by RICHARD P. KILLMEYER JR.
Supervisory Chemical Engineer, Department of Energy

A Performance Study of Baum and Batac Jigs

Since about 1960, the Department of Energy's Coal Preparation Division, which was part of the U.S. Bureau of Mines prior to October 1977, has been evaluating the cleaning performance of the major pieces of coal cleaning equipment used in the U.S. To date, performance studies have been published for concentrating tables, sand cones, dense-medium vessels, dense-medium cyclones and hydrocyclones. Also, a report on air tables will be published soon.

The final cleaning device to be investigated as part of the series is the jig. The jig study has been ongoing for the past six years. Three Baum and two Batac jigs have been sampled, but evaluation of the last Baum jig is not yet complete.

Principle of both jigs is the same

There have been several papers published in the last few years about the Batac jig, recently developed in Germany by Humboldt Wedag, and its performance in U.S. preparation plants. By now most people concerned with cool processing know of the basic differences between it and the Baum jig. The intent here is to describe the equipment and the installations sampled, not to endorse or suggest a particular unit for a given application. Although the principles of cleaning coal by jigging are the same for both jigs, the Batac has improved and automated the methods of air distribution, pulsation and bed control, while providing higher capacity in the same physical space.

In the Baum jig, jigging action in the coal bed is achieved from air pulsations in a chamber on one side of the vessel (fig. 1). Sliding or rotary valves provide the air pulsations. The pulsations are uniformly distributed along the width of the bed through a pipe directly underneath the bed screen, thus eliminating the side chamber and allowing for a wider jigging bed. Air pulsations are produced by the action of flat disc type valves, which provide a sharp cutoff of the air and are operated from an electronic pre-set timer in an instrument cabinet.

An important and interesting design variation of the Batac jig (fig. 2) is the use of feldspar beds in cells 3, 4 and 6 to facilitate fine coal (1/2 in. × 0) cleaning. These are not necessary for Batacs washing coarse (+ 1/2-in.) coal only. Although the three current installations in the U.S. are used for cleaning the fine coal while Baum jigs handle the coarse, in Europe, Batacs are also used for coarse coal cleaning.

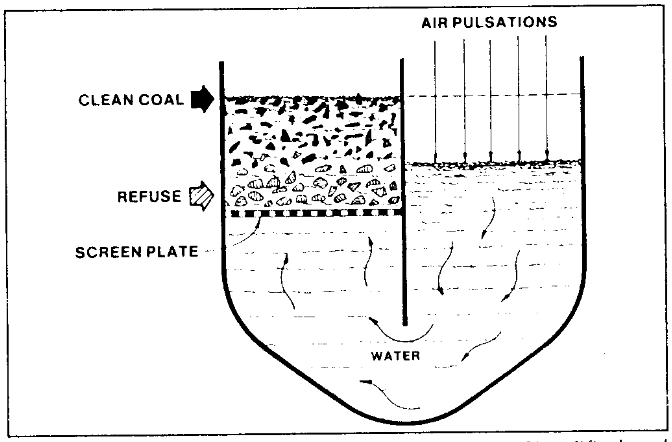


Fig. 1. Simplified end view of a Baum jig. Jigging action in the Baum jig is achieved by air pulsations provided by valve operation

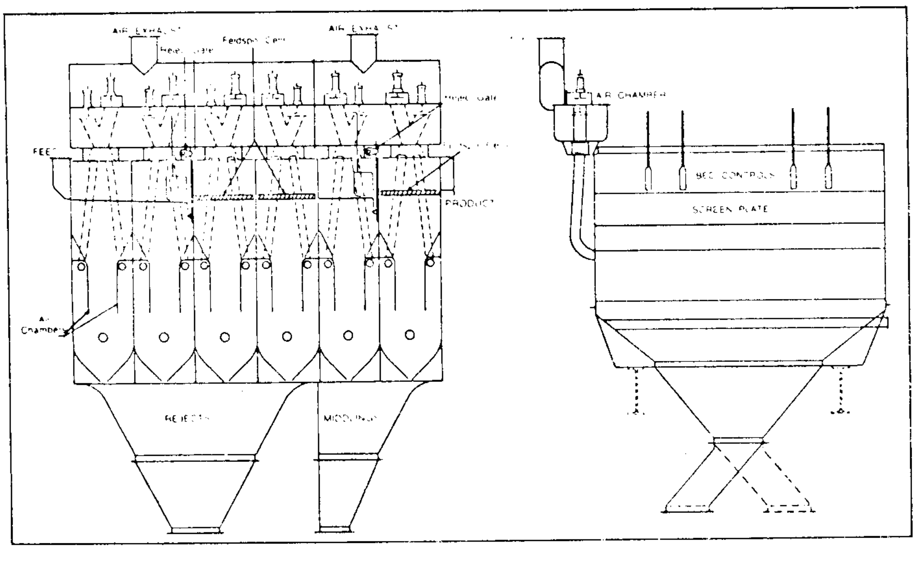


Fig. 2. Fine coal cleaning in the Batac jig is achieved by use of feldspar beds in cells 3, 4, and 6. Current installations in the U.S. clean only fine coal but they are applicable to coarse coal cleaning as well

	BAUM #1	BAUM #2	BATAC #1	BATAC #2
FEED SIZE RANGE, IN.	6 × 1/4	4 × 0	3/4 × 0	1/2 × 0
FEED RATE TO JIG, TPH	259	337	595	400
TOTAL JIGGING AREA, SQ FT	123	168	326	261
JIG FEED LOADING, TPH/FT²	2.1	2.0	1.8	1.5
NO. OF COMPARTMENTS-CELLS	2-5	3-8	3-6	3-6
SCREEN OPENINGS BY COMPARTMENT, IN.:				
PRIMARY	7/8	3/4	3/8	5/16
SECONDARY	5/8	1/2	7/8	5/8
TERTIARY	--	3/8	3/8	5/16
PULSATIONS PER MINUTE	31	22	55	55
WATER CONSUMPTION, GPM/TPH	12.7	7.1	10.0	10.2
JIGGING AIR PRESSURE, PSIG	3	3.5	5	6.5
FELDSPAR SIZE, IN.	--	--	3 × 1	1 1/2 × 3/4

Detailed washability done on each product

A summary of the operating conditions of the jigs sampled for this study (table 1) reveals some of the other differences between the new Batac and the conventional Baum, namely: (1) the higher jigging air pressure required by the Batac, (2) the higher pulse-per-minute rate of the Batac, (3) the larger jigging area of the Batac and (4) the lower feed loading in the Batac, primarily for the benefit of the fine size of the feed.

Since the Baum jigs were serving mainly as coarse coal washers, their performance was evaluated on the coal down to 14 mesh; the Batac jigs, cleaning fine coal, were evaluated down to 200 mesh.

Table 1. Summary of operating conditions of jigs

Table 2. Specific gravity analysis of the size fraction and composite clean coal of Baum #1

SIZE FRACTION INCH OR MESH	WEIGHT, PERCENT	SPECIFIC GRAVITY	DIRECT RECOVERY, WEIGHT	DIRECT PCT. ASH	DIRECT BTU/LB	DIRECT ASH, PCT.	DIRECT SULFUR, PYRITIC	DIRECT PCT. TOTAL	CUMULATIVE RECOVERY, WEIGHT	CUMULATIVE PCT. BTU	CUMULATIVE BTU/LB	CUMULATIVE ASH, PCT.	CUMULATIVE SULFUR, PYRITIC	CUMULATIVE PCT. TOTAL
6 BY 4	6.78 PERCENT	FLOAT 1.30	45.6	48.6	15290	2.8	0.08	0.58	45.6	48.3	15290	2.8	0.08	0.58
		1.30-1.35	25.2	25.9	14852	4.4	0.09	0.55	70.8	74.2	15134	3.4	0.08	0.57
		1.35-1.40	4.9	4.7	13990	7.8	0.03	0.46	75.7	78.9	15060	3.7	0.08	0.56
		1.40-1.50	24.4	21.1	12510	14.8	0.13	0.51	100.0	100.0	14439	6.4	0.09	0.55
		1.50-1.60	0.0	.....	.....	.....	.....	.....	100.0	100.0	14439	6.4	0.09	0.55
		1.60-1.70	0.0	.....	.....	.....	.....	.....	100.0	100.0	14439	6.4	0.09	0.55
		1.70-1.80	0.0	.....	.....	.....	.....	.....	100.0	100.0	14439	6.4	0.09	0.55
		SINK 1.80	0.0	.....	.....	.....	.....	.....	100.0	100.0	14439	6.4	0.09	0.55
4 BY 2	20.96 PERCENT	FLOAT 1.30	38.9	41.1	15310	2.8	0.14	0.55	38.9	41.1	15310	2.8	0.14	0.55
		1.30-1.35	33.4	34.2	14851	4.7	0.12	0.45	72.3	75.3	15098	3.7	0.13	0.50
		1.35-1.40	12.3	11.7	13790	9.4	0.19	0.55	84.6	87.0	14908	4.5	0.14	0.51
		1.40-1.50	10.7	9.3	12686	16.2	0.25	0.67	95.3	96.4	14659	5.8	0.15	0.53
		1.50-1.60	4.2	3.3	11410	23.8	0.25	0.54	99.5	99.7	14522	6.6	0.16	0.53
		1.60-1.70	0.5	0.3	9482	34.2	0.40	0.81	99.9	100.0	14498	6.7	0.16	0.53
		1.70-1.80	0.1	0.0	8770	38.2	0.16	0.62	100.0	100.0	14494	6.7	0.16	0.53
		SINK 1.80	0.0	.....	.....	.....	.....	.....	100.0	100.0	14494	6.7	0.16	0.53
2 BY 1	29.90 PERCENT	FLOAT 1.30	36.6	39.1	15350	2.4	0.14	0.58	36.6	39.1	15350	2.4	0.14	0.58
		1.30-1.35	32.9	34.2	14920	4.7	0.25	0.62	69.6	73.4	15146	3.5	0.19	0.60
		1.35-1.40	11.2	10.9	13890	9.7	0.22	0.63	80.8	84.2	14971	4.4	0.20	0.60
		1.40-1.50	11.7	10.3	12670	16.1	0.27	0.62	92.4	94.5	14681	5.8	0.21	0.61
		1.50-1.60	5.4	4.1	11080	25.6	0.30	0.62	97.8	98.6	14483	9.6	0.21	0.61
		1.60-1.70	1.5	1.0	9590	33.8	0.54	0.88	99.3	99.6	14410	7.3	0.22	0.61
		1.70-1.80	0.4	0.2	8390	41.1	0.44	0.72	99.7	99.9	14384	7.5	0.22	0.61
		SINK 1.80	0.3	0.1	6230	54.7	1.43	1.54	100.0	100.0	14362	7.6	0.22	0.61
1 BY 1/2	19.65 PERCENT	FLOAT 1.30	40.3	42.9	15390	2.4	0.14	0.60	40.3	42.9	15390	2.4	0.14	0.60
		1.30-1.35	30.9	31.9	14944	4.7	0.19	0.71	71.1	74.8	15196	3.4	0.16	0.65
		1.35-1.40	11.6	11.1	13944	9.6	0.19	0.78	82.7	85.9	15021	4.3	0.17	0.67
		1.40-1.50	10.1	8.9	12800	15.9	0.30	0.62	92.7	94.8	14780	5.5	0.18	0.66
		1.50-1.60	4.4	3.4	11072	24.7	0.38	0.65	97.1	98.2	14612	6.4	0.19	0.66
		1.60-1.70	1.7	1.1	9640	32.2	0.39	0.68	98.8	99.3	14526	6.8	0.19	0.66
		1.70-1.80	0.7	0.4	7994	42.8	0.76	1.05	99.5	99.7	14484	7.1	0.20	0.66
		SINK 1.80	0.5	0.3	8270	41.4	1.28	1.37	100.0	100.0	14452	7.2	0.20	0.67
1/2 BY 1/4	10.43 PERCENT	FLOAT 1.30	45.5	47.9	15380	2.3	0.12	0.59	45.5	47.9	15380	2.3	0.12	0.59
		1.30-1.35	30.0	31.5	14919	4.8	0.12	0.59	76.3	79.4	15193	3.3	0.12	0.59
		1.35-1.40	9.8	9.4	14000	9.8	0.23	0.63	86.1	88.7	15058	4.0	0.13	0.59
		1.40-1.50	8.5	7.5	12835	16.3	0.31	0.65	94.6	96.3	14857	5.2	0.15	0.60
		1.50-1.60	3.2	2.4	11088	25.9	0.40	0.63	97.8	98.7	14734	5.8	0.16	0.60
		1.60-1.70	1.2	0.8	9690	33.6	0.54	1.21	99.0	99.5	14672	6.2	0.16	0.61
		1.70-1.80	0.6	0.3	8362	40.8	0.97	1.53	99.6	99.8	14635	6.4	0.17	0.61
		SINK 1.80	0.4	0.2	6850	49.0	2.22	2.34	100.0	100.0	14605	6.5	0.17	0.62
1/4 BY 8	7.38 PERCENT	FLOAT 1.30	56.3	58.3	15450	2.1	0.09	0.59	56.3	58.3	15450	2.1	0.09	0.59
		1.30-1.35	26.7	26.8	15007	4.6	0.14	0.60	83.0	85.1	15307	2.9	0.11	0.59
		1.35-1.40	8.0	7.5	14037	9.2	0.27	0.62	91.0	92.6	15196	3.5	0.12	0.60
		1.40-1.50	5.9	5.2	13070	15.0	0.29	0.59	96.9	97.8	15067	4.2	0.13	0.60
		1.50-1.60	1.8	1.4	11627	21.3	0.39	0.67	98.7	99.2	15003	4.5	0.14	0.60
		1.60-1.70	0.7	0.5	10710	27.8	0.51	0.85	99.4	99.7	14947	4.6	0.14	0.60
		1.70-1.80	0.3	0.2	9330	31.0	0.72	0.89	99.7	99.8	14958	4.7	0.14	0.60
		SINK 1.80	0.3	0.2	7452	46.0	3.35	3.35	100.0	100.0	14933	4.8	0.15	0.61
8 BY 14	2.50 PERCENT	FLOAT 1.30	63.5	65.4	15510	1.8	0.12	0.58	63.5	65.4	15510	1.8	0.12	0.58
		1.30-1.35	23.3	23.2	15030	4.3	0.17	0.58	86.7	88.6	15381	2.5	0.13	0.58
		1.35-1.40	6.2	5.9	14313	8.7	0.22	0.60	93.0	94.5	15309	2.9	0.14	0.58
		1.40-1.50	4.3	3.7	13140	14.7	0.30	0.65	97.2	98.2	15214	3.4	0.15	0.58
		1.50-1.60	1.4	1.0	11623	23.0	0.45	0.62	98.6	99.3	15165	3.7	0.15	0.58
		1.60-1.70	0.5	0.4	10422	29.1	0.51	0.72	99.1	99.6	15139	3.8	0.15	0.59
		1.70-1.80	0.3	0.2	8610	36.8	0.84	1.09	99.4	99.8	15121	3.9	0.15	0.59
		SINK 1.80	0.6	0.2	4960	51.4	3.41	3.44	100.0	100.0	15058	4.2	0.17	0.60
COMPOSITE, 6 BY 14	97.60 PERCENT	FLOAT 1.30	41.6	44.1	15365	2.4	0.13	0.58	41.6	44.1	15365	2.4	0.13	0.58
		1.30-1.35	31.1	32.0	14912	4.7	0.18	0.59	72.7	76.1	15171	3.4	0.15	0.58
		1.35-1.40	10.5	10.1	13905	9.5	0.20	0.64	83.3	86.2	15011	4.2	0.16	0.59
		1.40-1.50	11.0	9.7	12707	15.8	0.25	0.62	94.3	95.9	14741	5.5	0.17	0.59
		1.50-1.60	3.9	3.0	11178	24.8	0.32	0.61	98.3	98.9	14598	6.3	0.17	0.59
		1.60-1.70	1.1	0.7	9669	33.0	0.48	0.85	99.4	99.7	14543	6.6	0.18	0.60
		1.70-1.80	0.4	0.2	8314	40.9	0.66	0.99	99.7	99.9	14521	6.7	0.18	0.60
		SINK 1.80	0.3	0.1	7147	47.7	1.80	1.88	100.0	100.0	14501	6.8	0.18	0.60

(1) 2.4 PERCENT OF THIS PRODUCT WAS MINUS 14 MESH MATERIAL CONTAINING 14820 BTU/LB, 5.3 PERCENT ASH, 0.14 PERCENT PYRITIC SULFUR, AND 0.56 PERCENT TOTAL SULFUR

SIZE, INCHES OR MESH		6 × 4	4 × 2	2 × 1	1 × 1/2	1/2 × 1/4	1/4 × 8	8 × 14	14 × 0	6 × 14
SCREEN ANALYSIS, PERCENT										
FEED		8.8	24.3	30.3	17.3	8.8	6.1	2.1	2.4	97.6
CLEAN COAL		6.8	21.0	29.9	19.7	10.4	7.4	2.5	2.4	97.6
REFUSE		11.6	29.2	30.8	13.7	6.2	4.1	1.6	2.5	97.5
BTU PER POUND										
FEED		8000	8845	9590	10958	11533	12500	12588	11753	9925
CLEAN COAL		14439	14494	14362	14452	14605	14933	15088	14820	14501
REFUSE		2407	2709	2567	3365	3717	5850	6694	7193	2981
ASH PERCENT										
FEED		45.1	40.1	35.1	27.9	24.8	19.1	18.6	23.5	33.7
CLEAN COAL		6.4	6.7	7.6	7.1	6.5	4.8	4.2	5.3	6.8
REFUSE		78.7	76.3	75.7	72.9	71.2	58.1	52.8	50.8	74.5
PYRITIC SULFUR, PERCENT										
FEED		0.20	0.21	0.26	0.27	0.29	0.30	0.31	0.36	0.25
CLEAN COAL		0.09	0.16	0.22	0.20	0.17	0.15	0.17	0.14	0.18
REFUSE		0.30	0.27	0.32	0.41	0.57	0.71	0.65	0.69	0.35
TOTAL SULFUR, PERCENT										
FEED		0.43	0.42	0.52	0.61	0.63	0.68	0.67	0.68	0.53
CLEAN COAL		0.55	0.53	0.61	0.67	0.62	0.61	0.60	0.56	0.60
REFUSE		0.33	0.31	0.38	0.48	0.65	0.87	0.82	0.86	0.41
BTU RECOVERY	PERCENT	83.9	85.3	89.2	90.3	90.9	87.5	84.3	.....	88.1
WEIGHT RECOVERY (YIELD)	DO	46.5	52.1	59.5	68.5	71.8	73.2	70.5	.....	80.3
THEORETICAL WEIGHT RECOVERY	DO	46.4	52.4	61.2	71.2	75.1	78.7	79.6	.....	82.5
WEIGHT RECOVERY EFFICIENCY	DO	100.0	99.3	97.2	96.2	95.5	93.1	88.5	.....	96.5
ASH ERROR	DO	0.0	0.1	0.6	0.9	1.0	0.9	1.4	.....	0.7
FLOAT IN REFUSE	PERCENT OF PRODUCT	1.9	4.1	7.0	12.2	15.4	26.5	32.6	.....	8.3
SINK IN CLEAN COAL	DO	0.5	1.9	1.8	1.7	1.6	2.0	2.8	.....	2.0
TOTAL MISPLACED MATERIAL	PCT OF FEED	1.3	2.9	3.9	5.0	5.5	8.5	11.6	.....	4.5
NEAR GRAVITY ± 0.10 MATERIAL	DO	14.2	6.5	6.0	4.5	3.9	6.6	7.3	.....	6.6
SPECIFIC GRAVITY OF SEPARATION		1.497	1.551	1.617	1.658	1.643	1.544	1.501	.....	1.585
PROBABLE ERROR		0.023	0.055	0.084	0.100	0.113	0.122	0.145	.....	0.087
IMPERFECTION		0.047	0.100	0.135	0.153	0.178	0.225	0.290	.....	0.148
ERROR AREA		5.0	36.0	52.0	62.0	69.0	75.0	87.0	.....	64.0
DISTRIBUTION, PERCENT TO CLEANED COAL (SPECIFIC GRAVITY FRACTION)										
FLOAT 1.30		99.5	99.5	99.1	98.4	97.6	96.3	93.4	.....	98.4
1.30-1.35		98.4	99.5	98.4	96.6	96.1	90.9	84.5	.....	97.2
1.35-1.40		100.0	98.9	98.6	95.3	93.5	84.2	74.6	.....	95.4
1.40-1.50		93.5	89.5	92.4	90.3	87.7	71.0	60.5	.....	89.6
1.50-1.60		0.0	50.3	71.1	76.4	71.4	48.6	40.2	.....	61.6
1.60-1.70		0.0	11.7	39.6	52.1	48.4	28.8	26.4	.....	31.9
1.70-1.80		0.0	2.6	15.5	26.7	28.6	15.7	17.3	.....	15.5
SINK 1.80		0.0	0.0	0.5	1.3	1.2	1.5	2.6	.....	0.5

Table 3. Summary of performance characteristics of Baum #1

SIZE, INCHES OR MESH		4 × 2	2 × 1	1 × 1/2	1/2 × 1/4	1/4 × 8	8 × 14	14 × 0	4 × 14
SCREEN ANALYSIS, PERCENT									
FEED		6.2	13.9	18.4	18.2	17.3	10.6	15.3	84.7
CLEAN COAL		1.9	6.9	14.4	19.6	21.5	14.0	21.5	78.8
REFUSE		12.6	24.3	24.4	15.9	11.1	5.6	6.2	93.8
BTU PER POUND									
FEED		3822	5159	7485	9839	11044	11286	8594	8546
CLEAN COAL		13448	13259	13395	13470	13487	13194	10025	13387
REFUSE		1669	1720	2281	3106	4032	4125	2420	2509
ASH PERCENT									
FEED		66.8	58.6	44.7	30.6	22.6	20.8	37.8	38.1
CLEAN COAL		8.9	10.5	9.1	8.7	8.3	9.4	28.9	8.9
REFUSE		79.8	79.0	76.2	71.1	64.6	63.7	76.2	74.4
PYRITIC SULFUR, PERCENT									
FEED		4.71	3.40	2.83	2.45	2.35	2.20	2.67	2.76
CLEAN COAL		2.00	2.57	2.11	1.93	1.70	1.51	2.12	1.86
REFUSE		5.32	3.75	3.08	3.41	4.22	4.79	5.03	3.65
TOTAL SULFUR, PERCENT									
FEED		5.40	4.28	3.79	3.82	3.95	3.78	4.53	4.03
CLEAN COAL		4.18	4.46	3.99	3.71	3.62	3.33	4.23	3.74
REFUSE		5.67	4.21	3.62	4.02	4.90	5.46	5.80	4.38
BTU RECOVERY	PERCENT	64.3	76.6	83.8	88.9	90.6	92.3	.....	86.9
WEIGHT RECOVERY (YIELD)	DO	18.3	29.8	46.8	65.0	74.3	79.0	.....	55.5
THEORETICAL WEIGHT RECOVERY	DO	19.3	33.4	52.5	71.3	81.1	85.4	.....	61.5
WEIGHT RECOVERY EFFICIENCY	DO	94.9	89.3	89.2	91.1	91.6	92.5	.....	90.3
ASH ERROR	DO	0.5	1.5	1.5	1.6	1.9	3.0	.....	1.9
FLOAT IN REFUSE	PERCENT OF PRODUCT	2.2	5.6	11.5	18.4	27.3	27.4	.....	12.7
SINK IN CLEAN COAL	DO	2.0	4.3	2.2	1.9	1.7	3.3	.....	2.9
TOTAL MISPLACED MATERIAL	PCT OF FEED	2.1	5.2	7.1	7.7	8.2	8.4	.....	7.3
NEAR GRAVITY ± 0.10 MATERIAL	DO	5.1	7.0	5.5	3.0	1.3	1.3	.....	4.0
SPECIFIC GRAVITY OF SEPARATION		1.508	1.528	1.578	1.658	1.799	1.823	.....	1.604
PROBABLE ERROR		0.061	0.083	0.077	0.146	0.210	0.313	.....	0.123
IMPERFECTION		0.120	0.157	0.133	0.223	0.263	0.380	.....	0.204
ERROR AREA		34.0	60.0	68.0	96.0	127.0	133.0	.....	87.0
DISTRIBUTION, PERCENT TO CLEANED COAL (SPECIFIC GRAVITY FRACTION)									
FLOAT 1.30		100.0	93.0	87.4	93.1	93.9	93.2	.....	92.9
1.30-1.35		97.4	93.8	93.8	93.0	93.6	96.5	.....	94.0
1.35-1.40		90.8	91.5	88.2	90.8	89.8	93.1	.....	90.4
1.40-1.50		72.8	72.2	79.2	88.7	85.3	89.8	.....	82.3
1.50-1.60		31.7	43.4	60.8	74.8	73.6	81.0	.....	64.7
1.60-1.70		0.0	15.3	22.5	51.3	61.5	71.9	.....	38.4
1.70-1.80		0.0	13.4	18.8	35.7	56.5	65.0	.....	30.2
1.80-2.00		0.0	3.7	7.9	19.4	31.9	33.0	.....	12.7
2.00-2.20		0.0	1.4	2.0	8.0	18.8	28.2	.....	8.7
SINK 2.20		0.0	0.1	0.1	0.9	3.6	12.8	.....	1.3

Table 4. Summary of performance characteristics of Baum #2

SIZE, INCHES OR MESH		3/4 × 1/2	1/2 × 3/8	3/8 × 1/4	1/4 × 8	8 × 14	14 × 28	28 × 48	48 × 100	100 × 200	200 × 0	3/4 × 200
SCREEN ANALYSIS, PERCENT												
FEED		13.8	9.8	11.7	31.8	11.2	6.1	4.7	3.5	2.4	5.4	94.6
CLEAN COAL		8.5	8.6	11.1	32.8	12.2	8.8	5.5	4.3	3.0	7.1	92.9
REFUSE		28.1	12.4	13.5	28.2	8.1	4.1	2.2	1.2	0.5	0.7	99.3
BTU PER POUND												
FEED		8824	9705	10400	11549	12108	12328	12653	12848	12510	10347	10735
CLEAN COAL		13384	13820	14113	14400	14533	14516	14188	13852	13109	10845	14175
REFUSE		1005	1406	1885	2057	1684	1380	1428	2099	2136	2350	1543
ASH PERCENT												
FEED		52.9	35.3	31.0	24.3	20.8	19.9	18.5	15.0	18.6	30.4	26.8
CLEAN COAL		13.0	10.6	9.3	7.8	6.5	7.0	7.7	9.8	13.4	28.7	8.8
REFUSE		88.1	83.9	82.0	79.2	80.6	81.7	80.4	73.6	71.8	77.5	82.1
PYRITIC SULFUR, PERCENT												
FEED		0.50	0.54	0.79	0.87	0.98	0.98	0.90	0.85	1.14	0.82	0.80
CLEAN COAL		0.48	0.51	0.70	0.44	0.32	0.34	0.30	0.37	0.83	0.54	0.47
REFUSE		0.34	0.59	1.00	2.28	3.84	4.04	5.10	7.21	9.94	2.90	1.68
TOTAL SULFUR, PERCENT												
FEED		0.78	0.87	1.07	1.28	1.43	1.44	1.40	1.44	1.82	0.88	1.20
CLEAN COAL		1.11	1.90	1.04	0.81	0.85	0.87	0.85	0.88	1.12	0.81	0.85
REFUSE		0.50	0.72	1.18	2.51	3.96	4.17	5.44	7.48	10.31	2.94	1.86
BTU RECOVERY	PERCENT	91.7	95.1	95.2	95.9	97.4	98.0	98.8	98.6	99.1	.....	98.1
WEIGHT RECOVERY (YIELD)	DO	45.4	66.3	70.1	78.9	81.2	82.6	88.0	91.5	94.5	.....	72.8
THEORETICAL WEIGHT RECOVERY	DO	45.8	66.8	70.8	78.1	82.1	81.4	88.7	92.5	95.8	.....	74.0
WEIGHT RECOVERY EFFICIENCY	DO	98.9	99.3	98.9	98.5	98.9	99.1	99.2	98.8	98.6	.....	98.3
ASH ERROR	DO	0.4	0.3	0.3	0.5	0.5	0.6	0.5	0.8	0.8	.....	0.7
FLOAT IN REFUSE	PERCENT OF PRODUCT	2.1	3.0	4.8	6.8	5.5	3.4	4.4	23.9	.....	.....	5.1
SINK IN CLEAN COAL	DO	1.9	1.1	1.2	1.0	0.8	1.3	2.6	4.4	.....	.....	1.8
TOTAL MISPLACED MATERIAL	PCT OF FEED	2.0	2.0	1.2	2.3	0.8	1.7	2.8	6.0	.....	.....	2.7
NEAR GRAVITY ± 0.10 MATERIAL	DO	3.4	2.9	2.9	2.1	1.0	0.8	1.1	3.3	.....	.....	1.9
SPECIFIC GRAVITY OF SEPARATION		1.788	1.742	1.742	1.883	1.813	1.887	1.950	2.198	.....	.....	1.752
PROBABLE ERROR		0.103	0.098	0.104	0.109	0.116	0.082	0.145	.....	.....	.....	0.123
IMPERFECTION		0.130	0.133	0.149	0.159	0.143	0.093	0.153	.....	.....	.....	0.164
ERROR AREA		62.0	84.0	85.0	71.0	86.0	59.0	87.0	93.0	.....	.....	78.0
DISTRIBUTION, PERCENT TO CLEANED COAL (SPECIFIC GRAVITY FRACTION)												
FLOAT 1.30		99.9	99.9	99.7	99.2	99.5	99.5	99.7	99.6	99.8	.....	99.5
1.30-1.35		99.9	99.9	99.5	99.0	99.6	99.7	99.5	98.9	99.2	.....	99.4
1.35-1.40		99.8	99.3	98.3	97.2	98.9	99.5	91.4	98.8	99.2	.....	98.4
1.40-1.50		98.9	98.2	98.0	93.9	97.3	98.7	98.2	98.3	90.1	.....	96.6
1.50-1.60		93.5	89.4	85.1	83.6	91.5	97.4	97.0	96.5	98.7	.....	89.1
1.60-1.70		82.8	75.8	62.0	58.5	78.0	91.0	93.3	93.5	92.3	.....	72.1
1.70-1.80		60.4	47.7	38.8	35.7	64.7	87.1	93.3	91.7	92.8	.....	50.5
1.80-2.00		24.2	17.5	12.1	13.3	28.7	45.8	61.3	80.3	91.8	.....	22.4
SINK 2.00		0.3	0.3	0.4	0.8	2.5	5.7	16.3	39.4	87.3	.....	3.0

Table 5. Summary of performance characteristics of Batac #1

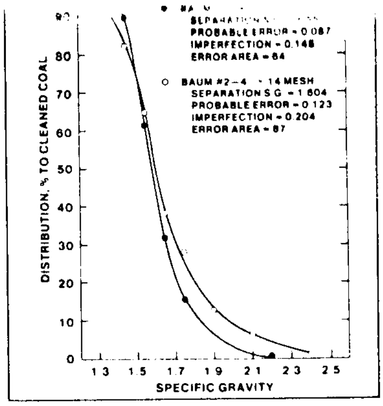


Fig. 3. Performance of Baum jigs #1 and #2 at +14 mesh composite

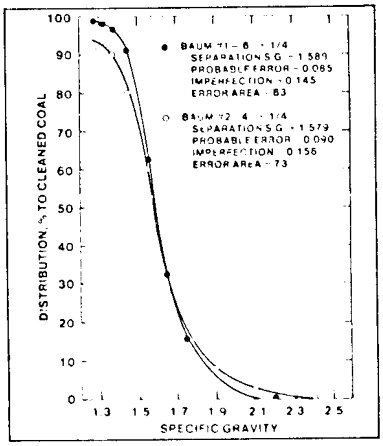


Fig. 4. Performance of Baum jigs #1 and #2 at ¼-in. composite

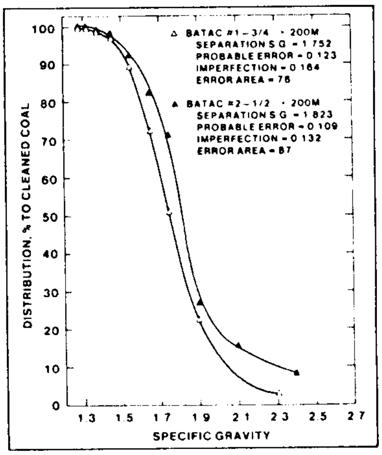


Fig. 5. Performance of Batac jigs #1 and #2 at +200 mesh composite

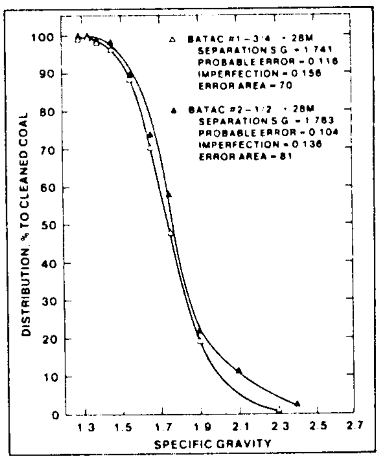


Fig. 6. Performance of Batac jigs #1 and #2 at +28 mesh composite

Table 6. Summary of performance characteristics of Batac #2

Table 7. Summary of performance characteristics of jigs

The plants selected for this study were well-kept, well-operated and amenable to a large scale sampling effort. Sampling of all streams was done according to ASTM standards as far as number and size of increments are concerned. Samples were taken from the plant streams over a three to four hour period during a normal operating shift. Sufficient amounts of each product were obtained for a complete, detailed washability. The samples were brought back to the coal preparation laboratory in Pittsburgh where they were screened into at least eight size fractions; each fraction (except for the finest size in each case) was then subjected to float-sink analysis in at least seven specific gravities. Finally, each specific gravity fraction was analyzed for ash, total and pyritic sulfur, and Btu contents (table 2).

All data for each product was compiled and fed to a computer program which reconstituted the feed from the products sampled, and calculated the performance characteristics of the jig's separation.

Baum performance aided by fines removal

Tables 3 and 4 present the complete sets of performance data by size fraction (and by + 14 mesh composite)

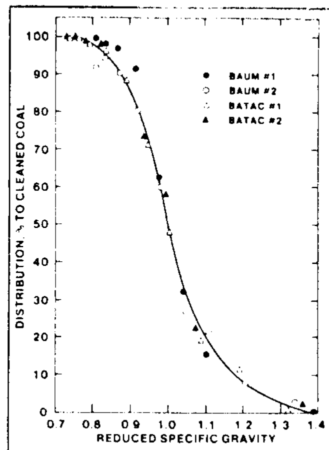


Fig. 7. Generalized distribution curve of Baum jigs at +¼-in. composite and Batac jigs at +28 mesh composite

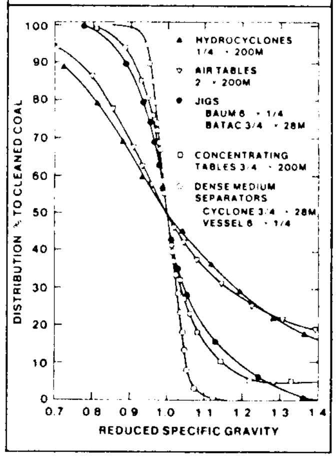


Fig. 8. Generalized distribution curves for major U.S. coal cleaning devices

for Baum #1 and Baum #2 respectively. The table shows how each size fraction behaved in the jig, information that is useful in improving the quality of the separation or discovering where the inefficiencies are. For instance, the two jigs have feeds which present similar difficulties of cleaning: the feed ash contents are 33.7 percent (#1) and 38.1 percent (#2), and the amounts of near gravity material are 6.6 percent (#1) and 4.0 percent (#2). But the difference in performance indicated in fig. 3 is substantial, as the probable errors and error areas reflect.

The cause for this inequity in performance can be found by examining the feed screen analysis in tables 3 and 4. Baum jig #1 feed contained 10.6 percent −¼-in. material, while jig #2 was being fed 43.3 percent. A high percentage of fines is extremely detrimental to the overall quality of the Baum jig separation since a Baum is not designed to clean the fines nearly as well as it does the coarse. This was demonstrated by removing the −¼-in. material's data from the evaluation by compositing the +¼-in. fractions. The results in fig. 4 show a much closer correlation between the two separations because the Baum #2 performance was greatly improved by removal of the finer material. An actual performance of the jig operated without the −¼-in. material may be even better without the influence of the fine particles on the coarse particle separations.

Batacs do good job down to 28 or 48 mesh

In fact, the need to improve the sharpness of separation of the finer material in jigging was the driving force behind the development of the Batac jig. Generally, the Batac jigs performed almost as well as the Baum jigs, but it is important to remember that we are comparing a fine coal cleaner with a coarse coal cleaner. The two

Batacs were fairly close in overall performance down to 200 mesh, as depicted in fig. 5.

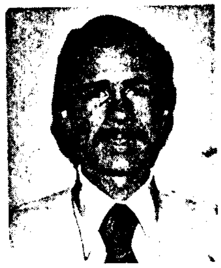
The performance characteristics summaries in tables 5 and 6 indicate that the Batacs do a good job of cleaning down to 28 or 48 mesh, but then the quality of separation deteriorates. The data was composited at 28 mesh and the result was slightly better sharpness of separation criteria for both jigs (see fig. 6). This performance data is in line with that reported in recent Batac jig papers.[1,2]

Cleaning performances similar for both jigs

As a summary, the performance characteristics for all four jig composites are presented in table 7. The cleaning performances of the Baum and Batac jig are similar: the probable errors ranged between 0.085 and 0.116, and the error areas only ranged from 63 to 81. But the Baum jig accounted for the lower values in both ranges, while the Batac had the higher ones. Since the four sets of data are alike despite the fact that each washed a different raw coal, it is interesting to plot the distribution data as a generalized distribution curve.[3] This is a method by which distribution curves at different specific gravities of separation, for a given piece of coal-cleaning equipment and a given raw coal feed, are combined into a single curve, normalized with respect to specific gravity. In fig. 7, the distribution data for the four jigs has been plotted. The majority of the data points lie on or near the generalized distribution curve, showing consistency among the units sampled.

To compare jig performance with that of other cleaning units studied in the series, the generalized curve of each unit for its respective size range was plotted on the same graph, as depicted in fig. 8. This clearly indicates the characteristic degree of sharpness of separation that each cleaning device possesses. Of course, the curves are only approximate predictions of performance because they will be affected by size distribution, size range, feed ash and mode of operation.

In conclusion, even though the Batac jig uses the same basic principles as the Baum jig, its design and operation allow it to clean the finer fraction of coal (3/4-in. × 28m) almost as well as the Baum cleans the coarse fraction (6 × 1/4-in.). The overall cleaning performance of jigs is below that of the dense-medium processes and is about the same as that of a concentrating table.



Richard P. Killmeyer Jr. has been engaged in studies involving coal preparation since joining the Coal Preparation Group of the U.S. Bureau of Mines five years ago. The group transferred to the Department of Energy in 1977 and Killmeyer now is a supervisory chemical engineer. His work has encompassed equipment performance studies, dense medium cyclone pilot-plant testing and instrumentation for preparation plant circuits.

References

[1] Tackett, Charles E. Greenwich Collieries: A Variation in the Art of Coal Washing by Jigs. Presented at AIME Annual Meeting, Atlanta, Ga., 1977.

[2] Hake, W. D. Application of the Batac Jig for Processing Fine Coal. Mining Congress Journal, September 1976.

[3] Gottfried, B. S. and P. S. Jacobsen. Generalized Distribution Curve for Characterizing the Performance of Coal-Cleaning Equipment. Bureau of Mines R.I. 8238, 1977.

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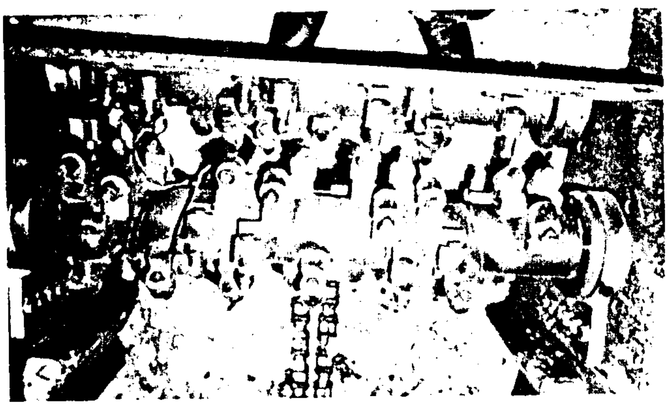

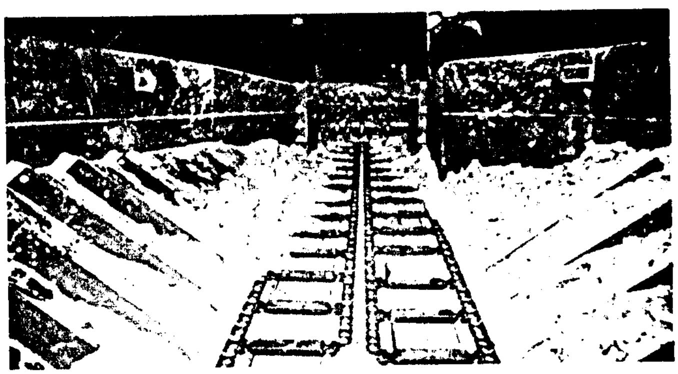

The feeder is advanced and the conveyor extended in 300-ft increments to give an average one-way haulage distance from the face of about 600 ft

In summation, conversion of the face haulage system at Ojibway has been a combination of triumphs and tribulations. The feeder breaker has generally performed well, especially with the dual, spiral breaker element. The LHD's have produced well when available but have been a high maintenance item. With the modifications made, however, especially in the past year, we now feel much more confident of these units. The economic life of these machines in our operation is still somewhat unknown, and to ensure fulfillment of our projected tonnage requirements, we have purchased a sixth LHD.

Overall the new system has substantially reduced operating labor, maintenance labor and maintenance material costs. At the same time the production capacity has increased, consistent with the original requirements of the project.

In the future, we plan to try and improve on our record and may include such items as extendable conveyor systems to allow conveyor extensions at shorter intervals and reductions in average haulage distance.

A. Hedley Duffield was employed in various production supervisory positions with the National Coal Board in England and Ashanti Goldfields Corp. in West Africa, before emigrating to Canada in 1967. He subsequently worked for Alwinsal Potash of Canada as a shift boss and senior industrial engineer. Duffield joined Canadian Rock Salt Co. in 1972 and since 1977 has been general superintendent of the Ojibway mine.