



BASIC DESIGN MANUAL
SPD0014ERN

PHYSICAL PROPERTIES

REV. : 2

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	BASIC DESIGN MANUAL PHYSICAL PROPERTIES	SPD0014ERN
		REV. : 2
		PAGE i OF ii
DATE : 2010.11. 25		

목 차

	PAGE
1. SCOPE -----	1
2. TERMS -----	1
3. PURE COMPONENTS -----	2
3.1 Location of Data -----	2
3.1.1 SECL's Data Base -----	2
3.1.2 API Technical Data Book -----	2
3.1.3 GPSA Engineering Data Book -----	2
3.1.4 Others -----	3
3.2 Calculation Method -----	3
4. THERMODYNAMIC PHYSICAL PROPERTIES FOR MIXTURES -----	4
4.1 Location of Data -----	4
4.2 Calculation Method -----	4
5. RECOMMENDABLE ESTIMATION METHOD FOR EACH INDUSTRY -----	4
5.1 Petroleum Refinery -----	4
5.2 Petrochemical Industry and General Chemical Industry -----	4
5.3 Gas Processing -----	4
5.4 Gas Manufacturing and Treating -----	4
5.5 Recommended Classes of Property methods for Different Applications -----	4
5.6 Choice Thermodynamic Models Used in the Process Industries -----	4
6. COMPUTER UTILIZATION -----	4
6.1 Program Available -----	4
6.2 General Procedure for Preparation for Physical Properties -----	4
7. REFERENCES -----	5
8. 작성내력 -----	25

	BASIC DESIGN MANUAL PHYSICAL PROPERTIES	SPD0014ERN
		REV. : 2
		PAGE ii OF ii
DATE : 2010.11. 25		

APPENDIX GUIDELINES FOR CHOOSING A PROPERTY METHODS	5
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TABLES AND FIGURES

Table 4-1. Thermodynamic Physical Property Calculation Method	6
Table 5-1. Recommendable Estimation Methods for Petroleum Refineries	9
Table 5-2. Recommendable Estimation Methods for Petrochemical and General Chemical Industries	12
Table 5-3. Recommendable Estimation Methods for Gas Processing	14
Table 5-4. Recommendable Estimation Methods for Gas Manufacturing and Treating	15
Table 5-5 Recommended Classes of Property methods for Different Applications	16
Table 5-6 Choice Thermodynamic Models Used in the Process Industries	21
Fig. A-1. Guidelines for Choosing a Property Method	22

	BASIC DESIGN MANUAL PHYSICAL PROPERTIES	SPD0014ERN
		REV. : 2
		PAGE 1 OF 25

1. SCOPE

This manual describes the basic concepts, sources of raw data, estimation procedures for physical properties. Physical properties are the basic information connected with basic design.

To comply with the requirements on the accumulation of basic design technologies, SECL has so far been collecting the data on the physical properties, while repeatedly studying and evaluating various calculation methods. Some items are missing or not properly arranged at present.

Only the items which will be the guiding principles for those involved in basic design work to actually handle the physical properties are herein referred.

2. TERMS

A great number of categories are available for the physical properties. The major physical properties shown below are roughly divided into three categories:

(1) Basic physical properties

– Critical physical properties:

Critical temperature	T _c
Critical pressure	P _c
Critical molal volume	V _c
Critical compressibility factor	Z _c
Acentric factor	w

– Standard physical properties

Molecular weight	MW
Specific gravity	SpGr
Normal boiling point	nBP
Melting point	MP

(2) Thermodynamic physical properties

K-value (Only mixture is available)	K
Vapor pressure	P _v
Compressibility factor	Z
Density	ρ
Enthalpy	H
Entropy	S
Isobaric heat capacity	C _p
Isochoric heat capacity	C _v
Heat capacity ratio	C _p /C _v

(3) Transport physical properties

viscosity (kinematic viscosity)	μ (ν)
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	BASIC DESIGN MANUAL PHYSICAL PROPERTIES	SPD0014ERN
		REV. : 2
		PAGE 2 OF 25

Thermal conductivity κ
Surface tension σ

3. PURE COMPONENTS

3.1 Location of Data

A great number of data relating to the physical properties extending over a wide area such as basic physical properties, thermodynamic physical properties, transport physical properties are actually available in scattered condition. Of these, the typical sources more generally used for carrying out the basic design are shown below

3.1.1 SECL's Data Base

"PPGEN" (A Physical Property Generation System) is the software package developed by SECL in 1990 for the purpose of collecting and calculating physical properties of pure components. This program invokes parameters from the Design Institute for Physical Property Data (DIPPR) bank to generate fixed, thermodynamic and transport properties for more than 1200 organic and/or inorganic components.

3.1.2 API Technical Data Book

Petroleum Refining 3rd Edit. is the data book for the basic design published by American Petroleum Institute in 1976 in which description is concentrated on the oil fraction handling. The physical properties regarding the substances of 1135 in number are therein collected, of which hydrocarbon constitutes the major portion. The following figure show the approximate number of substances in API Technical Data Book.

(1) Basic physical properties:

- Inorganic	20
- Hydrocarbon	400
- Others	100

(2) Thermodynamic physical properties:

- Inorganic	10
- Hydrocarbon	400
- Others	100

(3) Transport physical properties:

- Inorganic	Poor
- Hydrocarbon	50
- Others	Poor

3.1.3 GPSA Engineering Data Book

The above 11th Edit. is the data book for the basic design published jointly by Gas Processors Suppliers Association and Gas Processors Association (GPSA), in which description is concentrated on the handling of light hydrocarbon such as LNG, LPG.

	BASIC DESIGN MANUAL PHYSICAL PROPERTIES	SPD0014ERN
		REV. : 2
		PAGE 3 OF 25

The physical properties regarding the substances of 64 in number are therein collected, of which hydrocarbon constitutes the major portion. The following figures show the approximate number of substances in GPSA Engineering Data Book.

(1) Basic physical properties:

- Inorganic	11
- Hydrocarbon	53
- Others	Poor

(2) Thermodynamic physical properties:

- Inorganic	11
- Hydrocarbon	53
- Others	Poor

(3) Transport physical properties:

- Inorganic	Poor
- Hydrocarbon	Poor
- Others	None

3.1.4 Others

Other sources of physical properties are listed up in Para. 7.

3.2 Calculation Method

Calculations have to be made in order to get the various physical properties for the petroleum fraction which consists of a lot of hydrocarbon chains. The calculation method for the generation of physical properties of petroleum fraction are shown in API technical data book. Generalized calculation methods, however, are impossible for the other substances which, at present, are treated on a case by case basis. Outline of possibility of otherwise calculations is shown below per substance and physical property:

	Basic Physical Property	Thermodynamic Physical Property	Transport Physical Property
Petroleum fraction	API method (Note 1)	API method (Note 1)	API method
Inorganic	None	Same as calculation method at mixture	None
Hydrocarbon	Same as API	Same as API	Same as API
		Same as calculation method at mixture	

API method mentioned in the above table means the one based on API Technical Data Book.

Note 1: API herein referred to means application of the temperature up to 1,000C, attained by SECL(by means of extrapolation), though that of 500C or lower is recommended by API.

	BASIC DESIGN MANUAL PHYSICAL PROPERTIES	SPD0014ERN
		REV. : 2
		PAGE 4 OF 25
DATE : 2010.11. 25		

4. THERMODYNAMIC PHYSICAL PROPERTIES FOR MIXTURES

The outline of calculation methods utilized generally is given below. The detail application of each calculation method depends on the future evaluation and study of calculation methods.

Calculation methods, therefore, are roughly referred in Table 4-1.

5. RECOMMENDABLE ESTIMATION METHOD FOR EACH INDUSTRY

5.1 Petroleum Refinery

Refer to Table 5-1.

5.2 Petrochemical Industry and General Chemical Industry

Refer to Table 5-2.

5.3 Gas Processing

Refer to Table 5-3.

5.4 Gas Manufacturing and Treating

Refer to Table 5-4.

5.5 Recommended Classes of Property methods for Different Applications

Refer to Table 5-5

5.6 Choice Thermodynamic Models Used in the Process Industries

Refer to Table 5-6

6. COMPUTER UTILIZATION

6.1 Program Available

Basic design itself yearly aims at the establishment of save-energy processes. The higher accuracy is desired for various physical properties basically applied to basic design.

Particularly, many calculation methods for physical properties which are more accurate than the previous ones are being announced since 1970 in response to the save-energy slogan.

It is not happy, but the physical property derivative has a tendency to be more complicated than before. It is becoming more difficult to manually calculate the derivative in a shorter period as was in the past.

6.2 Preparation for Physical Properties Using Commercial Program

Commercial grade simulators such as PROII, HYSYS and Aspen Plus are mostly being used as physical property generator. Special software packages for the amine, electrolyte, glycol system and so on have also been issued commercially and used frequently.

	BASIC DESIGN MANUAL PHYSICAL PROPERTIES	SPD0014ERN
		REV. : 2
		PAGE 5 OF 25
DATE : 2010.11. 25		

7. REFERENCES

- (1) Study Report on Physical Property Calculation in accordance with New API (Edition of Basic Physical Properties)
- (2) JAPETS Technical Documents
- (3) Collection of AREPPS (A Retrieval and Estimation of Physical Property System) Data File
- (4) GPA Technical Publication
- (5) GPA Research Report
- (6) IGT Report
- (7) API Technical Data Book-Petroleum Refining
- (8) GPSA Engineering Data Book
- (9) Gas Encyclopedia
- (10) Chemical Handbook (Maruzen)
- (11) Perry's Chemical Engineers' Handbook
- (12) International Critical Table
- (13) Chemical Process Principles Charts
- (14) Physical Properties of Hydrocarbons
- (15) Physical Properties of Chlorohydrocarbons
- (16) Chemical Thermodynamics Diagram (Kagaku Kogyo Sha)
- (17) Calculation Charts (UOP)
- (18) Liquid-vapor Equilibrium Data (Kogan)
- (19) Vapor Pressure Data using Computer (Shuzo Ohe)
- (20) The Properties of Gases and Liquids (Reid)
- (21) GPA K & H Mod II Program Documentation
- (22) GPA Properties 75 Program Documentation
- (23) GPA Peng-Robinson Program Documentation
- (24) GPA Peng-Robinson Hydrate Program Documentation
- (25) SimSci/PROCESS Input Manual
- (26) Physical Property Constant (Maruzen)
- (27) Materials for JUSE-AESOPP
- (28) Materials for NIDIST for Research Meeting
- (29) Thermo-physical property of Gas and Liquid
- (30) Calculation Method of Physical Property Constant (Kazuo Sato)
- (31) Vapor-liquid Equilibrium Data Collection (Dechema)
- (32) Fluid Properties Research Inc. Report
- (33) Thermodynamic Properties and Reduced Correlations for Gases.

APPENDIX. GUIDELINES FOR CHOOSING A PROPERTY METHOD

Refer to Fig. A-1

	BASIC DESIGN MANUAL PHYSICAL PROPERTIES	SPD0014ERN
		REV. : 2
		PAGE 6 OF 25

Table 4-1 Thermodynamic Physical Property Calculation Method

Calculation Method	Peculiarity	Capability					Applicable	Necessary Data
		K	Z	H	S	Cp		
SRK (Soave-RK)	One gained by improving Van der waals type RK method aiming at elevation of accuracy in high pressure vapor-liquid equilibrium calculations. kij parameter is used for elevation of accuracy in the vicinity of critical point	0	0	0	0	0	Light and middle hydrocarbon including inorganic gas. Excluding ethylene tower, propylene tower. ($-160^{\circ}\text{C} \leq T \leq 320^{\circ}\text{C}$, $P \leq 340\text{atm}$)	Critical constant (kij parameter)
PR (Peng-Robinson)	A method gained by improving SRK method to advance the accuracy in the vicinity of critical point. kij parameter is used for elevation of accuracy	0	0	0	0	0	Light and middle hydrocarbon including inorganic gas but excluding H ₂ .	Critical constant (kij parameter)
CS (Chao-Seader)	Activity coefficient method is used for liquid phase based on regular solution theory and PK method is used for vapor phase.	0	-	-	-	-	Middle and heavy hydrocarbon including inorganic gas. ($-20^{\circ}\text{C} \leq T \leq 200^{\circ}\text{C}$, $P \leq 140\text{atm}$)	Critical constant Solubility parameter
GS (Grayson-Streed)	Enlarged CS method up to high temperature region including H ₂ .	0	-	-	-	-	Middle and heavy hydrocarbon including inorganic gas ($-20^{\circ}\text{C} \leq T \leq 350^{\circ}\text{C}$, $P \leq 170\text{atm}$)	Critical constant Solubility parameter
OLEF (Light olefin relative volatility)	Based on fitting of relative volatility chart on ethylene/ethane, propylene/propane.	0	-	-	-	-	Only ethylene tower, propylene tower.	Critical constant
SHBWR (Starting-Han-BWR)	A method gained from more generalization of viral developing type BWR method. kij parameter used for advancement of accuracy	0	0	0	0	0	Light and middle hydrocarbon including inorganic gas but excluding H ₂ ($-160^{\circ}\text{C} \leq T \leq 200^{\circ}\text{C}$, $P \leq 200\text{atm}$)	Critical constant (kij parameter)

	BASIC DESIGN MANUAL PHYSICAL PROPERTIES	SPD0014ERN
		REV. : 2
		PAGE 7 OF 25

Table 4-1 Thermodynamic Physical Property Calculation Method (continued)

Calculation Method	Peculiarity	Capability					Applicable	Necessary Data
		K	Z	H	S	Cp		
BK-10 (Braun K-10)	Generally useful for heavy refinery hydrocarbons at low pressures.	0	-	-	-	-	Middle & heavy hydrocarbon including inorganic gas. ($38^{\circ}\text{C} \leq T \leq 650^{\circ}\text{C}$, $P \leq 7\text{atm}$)	Critical constant Acentric factor
Non-Random Two Liquid (NRTL)	Generally useful for non-ideal applications, especially for partially immiscible systems. Describe VLE and LLE of strongly nonideal solutions.	0	-	-	-	-	General aqueous solution system including polarity substance, such as alcohol-water system (up to atmospheric temperature and mid-pressure)	Critical constant, vapor pressure, binary parameter
Universal QUasi Chemical (UNIQUAC)	Generally useful for non-ideal applications, especially for partially immiscible systems. Describe VLE and LLE of strongly nonideal solutions.	0	-	-	-	-	Any combination of polar and nonpolar compounds, upto very strong nonideality. No component should be close to its critical temperature.	Critical constant, vapor pressure, binary parameter
(UNIFAC)	Activity coefficient model, like NRTL or UNIQUAC. But it is based on group contributions rather than molecular contributions	0	-	-	-	-	Any combination of polar and nonpolar compounds, upto very strong nonideality. Gas-solvent interactions are not predicted by UNIFAC.	Critical constant, vapor pressure, group interaction parameter
Van Laar	Describe nonideal liquid solutions with positive deviations from Raoult's law	0	-	-	-	-	Any combination of polar and nonpolar compounds with positive deviations from Raoult's law. No component should be close to its critical temperature.	Critical constant, vapor pressure, binary parameter

	BASIC DESIGN MANUAL PHYSICAL PROPERTIES	SPD0014ERN
		REV. : 2
		PAGE 8 OF 25
DATE : 2010.11. 25		

Table 4-1 Thermodynamic Physical Property Calculation Method (continued)

Calculation Method	Peculiarity	Capability					Applicable	Necessary Data
		K	Z	H	S	Cp		
Wilson	Non-ideality is expressed by the liquid phase activity coefficient based on non heat of solution theory. VLLE is not supported.	0	-	-	-	-	General aqueous solution system including polarity substance(up to atmospheric temperature and midpressure)	Vapor pressure, Wilson parameter
Vapor Phase Association	Molecular association model is used for vapor phase and Wilson method is used for liquid phase.	0	-	-	-	-	Aqueous solution system including carboxylic acid(up to atmospheric temperature and midpressure)	Vapor pressure, Wilson parameter, Vapor phase association constant
LK (Lee-Kesler)	Virial developing type states equation. Consists of two nominals, i.e, simple fluid and reference fluid nominals.	-	0	0	0	0	Light, middle and heavy hydrocarbon.	Critical constant
RICE (Rice Property'75)	Fitting method cultivated by RICE university.	-	0	0	0	-	Light and middle hydrocarbon.	Critical constant
LY (Lyman-Yarborough)	Corresponding states equation based on hard-sphere model.	-	0	-	-	0	Hydrocarbon gas including H ₂ S, CO ₂ (Tr ≥ 1.0, P ≤ 800atm)	Critical constant

	BASIC DESIGN MANUAL PHYSICAL PROPERTIES	SPD0014ERN
		REV. : 2
		PAGE 9 OF 25

Table 5-1 Recommendable Estimation Method for Petroleum Refineries

Plant or Unit	Recommendable Estimation Method					Application	Remarks
	K	Z	H	S	CP		
Topping Topper (main column)	API (Vapor press.)		API (Chart)			T = 100 – 700°F, P = 0 – 30 psig	Computer program should be used
Vacuum Vacuum column	Maxwell (Vapor press.)		API (Chart)			T = 100 – 800°F, P = 30 – 150 mmHgA at flash zone	Agrees with actual data
FCC gas con.							
Primary absorber	SRK		LK				Agrees with actual data
Secondary absorber	SRK		LK				
Stripper (Deethanizer)	SRK		LK				
Debutanizer	SRK		LK				
Depropanizer	SRK		LK				
Hydro-desulfurization(HDS) Reactor section	GS	Z-chart	LK			T = 600 – 750°F, P = 1000 psig	GPA-recommended solubility parameters used

	BASIC DESIGN MANUAL PHYSICAL PROPERTIES	SPD0014ERN
		REV. : 2
		PAGE 10 OF 25

Table 5-1 Recommendable Estimation Method for Petroleum Refineries (Continued)

Plant or Unit	Recommendable Estimation Method					Application	Remarks
	K	Z	H	S	CP		
PL gas con. Deethanizer Depropanizer	PR(SRK) PR(SRK)		PR(SRK) PR(SRK)	PR(SRK) PR(SRK)			
Hydro-cracker Atmospheric tower Vacuum tower Depropanizer Debutanizer Reactor section	Braun K10 Braun K10 CS CS GS	Curl Pitzer Curl Pitzer Curl Pitzer Curl Pitzer Curl Pitzer				T < 380°C, P < 3 kg/cm2G T < 220°C, P < 28 kg/cm2G T = 300 - 800°F, P = 1500 psia	Program used
Coker Coker heater Gas con.	GS SRK	Nelson(Char) LK				T = 300 - 500°C, P = 10 kg/cm2G	Program used

	BASIC DESIGN MANUAL PHYSICAL PROPERTIES	SPD0014ERN
		REV. : 2
		PAGE 11 OF 25

Table 5-1 Recommendable Estimation Method for Petroleum Refineries (Concluded)

Plant or Unit	Recommendable Estimation Method					Application	Remarks
	K	Z	H	S	C _p		
Visbraker Fractionator Visbreaking heater	API(Vapor press.) API(Vapor press.)	API(Char t) API(Char t)				T < 380°C, P < 5 kg/cm2G	Process owner recommend (None of data available)
Aroma H2 Purification	SRK		SRK	SRK		T = -220°F - 100°F, P = 450 psig	
Distillate Dewaxing Reactor section Stripper (reboiler)	GS SRK	Curl Pitzer Curl Pitzer				T = 60 - 805°F, P = 355 - 604 psig H2 60 - 80 vol% T = 100 - 795°F, P = 5 - 35 psig H2 1.8 vol%	Program used
Foul water stripper						T < 120°C, P < 2 kg/cm2G	Program used

	BASIC DESIGN MANUAL PHYSICAL PROPERTIES	SPD0014ERN
		REV. : 2
		PAGE 12 OF 25

Table 5-2 Recommendable Estimation Method for Petrochemical and General Chemical Industries

Plant or Unit	Recommendable Estimation Method					Application	Remarks
	K	Z	H	S	CP		
Ethylene Quench oil fractionator and quench water tower	Braun K10		Johnson-Grayson	Curl Pitzer		T * 40°C, P * 7 kg/cm ² G	For the convenience of recycle simulation for system containing water program used
Demethanizer	SRK or PR		SRK or PR	SRK or PR			Program used
Ethylene splitter	OLEF		SRK				IF ethylene product purity is 90 mol% or lower, SRK will serve the purpose for K value.
Propylene splitter	OLEF		SRK				IF ethylene product purity is 90 mol% or lower, SRK will serve the purpose for K value. When using simulator, give attention to input data on basic properties and kij parameters.
Acrylic acid, acrylate Oxidation, extraction	Wilson	Remarks	C _P + 入		Ideal gas		

	BASIC DESIGN MANUAL PHYSICAL PROPERTIES	SPD0014ERN
		REV. : 2
		PAGE 13 OF 25

Table 5-2 Recommendable Estimation Method for Petrochemical and General Chemical Industries(Concluded)

Plant or Unit	Recommendable Estimation Method					Application	Remarks
	K	Z	H	S	C _P		
Epichlorohydrine, glycerine ALC, ECH, SW	Wilson	Remarks	C _P + λ		Ideal gas		Generally, to be estimated from molecular structure and to be corrected by actual data.
MDI	Actual data + AREPPS	Actual data + AREPPS	Actual data + C _P + λ		Ideal gas		
MMA	Wilson	Remarks	C _P + λ		Ideal gas		Generally contains much acid and alcohol. So, a simple fractional additive rule will not hold for the case. The modification based on the client's data is required.
Coal liquefaction Liquefaction Phenol distillation	GS Wilson	LK	LK + Actual data Actual data		LK		Special estimations will be required as to K, H, and MW.

	BASIC DESIGN MANUAL PHYSICAL PROPERTIES	SPD0014ERN
		REV. : 2
		PAGE 14 OF 25
DATE : 2010.11. 25		

Table 5-3 Recommendable Estimation Methods for Gas Processing

Plant or Unit	Recommendable Estimation Method					Application	Remarks
	K	Z	H	S	C _P		
Gas Processing (including LPG section)	SRK or PR	Vapor : SRK or PR Liquid : RICE	SRK or PR (Remarks)	SRK or PR (Remarks)	GPA data book		RICE used for cases requiring high precision. PR will be frequently used for 2000 psia or so pressure. When precision is generally required in a high pressure region, SRK + kij parameters should be used.

	BASIC DESIGN MANUAL PHYSICAL PROPERTIES	SPD0014ERN
		REV. : 2
		PAGE 15 OF 25

Table 5-4 Recommendable Estimation Method for Gas Manufacturing and Treating

Plant or Unit	Recommendable Estimation Method					Application	Remarks
	K	Z	H	S	C _p		
Steam Reformer H ₂ , O ₂ , methanol MRG	(Remarks)	AREPPS or Ideal gas	AREPPS or + Data book (Note 1)		AREPPS or Ideal gas		Steam table used for correcting steam characteristics. API used partially.
Sulfur SRU, SCOT	(Remarks)	Ideal gas	Data book (Note 1)		Ideal gas	Full range	Sulfur data book used as to sulfur vapor pressure.
DE SO ₂ SFGD, Moretana		Ideal gas	Data book (Note 1)		Ideal gas	Full range	
DE NO _x PARANOX		Ideal gas	Data book (Note 1)		Ideal gas	Full range	
Partial Oxidation SGP		Ideal gas	Data book (Note 1)		Ideal gas		
Gas Absorption MEA, ADIP, sulfinol hot potassium		Ideal gas	Data book (Note 1)		Ideal gas	Full range	Licensors data are available in some parts

Note 1: Petroleum Refinery Vol. 28, No. 1, January 1949

AREPPS: A Retrieval and Estimation of Physical Property System

	BASIC DESIGN MANUAL PHYSICAL PROPERTIES	SPD0014ERN
		REV. : 2
		PAGE 16 OF 25

Table 5-5 Recommended Classes of Property methods for Different Applications

Oil and Gas Production

Application	Recommended Property Method
Reservoir systems	Equations of state for high pressure hydrocarbon applications
Platform separation	Equations of state for high pressure hydrocarbon applications
Transportation of oil and gas by pipeline	Equations of state for high pressure hydrocarbon applications

Refinery

Application	Recommended Property Method
Low pressure applications(up to several atm)	Petroleum fugacity and K-value correlations (and assay data analysis)
Vacuum tower	
Atmospheric crude tower	
Medium pressure applications (up to several tens of atm)	Petroleum fugacity and K-value correlations
Coker main fractionator	Petroleum-tuned equations of state (and assay data analysis)
FCC main fractionator	
Hydrogen-rich applications	Selected petroleum fugacity correlations
Reformer	Petroleum-tuned equations of state (and assay data analysis)
Hydrofiner	
Lube oil unit	Petroleum-tuned equations of state (and assay data analysis)
De-asphalting unit	

Gas Processing

Application	Recommended Property Method
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	BASIC DESIGN MANUAL PHYSICAL PROPERTIES	SPD0014ERN
		REV. : 2
		PAGE 17 OF 25

Hydrocarbon separations	Equations of state for high pressure hydrocarbon applications (with kij)
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Demethanizer

C3-splitter

Cryogenic gas processing	Equations of state for high pressure hydrocarbon applications
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Air separation	Flexible and predictive equations of state
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Gas dehydration with glycols	Flexible and predictive equations of state
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Acid gas absorption with Methanol (rectisol) NMP (purisol)	Flexible and predictive equations of state
--	--

Acid gas absorption with Water Ammonia Amines Amines + methanol (amisol) Caustic Lime Hot carbonate	Electrolyte activity coefficients
--	-----------------------------------

Claus process	Flexible and predictive equations of state
---------------	--

Petrochemicals

Application	Recommended Property Method
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Ethylene plant

Primary fractionator	Petroleum fugacity correlations (and assay data analysis)
----------------------	---

Light hydrocarbons separation train	Equations of state for high pressure hydrocarbon applications
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Quench tower	Equations of state for high pressure hydrocarbon applications
--------------	---

Aromatics	Liquid activity coefficients (very sensitive to parameters)
-----------	---

BTX extraction

Substituted hydrocarbons	Equations of state for high pressure hydrocarbon applications
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VCM plant

Acrylonitrile plant

Ether production	Liquid activity coefficients
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	BASIC DESIGN MANUAL PHYSICAL PROPERTIES	SPD0014ERN
		REV. : 2
		PAGE 18 OF 25

MTBE, ETBE, TAME

Ethylbenzene and styrene plants	Equations of state for high pressure hydrocarbon applications and Ideal (with Watsol) or liquid activity coefficient
Terephthalic acid	Liquid activity coefficients(with dimerization in acetic acid section)

Chemicals

Application	Recommended Property Method
Azeotropic separations	Liquid activity coefficients
Alcohol separation	
Carboxylic acids	Liquid activity coefficients
Acetic acid plant	
Phenol plant	Liquid activity coefficients
Liquid phase reactions	Liquid activity coefficients
Estrification	
Ammonia plant	Equations of state for high pressure hydrocarbon applications (with k_{ij})
Fluorochemicals	Liquid activity coefficients (and HF equation of state)
Inorganic Chemicals	Electrolyte activity coefficients
Caustic	
Acids	
Phosphoric acid	
Sulphuric acid	
Nitric acid	
Hydrochloric acid	
Hydrofluoric acid	Electrolyte activity coefficient (and HF equation of state)

Coal Processing

Application	Recommended Property Method
Size reduction	Solids processing (with coal analysis and particle size distribution)
crushing, grinding	
Separation and cleaning	Solids processing (with coal analysis and and particle size distribution)
sieving, cyclones, precipitation, washing	

	BASIC DESIGN MANUAL PHYSICAL PROPERTIES	SPD0014ERN
		REV. : 2
		PAGE 19 OF 25

Combustion	Equations of state for high pressure hydrocarbon applications (with combustion databank)
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Acid gas absorption	See Gas Processing
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Coal gasification and liquefaction	See Synthetic Fuel
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Power Generation

Application	Recommended Property Method
Combustion	Equations of state for high pressure hydrocarbon applications (with combustion databank) (and assay analysis with coal correlations)
Coal	(and assay analysis)
Oil	
Steam cycles	Steam tables
Compressors	
Turbines	
Acid gas absorption	See Gas Processing earlier in this discussion.

Synthetic Fuel

Application	Recommended Property Method
Synthesis gas	Equations of state for high pressure hydrocarbon applications
Coal gasification	Equations of state for high pressure hydrocarbon applications
Coal liquefaction	Equations of state for high pressure hydrocarbon applications with K_{ij} and assay (analysis with coal correlations)

Environmental

Application	Recommended Property Method
Solvent recovery	Liquid activity coefficients
(Substituted) hydrocarbon stripping	Liquid activity coefficients
Acid gas stripping from Methanol (rectisol) NMP (purisol)	Flexible and predictive equations of state
Acid gas stripping from Water Ammonia	Electrolyte activity coefficients

	BASIC DESIGN MANUAL PHYSICAL PROPERTIES	SPD0014ERN
		REV. : 2
		PAGE 20 OF 25
DATE : 2010.11. 25		

Amines
Amines + methanol (amisol)
Caustic
Lime
Hot carbonate

Water and Steam

Application	Recommended Property Method
Steam systems	Steam tables
Coolant	Steam tables

Mineral and Metallurgical Processes

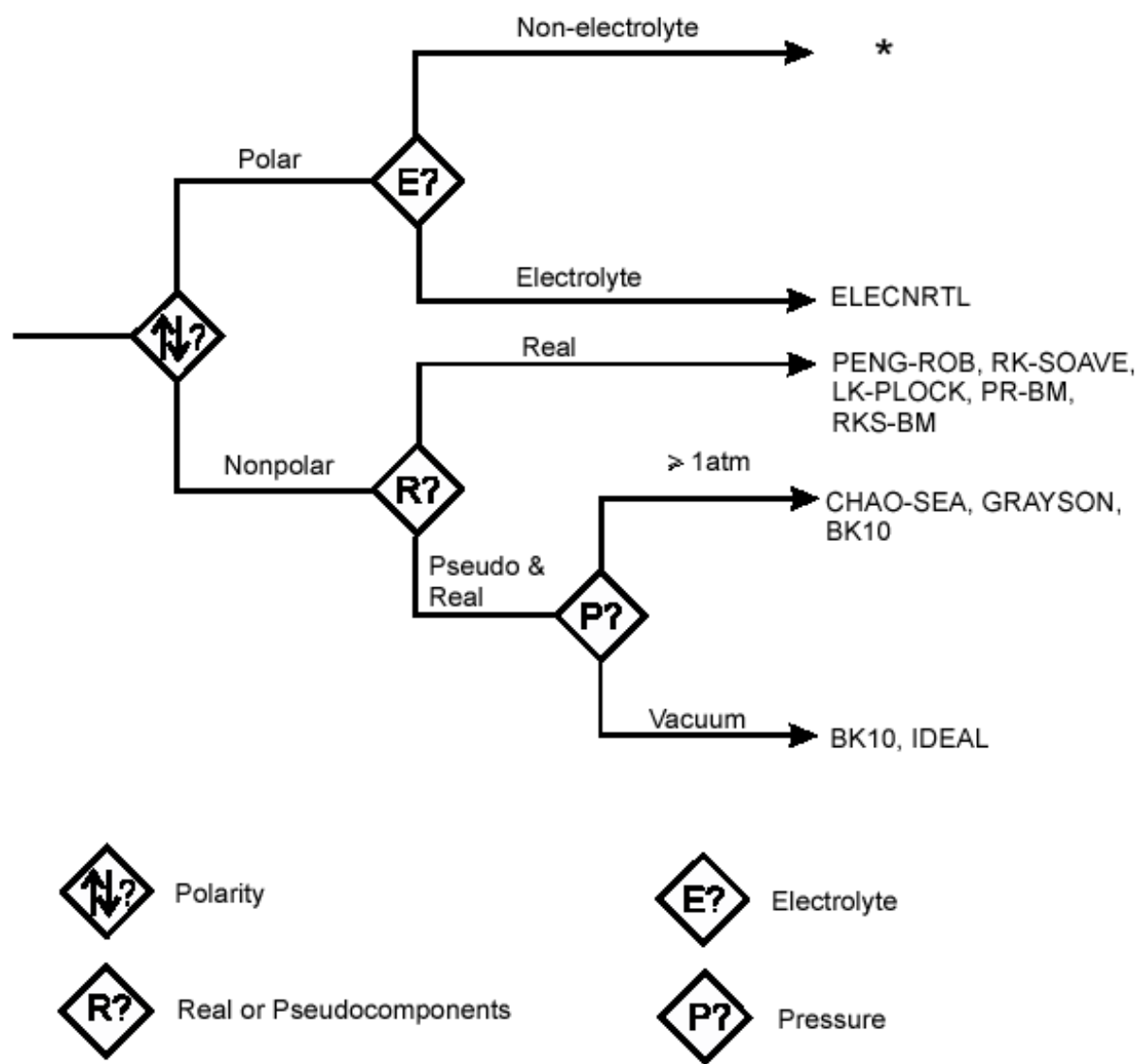
Application	Recommended Property Method
Mechanical processing crushing, grinding, sieving, washing	Solids Processing (with inorganic databank)
Hydrometallurgy Mineral leaching	Electrolyte activity coefficients
Pyrometallurgy Smelter Converter	Solids Processing (with inorganic databank)

	BASIC DESIGN MANUAL PHYSICAL PROPERTIES	SPD0014ERN
		REV. : 2
		PAGE 21 OF 25

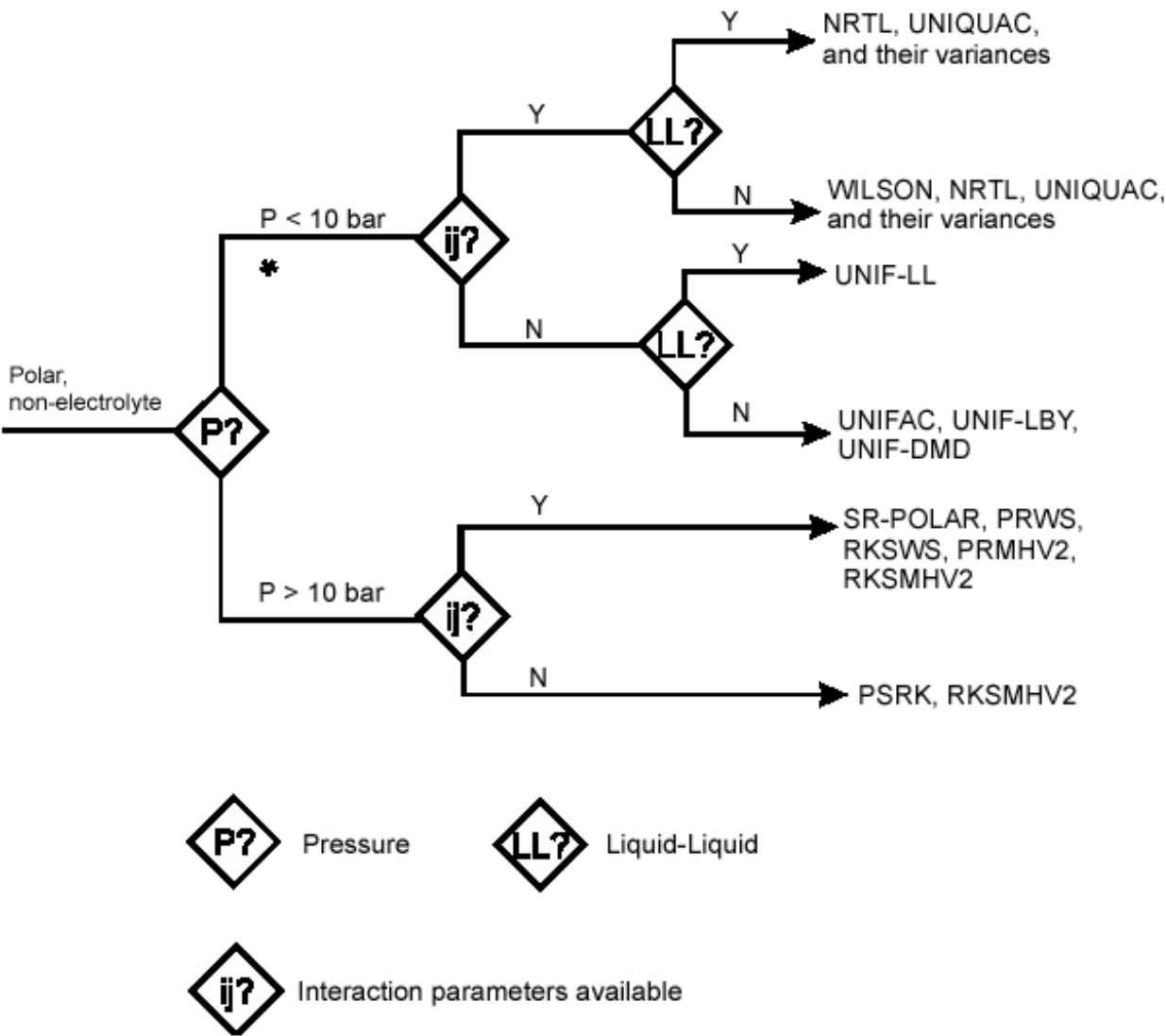
Table 5-6 Choice Thermodynamic Models Used in the Process Industries

Chemical System	Primary Choice Models of Today	Secondary Choice Models	Problem Areas
Air Separation	Peng-Robinson, Soave-Redlich-Kwong	Corresponding States	
Gas Processing	Peng-Robinson, Soave-Redlich-Kwong	BWRS	
Gas Treating	Kent-Eisenberg, Electrolyte NRTL		Data, Parameters, Models for mixed amines
Petroleum Refining	BK10, Chao-Seader, Grayson-Streed, Peng-Robinson, Soave-Redlich-Kwong, Lee-Kessler-Plocker		Heavy crude characterization
Petrochemicals-VLE	Peng-Robinson, Soave-Redlich-Kwong, PSRK	NRTL, UNIQUAC, UNIFAC	Data, Parameters
Petrochemicals-LLE	NRTL, UNIQUAC		Data, Parameters, Models for VLLE systems
Chemicals	NRTL, UNIQUAC, PSRK	UNIFAC	Data, Parameters
Electrolytes	Electrolyte NRTL, Zemaitis	Pitzer	Data, Parameters, Databanks, Models for polyelectrolytes
Oligomers	Polymer NRTL	UNIQUAC, UNIFAC	Pure component fugacity, Databanks
Polymers	Polymer NRTL, SAFT	PC-Sanchez-Lacombe, SAFT, UNIFAC-FV	Data, parameters, Databanks, Flash algorithms, Models for polar polymers, block copolymers
Steam	NBS/NRC		
Environmental	UNIFAC+Henry's Law		Data
Pharma/Biological	None		Data, Databanks, Models

Fig. A-1 Guidelines for Choosing a Property Method

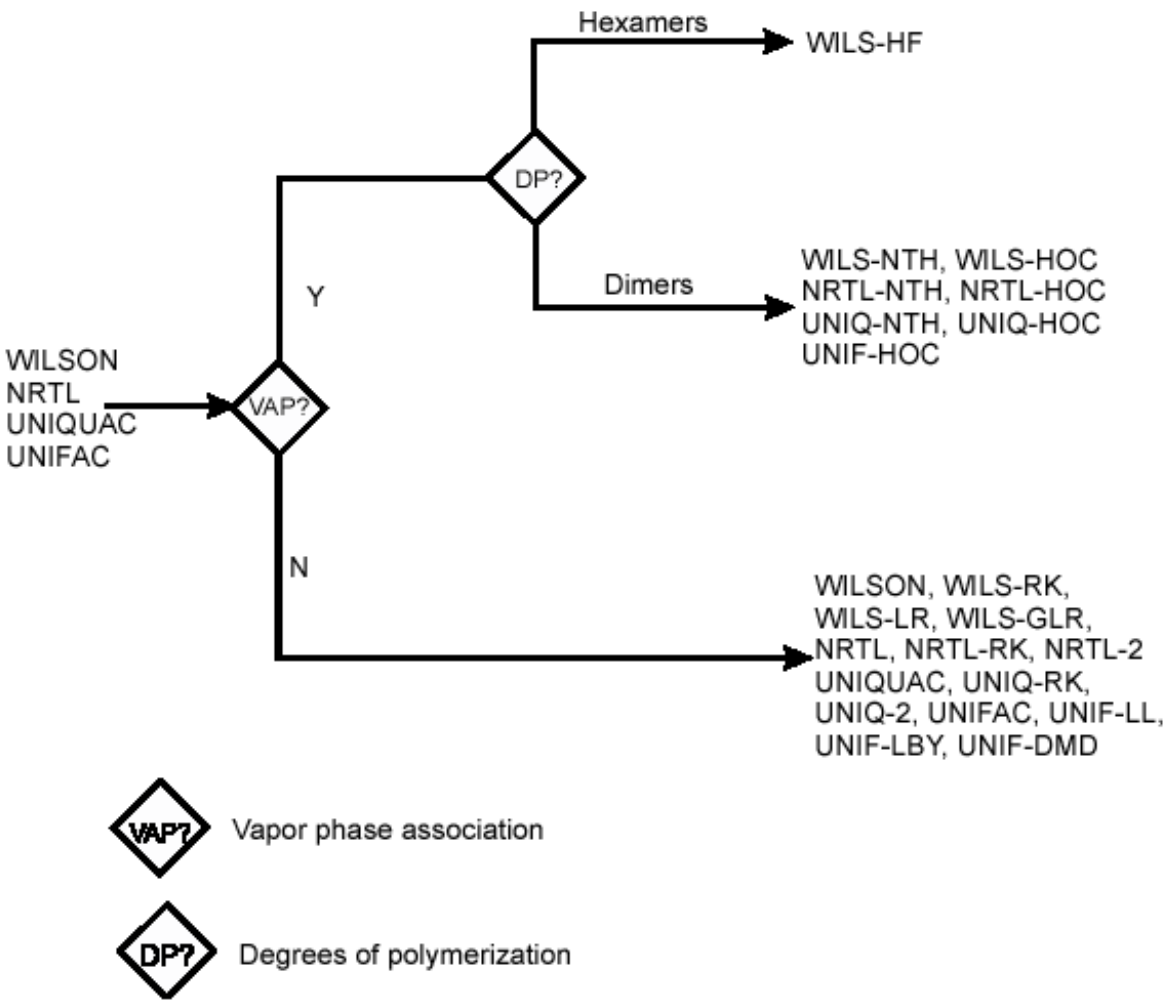


Guidelines for Choosing a Property Method (continued)



	BASIC DESIGN MANUAL PHYSICAL PROPERTIES	SPD0014ERN
		REV. : 2
		PAGE 24 OF 25

Guidelines for Choosing a Property Method (continued)



	BASIC DESIGN MANUAL PHYSICAL PROPERTIES	SPD0014ERN
		REV. : 2
		PAGE 25 OF 25
DATE : 2010.11. 25		

8. 작성내력

개정번호	개 정 일 자	개정 페이지	개 정 사 유
1	2004. 10. 25	전 페이지	신규 제정 - 작성부서 : 공정팀 - 작성자 : 이원재 - 검토자 : 구영열 박종현 노재철 - 승인자 : 정찬설
2	2010.11.25.		- Document number change due to new numbering system - Written at Process Eng'g Dept.II Written by : C.H.Yun Checked by : J.H.Park Approved by : Y.Y.Koo