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OF SOUTH AFRICA

ONDERWERP:
SUBJECT: A STATISTICAL TREATMENT OF THE DATA OBTAINED WITH THE DORRCLONE CLASSIFIER

AFDELING:
DIVISION: ENGINEERING

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A STATISTICAL TREATMENT OF THE DATA OBTAINED WITH THE DORRCLONE CLASSIFIER

1. Like any other separation process depending on probability, the classification process also produces misplaced material in both product streams. Thus, one of the more comprehensive means of illustrating the effectiveness of the process is by means of the so-called partition curve, of which examples are to be found in the work of A. Saler, reproduced in F.R.I. Technical Memorandum No. 51 of 1973.

These partition curves are analogous to those of the Tromp distribution curve, the difference being that in these the distribution factor is plotted against the particle size rather than against specific gravity. This similarity leads one to believe that the basic principles, developed for determining the statistically best-fitting smooth curve through the experimentally determined coordinates of a Tromp curve, should also apply to the data obtained from the classification process.

The advantage of any statistical treatment lies in the fact that all of the experimentally determined coordinates are equally weighted, whereas if the partition curve is drawn by hand, one naturally tends to place more emphasis on the coordinates near to the inflection point, sometimes at the cost of those constituting the plateau on either end of the curve.

2. In F.R.I. Report No. 4/73, it was demonstrated that the relationship between the distribution factor and the specific gravity, i.e. the Tromp curve, can be linearized by means of the following transformation:-

$$\text{Arc Tan } (k(S - C)) = t_{e2} - D(t_{e2} - t_{e1})/100 \quad \ldots\ldots\ldots(1)$$

wherein the meanings of the symbols are:-

D: the distribution factor;
S: the specific gravity;
k, C, t_{e1} and t_{e2}: characteristic constants.

By analogy, the transformation linearizing the relationship between the distribution factor, D, and the particle size, P, for the classification process would be:-

$$\text{Arc Tan}\,(k(P - C)) = A + B \cdot D/100 \quad \text{...............(2)}$$

wherein A, B, C and k are once again characteristic constants for a given process under specified conditions.

In the transformed state, the statistically best-fitting smooth curve through the experimentally determined coordinates can be determined readily. Using the experimental results in conjunction with various combinations of the constants, k and C, the coefficient of linear correlation may be optimized. Having thus determined the optimum values of k and C, the constants A and B can be determined by means of straightforward regression techniques. Equation (2) may then be used to construct the best-fitting smoothed curve.

3. A computer programme (see appendix) has been compiled specifically to treat the data recorded by A. Saler in Technical Memorandum No. 51/73. Nevertheless, with a few minor modifications the applicability of the programme can be extended to situations covering a wider particle size range, made up of different increments.

The programme logic and mode of execution are briefly indicated hereunder. Statements 10 - 70 facilitate the reading and storing of the relevant particle sizes and the corresponding distribution factors; in that order.

Distribution factors in excess of 99,9 per cent are disregarded in the statistical treatment, and statements 80 - 120 are designed to eliminate these, and their corresponding particle sizes, from subsequent analytical treatment.

In statements 130 - 350 the experimental data, and various combinations of k and C, are scrutinised for the optimum value of the coefficient of linear correlation which, together with the corresponding values of k and C, are printed in statements 360 - 380.

These values are used in statements 400 - 510, by means of which the regression analysis is performed in order to obtain the constants A and B. In statements 252 and onwards, the coordinates of the smooth curve are evaluated and printed.

The evaluation of other relevant information, such as the probable error, has been omitted from this programme as the basic principles for the evaluation of these are fully covered in Reports Nos. 4 and 7 of 1973.

4. All of the data presented in Technical Memorandum No. 51/73 have been treated using this programme, and the coefficients of linear correlation generally exceeded 0,99. No significant differences between the hand-drawn and the statistically best partition curves were observed.

5. If the particle size range and/or the number of size incre= ments have to be changed, then statements 10, 40, 50, 80 and 90 must be changed accordingly. If the incremental steps in statement 130 need to be altered, this will affect statements 380, 400 and 549.

If it is suspected that the optimum combination of the constants k and C lies outside the range assumed in the pro= gramme, then the limiting values in statements 130 and 140 can be changed.

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PRETORIA
3rd December, 1973.
TCE/JSW

APPENDIX

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5 DIM C(500),D(500),R(500)
10 FOR I=1 TO 10
20 READ A(I)
30 NEXT I
40 DATA 0, 22.5, 54, 69, 100, 152.5, 215, 375, 750, 1500
50 FOR I=1 TO 10
60 READ B(I)
70 NEXT I
80 N=10
90 FOR I=1 TO10
100 IF B(I)<99.9 THEN 120
110 N=N-1
120 NEXT I
130 FOR K=0.01 TO10 STEP 0.01
140 FOR C=10 TO300
150 FOR I=1 TO N
160 Y=ATN(K*(A(I)-C))
170 X=B(I)/100
180 Y1=Y1+Y
190 Y2=Y2+Y*Y
200 X1=X1+X
210 X2=X2+X*X
220 Y3=Y3+X*Y
230 NEXT I
240 R1=N*Y3-X1*Y1
250 R2=SQR((N*X2-X1*X1)*(N*Y2-Y1*Y1))
260 R=R1/R2
270 Y1=Y2=Y3=X1=X2=0
280 R(C)=ABS(R)
290 IF R(C)<R(C-1) THEN 310
300 NEXT C
310 M=M+1
320 C(M)=R(C-1)
330 D(M)=C-1
340 IF C(M)<C(M-1) THEN 360
350 NEXT K
360 PRINT"R=";C(M-1)
370 PRINT"C=";D(M-1)
380 PRINT"K=";K-0.01
390 FOR I=1 TO N
400 Y=ATN((K-0.01)*(A(I)-D(M-1)))
410 X=B(I)/100
420 Y1=Y1+Y
430 Y2=Y2+Y*Y
440 X1=X1+X
450 X2=X2+X*X
460 Y3=Y3+X*Y
470 NEXT I
480 B=(N*Y3-X1*Y1)/(N*X2-X1*X1)
490 A=(Y1-B*X1)/N
500 PRINT"A=";A
510 PRINT"B=";B
585 M=N=Y1=Y2=Y3=X1=X2=0
530 FOR S=20 TO 300 STEP 20
549 Y=ATN((K-0.01)*(S-D(M-1)))
550 D=100*(Y-A)/B
560 PRINT USING 580,S,D
570 NEXT S
580: ####  ####.#
525 PRINT" S.F.    D.F."
590 GOTO 50
```