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FUEL RESEARCH INSTITUTE

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TECHNICAL MEMORANDUM   NO. 8 OF 1977

AN ALTERNATIVE APPROACH TO MASS BALANCES
IN COAL WASHING PLANT PERFORMANCE TESTS.

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INTRODUCTION

In many tests the separating bath is fed with coal covering a wide
range of sizes.   In the analysis both feed and products are screened
into a range of sizes each of which is separately analysed for yield
of r.d. fractions and their ash contents.   For each size fraction
analysed, yields of product and discard are calculated by ash balance.
However, some size degradation takes place in the washing operation,
so that the raw coal ash contents of the feed coal fractions do not
necessarily apply to the products of the separation.   Also, if a
mass balance is to be worked out, what data are to be used?   If ash
balance is used to determine yields, then the mass balance should
perhaps be based on the size distribution of the feed coal.   However
this will in many cases lead to size distribution of the various pro-
ducts which in some cases will differ significantly from the size
distribution obtained from the screening of product and discard.
This note is based on a study of data contained in FRI Report No.44
of 1977 (confidential).

STUDY OF REPORT NO. 44 OF 1977

At the start it must be pointed out that some approximations were
used in the calculations.   In the feed and in the products a small
amount of minus 12 mm coal is present - this was largely ignored.

The basic information for the heavy medium static plant (on which
the study is based) is as follows.

TABLE 1

SIZING AND ASH CONTENTS OF FEED AND PRODUCTS

	150 x 60 mm		60 x 30 mm		30 x 12 mm		-12 mm
	Yield %	Ash %	Yield %	Ash %	Yield %	Ash %	Yield %
Primary Feed	26,7	20,5	39,5	15,5	32,8	14,8	1,0
Clean Coal	18,2	8,5	39,8	8,2	40,4	7,8	1,6
Primary Discard*	27,9	37,4	39,1	29,5	31,7	26,9	1,3
Middlings	18,6	20,1	38,1	17,9	42,6	18,2	0,7
Final Discard	27,6	50,2	40,6	54,1	31,2	51,9	0,6

* Assumed to be the same as the secondary feed.

From the ash balances, the following yields of products were obtained first column per size grade), while in the second column the yields, based on the original feed coal and its size distribution are given.

TABLE 2

Size Grade	150 x 60		60 x 30		30 x 12		
	Yield %	Yield % on Primary Feed	Yield %	Yield % on Primary Feed	Yield %	Yield % on Primary Feed	Final Product
First Stage							
Product	58,58	15,6	65,57	25,9	63,46	20,8	Clean Coal
Discard	41,42	11,1	34,43	13,6	36,54	12,0	
Second Stage							
Product	42,47	4,7	67,91	9,2	74,06	8,9	Middlings
Discard	57,53	6,4	32,09	4,4	25,94	3,1	Discard

From these data the percentages in the three sizes for clean coal, primary discard, middlings and final discard can be calculated and compared with the original data given in Table 1. This is done below.

<div align="center">TABLE 3</div>

	Clean Coal		Primary Discard		Middlings		Final Discard	
	Calc	Original	Calc	Original	Calc	Original	Calc	Original
150 x 60	25,0	18,2	30,2	27,9	20,6	18,6	46,0	27,6
60 x 30	41,6	39,8	37,1	39,1	40,4	38,1	31,7	40,6
30 x 12	33,4	40,4	32,7	31,7	39,0	42,6	22,3	31,2
Total	100,0	98,4	100,0	98,7	100,0	99,3	100,0	99,4

The differences in size distribution are particularly marked in the final discard and the clean coal.

THE ALTERNATIVE APPROACH

The alternative approach that has been used is to consider the washing operation as a single entity. The ash content of the feed coal as a whole is calculated from the yields and ash contents of the subsidiary size grades, and the same is done for the two products of the bath. For this approach, feed, washed coal and discard must each be able to be sampled as an entity, and for accurate results the samples must be as representative as possible for size grading as well as for ash content. Ideally the whole width of the discharge from the rinsing screens must be taken in each increment. The yields of total product and total discard are calculated by ash balance. In this method the ash balance is not as sensitive to the effects of breakage, as errors (apart from those of sampling and analysis) will be due only to the difference in ash content of that part of the feed broken below the limiting size of testing (in the example 12 mm) whereas breakage between the upper and lower limiting screens has no effect on ash content.

Ash contents for the four total products of the two baths were calculated, and the corresponding yields by ash balance. The results are given in Table 4.

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TABLE 4

	Ash %	Yield %	Yield % of Raw Coal
Raw Coal	16,62	100,0	100,0
Clean Coal	8,09	62,6	62,6
Primary Discard	30,90	37,4	37,4
Middlings	18,44	63,2	23,6
Final Discard	52,33	36,8	13,8

The yields of the three final products in the different size grades can then be calculated from the data in Table 1. These data are compared in Table 5 with the corresponding calculated data ex Table 2.

TABLE 5

YIELDS OF PRODUCTS IN VARIOUS SIZES

Size of Coal	150 x 60		60 x 30		30 x 12		Total	
	A	B	A	B	A	B	A	B
Clean Coal	11,4	15,6	24,9	25,9	25,3	20,8	61,6	62,3
Middlings	4,4	4,7	9,0	9,2	10,1	8,9	23,5	22,8
Discard	3,8	6,4	5,6	4,4	4,3	3,1	13,7	13,9
Totals	19,6	26,7	39,5	39,5	39,7	32,8	98,8	99,0

A. Data derived from Table 4.
B. Data from Table 2.

The differences in the totals in the bottom line of the Table reflect degradation of the coal in the two stage washing process (assuming no sampling or analytical errors in regard to size consist or ash content). The calculated ash contents for the reconstituted raw coal (A) for the three size groups above are 19,2%, 16,9% and 15,2%, compared with original raw coal ash contents of 20,5%, 15,5% and 14,8%.

The relative differences in yields for the different size grades can be more easily seen by converting the "mass" yields in Table 5 to percentages. These figures are given in Table 6.

TABLE 6

PERCENTAGE YIELDS OF PRODUCTS IN EACH SIZE RANGE

Size of Coal	150 x 60		60 x 30		30 x 12		Total	
	A	B	A	B	A	B	A	B
Clean Coal	58,2	58,4	63,0	65,6	63,7	63,4	62,3	62,9
Middlings	22,4	17,6	22,8	23,3	25,5*	27,1	23,8	23,0
Discard	19,4	24,0	14,2	11,1	10,8	9,5	13,9	14,1*

* Adjusted upward by 0,1% to make totals of 100%.

If the alternative approach is used, different performance data for the size groups will be obtained as the yields of the A columns of Table 5 should be used. No attempt has been made to do this in this memorandum.

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