Brown Stock Washing Material Balance A Computer Program in BASIC

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The growth of small computers in recent years has resulted in many mills having access to such devices, Most mills are using personal computers in various work areas. The program listed at the end of the text is written in BASIC and can be run on a personal computer or any other computer with BASIC compiler or interpreter. The program calculates :

1. Washing losses as total dissolved solids, kg/t o.d. pulp
2. Weak black liquor generation rate, kg/kg o. d. pulp
3. Weak black liquor solids concentration, %

for washing systems for any number of counter current stages.

The calculations are based upon a series of individual stage mass balances using the displacement ratio concept[1]. The program proceeds interactively and asks for the following input variables :

1. number of stages
2. total dissolved solids, kg/kg o.d. pulp entering the washer system
3. consistency of pulp as blown, % fibres
4. Dilution factor, kg of wash water added to the weak black liquor per kg o.d. pulp
5. wash water concentration, dissolved solids kg/kg wash water
6. vat consistency in a washer, % fiber
7. consistency of the mat leaving a washer, % fibre
8. Displacement ratio at nth washer, defined as

$$DR\ (n) = \frac{X\ (n) - x\ (n)}{X\ (n) - y\ (n+1)}$$

where,

DR (n) = Displacement ratio
X (n) = Concentration in vat, kg TDS/kg liquor
x (n) = Concentration of carry over liquor, kg TDS/kg liquor
y (n+1) = Concentration of filtrate in the next stage.

Water has been used here as wash solvent. While it has been assumed that the consistency in the vat and of the mat at all stages are same, the different values of displacement ratios can be used at different stages. The response of the washer system to change in system parameters can be examined by running the program several times. If required the INPUT and OUTPUT statements in the program can be modified to read data and write results in files stored in computer.

SAMPLE PROBLEM

To illustrate the use of this program let us take the sample problem of Ried Miner[2].

A 3 stage washer system loosing 34.5 kg TDS/t is subjected to a sampling programme, which provides the following descriptive data.

1.	number of stages	3
2.	total dissolved solids, kg/kg o.d. pulp entering the washer system	1.8
3.	consistency of pulp as blown, % fibres	10
4.	Dilution factor, kg of wash water added to the weak black liquor per kg o.d. pulp	0 5
5.	wash water concentration dissolved solids kg/kg wash water	500 ppm
6.	vat consistency in a washer,% fibre	1.0

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7.	consistency of the mat leaving a washer, % fibre	15
8.	Displacement ratio at	
	Stage 1	0.85
	Stage 2	0 85
	Stage 3	0.85

The mill is interested in estimating the effects of adding a fourth identical washer to the existing line.

The results for two runs of the program for 3 and 4 washing stages have been shown below. Same value of displacement ratio has been assumed for all satges

The number of washing stages	= 3
The washing efficiency (%)	= 98.093
Black liquor going to recovery kg/kg pulp	= 9.5
% solids in liquor going to recovery	= 18.6075
Washing losses TDS kg/t o.d. pulp	= 34 3266

The number of washing stages	= 4
The washing effiency (%)	= 98.8537
Black liquor going to recovery kg/kg pulp	= 9.5
% solids in liquor going to recovery	= 18.6899
Washing losses TDS kg/t o.d. pulp	= 20.6324

REFERENCES

1. Perkins, J. K., Welsh, H. S., and Mappus, J. H., Tappi 37 (3) 83 (1954)
2. Miner, R., Tappi 63(8) 101 (1980)

THE PROGRAM

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10    CLS : BEEP : BEEP : BEEP
20    PRINT "Material balance for counter-current washing"
30    PRINT :                    PRINT
40    PRINT "Enter the following data"                          : PRINT
50    PRINT "Number of washing stages";                         : INPUT N%
60    PRINT "TDS kg/kg pulp as blown";                          : INPUT D
70    PRINT "Consistency of pulp aa blown, %";                  ; INPUT CO
80    PRINT "Mat Consistency,%";                                : INPUT Cn
90    PRINT "Vat Consistency,%"                                 : INPUT C
100   PRINT "Dilution factor, kg/kg pulp";                      : INPUT DF
110   PRINT "Wash solvent DS kg/kg liquor":                     : INPUT Y (N%+1)
120   FOR K%=1 to N%
130   PRINT "Displacement ratio of stage no. "K%;                : INPUT DR(K%)
140   NEXT K%
150   Lo=100 0/Co—1.0
160   Ln=100,0/Cn—1.0
170   L =100.0/C —1.0
180   Vn=Ln+DF
190   V=L+Vn—Ln
200   e=0.9
210   Xn (N%) =D* (1-e)/Ln
220   FOR I%=N% TO 1 STEP-1
230   X (I%)=Y (I%+1) + (Xn (I%) — Y (I%+1) ) / (—1.0—DR (I%) )
240   Y (I%)=(L * X (I%)+Y (I%+1) * Vn—Ln * Xn (I% ) / V
250   IF I% = 1 THEN 280
260   Xn (I%—1) = ( L * X (I%)—(V—Vn) * Y (I%) ) /Ln
270   NEXT I%
280   Xn (O) = (L*X (1)—(L-LO)* Y (1) ) /LO
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290     el = 1 — Xn (N%) *Ln / (Xn(O)*LO)
300     t = ABS (e — el)
310     IF t < 0.0001 GOTO 350
320     e = el
330     GOTO 210
340     REM print out the results
350     BEEP
360     PRINT :          PRINT
370     PRINT  "The results"
380     PRINT : PRINT : PRINT
390     PRINT "  The number of washing stages                          = "; N%
400     PRINT "  The washing efficiency (%) = "; e * 100.0
410     PRINT "  Black liquor going to recovery kg/kg pulp             = "; LO + DF
420     PRINT "  % solids in liquor going to recovery                  = "; 100 * Y (1)
430     PRINT "  Washing losses TDS kg/t o.d. pulp                     = Xn (N%) * Ln*100.00
450     END
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