

PROGRAM SUBMITTAL

☒ New Program

☐ Revision to Program

Model No.

☐ 67

☐ 97

☒ 41

Program Title

Saturation pH - Calculation of
Langelier and Ryzner indices

No. Lines

012100

Bytes

07114

Category No.

120

11818

11819

15310

(Primary)

Primary

Category Name

Chemical Engineering

Abstract-75 Word Maximum

To anticipate problems associated with the operation of

cooling towers (i.e. scaling or corrosive behavior of the water), two indices

are commonly used. These are the Langelier and Ryzner (aggressive) indices.

The program will calculate values for both based on either a full or partial
water analysis.

Necessary Accessories: HP-41 requires 1 memory module or quad memory. Card Reader
and Printer Plotter are helpful.

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Hewlett Packard Dealer American Scientific Products

Acceptance Choice:

☒ FOUR \$6.00 PROGRAMS

☐ ONE POINT CERTIFICATE

HP41CV

0112121010

01197715

010914915

010517109

Please use the checklist below to insure submittal of all proper program documents

☒ SIGNED PROGRAM
SUBMITTAL PAGE

☒ Program Description II

☒ Program Listing(s)

☒ Registers, Status...

☒ Program Description I

☒ User Instructions

☒ MASS STORAGE
MEDIA

☐ Keyboard, Card Labeling
(optional)

ACKNOWLEDGMENT AND AGREEMENT

To the best of my knowledge, I have the right to contribute this program material without breaching any obligation concerning nondisclosure of proprietary or confidential information of other persons or organizations. I am contributing this program material on a nonconfidential nonobligatory basis to Hewlett-Packard Company ("HP") for inclusion in its program library, and I agree that HP may use, duplicate, modify, publish, and sell the program material, and authorize others to do so without obligation or liability of any kind. HP may publish my name and address, as the contributor, to facilitate user inquiries pertaining to this program material.

Signature

Ronald L. Dielman

Date

5-31-83

HP USE ONLY

No.
Pages:

Mag Cards
Cassette:

Price:

PROGRAM DESCRIPTION I

Page 1 of 7

Program Title Saturation pH - Calculation of Langelier and Ryzner Indices

Contributor's Name Ronald L. Dielman

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Program Description, Equations, Variables The program prompts for Ca^{++} , total alkalinity, total dissolved solids, water temperature and system pH or if a balanced water analysis is available it prompts for Ca^{++} , total alkalinity, Mg^{++} , $SO_4^{=}$, total cations or anions, water temperature in $^{\circ}F$ and system pH. Units are in ppm as $CaCO_3$, except TDS - mg/L (ppm), system pH and water temperature. The following equations as described by J.R. Hefler are used for calculations:

$$pH_s = (pk_2 - pk_s) + pCa + pAlk$$

$$\text{Langelier Saturation Index (L.S.I.)} = pH_a - pH_s$$

$$\text{Ryzner Saturation Index (R.S.I.)} = 2(pH_s) - pH_a$$

$$\text{where } pH_a = \text{System pH}; pH_s = \text{Saturation pH}; K_2 = \frac{(H^+)(CO_3^{2-})}{(HCO_3^-)}$$

$$\text{and } K_s = (Ca^{++})(CO_3^{=})$$

Necessary Accessories HP41 requires 1 memory module or 1 quad memory module. Card Reader and Printer Plotter helpful.

Operating Limits and Warnings Strict interpretation of results left to user. Program does not check input data. pH of system must be in the 6.5 - 9.5 range. Temperature range of system 32 to 140 $^{\circ}F$.

Reference(s) J.R. Hefler, "Determination of Saturation pH by Hand Calculator", Materials Performance, April, 1983, 20-22.

This program has been verified only with respect to the numerical example given in Program Description II. User accepts and uses this program material AT HIS OWN RISK, in reliance solely upon his own inspection of the program material and without reliance upon any representation or description concerning the program material.

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PROGRAM DESCRIPTION II

Page 2 of 7

Sample Problem (Sketch if Desired)

Example 1

Ca = 132 ppm as CaCO_3
 Total Alkalinity = 107 ppm as CaCO_3
 Temperature = 55°F
 TDS = 296 mg/L (ppm)
 (Total Dissolved Liquids)
 System pH = 7.62

Note: This example does not have a balanced water analysis. See example two for that computation.

Example 2 (Balanced Water Analysis)

Water Temp. °F = 55°
 System pH = 7.62
 By Analysis (ppm)
 Total Alkalinity 107
 Ca 132 SO_4 53
 Mg 51.5 Cl 30.3
 Na 21.6 NO_3 14.8

Total Cations
 205.1

Total Anions
 205.1

SOLUTION:

Display	Input	Function	Comments
Example #1		[XEQ] Size 017	Minimum Size
CA^{++} as CaCO_3 ?	132	[XEQ] PHS	
Total Alkalinity ?	107	R/S	
Bal H ₂ O Analysis 1 = yes	0	R/S	
TDS in Mg/L ?	296	R/S	Total water analysis not available
Water Temp. in °F ?	55	R/S	
System pH ?	7.62	R/S	
L.S.I. = -0.35			Solution for Langelier
CaCO_3 Dissolves			Saturation Index
R.S.I. = 8.31			Solution for Ryznar
Corrosive			Saturation Index
		[XEQ] Size 017	Minimum Size
		[XEQ] PHS	
Example #2			
CA^{++} As CaCO_3 ?	132	R/S	
Total Alkalinity ?	107	R/S	
Bal H ₂ O Analysis 1 = yes	1	R/S	
Mg^{++} AS CaCO_3 ?	51.5	R/S	
SO_4 = As CaCO_3 ?	53.0	R/S	
Total Cations or			
Anions ?	205.1	R/S	
Water Temp. in °F ?	55	R/S	
System pH	7.62	R/S	
L.S.I. = -0.34			Solution for Langelier
CaCO_3 Dissolves			Saturation Index
RSI = 8.30			Solution for Ryznar
Corrosive			Saturation Index

USER INSTRUCTIONS

Page 3 of 7

				SIZE: (HP-41C)
STEP	INSTRUCTIONS	INPUT	FUNCTION	DISPLAY
1	Enter The Program		[XEQ] Size 017	
2	Begin The Program		[XEQ] PHS	
3	Enter Analytical Data			
3a	Example 1 - Short Analysis - (See Page 2)	Ca Alkalinity 0 TDS °F pH		
3b	Example 2 - Balanced Analysis (See Page 2) Balanced? (1=Yes)	Ca Alkalinity 1 Mg SO ₄ Total Cations or Total Anions °F pH	} One Step, Either/Or	
4	Solutions Displayed			L.S.I. = R.S.I. =

PROGRAM LISTING

Page 4 of 7

☐ 67 ☐ 97 ☒ 41C

STEP/ LINE	KEY ENTRY	KEY CODE (67/97 only)	COMMENTS	STEP/ LINE	KEY ENTRY	KEY CODE (67/97 only)	COMMENTS
01	LBL "PHS			41	0		Determination of
02	CF 00			42	RCL 14		a Calculated
03	0		Neutral Value	43	2		TDS Value
04	STO 15			44	*		
05	6		Neutral Value	45	RCL 01		
06	STO 16			46	+		
07	0			47	RCL 12		
08	"Ca++ AS		Ca ⁺⁺ ppm	48	+		
	CaCO3 ?"			49	RCL 13		
09	PROMPT			50	+		
10	STO 01			51	.4		
11	0			52	*		
12	"TOTAL A		Alkalinity ppm	53	STO 03		
	LK. AS"			54	LBL 06		
13	"F CaCO3			55	"WATER T		Temp. °F
	?"				EMP IN D"		
14	PROMPT			56	"FEGREES		
15	STO 02				F ?"		
16	0			57	PROMPT		
17	"BAL. H2		Total Cation,	58	STO 04		
	0 ANAL. "		Anion Analysis?	59	0		
18	"F? 1=YE			60	"SYSTEM		
	S"				PH ?"		
19	PROMPT			61	PROMPT		
20	X>0?			62	STO 09		
21	GTO 05			63	0		
22	0			64	RCL 01		
23	"TDS IN		TDS ppm	65	RCL 02		
	MG/L ?"			66	*		
24	PROMPT			67	LOG		
25	STO 03			68	STO 05		Determination
26	0			69	RCL 04		Temp. > 77° or
27	GTO 06			70	77		< 77° F
28	LBL 05			71	-		
29	"MG AS C		Mg ⁺⁺ ppm	72	X<0?		
	aCO3 ?"			73	GTO 01		
30	PROMPT			74	RCL 04		
31	STO 12			75	.00915		
32	0			76	*		
33	"SO4 AS		SO ₄ = ppm	77	RCL 05		
	CaCO3 ?"			78	+		
34	PROMPT			79	STO 05		
35	STO 13			80	GTO 02		
36	0			81	LBL 01		Temp. < 77° F
37	"TOTAL C		Total of Only	82	SF 00		
	ATIONS 0"		Cations or Anions	83	RCL 04		
38	"FR ANIO			84	.0142		
	NS ?"			85	*		
39	PROMPT			86	RCL 05		
40	STO 14			87	+		
				88	STO 05		
				89	LBL 02		

PROGRAM LISTING

Page 5 of 7

☐ 67 ☐ 97 ☒ 41C

STEP/ LINE	KEY ENTRY	KEY CODE (67/97 only)	COMMENTS	STEP/ LINE	KEY ENTRY	KEY CODE (67/97 only)	COMMENTS
90	RCL	03		138	*****		
91	LOG			*****			
92	.10			139	AVIEW		
93	*			140	PSE		
94	STO	06		141	CF 12		
95	FS?	00	Determination of	142	ADV		
96	GTO	03	which constant to	143	"	**	
97	RCL	06	add to temperature	****			
98	12.27		T > 77 + 12.27	144	AVIEW		
99	+		T < 77 + 12.65	145	ADV		
100	STO	07		146	RCL 10		
101	GTO	04		147	"L. S. I		
102	LBL	03		.	=		
103	RCL	06		148	ARCL X		
104	12.65			149	AVIEW		
105	+			150	PSE		
106	STO	07		151	"< 0 = N		Determination of
107	LBL	04		EUTRAL >"			depositing or
108	RCL	07		152	AVIEW		dissolving
109	RCL	05		153	PSE		characteristics
110	-			154	ADV		
111	STO	05		155	RCL 15		
112	RCL	05		156	X>Y?		
113	FIX	2		157	GTO 07		
114	STO	08		158	"CaCO3 D		
115	RCL	09		EPOSITS"			
116	RCL	08		159	AVIEW		
117	-			160	PSE		
118	STO	10		161	GTO 08		
119	RCL	08		162	LBL 07		
120	2			163	"CaCO3 D		
121	*			ISSOLVES"			
122	RCL	09		164	AVIEW		
123	-			165	PSE		
124	STO	11		166	LBL 08		
125	SF	12		167	ADV		
126	*****		Printing and/	168	"	**	
*****			or viewing of	****			
127	AVIEW		results	169	AVIEW		
128	PSE			170	ADV		
129	"	COOLI		171	RCL 11		
NG"				172	"R. S. I		
130	AVIEW			.	=		
131	PSE			173	ARCL X		
132	"	WATE		174	AVIEW		
R"				175	PSE		
133	AVIEW			176	"< 6= NE		
134	PSE			UTRAL >"			
135	"	ANALY		177	AVIEW		
SIS"				178	PSE		
136	AVIEW			179	ADV		
137	PSE			180	RCL 16		

PROGRAM LISTING

Page 6 of 7

☐ 67 ☐ 97 ☒ 41C

STEP/ LINE	KEY ENTRY	KEY CODE (67/97 only)	COMMENTS	STEP/ LINE	KEY ENTRY	KEY CODE (67/97 only)	COMMENTS
181	X>Y?		Determination of corrosive or scaling tendencies. These are similar to steps 155-163.		*****		If printer is used the results will be as shown at left.
182	GTO 09				COOLING		
183	"CORROSI				WATER		
184	AVIEW				ANALYSIS		
185	PSE				*****		
186	GTO 10				****		
187	*LBL 09				L. S. I. = -0.35		
188	"SCALING				< 0 = NEUTRAL >		
189	AVIEW				CaCO3 DISSOLVES		
190	*LBL 10				****		
191	ADV				R. S. I. = 8.31		
192	"	**			< 6= NEUTRAL >		
193	AVIEW				CORROSIVE		
194	ADV				****		
195	ADV						
196	ADV						
197	ADV						
198	ADV						
199	.END.						
30				80			
40				90			
50				00			

Note: Refer to "HP-41C OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for specific information on keystrokes. The Function Index is found at the very back of the Handbook. Refer to Appendix E in 67 or 97 "OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for exact keystrokes.

REGISTERS, STATUS, FLAGS, ASSIGNMENTS

DATA REGISTERS		STATUS			
01	Ca ⁺⁺	SIZE 017	TOT. REG. 102	USER MODE	
02	Total Alkalinity	ENG X	FIX 6	SCI	ON OFF X
03	TDS	DEG	RAD	GRAD	
		FLAGS			
		#	INIT S/C	SET INDICATES	CLEAR INDICATES
04	Water Temp In °F	00	C	°F < 77	°F > 77
05	Log (Alkalinity x CaCO ₃)				
06	Log (TDS) x 0.10				
07	Log (TDS) x 0.10 + 12.65 if °F < 77 or 12.27 if °F < 77				
08	Log (Alkalinity x CaCO ₃); Fix 2				
09	System pH				
10	pHa - pHs				
11	2(pHs) - pHa				
12	Mg ⁺⁺				
13	SO ₄ =				
14	Total Cations or Anions				
15	L.S.I. Neutral Value 0				
16	R.S.I. Neutral Value 6				
		ASSIGNMENTS			
		FUNCTION	KEY	FUNCTION	KEY
		N/A			