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INVESTIGATION OF THE HALDEX (SIMDEX) PROCESS FOR BENEFICATING COAL REFUSE

Hungarian Practice — 1969

by

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STATEMENT OF TRANSMITTAL

Special Report SR-80 transmitted herewith has been prepared by the Coal Research Section of the College of Earth and Mineral Sciences Experiment Station. Each of the Special Reports listed below presents results obtained in connection with one of the research projects supported by the Commonwealth of Pennsylvania or a technical discussion of related research. The following is a list of Special Research Reports issued to date:

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SR-31	Mineral Matter Removal from Anthracite by High Temperature Chlorination	March 26, 1962
SR-32	The Effect of Crusher Type on the Liberation of Sulfur in Bituminous Coal	April 29, 1962
SR-33	Investigation of the Circular Concentrator - Flotation Circle System for Cleaning Fine Coal	September 10, 1962
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SR-43	The Effect of Concentration and Particle Size on the Burning Velocity of Laminar Coal Dust Flames	March 1, 1964
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SR-54	A Study of the Reactions Between Coal and Coal Mine Drainage	November 22, 1965
SR-55	Methods Employed for Underground Stowing (A Resume of a Literature Survey)	February 28, 1966
SR-56	Computer Simulation of Materials Handling in Open Pit Mining	June 6, 1966
SR-57	The Evaluation of Anthracite Refuse as a Highway Construction Material	July 30, 1966
SR-58	An Investigation of the Cleaning of Bituminous Coal Refuse Fines by an Experimental Hydrocyclone	August 15, 1966
SR-59	Chlorination and Activation of Pennsylvania Anthracites	October 24, 1966
SR-60	Development and Testing of an Injection Well for the Subsurface Disposal of Acid Mine Water	February 1, 1967
SR-61	Investigations of the Cyclone Washing of Fine Coal in Water	December 12, 1966
SR-62	Linear Programming Short Course	May 1, 1967
SR-63	Planning Belt Conveyor Networks Using Computer Simulation	May 15, 1967
SR-64	The Economic Importance of the Coal Industry to Pennsylvania	August 1, 1967
SR-65	An Evaluation of Factors Influencing Acid Mine Drainage Production from Various Strata of the Allegheny Group and the Ground Water Interactions in Selected Areas of Western Pennsylvania	August 15, 1967
SR-66	Potential Injection Well Strata for Acid Mine Water Disposal in Pennsylvania	October 25, 1967
SR-67	A Survey of the Location, Magnitude, Characteristics and Potential Uses of Pennsylvania Refuse	January 25, 1968
SR-68	A Landscape Architectural Approach to Reclamation of Development of Deep Anthracite Strip Pits	July 1, 1968

SR-69	The Oxygenation of Iron (II) - Relationship to Coal Mine Drainage Treatment	November 1, 1968
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SR-71	The Revegetation of Highly Acid Spoil Banks in the Bituminous Coal Region of Pennsylvania	February 10, 1969
SR-72	Acid and Aluminum Toxicity as Related to Strip-Mine Spoil Banks in Western Pennsylvania	May 1, 1969
SR-73	Designing a Rock Bolting System	May 15, 1969
SR-74	An Electrokinetic Study of Bituminous Coal Froth Flotation and Flocculation	May 23, 1969
SR-75	A Complete Coal Mining Simulation	November 10, 1969
SR-76	An Investigation of the Natural Beneficiation of Coal Mine Drainage	May 15, 1970
SR-77	Application of a Continuous Mining System in a Medium Pitching Anthracite Bed of Northeastern Pennsylvania	May 31, 1970
SR-78	Evaluation of a Monorail Mine Haulage System	February 1, 1971
SR-79	Pennsylvania Anthracite Refuse A Summary of a Literature Survey on Utilization and Disposal	March 15, 1971

William Spackman, Director
Coal Research Section and
Office of Coal Research
Administration

SUMMATION OF RESULTS

The successful separation of anthracite refuse into products with more marketing potential would offer a highly palatable solution to the problem of refuse bank reclamation. Several refuse treatment plants in the United States and Europe have been reported which produce a variety of marketable or more useful products from such materials. Perhaps the most versatile operation reported is the Tatabanya Mine Dump Reclamation Plant in Tatabanya, Hungary.

This plant uses the Haldex (Simdex) process. The heart of the process is the Haldex Cyclone which employs a heavy media created from the material being processed, and has been very successful in recovering fuel and a variety of other marketable products. Upon personal inspection of this operation by Mr. Kogelmann, it became apparent that while this process efficiently separates the refuse material into several marketable streams, it did not incorporate any technology beyond current off-the-shelf equipment. It is, therefore, the recommendation of this report that a similar type of philosophy and technology be employed to develop anthracite refuse fractions which can be utilized commercially.

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Purpose of the Study

Operation Anthracite Refuse is a research assault which is seeking to establish approaches and capabilities for utilizing and/or disposing of refuse generated from anthracite mining by determining the characteristics, methods of beneficiation and economic value of current and *in situ* refuse. The total quantity of refuse materials found in the Pennsylvania anthracite region has been estimated at 910,000,000 cubic yards, distributed in 800 banks, which occupy approximately 12,000 acres of land. Improving the economic potential of the anthracite region requires enhancing the appearance of the region, making valuable land areas available for industrial expansion, reducing air and water pollution problems in the area, and developing products of economic significance.

The purpose of this study was to investigate a technique used by European treatment plants in the reclamation of coal refuse. A field trip was made to observe the operation of a Haldex (Simdex) process in Tatabanya, Hungary. The ultimate aim of this study is to examine the potential of applying current technology to the treatment of anthracite refuse as a means of removing this solid waste and, at the same time, generating valuable by-products which could underwrite the cost of such an operation.

Acknowledgments

The authors wish to express their sincere appreciation to the Austrian-Alpine Mining and Manufacturing Company (Oestereichisch Alpine Montangesellesschaft), Vienna, Austria, for their quick, efficient handling of the necessary arrangements for the field investigation trip.

Introduction

The ideal solution to the anthracite refuse problem is a process which will recover a variety of useful products from the anthracite refuse banks by a simple treatment. A process which has this potential is a modified heavy-media operation in which the fine sizes of the refuse itself are used as a low cost specific gravity controlling medium. Utilizing a refuse material containing 10 to 20% coal as plant feed, a well-controlled, versatile, heavy-media plant can produce a variety of products including clean coal (12% ash max.), low-grade fuel (20-40% ash), raw material for brick, lightweight aggregate and cement manufacture. Mine backfill material is another product possibility. If the refuse contains high inorganic sulfur values, a pyrite concentrate suitable for sulfuric acid manufacture can also be produced."

The ideas of merchantable product recovery from coal refuse and the use of finely sized refuse as the separating medium are not recent concepts (11, 16, 18). In fact, anthracite washeries have been reporting production of coal by reprocessing their rejects since 1895, and later, plants were constructed for the sole purpose of processing refuse to produce merchantable coal (3). But the primary interest of this report is focused upon recent commercial size refuse treatment plants. No one refuse treatment plant has ever been operated anywhere which produces this whole range of products, but the potential exists to make such an operation feasible.

Typical Refuse Processing Plants in the United States

Several plants have been built or proposed in the United States to produce one or two salable end products from coal refuse. These include the following:

1. State Coal Company--Mt. Carmel, Pennsylvania (4, 12)

This refuse recovery plant came into operation in 1964 and initially treated 335 tph of well-oxidized material from anthracite tailings banks left at the old Pennsylvania Colliery of Susquehanna Collieries Company containing 22% recoverable coal. The function of this plant was to recover clean coal and dewatered -3/4 x 30 mesh tailings for strip mine backfill.

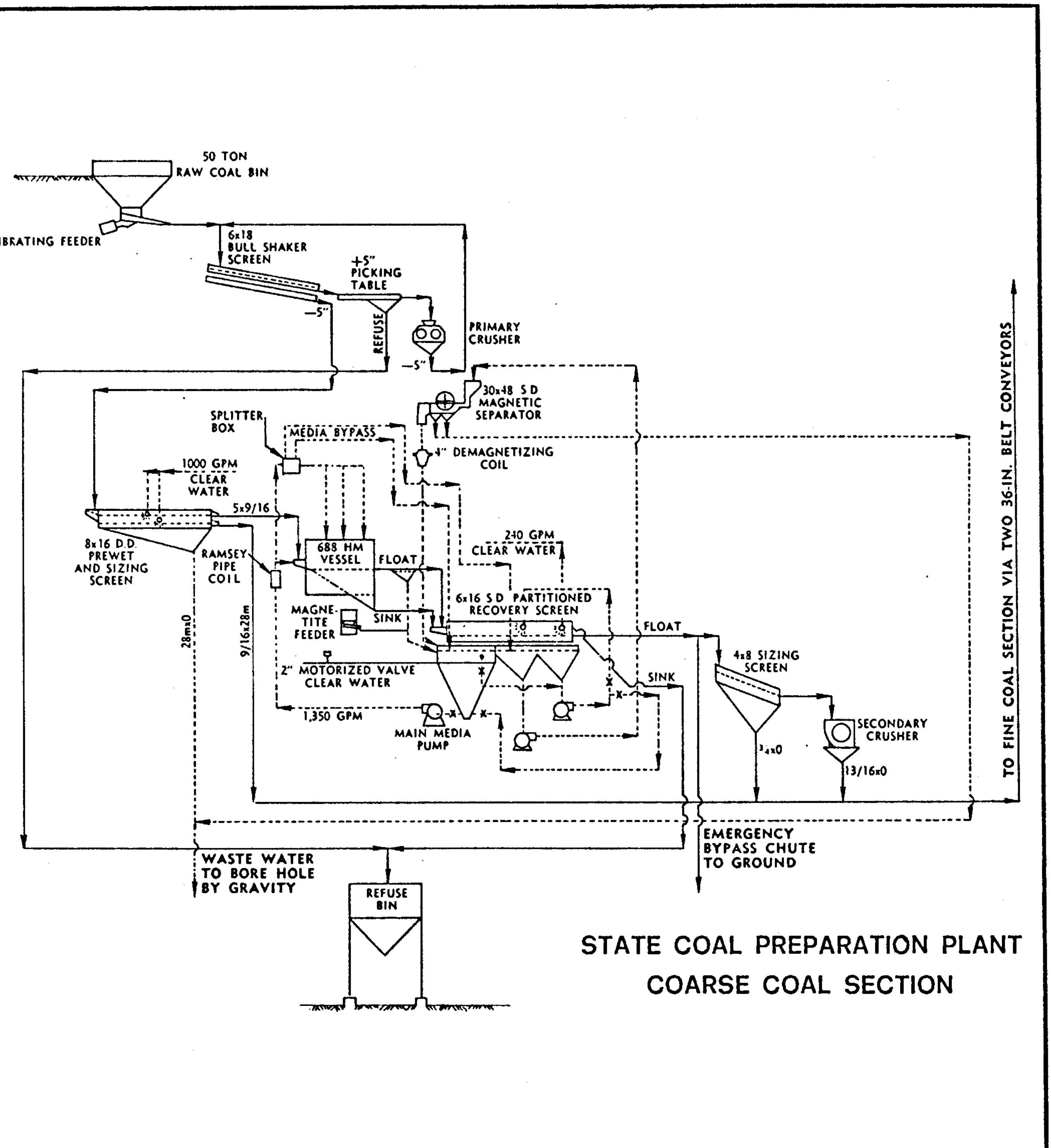
The basic flowsheet (see Fig. 1) consisted of a Wilmot-OCC 688 heavy media vessel to treat plus 3/4" sizes and four 15 1/2" diameter Wilmot Dyna Whirlpool cyclones for the finer sizes. Magnetite was used as the medium which was controlled at 1.67 to produce a clean coal (-3/4" x 30 mesh) containing 12% ash maximum. The clean refuse was dewatered and deslimed on screens and trucked to nearby abandoned strip pits as backfill material.

Water for this operation was obtained at about pH 5 from an abandoned mine shaft near the plant. Black waste water was returned underground via an old caved strip pit.

This plant was reported to have had severe operating difficulties when the grade of coal in the refuse dropped to about 15% and the truck haulage distance of feed to the plant increased with gradual consumption of the waste banks.

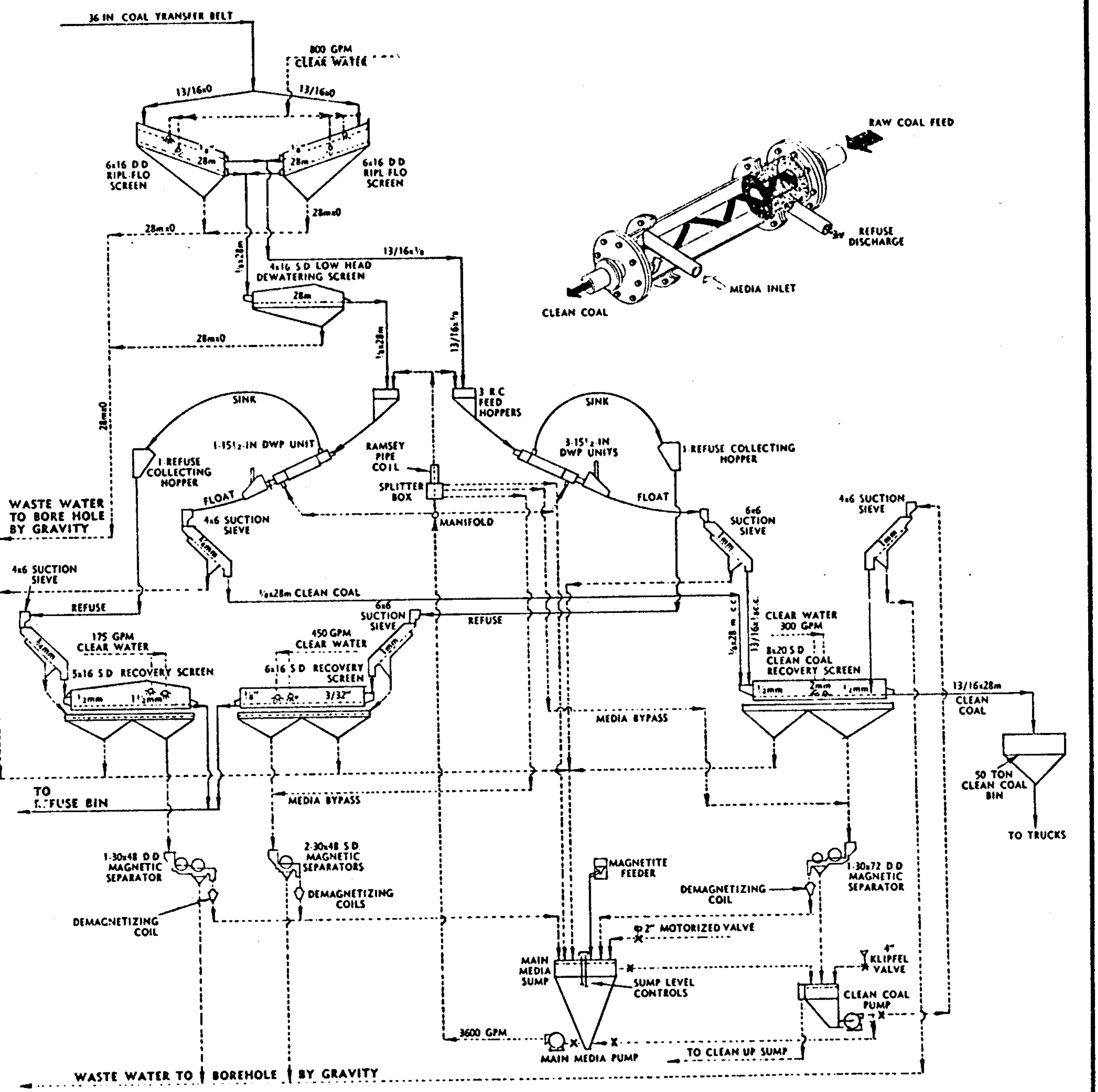
2. Penn State Pilot Plant-Barnesboro, Pennsylvania (10, 14, 15)

In 1965, a 50 ton per hour pilot coal refuse treatment plant went into operation on the Lancashire No. 15 property of the Barnes and Tucker Coal



50 TON
RAW COAL BIN
IBRATING FEEDER
6x18
BULL SHAKER
SCREEN
+5"
PICKING
TABLE
−5"
REFUSE
PRIMARY
CRUSHER
−5"
30x48 S D
MAGNETIC
SEPARATOR
SPLITTER
BOX
MEDIA BYPASS
4" DEMAGNETIZING
COIL
1000 GPM
CLEAR
WATER
5x9/16
8x16 D.D.
PREWET
AND SIZING
SCREEN
RAMSEY
PIPE
COIL
688 HM
VESSEL
FLOAT
240 GPM
CLEAR WATER
6x16 S D PARTITIONED
RECOVERY SCREEN
MAGNE-
TITE
FEEDER
SINK
28mx0
9/16x28m
FLOAT
2" MOTORIZED VALVE
CLEAR WATER
SINK
4x8 SIZING
SCREEN
1,350 GPM
MAIN MEDIA
PUMP
SECONDARY
CRUSHER
3/4x0
13/16x0
TO FINE COAL SECTION VIA TWO 36-IN. BELT CONVEYORS
EMERGENCY
BYPASS CHUTE
TO GROUND
WASTE WATER
TO BORE HOLE
BY GRAVITY
REFUSE
BIN
STATE COAL PREPARATION PLANT
COARSE COAL SECTION

Figure 1



STATE COAL PREPARATION PLANT
FINE COAL SECTION

Figure 1 (cont'd)

Company. This was a heavy media plant (see Figure 2) designed to handle a high sulfur, fresh refuse from an adjacent cleaning plant. It was designed and operated under the supervision of the Mineral Preparation Department of the College of Earth and Mineral Sciences under a grant from the Division of Air Pollution of the United States Public Health Service. The objectives of this research demonstration plant were (1) to produce a refuse as coal-free as possible which would not self-ignite when piled in heaps; (2) to recover a salable grade of coal product; (3) to determine which components in refuse were critical in so far as effect on auto-ignition of refuse piles was concerned; and (4) to attempt to produce marketable building-construction products from the treated refuse. This plant operated very successfully to produce clean coal and low carbon refuse. However, the most important point demonstrated was that sulfide minerals in refuse were probably more responsible for auto-ignition of refuse piles than coal content. This lead to some preliminary work to attempt to produce pyrite concentrates from a high gravity sink product by cycloning techniques using special cyclone designs. It was shown that a good potential existed for producing a pyrite concentrate that would be acceptable for sulfuric acid manufacture. This plant was eventually purchased by Barnes and Tucker for use as a general pilot plant for testing coal from new mines.

3. <u>Pennsylvania State Department of Mines Culm Bank Processing Plant</u> (13)

This was a 50 ton per day pilot plant identical to the Barnesboro plant described above. Its purpose was to treat anthracite refuse to produce a salable low-grade coal and a nonburning secondary refuse for restacking or for use as backfill material. This plant, operated by Heyl and Patterson, Inc., started operations in October, 1965. Several 200-ton lots of coal

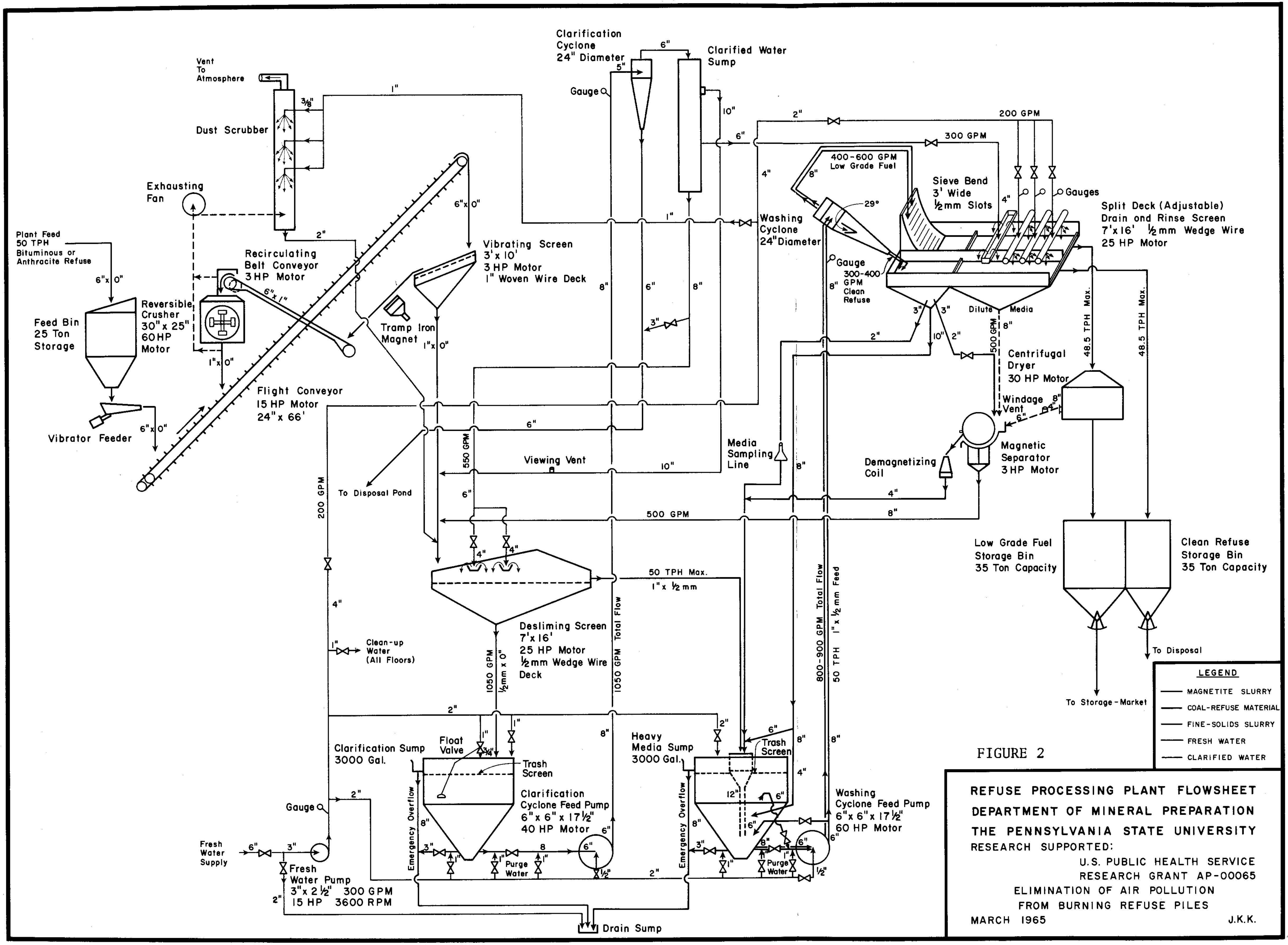


FIGURE 2

REFUSE PROCESSING PLANT FLOWSHEET
DEPARTMENT OF MINERAL PREPARATION
THE PENNSYLVANIA STATE UNIVERSITY
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ELIMINATION OF AIR POLLUTION
FROM BURNING REFUSE PILES
MARCH 1965 J.K.K.

(12-28% ash) from several culm banks were prepared for trial firing in operating boilers.

The plant proved capable of attaining its objectives, and the construction of larger production plants was recommended as being economically feasible. Some important information produced included the following:

1. The plant could produce 12% ash coal with high recoveries of coal.
2. The capital cost estimated for plants larger than 100 tons per day was $2,500. per ton hour exclusive of water clarification and special refuse storing equipment, but including feed and product storage, foundations, and erection.
3. A 100-ton per hour plant would require one operator and one helper.
4. Horsepower requirements: 3 to 4 hp per ton/hour of material processed.
5. Media consumption (magnetite): considerably less than 1 lb./ton refuse.
6. Maintenance, labor, and supplies: less than 10¢/ton.

This plant was operated for about one year, when the project was discontinued.

4. Kaiser Steel Corporation, Sunnyside, Utah (8, 19)

At this operation, current refuse from the coal cleaning plant is processed by screening, crushing, grinding, and blending with flotation tailings to produce mine backfill. Plant capacity is 1500 to 1800 tons per day of 6" x 0 refuse, which is ground and sized to minus 1/8", and pumped into abandoned workings adjacent to main haulage ways and air courses.

Typical European Refuse Processing Plants

The mining industry in Europe has been concerned for many years with: (1) recovery of values from refuse piles, (2) the production of backfill material to prevent subsidence, and (3) land reclamation and restoration (9). As a result, their technology in these areas is highly developed. Examples of European coal refuse recovery operations are:

1. N. C. B. Baddesley Colliery (England) (5, 7)

This plant treats 80 long tons per hour of refuse (containing 10% coal) to recover 365 long tons of clean coal per week with 86.9% rejection of sterile waste. Key to the process is a Wemco 8' x 10' Drum Separator operating at a gravity of 1.6 to 1.8 using magnetite as a heavy media. A report on this operation states that refuse containing 5% coal can be operated profitably. In this case, the clean coal produced is pumped to an adjacent cleaning plant to be combined with a standard washery product.

2. N. C. B. "Manvers Main" Central Coal Preparation Plant (21)

In 1959, this was the largest operation of its kind, treating 1,320 tons per hour from four collieries mining five different coalbeds. The unique feature of this plant is the use of flotation tailings refuse as heavy media to produce a wide range of coal products from a complex plant feed. The heavy medium equipment used is the Barvoys bath, and medium control is such that operating gravities in various vessels can be maintained within plus or minus 0.004. This size of operation demonstrates quite vividly that use of refuse as a heavy medium is an established mineral preparation technique.

3. Simonacco Ltd., Carlisle, England (6, 17)

This company has exclusive rights in the United Kingdom to the use of the Simdex (Haldex) cyclone process for treating coal refuse, washery rejects, and other coal containing materials using a specially designed heavy media cyclone that uses fine refuse as the medium. The Simdex cyclone is the same as the Haldex cyclone that was originally developed in Hungary.

Simonacco has built several portable Simdex cyclone plants in England ranging in size from 50 to 150 tons per hour, (see Figure 3). The first plant was built in 1965. The operating characteristics of these plants are reported to be very satisfactory.

4. Tatabanya Mine Dump Reclamation Plant, Tatabanya, Hungary (2)

The Tatabanya plant is a refuse processing plant that is near ideal in its approach to refuse reclamation. It employs the Haldex (Simdex) cyclone utilizing refuse as heavy medium, and recovers coal and a wide variety of building product raw materials.

5. Gartshore Plant, Glasgow, Scotland (1, 20)

During the years 1970-76, this plant (see Figure 4) will process 2.6 million tons of anthracite colliery waste at the rate of 2000 TPD of minus 3-inch feed material (140 TPH on 2-shift basis) to recover coal and shale for lightweight aggregate. The 3 x 3/8" fraction will be cleaned in Simonacco-Drewboy heavy media vessels to produce three products--clean coal, middlings, and clean shale. The minus 3/8" fraction will be processed in Vorsyl separators (dense media cyclones). Both types of cyclones will use magnetite as the medium.

One of the main purposes of the plant is to provide 500 TPD of clean shale to a new 1.8 million dollar lightweight aggregate plant located on an adjacent 80-acre site. Any surplus shale produced will be stockpiled.

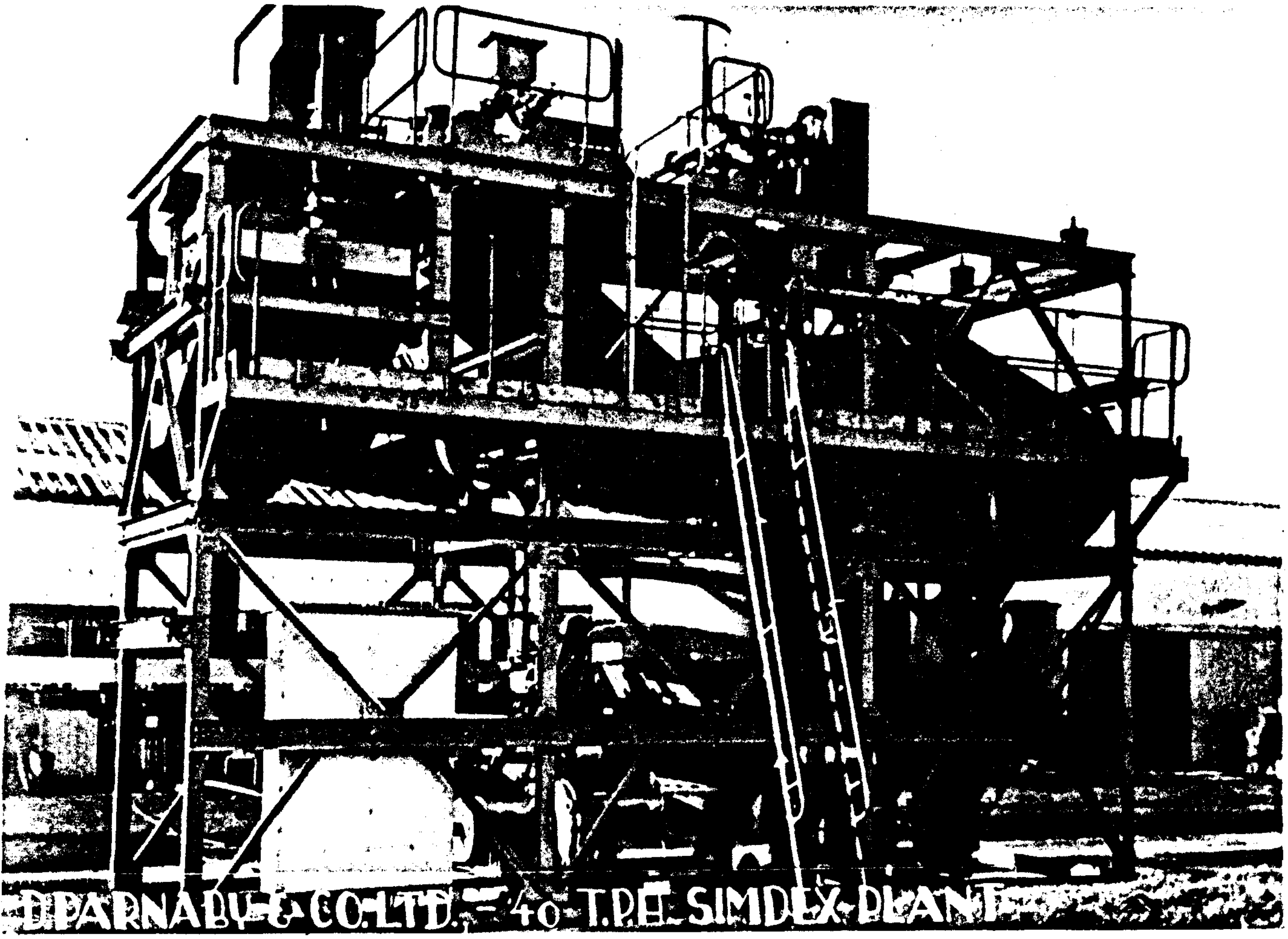
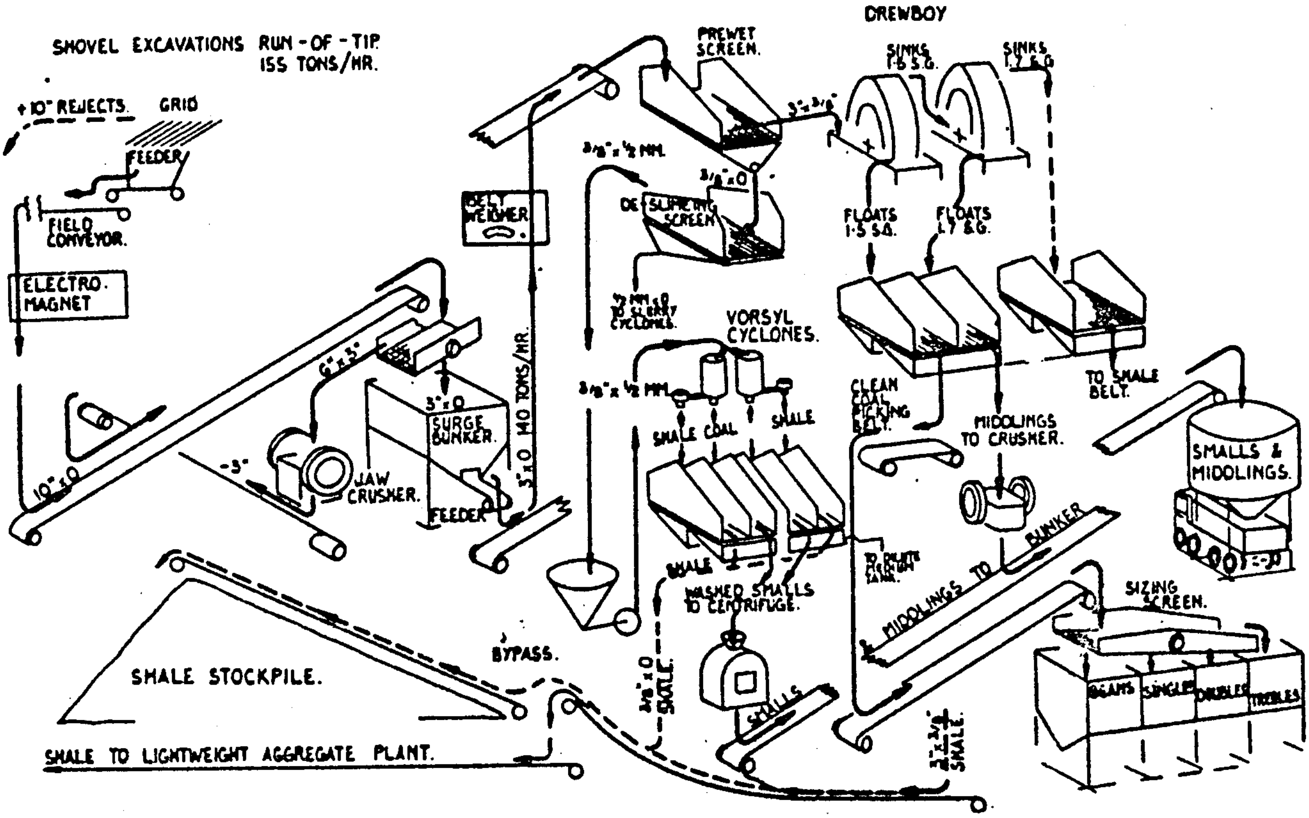


Figure 3



FLOW DIAGRAM OF THE GARTSHORE WASHING PLANT

Figure 4

State of the Anthracite Field Investigation

As a result of the survey made of both domestic and foreign literature on coal refuse recovery processes, there was strong evidence that the portable Simdex-Haldex cyclone plant concept had good potential for economically processing mine dump material in Pennsylvania. The Haldex/Simdex process had been given wide publicity in the trade literature during 1965-1966, but had not been reported upon recently. It was extremely fortunate that one of the authors (Mr. Kogelmann) was making a privately financed trip to Austria. This provided an opportunity to arrange a side trip to Hungary to get first-hand information on the latest developments in mine dump material processing. He visited both the engineering offices of NIKEX (the owners of the Haldex patent) and the Tatabanya Plant. The actual travel schedule involved was as follows:

November 14, 1968	Visit to NIKEX, Hungarian Trading Company for Products of Heavy Industry, Budapest 5, Josef Hador Ter 5-6, Hungary. Meeting with NIKEX representative Mrs. Agnes Galos-Budai.
November 15, 1968	Visit to Tatabanya Mine Dump Reclamation Plant, Tatabanya, Hungary (about 40 miles northwest of Budapest)
November 16, 1968	Meeting with Dr. Kulcsar Gyula, Head of Tatabanya Mine Dump Reclamation Plant, and Mssrs. Ing. Levente Panyi and Ing. Ruticza Gyula, Tatabanya, Hungary.

The information graciously provided by the above individuals, is summarized in the subsequent sections of this report.

The Haldex/Simdex Process

This process is a modified heavy media process which employs a specially designed horizontal cyclone (see Figure 5) and utilizes refuse fines (32 mesh x 0) as the heavy medium. Table 1 indicates the sizes of Haldex cyclones that are available:

Table 1. Haldex/Simdex Cyclone Data

Cyclone Size (mm)	(inches)	Capacity tons/hr/cyclone	Particle Size Range
250	10"	18	3/4" x 0
300	12"	25	1" x 0
380	15"	40	1 1/4" x 0

A typical plant flowsheet is shown in Figure 6.

Examples of the accuracy achieved by Haldex/Simdex cyclones on coal recovery from colliery waste in the United Kingdom are shown in Table 2.

Table 2. Separation Accuracies of Haldex Cyclones

Refuse Size	Probable Error (ep)
1" x 5/8"	0.001
5/8" x 3/8"	0.035
3/8" x 1/8"	0.040
1/8" x 30 mesh	0.090
1" x 30 mesh	0.070

These results show an accuracy of washing greater than has yet been possible by conventional jig washers on similar applications. Furthermore, a much greater consistency in washing conditions is achieved.

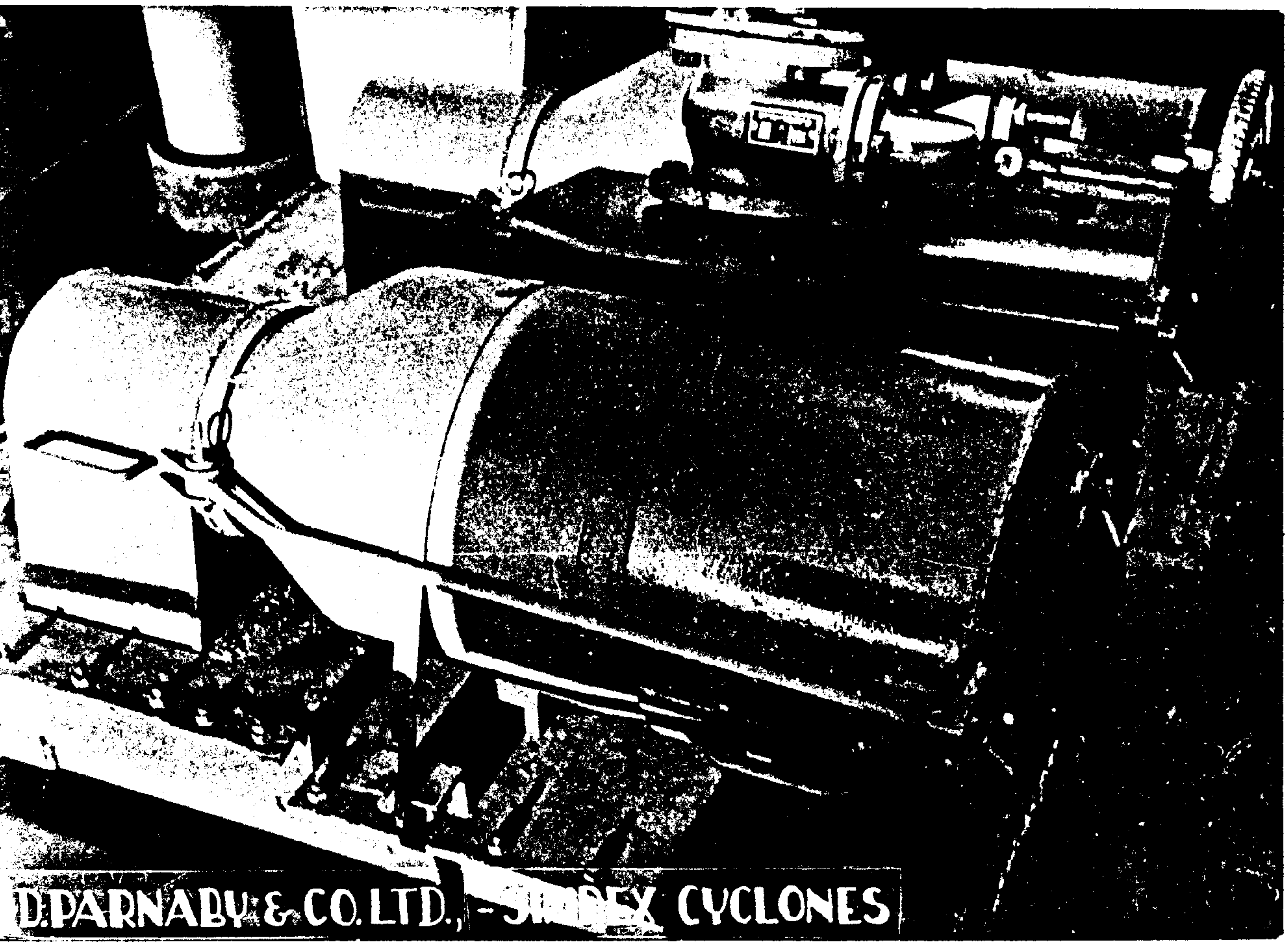
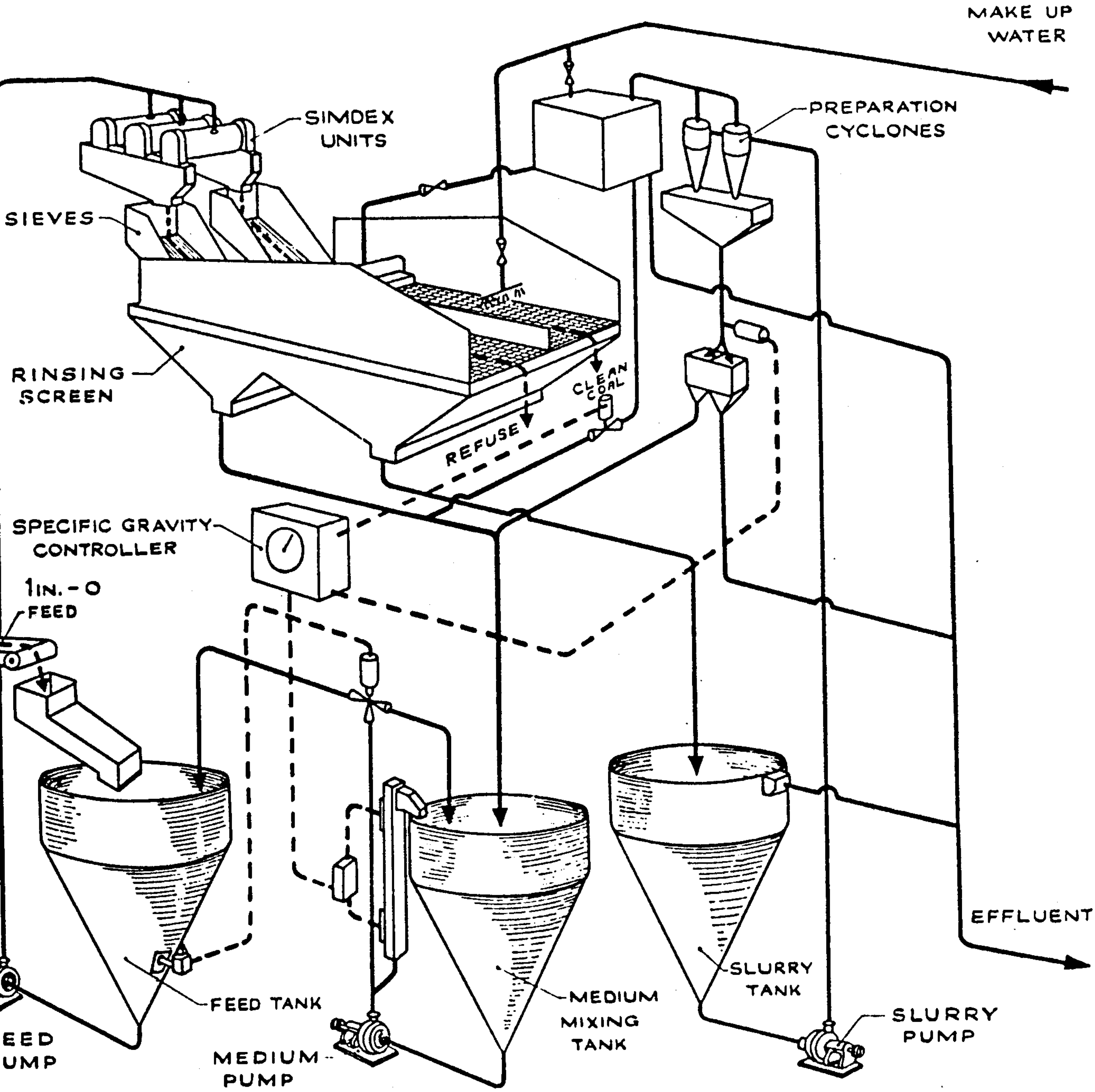


Figure 5



FLOW DIAGRAM OF A CYCLONE WASHERY
Figure 6

The Haldex-Simdex Plant At Tatabanya, Hungary (100 TPH)

1. Industrial Utilization of Colliery Waste with Simultaneous Recovery of Coal

Nikex, the Hungarian Trading Company for Projects of Heavy Industry, provided the following description of the Tatabanya Haldex-Simdex plant: (2)

"The coalfield of Tatabanya, Hungary, has been yielding a good class of brown coal for almost seven decades. Like many other mines in the world, about 20% of the mined quantity is discarded on the refuse dump in Tatabanya. The material of the dump is mainly, shale, clay, sandstone and limestone.

The coal contained in the dump material is about 5 to 20%. During many years of storage the loose porous structure receives abundant oxygen supply under the effect of atmospherics and due to pyrite bands, it starts to heat up and catches fire. This is detrimental to health since it contaminates the environmental air with carbon oxide gases, sulfur dioxide, etc. The surroundings of mines operated for several decades are being filled with dumps requiring much space, thus preventing the development of industry.

These considerations induced the management of the Tatabanya coal basin to find adequate technical solutions with respect to eliminating the coal tips (refuse piles).

After World War II, the coalfield of Tatabanya underwent a speedy development, with the daily turnout attaining the highest possible rate. This circumstance drew attention to the fact that something should be done regarding the dumps produced.

In 1959, a new process was patented which offered means for extraction of coal from the dump on an up-to-date technical level and solved the problem of the industrial utilization of the whole amount of waste."

2. Recovery of the Coal From Shale Tips

"Extensive laboratory tests were carried out in order to determine the characteristics of the dump material considered to be utilizable and to determine its coal content. Average samples were taken from the daily fresh waste stock and by drilling old tips." The waste, consisting of a mixture of coal and accompanying rock, is processed in a hydrocyclone-type washing plant with the aid of heavy suspension provided by the raw material itself. The system yields a good quality coal product with good efficiency. "The ecart probable index of the technology established (Tromp method basis) is 0.05 to 0.07 which is technically acceptable.

"The waste delivered into the plant is freed from ferrous and other contaminations by electromagnet and by hand sorting. The whole lot is then crushed in an impact crusher to a grain size of 1.18 x 0 inch and separated by means of resonance screens and passed on a rubber belt conveyor to a tank where it is mixed into a slurry consisting of a suspension of the same material (minus 32 mesh) recirculated from the processing system."

" The slurry is adjusted to appropriate density and is fed into hydrocyclones by means of slurry pumps. Working under medium pressure (18 psi), the hydrocyclones separate the coal product with an average coal content of about 92-98 per cent from the refuse. The coal contained in the slurry passing through the upper aperture of the hydrocyclones is separated from a considerable part of its water content and of fine impurities adhering to the coal by washing and sizing vibrating screens, and dewatering centrifuges or vibrating dewatering troughs.

The refuse leaving the hydrocyclones at the bottom aperture is subjected to further processing and utilization. The coal obtained is classified to optional grain size on the vibrating screens and sold as fine and peaslack coal."

By the end of 1965 this plant had produced about 1.2 million metric tons of coal from the dumps within 10 years, about half of which was obtained by the new technological process. The production costs of coal obtained on the basis of this new technology averaged about 60 per cent of the underground mining costs, with the quality of the coal being superior to the latter."

3. Industrial Utilization of the Accompanying Rock

"Since the method of extracting coal from the waste utilizes only 10 to 15 per cent of the total content of the dumps, comprehensive studies were made with a view to making use of the accompanying rock as well. Experiments proved that the waste rock product may be utilized economically for industrial purposes; permitting products of lower cost in every respect, than products made from previously used raw materials. The waste product is now used in millions of tons for the production of:

clay products (bricks),

stowage,

cement-manufacture,

porous, lightweight concrete aggregates,

panels and other building elements.

The applicability of the waste product was established in laboratory and pilot plant tests on the basis of its components. Many years of experience have proved that the waste product from the different mining districts can be used for one or the other of the purposes listed above.

The best types of rock are the shales. After suitable dressing they may be used--almost without exception--for any one of the five purposes mentioned above. A specific processing plant is designed on the basis of the results of previous studies. The waste is processed so as to involve no further processing in the industrial plant of its destination, but to be used directly as raw material.

The waste used as the raw material for brick and lightweight aggregates production is crushed to 1.12 x 0 inch and treated by means of the hydro-cyclone in such a manner that its coal content is suitable for the firing system applied in the user's technology. This raw material is burned into a highly resistant, weather-proof building material either alone or as the component of the raw material used by the brick works, then added in suitable percentage. As a result about 40 to 100 per cent of the fuel used for brick baking can be saved, depending on the characteristics of the raw material. The utilization of the material calls for no investment, and for no substantial changes of the existing technological equipment in the ceramic plants and cement works as pointed out before.

The waste shale product represents in itself (or mixed with clay and burned to brick) a perfect building material of superior strength to products obtained by the old technology. It permits an average increase of 30 per cent of the burning equipment capacity and reduces the bulk density of the products. The process allows a 75 to 90 per cent reduction in fuel cost in the ceramic industry by eliminating the use of commercial coal. As a result waste shale dressed by the new process in Hungary and Poland is already utilized to the extent of one million metric tons per year.

The waste shale supplied by the new cleaning plants has also been successfully used for cement-manufacture. In this case it acts as a silicate component in the raw mixture required for the production of Portland cement clinker. The quality and mechanical strength of the clinker obtained, are satisfactory in all cases. In this application it is possible to utilize

75 to 80 per cent of the residual coal content of the raw material in the course of clinker burning, substituting for part of the conventional fuel energy required. The costs of the fuel consumed in this case are also reduced by 75 to 90 per cent. The cement works in the proximity of Polish dumps use about a half-million tons of beneficiated waste shale.

Swelling and simultaneous burning are practicable with particularly favourable results in the case of waste with shale-content. In the course of treatment, adequate quantity of coal is retained in homogenous distribution in the raw material to provide for suitable burning. The process needs only initial ignition, burning being maintained automatically, once started, by means of aspirated air. By addition of cement it is thus possible to produce building elements with a compressive strength of 710 to 5690 psi and a bulk weight of 37.5 to 100 lbs./cu./ft.

Panel elements of higher compressive strength are provided, naturally, with reinforcement. For reinforcement, about 10 per cent less steel is required than in the case of heavy concretes, the panels produced of light concrete constructions being almost 50 per cent lower bulk weight with identical strength compared to conventional concretes. Moreover, building with lightweight concrete, proves to be economical with regard to its favourable heat-and-sound insulating characteristics."

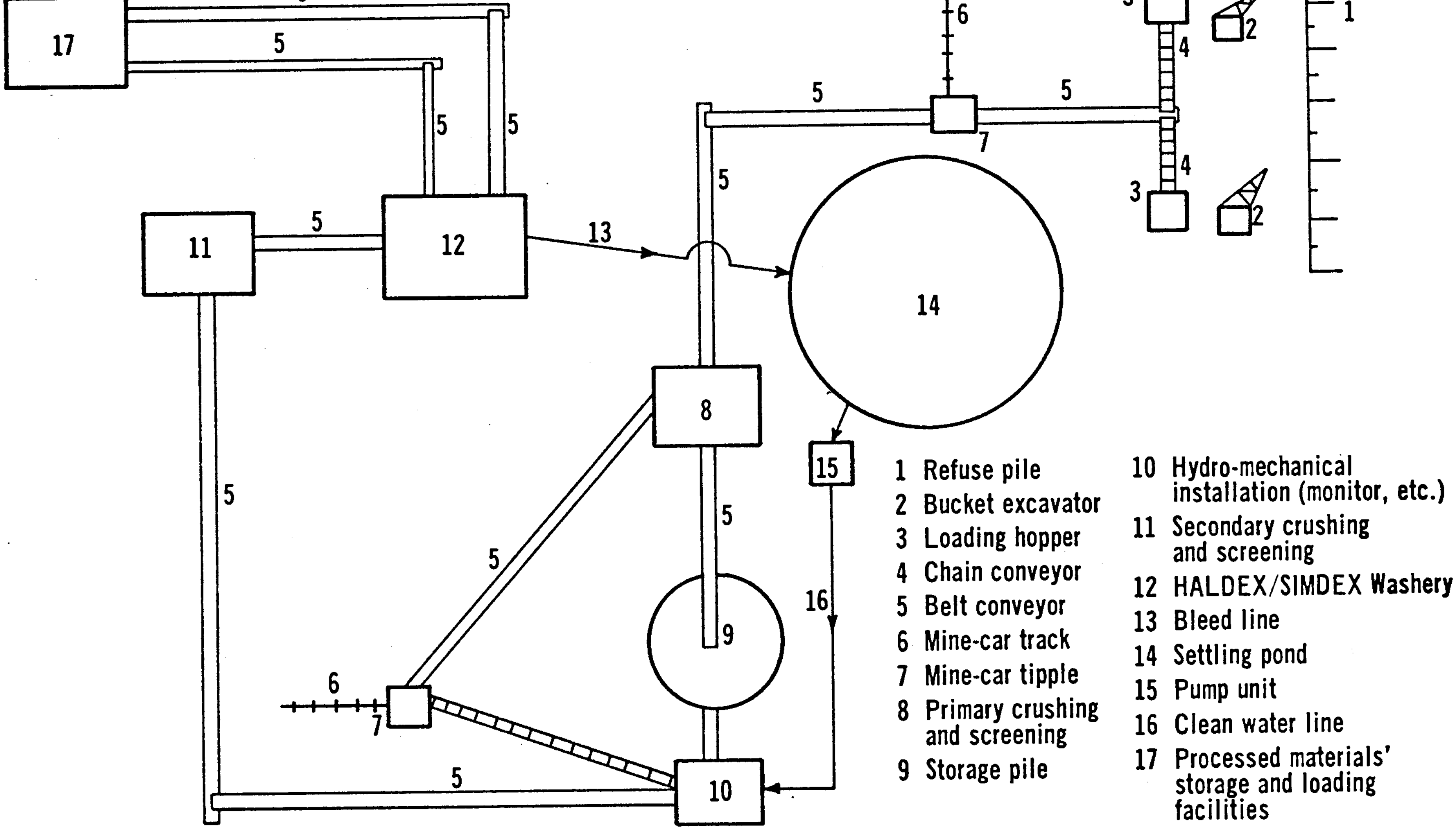
4. Backfill Applications

"The waste product processed with the technology under review is suitable also for stowage purposes. The coal content and the granulometry of the waste product may be adjusted in compliance with the standard specifications for stowage. After hydromechanical transport and settling it provides a backfill complying with standards in all respects. It is sometimes mixed with sand to 50 per cent, especially in the case of undertown mines. For pneumatic stowage it serves as 100 per cent raw material, dressed regarding grain size, coal content and moisture content so as to suit the requirements of pneumatic stowing machines. The resistance to compression produced by this waste product meets required specifications.

The products used for backfill are obtained in all cases in the neighborhood of the consuming mine. Consequently, it is competitive in price and in transport costs with filling sand. The higher expenses and the longer transport distance of filling sand even in large-scale production are obvious in comparison with waste. Hungarian and Polish coal mining makes use of about two million tons of waste for stowage every year."

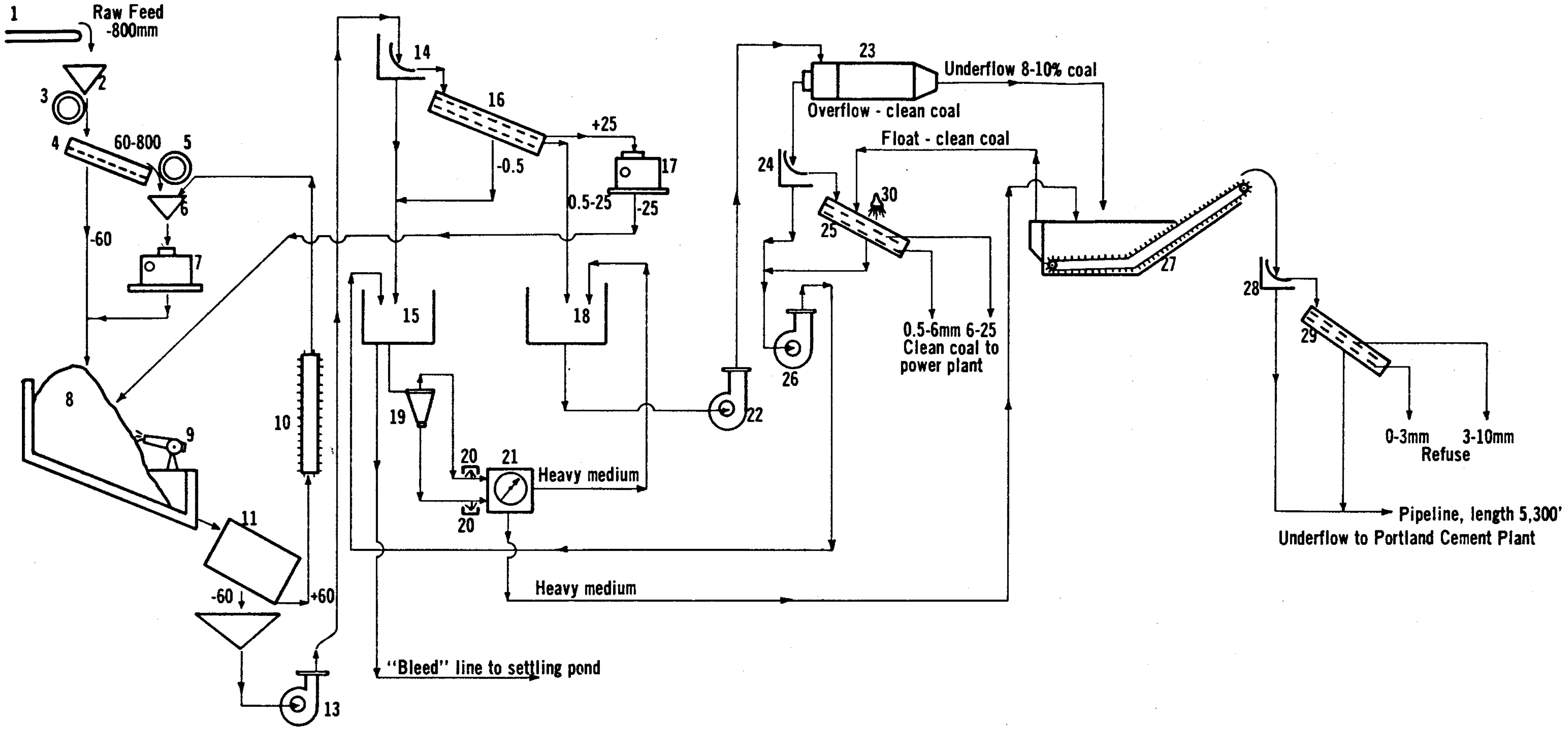
The Tatabanya Physical Plant

During author Kogelman's visit to the Tatabanya plant on November 15 and 16, 1968, he was graciously given full information regarding the entire operation. This enabled him to prepare the two flowsheets (Figures 7 and 8) which present a detailed breakdown of the entire process. Detailed operational data were also supplied all of which is presented in the following section.



PLAN OF THE HALDEX/SIMDEX MINE-DUMP MATERIAL RECLAMATION PLANT AT TATABANYA, HUNGARY

Figure 7



This flowsheet has been drawn from the notes taken by the author, because the Hungarian authorities didn't provide a flowsheet, and refused permission to take pictures.

1 Raw-feed belt conveyor
2 Feed Bin
3 Magnet for tramp iron
4 Vibrating screen
5 Magnet for tramp iron
6 Chute
7 Impact crusher
8 Storage pile
9 Hydraulic Gun (Monitor)
10 Scraper conveyor
11 Trommel Screen
12 Chute
13 Slurry pump
14 Sieve bend
15 Slurry tank
16 Vibrating screen
17 Impact crusher
18 Haldex-Cyclone feed tank
19 Thickener-cyclone: Diameter 300mm
20 Thorium-Isotope density recorder
21 Automatic Gravity Controller
22 Slurry pump
23 Haldex-Wahing Cyclone units (3)
24 Sieve bend
25 Vibrating screen
26 Slurry pump
27 Trough-type Vessel
28 Sieve bend
29 Vibrating screen
30 Spray Nozzels

FLOW SHEET OF MINE-DUMP MATERIAL RECLAMATION PROCESS; SYSTEM HALDEX/SIMDEX
"TATABANYA" PLANT, HUNGARY

1. Plant Operating Data

Dump Material:	Glance Coal (i.e. sub-bituminous coal, 1.4 sp. gr.) Coal Slate (From mine development works) with the major portion being clay, 1.6 to 1.7 sp. gr.
Coal Content of Dump Material:	23%
Refuse Content of Dump Material:	77%
Particle Size of Feed after Primary Crushing:	x 1" (0-25mm)
Particle Size Distribution of 0 x 16 M Fraction:	(59% of total)

-16 + 32 mesh -Tyler	21%
-32 + 270 mesh -Tyler	77%
-270 mesh -Tyler	32%
	100%

Density of Feed Slurry:	1.38
Capacity of One Cyclone Unit:	31.5 tons/hr.

2. Cyclone Data

Thickener Cyclone:

Diameter:	12" 300mm
Feed pressure:	1.2 atmospheres 18 psi
Overflow:	minimum sp. gr. 1.08
Underflow:	maximum sp. gr. 1.7

The thickener cyclones are installed in a vertical position.

Haldex/Simdex Washing Cyclone:

Diameter:	12" 300mm
Theoretical Capacity:	25 tph

The washing cyclones are installed in a horizontal position.

3. Operational Results Per Haldex/Simdex Unit:

Coal Yield:	6.5 tons/hr. 3/8" - 1" (10-25mm) 8100-8300 Btu/lb. 32 mesh Tyler - 3/8" (0.5-10mm) 7650-7750 Btu/lb.
Clean Coal Grade:	5/8% Ash
Refuse:	25.0 tons/hr.
Coal Recovery:	84.5%
Remaining Calorific Value in Refuse:	Size Fraction -2mm (-9 Tyler mesh) 810 Btu/lb. Size Fraction +2mm (+9 Tyler mesh) 496 Btu/lb.
Specific gravity of separation:	1.55

(The author has samples of both the raw feed and the processed material.)

4. Performance Data Per Three Haldex/Simdex Units

Cyclone Feed Rate	77-121 tons per hour
Energy Consumption	4-6 kwh/ton
Total Motor Power	850 kw
Water Consumption	135 gpm
Manpower Requirements	4-6 men per shift

5. Breakdown of Investment Costs:	1963 Prices
Mechanical Equipment	$470,000.
Electrical Equipment	$125,000.
Planning	$ 34,000.
Construction	$151,000.
Railroad Yard Facility	$105,000.
Total	$885,000.

Total Plant Cost (including office, workshop, road construction, railroad siding, water and power supply) $950,000.

6. Processing Costs

Basis:	3 shifts (@ 8 hours) working day 275 tpd Clean Coal 2040 tpd Usable Refuse		
	Annual Cost		
Wages, Fringe Benefits and Social Cost	$120,000.		
Raw Material and Supplies	$189,000.		
Debt Reduction and Interest	$ 89,000.		
Maintenance	$ 32,000.		
Overhead	$ 55,000.		
Total Annual Processing Cost	$484,000.		
Processing Cost of One Ton of Usable Product:		Coal	$4.00
		Refuse	$0.27

Conclusions and Recommendations

The Haldex/Simdex process is a low cost, economical process for reclamation of both coal and refuse. With the exception of "red dog", which has about the same specific gravity as coal, it is applicable to all kinds of mine dump materials and coals. Tests with Russian anthracite have also been run successfully in Tatabanya.

The system consists of standard mineral preparation machinery. Since this process has been applied on a commercial basis since 1960, no major technological problems are now involved in its operation.

The authors suggest that an anthracite refuse reclamation process could be developed. Practically all machinery elements such as cyclones, sieve bends, isotype-density controls, etc., are manufactured in this country. The only presently unknown factors are the economics of this process when applied in the United States. In countries like Hungary, Poland, and England with difficult geological and mining conditions (deep mines, disturbed seams, etc.), the high cost of mining coal (up to $14/metric ton) makes it profitable to recover coal from mine dumps. Hence, the main goal of future investigations should be to conduct market surveys to determine where markets and outlets for the products of this process can be found.

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