OPEN-FILE REPORT 83-10

PROGRAMMABLE CALCULATOR SOLUTIONS FOR COAL QUALITY DETERMINATIONS

by

Peter Rushworth

Colorado Geological Survey
Department of Natural Resources
Denver, Colorado 80203
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TITLE: COAL QUALITY WEIGHTED AVERAGES

ABSTRACT:

The program computes the weighted averages of user-selected coal quality characteristics. Up to 140 coal quality factors may be weighted for analysis. Useful in mine planning and blending of stockpile material.

Program Lines: 118
Bytes: 236
Accessories: None

PROGRAM DESCRIPTION I

Program Title COAL QUALITY WEIGHTED AVERAGES

Contributor's Name Peter Rushworth

Address Colorado Geological Survey 1313 Sherman St. Room 715

City Denver **State/Country** CO /USA **Zip Code** 80203

Program Description, Equations, Variables

Weighted average is determined in the following manner:

$$\frac{\sum(\text{tons} * \text{quality characteristic})}{\sum \text{tons}} = \text{Weighted average of quality characteristic}$$

The maximum number if factors is:

$$\frac{\text{Total registers} - 38}{2} \quad \text{for HP41CV} = 140$$

Size is computed as follows: 2(# factors) + 6

Necessary Accessories None

Operating Limits and Warnings CLRG used in line 007, use with printer in NORMal mode.

Reference(s)

PROGRAM DESCRIPTION II

Sample Problem (Sketch if Desired)

For a longwall panel the following were measured:

Reserve	Heating Value (Btu/lb)	Ash Content (%)	Sulfur Content (%)
13,306	10,965	2.1	0.70
11,400	10,960	2.1	0.70
77,112	10,940	2.3	0.70
421,478	10,930	2.4	0.73
442,512	10,910	2.7	0.75

COMPUTE TOTAL TONS AND WEIGHTED AVERAGES OF COAL QUALITY

Solution:

965,808	10,922	2.5	0.74

SOLUTION:

Display	Input	Function	Comments
		Size 006	minimum size
		Xeq Wt	run program
NO. FACTORS	3	R/S	number of quality factors
SIZE >=12		Size 012	resize accordingly
11		Xeq Wt	
NO. FACTORS	3	R/S	
FACTOR	BTU	R/S	enter alpha factor
FACTOR	ASH	R/S	
FACTOR	SULFUR	R/S	
TONS	13,306	R/S	enter reserve data
BTU	10,965	R/S	enter corresponding quality data
ASH	2.1	R/S	
SULFUR	0.70	R/S	
TONS	11,400	R/S	
BTU	10,960	R/S	
ASH	2.1	R/S	
SULFUR	0.7	R/S	
TONS	77,112	R/S	
BTU	10,940	R/S	
ASH	2.3	R/S	
SULFUR	0.7	R/S	
TONS	421,478	R/S	
BTU	10,930	R/S	
ASH	2.4	R/S	
SULFUR	0.73	R/S	
TONS	442,512	R/S	
BTU	10,910	R/S	
ASH	2.7	R/S	
SULFUR	0.75	R/S	
TONS		R/S	no entry R/S for compute
TONS=965,808.		R/S	
BTU=10,922.47		R/S	no R/S if printer
ASH=2.52		R/S	
SULFUR=0.74		R/S	
TONS			program reinitializes, tone sounds

USER INSTRUCTIONS

SIZE: (HP-41C) 006

STEP	INSTRUCTIONS	INPUT	FUNCTION	DISPLAY
1	Key in WT			
2	XEQ size 006 or larger		Size	
3	XEQ WT			No. factors
4	Enter number of coal quality factors	No. Factors	R/S	Size = X
4a	Size = X appears only if size inadequate, else 5 resize if necessary		Size X	
5	Enter alpha prompt repeat n times	Alpha Name	R/S	Factor
6	Enter tonnage and quality data, prompts with previously entered alphas when data entry complete R/S to exit	Input Tons Input Quality Data	R/S R/S	Tons Alpha Prompt Tons =
7	Outputs total tons and weighted averages for each alpha prompt		R/S R/S	Alpha = Tons
8	Program reinitializes with same alpha prompts, program control returns to step 6. To fully reinitialize go to step 3.			

*If larger size is required it is computed.

PROGRAM LISTING

STEP/ LINE	KEY ENTRY	COMMENTS
01	◆LBL "WT"	
02	FS? 55	
03	PRBUF	Sets
04	CF 21	Printer
05	FS? 55	Flags
06	SF 21	
07	SF 29	
08	FIX 0	
09	CLRG	
10	◆LBL 02	
11	"NO. FACTORS"	Prompts for number of factors and computes size
12	PROMPT	
13	STO 04	
14	STO 05	
15	ST+ X	
16	6	
17	+	
18	"SIZE>="	
19	ARCL X	
20	1	
21	−	Displays if necessary
22	SF 25	
23	RCL IND X	
24	FC?C 25	
25	PROMPT	
26	XEQ 10	
27	◆LBL 00	
28	"FACTOR"	Prompt for alpha factor repeats for all factors
29	AON	
30	PROMPT	
31	AOFF	
32	ASTO IND 02	
33	XEQ 12	
34	DSE 05	
35	GTO 00	
36	GTO 01	
37	◆LBL 03	
38	FIX 2	Prompts
39	CLA	
40	ARCL IND 02	and
41	PROMPT	stores
42	RCL 00	
43	*	Coal quality
44	ST+ IND 03	data
45	DSE 05	
46	XEQ 12	
47	RCL 05	
48	X<=0?	
49	GTO 01	
50	GTO 03	
51	◆LBL 14	Output
52	"⊢="	Subroutine
53	ARCL X	
54	AVIEW	
55	FS? 55	
56	RTN	
57	STOP	
58	RTN	
59	◆LBL 01	Prompts for
60	XEQ 10	tons
61	CF 22	output if
62	"TONS"	no entry
63	PROMPT	
64	FC? 22	
65	GTO 04	
66	STO 00	
67	ST+ 01	
68	GTO 03	Accumulates
69	◆LBL 04	tons
70	XEQ 10	
71	RCL 01	
72	"TONS"	Output
73	XEQ 14	sequence
74	◆LBL 05	
75	FIX 2	
76	CLA	
77	RCL IND 03	Iteration for alpha output
78	RCL 01	
79	/	
80	ARCL IND 02	
81	XEQ 14	
82	DSE 05	
83	XEQ 12	
84	RCL 05	
85	X>0?	
86	GTO 05	
87	CLD	
88	ADV	Zero previous
89	TONE 9	accumulations
90	0	
91	STO 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

PROGRAM LISTING

STEP/ LINE	KEY ENTRY	COMMENTS
92	STO 01	
93	7.14002	
94	STO 03	
95	◆LBL 09	Initialization
96	SF 25	of
97	0	counter
98	STO IND	registers
03		
99	FC?C 25	
100	GTO 01	
101	ISG 03	
102	GTO 09	
103	0	
104	1/X	
105	◆LBL 12	
106	ISG 02	
107	ISG 03	
108	RTN	
109	◆LBL 10	
110	FIX 0	
111	6.14002	
112	STO 02	
113	7.14002	
114	STO 03	
115	RCL 04	
116	STO 05	
117	RTN	
118	END	

STEP/ LINE	KEY ENTRY	COMMENTS

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.

REGISTERS, STATUS, FLAGS, ASSIGNMENTS

DATA REGISTERS

00	Tons	
01	Accumulated tons	
02	Counter for alpha data	
03	Counter for quality data	
04	No. factors-preserves data for 05	
05	No. factors-decrementing	
06	Alpha store	
07	Accumulation for quality data	
08	...	
09	...	Repeat
10	...	as
11	---	Necessary

STATUS

SIZE	006	TOT. REG.	32			USER MODE	
ENG	-	FIX	2	SCI	-	ON	OFF X
DEG	-	RAD	-	GRAD	-		

FLAGS

#	INIT S/C	SET INDICATES	CLEAR INDICATES
21	s/c	Printer enable	
22	s/c	Digit entry	-
25	C	Error ignore	-
29	S	Digit grouping	-
55	s/c	Printer existence	-

ASSIGNMENTS

FUNCTION	KEY	FUNCTION	KEY
Wt	any		

TITLE: COAL QUALITY CALCULATIONS

ABSTRACT:

The program accepts coal quality data from a proximate analysis and calculates coal quality on a dry-, and dry, ash-free basis. Coal quality factors are normalized to 100 percent. In addition, coal quality on a dry, ash-free basis is calculated by the Parr Formula.

Program Lines: 229
Bytes: 488
Accessories: 1 memory module equivalent

PROGRAM DESCRIPTION I

Program Title COAL QUALITY CALCULATIONS

Contributor's Name Peter Rushworth

Address Colorado Geological Survey 1313 Sherman St. Room 715

City Denver **State/Country** CO/USA **Zip Code** 80203

Program Description, Equations, Variables

The program calculates coal quality on a dry and dry,ash-free basis given coal quality on an as-received basis. The Parr Formulas are used to compute dry,ash-free coal quality as well. The Parr Formulas are as follows:

daf FC=(FC-0.15S)/(100-(M+1.08A+0.55S))*100

daf VM=100-daf FC

daf BTU=(BTU-50S)/(100-1.08A+0.55S))*100

Necessary Accessories printer desirable, 1 memory module or equivalent

Operating Limits and Warnings

Parr Formula volatile matter is not a reliable rank indicator. Use with printer in MANual mode.

Reference(s) n/a

PROGRAM DESCRIPTION II

Sample Problem (Sketch if Desired)

Given a proximate analysis:

Moisture	0.7%
Ash	27.8%
Fixed Carbon	56.1%
Volatile Matter	15.4%
Heating Value	11,200 Btu/lb
Sulfur	0.58%

Determine coal quality on a dry-, and dry, ash-free basis. Also determine values from the Parr Formulas.

SOLUTION: NON-PRINT VERSION

Display	Input	Function	Comments
	Size 011		
Key in cq	xeq cq	As received	
		Moisture	Data from proximate analysis
0.7	r/s	Ash	
27.8	r/s	Fix Carb	
56.1	r/s	Vol Mat	
15.4	r/s	Heat Val	
11,200	r/s	Sulfur	
0.58	r/s	Dry Basis	
		Ash=28.0	
	r/s	Fix Carb=56.5	
	r/s	Vol Mat=15.5	
	r/s	Heat Val=11,279.0	OUTPUT
	r/s	Sulfur=0.6	
	r/s	Dry,Ash-free	
		Fix Carb=78.5	
	r/s	Vol Mat=21.5	
	r/s	Heat Val=15,664.3	
	r/s	Sulfur=0.8	
	r/s	Parr Formula	
		Vol Mat=18.8	
	r/s	Fix Carb=81.2	
	r/s	Heat Val=16037.2	
		As received	Loops back

(CONTINUATION PAGE)

ID NO-123

AS RECEIVED

MOISTURE=0.7
ASH=27.8
FIX CARB=56.1
VOL MAT=15.4
HEAT VAL=11,200.0
SULFUR=0.6

DRY BASIS

ASH=28.0
FIX CARB=56.5
VOL MAT=15.5
HEAT VAL=11,279.0
SULFUR=0.6

DRY-ASH FREE

FIX CARB=78.5
VOL MAT=21.5
HEAT VAL=15,664.3
SULFUR=0.8

PARR FORMULA

VOL MAT=18.8
FIX CARB=81.2
HEAT VAL=16,037.2

Print version data entry same as non-print

However, in print version a prompt for labeling the output is incorporated.

The as-received input data is printed out as is dry and dry, ash-free calculations

Parr Formula printed out below dry, ash-free calculation.

USER INSTRUCTIONS

SIZE: (HP-41C) 011

STEP	INSTRUCTIONS	INPUT	FUNCTION	DISPLAY
1	Minimum size and xeq CQ		Size 011	
1*	If printer connected enter id number			Id No.
1*		Id No.	r/s	
2	Enter data from proximate analysis			As Received
				Moisture
2a		Moisture	r/s	Ash
2b		Ash	r/s	Fix Carb
2c		Fix Carb	r/s	Vol Mat
2d		Vol Mat	r/s	Heat Val
2e		Heat Val	r/s	Sulfur
2f	Enter heating value in Btu/lb	Sulfur	r/s	Dry Basis
2g	If printer is connected the as-received		r/s	Ash=xx.x
2h	data will be printed at this point.		r/s	Fix Carb=xx.x
2i	No r/s required if printer connected.		r/s	Vol Mat=xx.x
2j			r/s	Heat Val=xxxx.x
2k			r/s	Sulfur=x.xx
2l			r/s	Dry,Ash-free
2m	Dry-ash-free output			Fix Carb=xx.x
2n			r/s	Vol Mat=xx.x
2o			r/s	Heat Val=xx.x
2p			r/s	Sulfur=x.xx
2q			r/s	Parr Formula
2r	Output for Parr Formula			Vol Mat=xx.x
2s			r/s	Fix Carb=xx.x
2t			r/s	Heat Val=xxxx.x
3	If printer then step 1* else step 2		r/s	As Received

PROGRAM LISTING

STEP/ LINE	KEY ENTRY	COMMENTS
01	◆LBL "CQ"	
02	FS? 55	
03	PRBUF	
04	CF 21	printer flag
05	FS? 55	test
06	SF 21	
07	◆LBL 10	
08	FC? 55	
09	GTO 09	
10	CF 29	
11	FIX 0	
12	XEQ 07	if printer ask
13	PROMPT	for sample no.
14	STO X	
15	XEQ 07	
16	SF 12	
17	XEQ 55	
18	CF 12	
19	ADV	
20	◆LBL 09	
21	SF 29	
22	FIX 1	
23	CLA	
24	SF 12	
25	"AS RECE	
	IVED"	
26	XEQ 56	
27	CF 12	prompt for
28	ADV	
29	XEQ 00	data on
30	PROMPT	
31	STO 00	as received
32	XEQ 01	
33	PROMPT	basis
34	STO 01	
35	XEQ 02	
36	PROMPT	
37	STO 02	
38	XEQ 03	
39	PROMPT	
40	STO 03	
41	XEQ 04	
42	PROMPT	
43	STO 04	
44	XEQ 05	
45	PROMPT	
46	STO 05	set increment
47	.005	
48	STO 06	
49	FC? 55	
50	GTO 06	
51	◆LBL 11	
52	RCL IND	if printer then
	06	reprint as-
53	XEQ IND	received data
	06	
54	"⊢="	
55	XEQ 55	
56	ISG 06	else
57	GTO 11	
58	ADV	
59	◆LBL 06	compute
60	RCL 05	Parr Formula
61	.55	criteria
62	*	based on
63	RCL 01	original
64	1.08	as-received
65	*	data
66	+	
67	RCL 00	
68	+	
69	100	
70	X<>Y	
71	-	
72	STO X	
73	RCL 05	
74	.15	
75	*	
76	RCL 02	
77	X<>Y	
78	-	
79	RCL Y	
80	/	
81	100	
82	*	
83	STO 07	
84	100	
85	X<>Y	
86	-	
87	STO 08	
88	RCL 05	
89	.55	
90	*	
91	RCL 01	
92	1.08	
93	*	
94	+	
95	100	

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.

PROGRAM LISTING

STEP/ LINE	KEY ENTRY	COMMENTS
96	X<>Y	
97	-	
98	RCL 05	
99	50	
100	*	
101	RCL 04	
102	X<>Y	
103	-	
104	RCL Y	
105	/	
106	100	
107	*	
108	STO 09	
109	100	compute
110	RCL 00	ratio
111	-	multiplication
112	RCL 02	factor
113	100	for dry basis
114	*	
115	X<>Y	
116	/	
117	RCL 02	
118	/	
119	STO 10	
120	1.005	
121	STO 06	reset increment
122	◆LBL 08	
123	RCL IND 06	
124	RCL 10	apply to
125	ST* IND 06	original factors
126	ISG 06	
127	GTO 08	
128	SF 12	
129	"DRY BASIS"	print or
130	XEQ 56	display header
131	CF 12	
132	ADV	
133	1.005	reset increment
134	STO 06	for output
135	◆LBL 13	
136	RCL IND 06	
137	XEQ IND 06	output dry basis data
138	"⊢="	
139	XEQ 55	
140	ISG 06	
141	GTO 13	
142	100	
143	RCL 01	
144	-	
145	RCL 02	compute new
146	100	multiplication
147	*	factor for
148	X<>Y	dry,ash-free
149	/	basis
150	RCL 02	
151	/	
152	STO 10	
153	2.005	reset increment
154	STO 06	
155	ADV	
156	◆LBL 12	
157	RCL IND 06	multiply factor against data
158	RCL 10	
159	ST* IND 06	
160	ISG 06	
161	GTO 12	
162	SF 12	
163	"DRY-ASH FREE"	
164	XEQ 56	
165	CF 12	
166	ADV	
167	2.005	reset increment
168	STO 06	for output
169	◆LBL 14	
170	RCL IND 06	
171	XEQ IND 06	
172	"⊢="	
173	XEQ 55	
174	ISG 06	
175	GTO 14	
176	ADV	
177	SF 12	
178	"PARR FORMULA"	display Parr
179	XEQ 56	Formula data
180	CF 12	
181	ADV	
182	RCL 08	

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.

PROGRAM LISTING

STEP/ LINE	KEY ENTRY	COMMENTS
183	XEQ 03	
184	"⊢="	
185	XEQ 55	
186	RCL 07	
187	XEQ 02	
188	"⊢="	
189	XEQ 55	
190	RCL 09	
191	XEQ 04	
192	"⊢="	
193	XEQ 55	
194	ADV	
195	GTO 10	
196	◆LBL 00	alpha subroutines for prompting and output
197	"MOISTUR E"	
198	RTN	
199	◆LBL 01	
200	"ASH"	
201	RTN	
202	◆LBL 02	
203	"FIX CAR B"	
204	RTN	
205	◆LBL 03	
206	"VOL MAT "	
207	RTN	
208	◆LBL 04	
209	"HEAT VA L"	
210	RTN	
211	◆LBL 05	
212	"SULFUR"	
213	RTN	
214	◆LBL 07	
215	"ID NO-"	
216	RTN	
217	◆LBL 55	output subroutine
218	ARCL X	
219	AVIEW	
220	FC? 55	
221	STOP	
222	RTN	
223	◆LBL 56	
224	FS? 55	
225	PRA	
226	FC? 55	
227	AVIEW	
228	RTN	
229	END	

STEP/ LINE	KEY ENTRY	COMMENTS

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.

REGISTERS, STATUS, FLAGS, ASSIGNMENTS

DATA REGISTERS

00 Moisture(%)
01 Ash(%)
02 Fixed carbon(%)
03 Ash(%)
04 Heat Value (Btu/lb)
05 Sulfur(%)
06 Index of increment
07 Parr Formula fixed carbon(%)
08 Parr Formula volatile matter(%)
09 Parr Formula heating value(Btu/lb)
10 Multiplication factor

STATUS

SIZE	011	TOT. REG.	81	USER MODE	
ENG		FIX	X	ON	OFF X
DEG		RAD		GRAD	

SCI

FLAGS

#	INIT S/C	SET INDICATES	CLEAR INDICATES
12	s/c	doublewide	x
21	s/c	printer enable	x
29	s/c	digit grouping	x
55	s/c	printer exist	x

ASSIGNMENTS

FUNCTION	KEY	FUNCTION	KEY
cq	any		