### SUMMARY

This program was begun with chemical research personnel on February 4, 1975 and with chemical marketing and food research personnel on March 4, 1975. The survey was completed July 31, 1975.

The questionnaire response rates, 88% for chemical research personnel, 69% for food research personnel, and 100% for chemical marketing personnel, indicate high level interest in this program. User reactions via the questionnaire show successful achievement of the program's goal: to provide more timely coverage of a greater number of patents without an expenditure of considerable time.

Alternatives for improving access to foreign patent information are being studied. Among the possibilities being considered are (1) bringing foreign patent specifications in-house on microfilm, (2) subscribing to Derwent's Basic Abstract Journals, and (3) subscribing to Derwent's Basic Abstracts on Microfilm. The latter two subscriptions contain more detailed summaries of the patents than the corresponding alerting bulletins.

## The International Metric System in American Petroleum Institute Research Project 44 and Thermodynamics Research Center Data Project Tables of Physical and Thermodynamic Data

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The physical and thermodynamic properties included in the American Petroleum Institute Research Project 44 and Thermodynamic Research Center Data Project Tables for hydrocarbons and other chemical substances are briefly reviewed. In Table I the property units used in the two sets of tables are compared with the corresponding SI units. The numerical factors needed to convert the present property values to those in SI units are also listed.

The International Metric System (in French, *Système International d'Unités* or abbreviated as SI) has been adopted by the world scientific and technical communities as the standard units for weights and measures for more than a decade.<sup>1-4</sup> In order to encourage scientists and engineers in the U.S. to adopt the SI units in their R&D work, the SI units to be used in the American Petroleum Institute Research Project 44 and the Thermodynamics Research Center Data Project Tables of physical and thermodynamic data have been compiled and are presented in Table I and recommended for use.

#### THE AMERICAN PETROLEUM INSTITUTE RESEARCH PROJECT 44

This is one of the four numerical data projects at the Thermodynamics Research Center (TRC), Texas A&M University.<sup>5</sup> For more than three decades, the APIRP 44 has served as a central agency for the American Petroleum Institute to provide the best available numerical values on physical and thermodynamic properties for all classes of hydrocarbons and a limited number of classes of sulfur and

nitrogen derivatives of hydrocarbons present in petroleum. The official title of this loose-leaf format serial publication is "Selected Values of Properties of Hydrocarbons and Related Compounds", known as API 44 Tables. At the present, the primary set of API 44 Tables contains approximately 500,000 numerical values of properties of 3700 chemical compounds on 2900 valid sheets, grouped into seven volumes. These critically evaluated property tables have been used extensively by scientists and engineers in the U.S. and abroad for over 30 years.

#### THE THERMODYNAMICS RESEARCH CENTER DATA PROJECT

This numerical data project, formerly the Manufacturing Chemists Association Research Project,<sup>6</sup> is similar in format and style to the API 44 Tables, except this serial publication serves as a numerical data bank for the properties on all pure inorganic and organic substances outside of the hydrocarbon area. The numerical tables issued are known as "Selected Values of Properties of Chemical Compounds", or TRCDP Tables, and provide basic information for the chemical and

Table I. Property Tables of the API Research Project 44 and TRC Data Project

Table code	Properties	SI unit	Conversion factor
$\delta, \delta\text{-S}$	Molecular weights of hydrocarbons and sulfur compounds		1973 International Atomic Weights: C = 12.011, H = 1.0079, S = 32.06
aa	Boiling point ( $^{\circ}\text{C}$ ) at 1 atm Refractive index ( $n_D$ ) at 20 and 25 $^{\circ}\text{C}$	K	$T(\text{K}) = t(^{\circ}\text{C}) + 273.15$ $n_D$ wavelength, 5892.6 Å = $5.8926 \times 10^{-7}$ m
	$dt/dp$ ( $^{\circ}\text{C}\cdot\text{Torr}^{-1}$ ) at 1 atm	$\text{K}\cdot\text{m}^2\cdot\text{N}^{-1}$	$1^{\circ}\text{C}\cdot\text{torr}^{-1} = 7.500617 \times 10^{-3} \text{ K}\cdot\text{m}^2\cdot\text{N}^{-1}$
	Density ( $\text{g}\cdot\text{cm}^{-3}$ ) at 20 and 25 $^{\circ}\text{C}$	$\text{kg}\cdot\text{m}^{-3}$	$1 \text{ g}\cdot\text{cm}^{-3} = 10^3 \text{ kg}\cdot\text{m}^{-3}$
	Freezing point ( $^{\circ}\text{C}$ ) in air at 1 atm	K	
a	Same as those in aa table		
a-E	Boiling point ( $^{\circ}\text{F}$ ) at 29.921 in.Hg $dt/dp$ ( $^{\circ}\text{F}\cdot\text{in.Hg}^{-1}$ ) at 29.921 in.Hg	K $\text{K}\cdot\text{m}^2\cdot\text{N}^{-1}$	$T(\text{K}) = 5/9 [t(^{\circ}\text{F}) - 32] + 273.15$ $1^{\circ}\text{F}\cdot(\text{in.Hg})^{-1} = 1.640555 \times 10^{-4} \text{ K}\cdot\text{m}^2\cdot\text{N}^{-1}$
	Refractive index ( $n_D$ ) at 68 and 77 $^{\circ}\text{F}$		
	Density ( $\text{lb}\cdot\text{ft}^{-3}$ ) at 60, 68, and 77 $^{\circ}\text{F}$	$\text{kg}\cdot\text{m}^{-3}$	$1 \text{ lb}\cdot\text{ft}^{-3} = 16.01846 \text{ kg}\cdot\text{m}^{-3}$
	Density ( $\text{lb}\cdot\text{gal}^{-1}$ ) at 60, 68, and 77 $^{\circ}\text{F}$	$\text{kg}\cdot\text{m}^{-3}$	$1 \text{ lb}\cdot\text{gal}^{-1} = 119.8264 \text{ kg}\cdot\text{m}^{-3}$
	Specific gravity, 60 $^{\circ}\text{F}/60^{\circ}\text{F}$		$60^{\circ}\text{F}/60^{\circ}\text{F} = 288.71 \text{ K}/288.71 \text{ K}$
	Freezing point ( $^{\circ}\text{F}$ ) in air at 1 atm	K	
b	Molal volume ( $\text{cm}^3\cdot\text{mol}^{-1}$ ) at 20 and 25 $^{\circ}\text{C}$	$\text{m}^3\cdot\text{mol}^{-1}$	$1 \text{ cm}^3\cdot\text{mol}^{-1} = 10^{-6} \text{ m}^3\cdot\text{mol}^{-1}$
	Molal refraction ( $\text{cm}^3\cdot\text{mol}^{-1}$ ) at 20 and 25 $^{\circ}\text{C}$	$\text{m}^3\cdot\text{mol}^{-1}$	
	Specific refraction ( $\text{cm}^3\cdot\text{g}^{-1}$ ) at 20 and 25 $^{\circ}\text{C}$	$\text{m}^3\cdot\text{kg}^{-1}$	$1 \text{ cm}^3\cdot\text{g}^{-1} = 10^{-3} \text{ m}^3\cdot\text{kg}^{-1}$
	Refractivity intercept at 20 and 25 $^{\circ}\text{C}$		
	Specific dispersion ( $\text{cm}^3\cdot\text{g}^{-1}$ )	$\text{m}^3\cdot\text{kg}^{-1}$	
c	Dynamic viscosity (centipoises) at temperatures in $^{\circ}\text{C}$	$\text{N}\cdot\text{s}\cdot\text{m}^{-2}$	$1 \text{ centipoise} = 10^{-3} \text{ N}\cdot\text{s}\cdot\text{m}^{-2}$
c-E	Kinematic viscosity (centistokes) at temperatures in $^{\circ}\text{F}$	$\text{m}^2\cdot\text{s}^{-1}$	$1 \text{ centistoke} = 10^{-6} \text{ m}^2\cdot\text{s}^{-1}$
c-K	Kinematic viscosity (centistokes) at temperatures in $^{\circ}\text{C}$	$\text{m}^2\cdot\text{s}^{-1}$	
d	Density ( $\text{g}\cdot\text{cm}^{-3}$ ) at temperatures in $^{\circ}\text{C}$	$\text{kg}\cdot\text{m}^{-3}$	
d-E	Density ( $\text{lb}\cdot\text{ft}^{-3}$ ) at temperatures in $^{\circ}\text{F}$	$\text{kg}\cdot\text{m}^{-3}$	
e	Surface tension ( $\text{dyne}\cdot\text{cm}^{-1}$ ) at temperatures in $^{\circ}\text{C}$	$\text{N}\cdot\text{m}^{-1}$	$1 \text{ dyne}\cdot\text{cm}^{-1} = 10^{-3} \text{ N}\cdot\text{m}^{-1}$
fa	Refractive index, at wavelengths in Å		
fb	Refractive index, at temperatures in $^{\circ}\text{C}$		
h	Second virial coefficients of gases ( $\text{cm}^3\cdot\text{mol}^{-1}$ )	$\text{m}^3\cdot\text{mol}^{-1}$	
i	Critical temperature (K, $^{\circ}\text{C}$ , $^{\circ}\text{R}$ , $^{\circ}\text{F}$ )	K	$T(\text{K}) = 5/9 [t(^{\circ}\text{R})]$
	Critical pressure (atm, $\text{lb}\cdot\text{in}^{-2}$ )	$\text{N}\cdot\text{m}^{-2}$	$1 \text{ atm} = 101325 \text{ N}\cdot\text{m}^{-2}$ $1 \text{ lb}\cdot\text{in}^{-2} = 6894.76 \text{ N}\cdot\text{m}^{-2}$
	Critical density ( $\text{g}\cdot\text{cm}^{-3}$ , $\text{lb}\cdot\text{ft}^{-3}$ )	$\text{kg}\cdot\text{m}^{-3}$	
	Critical volume ( $\text{L}\cdot\text{mol}^{-1}$ , $\text{ft}^3\cdot\text{lb}\cdot\text{mol}^{-1}$ )	$\text{m}^3\cdot\text{kg}\cdot\text{mol}^{-1}$	$1 \text{ L}\cdot\text{mol}^{-1} = 10^{-3} \text{ m}^3\cdot\text{mol}^{-1}$ $1 \text{ ft}^3\cdot\text{lb}\cdot\text{mol}^{-1} = 0.062428 \text{ m}^3\cdot\text{kg}\cdot\text{mol}^{-1}$
	Critical compressibility factor		
ja	Compressibility factor for the real gas, $Z = PV/RT$ , at selected pressures in atm and temperatures in K		
ja-E	Compressibility factor for the real gas, $Z = PV/RT$ , at selected pressures in $\text{lb}\cdot\text{in}^{-2}$ and temperature in $^{\circ}\text{R}$		
jb	Activity coefficient for the real gas, $\gamma = f/P$ at selected pressures in atm and temperatures in K		
jb-E	Activity coefficient for the real gas, $\gamma = f/P$ at selected pressures in $\text{lb}\cdot\text{in}^{-2}$ and temperatures in $^{\circ}\text{R}$		
jc	Relative enthalpy for the real gas, $H - H^{\circ}$ , at selected pressures in atm and temperatures in K, $\text{cal}\cdot\text{mol}^{-1}$	$\text{J}\cdot\text{mol}^{-1}$	$1 \text{ cal}\cdot\text{mol}^{-1} = 4.184 \text{ J}\cdot\text{mol}^{-1}$
jc-E	Relative enthalpy for the real gas, $H - H^{\circ}$ , at selected pressures in $\text{lb}\cdot\text{in}^{-2}$ and temperature in $^{\circ}\text{R}$ , $\text{Btu}\cdot\text{lb}^{-1}$	$\text{J}\cdot\text{kg}^{-1}$	$1 \text{ Btu}\cdot\text{lb}^{-1} = 2326.00 \text{ J}\cdot\text{kg}^{-1}$
jd	Enthalpy function for the real gas, $(H - H^{\circ})/T$ , at selected pressures in atm and temperatures in K, $\text{cal}\cdot\text{K}^{-1}\cdot\text{mol}^{-1}$	$\text{J}\cdot\text{K}^{-1}\cdot\text{mol}^{-1}$	$1 \text{ cal}\cdot\text{K}^{-1}\cdot\text{mol}^{-1} = 4.184 \text{ J}\cdot\text{K}^{-1}\cdot\text{mol}^{-1}$
je	Relative entropy for the real gas, $S - S^{\circ}$ (ideal), at selected pressures in atm and temperatures in K, $\text{cal}\cdot\text{K}^{-1}\cdot\text{mol}^{-1}$	$\text{J}\cdot\text{K}^{-1}\cdot\text{mol}^{-1}$	
jf	Relative entropy for the real gas, $S - S^{\circ}$ (at the same temperature) at selected pressures (atm) and temperatures (K), $\text{cal}\cdot\text{K}^{-1}\cdot\text{mol}^{-1}$	$\text{J}\cdot\text{K}^{-1}\cdot\text{mol}^{-1}$	
jf-E	Relative entropy for the real gas, $S - S^{\circ}$ (at the same temperature) at selected pressures in $\text{lb}\cdot\text{in}^{-2}$ and temperatures in $^{\circ}\text{R}$ , $\text{Btu}\cdot\text{lb}^{-1}\cdot^{\circ}\text{R}^{-1}$	$\text{J}\cdot\text{K}^{-1}\cdot\text{kg}^{-1}$	$1 \text{ Btu}\cdot\text{lb}^{-1}\cdot^{\circ}\text{R}^{-1} = 4186.8 \text{ J}\cdot\text{K}^{-1}\cdot\text{kg}^{-1}$
jg	Relative Gibbs energy for the real gas, $G - G^{\circ}$ (ideal), at selected pressures in atm and temperatures in K, $\text{cal}\cdot\text{mol}^{-1}$	$\text{J}\cdot\text{mol}^{-1}$	
jh	Relative Gibbs energy for the real gas, $G - G^{\circ}$ (at the same temperature) at selected pressures in atm and temperatures in K, $\text{cal}\cdot\text{mol}^{-1}$	$\text{J}\cdot\text{mol}^{-1}$	
ji	Relative Gibbs energy function for the real gas, $(G - G^{\circ})/(T)$ , at selected pressures in atm and temperatures in K, $\text{cal}\cdot\text{K}^{-1}\cdot\text{mol}^{-1}$	$\text{J}\cdot\text{K}^{-1}\cdot\text{mol}^{-1}$	
jj	Relative heat capacity for the real gas, $C_p - C_p^{\circ}$ (at the same temperature) at selected pressures in atm and temperature in K, $\text{cal}\cdot\text{K}^{-1}\cdot\text{mol}^{-1}$	$\text{J}\cdot\text{K}^{-1}\cdot\text{mol}^{-1}$	
k	Vapor pressures (Torr) and boiling points ( $^{\circ}\text{C}$ ), 10–1500 Torr	$\text{N}\cdot\text{m}^{-2}$	$1 \text{ torr} = 133.32237 \text{ N}\cdot\text{m}^{-2}$

Table I (Continued)

Table code	Properties	SI unit	Conversion factor
ka	Vapor pressures (Torr) and boiling points ( $^{\circ}\text{C}$ ), below 10 Torr	$\text{N}\cdot\text{m}^{-2}$	
kb	Vapor pressures (Torr) and boiling points ( $^{\circ}\text{C}$ ), above 1 atm	$\text{N}\cdot\text{m}^{-2}$	
k-E	Vapor pressures ( $\text{lb}\cdot\text{in}^{-2}$ ) and boiling points ( $^{\circ}\text{F}$ ), 0.2–30 $\text{lb}\cdot\text{in}^{-2}$	$\text{N}\cdot\text{m}^{-2}$	
m	Phase transition pressure (Torr)	$\text{N}\cdot\text{m}^{-2}$	
	Phase transition temperature ( $\text{K}$ , $^{\circ}\text{C}$ )	$\text{K}$	
	Enthalpy of phase transition ( $\text{kcal}\cdot\text{mol}^{-1}$ )	$\text{kJ}\cdot\text{mol}^{-1}$	$1 \text{ kcal}\cdot\text{mol}^{-1} = 4.184 \text{ kJ}\cdot\text{mol}^{-1}$
	Entropy of phase transition ( $\text{cal}\cdot\text{K}^{-1}\cdot\text{mol}^{-1}$ )	$\text{J}\cdot\text{K}^{-1}\cdot\text{mol}^{-1}$	
	Temperature derivative of enthalpy ( $\text{cal}\cdot\text{K}^{-1}\cdot\text{mol}^{-1}$ )	$\text{J}\cdot\text{K}^{-1}\cdot\text{mol}^{-1}$	
n	Cryoscopic constant (mole fraction $\cdot\text{K}^{-1}$ )	$\text{K}^{-1}$	
	Enthalpy of combustion ( $\text{kcal}\cdot\text{mol}^{-1}$ , $\text{cal}\cdot\text{g}^{-1}$ , and $\text{Btu}\cdot\text{lb}^{-1}$ ) at $25^{\circ}\text{C}$ and constant pressure	$\text{kJ}\cdot\text{mol}^{-1}$ , $\text{J}\cdot\text{kg}^{-1}$	$1 \text{ cal}\cdot\text{g}^{-1} = 4184.0 \text{ J}\cdot\text{kg}^{-1}$
p	Enthalpy of formation ( $\text{kcal}\cdot\text{mol}^{-1}$ ) at $25^{\circ}\text{C}$	$\text{kJ}\cdot\text{mol}^{-1}$	
	Gibbs energy of formation ( $\text{kcal}\cdot\text{mol}^{-1}$ ) at $25^{\circ}\text{C}$	$\text{kJ}\cdot\text{mol}^{-1}$	
	Logarithm of equilibrium constant of formation at $25^{\circ}\text{C}$		
q	Entropy ( $\text{cal}\cdot\text{K}^{-1}\cdot\text{mol}^{-1}$ ) at $25^{\circ}\text{C}$	$\text{J}\cdot\text{K}^{-1}\cdot\text{mol}^{-1}$	
	Heat capacity ( $\text{cal}\cdot\text{K}^{-1}\cdot\text{mol}^{-1}$ ) at $25^{\circ}\text{C}$	$\text{J}\cdot\text{K}^{-1}\cdot\text{mol}^{-1}$	
	Standard enthalpy of vaporization ( $\text{kcal}\cdot\text{mol}^{-1}$ ) at $25^{\circ}\text{C}$	$\text{kJ}\cdot\text{mol}^{-1}$	
	Standard entropy of vaporization ( $\text{cal}\cdot\text{K}^{-1}\cdot\text{mol}^{-1}$ ) at $25^{\circ}\text{C}$	$\text{J}\cdot\text{K}^{-1}\cdot\text{mol}^{-1}$	
	Standard Gibbs energy of vaporization ( $\text{kcal}\cdot\text{mol}^{-1}$ ) at $25^{\circ}\text{C}$	$\text{kJ}\cdot\text{mol}^{-1}$	
r	Enthalpy function ( $\text{cal}\cdot\text{K}^{-1}\cdot\text{mol}^{-1}$ ) at temperatures in $\text{K}$	$\text{J}\cdot\text{K}^{-1}\cdot\text{mol}^{-1}$	
s	Gibbs energy function ( $\text{cal}\cdot\text{K}^{-1}\cdot\text{mol}^{-1}$ ) at temperatures in $\text{K}$	$\text{J}\cdot\text{K}^{-1}\cdot\text{mol}^{-1}$	
t	Entropy ( $\text{cal}\cdot\text{K}^{-1}\cdot\text{mol}^{-1}$ ) at temperatures in $\text{K}$	$\text{J}\cdot\text{K}^{-1}\cdot\text{mol}^{-1}$	
t-E	Entropy ( $\text{Btu}\cdot\text{lb}^{-1}\cdot^{\circ}\text{R}^{-1}$ ) at temperatures in $^{\circ}\text{R}$	$\text{J}\cdot\text{K}^{-1}\cdot\text{kg}^{-1}$	
u	Enthalpy ( $\text{cal}\cdot\text{mol}^{-1}$ ) at temperatures in $\text{K}$	$\text{J}\cdot\text{mol}^{-1}$	
u-E	Enthalpy ( $\text{Btu}\cdot\text{lb}^{-1}$ ) at temperatures in $^{\circ}\text{F}$	$\text{J}\cdot\text{kg}^{-1}$	
u-G	Enthalpy ( $\text{cal}\cdot\text{g}^{-1}$ ) at temperatures in $^{\circ}\text{C}$	$\text{J}\cdot\text{kg}^{-1}$	
v	Heat capacity ( $\text{cal}\cdot\text{K}^{-1}\cdot\text{mol}^{-1}$ ) at temperatures in $\text{K}$	$\text{J}\cdot\text{K}^{-1}\cdot\text{mol}^{-1}$	
v-E	Heat capacity ( $\text{Btu}\cdot\text{lb}^{-1}\cdot^{\circ}\text{F}^{-1}$ ) at temperatures in $^{\circ}\text{F}$	$\text{J}\cdot\text{K}^{-1}\cdot\text{kg}^{-1}$	$1 \text{ Btu}\cdot\text{lb}^{-1}\cdot^{\circ}\text{F}^{-1} = 4186.8 \text{ J}\cdot\text{K}^{-1}\cdot\text{kg}^{-1}$
v-G	Heat capacity ( $\text{cal}\cdot\text{g}^{-1}\cdot\text{K}^{-1}$ ) at temperatures in $^{\circ}\text{C}$	$\text{J}\cdot\text{K}^{-1}\cdot\text{kg}^{-1}$	$1 \text{ cal}\cdot\text{g}^{-1}\cdot\text{K}^{-1} = 4184.0 \text{ J}\cdot\text{K}^{-1}\cdot\text{kg}^{-1}$
w	Enthalpy of formation ( $\text{kcal}\cdot\text{mol}^{-1}$ ) at temperatures in $\text{K}$	$\text{kJ}\cdot\text{mol}^{-1}$	
x	Gibbs energy of formation ( $\text{kcal}\cdot\text{mol}^{-1}$ ) at temperatures in $\text{K}$	$\text{kJ}\cdot\text{mol}^{-1}$	
y	Logarithm of equilibrium constant of formation, at temperatures in $\text{K}$		

petrochemical industries. The present set of TRCDP loose-leaf property sheets contains 60,000 numerical values for 2530 compounds on 1356 valid sheets grouped into four volumes.

#### PHYSICAL AND THERMODYNAMIC PROPERTIES

The physical and thermodynamic properties included in the above-mentioned two sets of critical tables are listed in Table I. In brief, these properties can be classified as: (1) simple physical properties—normal boiling point, freezing point, refractive index, density, molal volume, molal refraction, critical constants, etc.; (2) properties at selected temperatures—density, surface tension, refractive index (both as a function of wavelength at different temperatures and as a function of temperature at selected wavelengths), vapor pressure (in three pressure ranges: 0.001–10 Torr, 10–1500 Torr, and above 1 atm up to the critical point), second virial coefficient of gases (as a function of reduced temperature); (3) properties of real gases—compressibility factor, activity coefficient, relative enthalpy, enthalpy function, relative entropy, relative Gibbs energy, Gibbs energy function, relative heat capacity; and (4) chemical thermodynamic properties—phase transition properties (temperature, enthalpy and entropy of fusion, vaporization and/or sublimation, and cryoscopic constant), thermochemical properties (enthalpy of combustion, standard enthalpy, entropy, and Gibbs energy of vaporization), and ideal gas thermodynamic properties (heat capacity, enthalpy, entropy, Gibbs energy function, enthalpy of formation, Gibbs energy of formation, logarithm of equilibrium constant of formation).

The above properties are expressed mainly in terms of cgs units. In API 44 Tables, the English units are also adopted

for certain properties which are used frequently by industrial engineers. Four temperature scales, namely  $^{\circ}\text{C}$ ,  $^{\circ}\text{F}$ ,  $^{\circ}\text{R}$ , and  $\text{K}$ , are employed for different properties in various property tables.

#### CHEMICAL COMPOUNDS

The major classes of hydrocarbons included in API 44 Tables are alkanes, cycloalkanes, alkenes, alkadienes, alkyl cycloalkenes, alkynes, alkyl benzenes, naphthalenes, alkyl anthracenes, alkyl phenanthrenes, alkyl indans, styrenes, and alkyl indenenes. The class of chemical compounds having similar molecular structure and composition is listed in the same table for each kind of property in the order of number and kinds of atoms in the molecular formula. The arrangement of classes of hydrocarbons is based on the degree of saturation.

In TRCDP Tables, chemical compounds not included in API 44 Tables are arranged according to the Standard Order of Arrangement of the Elements which was developed at the National Bureau of Standards.<sup>7</sup> As of 1975, the inorganic and organic compounds contain the following elements: O, H, inert gases, halogens, S, Se, Te, Po, N, P, C, Si, and B.

#### CONVERSION FACTORS TO SI UNITS

It is unlikely that the published property values listed in the API 44 and TRCDP Tables can be completely recalculated and reissued in SI units in the very near future by the TRC; thus the brunt of the problem must fall on the individual users of these tables to convert the listed property values from the cgs or English units found in the tables to the corresponding properties in SI units. In order to simplify the user's problem,

Table I gives the SI units for each physical and thermodynamic property covered in these two sets of critical tables, shown in column 3. Also indicated in the last column are the necessary conversion factors which should be employed to derive the needed quantities in SI units.

It should be mentioned that all new and revised API 44 and TRCDP Tables, which are continuously being issued, are now conforming to SI units and the official IPTS-68 temperature scale, whenever possible.

#### ACKNOWLEDGMENT

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- (2) G. Socrates, *J. Chem. Educ.*, **46**, 710 (1969).

- (3) *Nat. Bur. Stand. U.S. Tech. News Bull.*, January 1971; *J. Chem. Educ.*, **48**, 569 (1971).
- (4) M. A. Paul, *J. Chem. Doc.*, **11**, 3 (1971).
- (5) The APIRP 44 was initiated in 1942 at the National Bureau of Standards in Washington, D. C., with the sponsorship and financial support of the American Petroleum Institute and, until 1960, under the direction of F. D. Rossini. In 1950, the project was moved to Carnegie Institute of Technology (now Carnegie-Mellon University), Pittsburgh, Pa.; and in 1961, it was again relocated in Texas A&M University, College Station, Texas, with Bruno J. Zwolinski as the new director. Since 1966, the project has been on a self-supporting basis with an appointed API Advisory Committee providing scientific and technical guidance. Recently, this committee has been replaced by the API Subcommittee on Technical Data with C. C. Williams, III, as chairman.
- (6) The Manufacturing Chemists Association established this critical data project in 1955 at Carnegie Institute of Technology. The project was also relocated with the API 44 Project in 1961 and incorporated into the Thermodynamics Research Center at Texas A&M University under the direction of Professor Bruno J. Zwolinski. The project was renamed the Thermodynamics Research Center Data Project on July 1, 1966, and it has been independently operated on a self-supporting basis since July 1, 1964.
- (7) F. D. Rossini, D. D. Wagman, W. H. Evans, S. Levine, and I. Jaffe, "Selected Values of Chemical Thermodynamic Properties", *Nat. Bur. Stand. U.S. Circ. 500* (1952). This circular was published under the direction of F. D. Rossini, former director of the APIRP 44, now professor of chemistry, Rice University, Houston, Tex.

## On-Line Information Systems in Perspective<sup>†</sup>

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The rationale supporting the desirability of on-line information systems and the arguments underlying their development are discussed. A major argument in favor of on-line retrieval has been the assumption that the opportunity to negotiate search problems through on-line access to the data base has the inherent effect of improved system performance. The extent to which on-line retrieval has fulfilled this and other expectations is considered along with trends relating to the operational characteristics of existing systems.

On-line information systems have been with us for some time and, at least on the surface, their design and implementation have become quite routine. At the same time, a variety of rather interesting and significant problems remain, many of which relate to current trends in computer use and to the fact that the community of computer users is becoming increasingly heterogeneous. Computer users today include the many individuals for whom on-line computing is a tool that facilitates their work in their respective fields. The behavior pattern and functioning of these users at the on-line interface have important implications for system design.

In the design of on-line systems the development of the technology and the solution of data and file management problems have been emphasized. Relatively little research has been oriented toward the user concerning the nature of the man/computer interaction in a time-sharing environment and the human factors that affect the quality and productivity of these interactions.

In an on-line information system the user can interface with the computer on a real-time basis and has direct and immediate access to the data base. This type of computing provides both the need and the opportunity for extensive man/system interaction allowing for the combination of the algorithmic and heuristic approaches to problem solving.

It is generally assumed that inherent in the ability to work with the computer in a conversational mode—allowing for

continuous two-way communication between user and system—is the potential for improved system performance. It has been argued that the on-line capability will in a very real sense improve output and, through it, overall system performance.

At the most general level, the dynamics of an interactive system can be described in terms of the two states of the interaction: *the working part of the interaction*, the time during which the user is waiting for the system; and *the console part of the interaction*, the time during which the system is waiting for the user.<sup>1</sup>

The major components involved in the interactions are the data base, system parameters, command language, query formulation, feedback, hardware, and cost. All these components significantly affect the performance of the system in terms of its ability to satisfy the user's information needs, and they can be analyzed in various ways. One of these is the point-of-view of the user.

#### DEMANDS ON THE USER

The user of an on-line information system must bring to the terminal a considerable amount of sophisticated background knowledge concerning the characteristics of the data base, both in terms of its intellectual content and the logic of its organization. This kind of knowledge is essential for the intellectual aspects of query formulation and for the ability to respond to and be able to utilize feedback from the system.

Familiarity with the data base must be combined with the thorough understanding of system parameters to formulate

<sup>†</sup> Presented before the Division of Chemical Literature, 169th National Meeting of the American Chemical Society, Philadelphia, Pa., April 8, 1975.