Energy, Mines and Resources Canada
Énergie, Mines et Ressources Canada

CANMET
Canada Centre for Mineral and Energy Technology
Centre canadien de la technologie des minéraux et de l'énergie

PRESENT AND FUTURE COAL PREPARATION TECHNOLOGY FOR COAL COMBUSTION

M. W. Mikhail
Coal Research Laboratory

September 1983

For presentation to Canadian Electrical Association Meeting, St. John, New Brunswick, October, 1983

ENERGY RESEARCH PROGRAM
COAL RESEARCH LABORATORY
ERP/CRL 83-18 (OP)

PRESENT AND FUTURE COAL PREPARATION

TECHNOLOGY FOR COAL COMBUSTION

by

M.W. Mikhail*

ABSTRACT

This paper briefly describes characteristics of Canadian coals and some unique problems associated with their cleaning. Degradation of friable coals, shales and release of clay during washing are associated with Western coals, and high levels of finely disseminated sulphur with Eastern coals. Coal preparation technology and equipment related to size reduction, cleaning and dewatering are briefly described in regard to principle of operation, application and limitations. Levels of preparation are summarized in relation to coal preparation economics and factors that influence coal preparation cost. Beneficial effects of coal cleaning on power plant operation are shown in relation to improved performance, lower maintenance cost and increased availability of power plant.

An integrated system for coal handling, beneficiation and transportation to produce a dense coal slurry for combustion is outlined. Deep cleaning of coal, process control and optiminzation techniques are discussed as tools to produce an environmentally acceptable product that can compete, with other sources of energy and make Canadian coals competitive on the international market.

---

*Head, Coal Beneficiation Research Unit, Coal Research Laboratory, Edmonton, Alberta, Canada, Centre for Mineral and Energy Technology, Department of Energy, Mines and Resources, Canada.

TECHNIQUES ACTUELLES ET FUTURES DE CONDITIONNEMENT DU CHARBON EN VUE DE SA COMBUSTION

M.W. Mikhail*

RÉSUMÉ

Le présent document fait rapidement état des caractéristiques des charbons canadiens et de certains problèmes propres à leur épuration. Ces problèmes sont la dégradation des charbons et des schistes friables ainsi que la production d'argile pendant le lavage dans le cas des charbons de l'Ouest, et la présence de grandes quantités de soufre finement disséminé dans le cas des charbons de l'Est. Les techniques de conditionnement du charbon ainsi que les équipements servant à la réduction des dimensions, à l'épuration et à la déshydratation du charbon sont décrites dans le document, du point de vue de leur principe de fonctionnement, de leur utilisation et de leurs limitations. Sont par ailleurs résumés les degrés de conditionnement atteignables en fonction des aspects économiques du conditionnement et des facteurs qui influent sur les coûts de ce conditionnement. Les avantages de l'épuration des charbon pour l'exploitation d'une centrale sont présentés: rendement accru, abaissement des frais de maintenance et disponibilité accrue de la centrale.

Enfin, on présente les grandes lignes d'un système intégré de manutention, d'enrichissement et de transport du charbon permettant de produire une suspension dense de charbon. Il est aussi question de l'épuration à fond du charbon, de la régulation des procédés et des techniques d'optimalisation comme moyen d'obtenir un produit acceptable pour l'environnement qui soit en mesure de faire concurrence aux autres sources d'énergie et qui soit compétitif sur le marché international.

* Chef, Unité de recherche sur l'enrichissement, Laboratoires de recherche sur le charbon, Edmonton (Alberta), Canada, Centre canadien de la technologie des minératux et de l'énergie, Énergie, Mines et Ressources Canada.

INTRODUCTION

Estimated Canadian coal reserves are 120 billion tonnes, of which 80% are located in Alberta and British Columbia. Canadian coal production in 1980 was estimated at 36 million tonnes, of which just over 16 million tonnes were used at mine mouth generating plants. The remaining 20 million tonnes received extensive preparation prior to transport to distant markets for thermal and metallurgical use. Prepared coal production in Canada has increased ten-fold since 1965. New facilities under construction will bring prepared coal production up to 30 million tonnes by 1985. Production is projected to be between three and five times that of 1980 by the end of the century i.e. approximately 100 to 180 million tonnes with a similar proportion of the additional output requiring preparation (90 to 150 million tonnes).

Most of the increase in production will be destined for overseas or central Canada. Presently, transportation cost represents approximately 50% of the total cost per tonne of coal. Limited capacity of Canadian railways and increased cost of transportation from Western Alberta to the west coast terminals ($17.5/tonne in 1981 as compared with $2.50 in 1971) suggest other means of transportation such as slurry pipelining. Preparation of coal for slurry transportation and dewatering and drying coal at the end of the pipeline are applications of coal preparation technology.

Mining costs of Canadian coals are often favourable with the exception of underground operations in Eastern Canada, resulting in an acceptable product cost. Preparation is therefore a major rather than an auxiliary function in the control and costing of Canadian coal production.

COAL CHARACTERISTICS

Canadian coal characteristics related to coal preparation technology can be identified as follows (1):

1. Eastern coals have high sulphur contents, essentially similar to those of eastern United States. Ash removal is easily achieved by preparation resulting in low ash content, however, sulphur removal is

limited.

2. Rocky Mountain metallurgical coals are included in highly sheared seams which have been subjected to rapid coalification. The high friability of these coals means that degradation during mining, handling and processing cannot be avoided. Widely varying geological structure and exposure to the atmosphere and to ground water result in different degrees of oxidation which perform inconsistently in cleaning by froth flotation.

3. Foothills high volatile bituminous coals are frequently interbedded with soft shales and bentonitic clays. The clays disintegrate during washing and produce large volumes of tailings. Clay in the fissures also results in degradation of the otherwise hard coal particles during washing.

4. Plains coals include subbituminous coals and lignites. These coals are relatively low in ash, high in inherent moisture and traditionally are used at mine mouth power generation plants without washing.

Many of the characterisics of Canadian coals are similar to those of coals in other countries. However, two characteristics are identified with Canadian coals: friability common in western Canadian coals and finely disseminated pyritic sulphur in eastern Canadian coals.

COAL FRIABILITY

Some western Canadian coals are known for their friability, containing 20 to 60% by mass minus 0.6mm. Tectonic movements are the major cause of extensive fracturing of coal in the mountain districts. Mining method, handling and processing contribute to the generation of fines. However, the amount generated depends significantly on the degree of natural fissuration (2).

The relative friability of different coals is of great importance in preparation because the greater the proportion of fines the greater the total preparation costs. In fact, the cost per tonne of feed is a function of the number of particles per tonne. Thus preparation costs increase rapidly as the mean particle size becomes smaller. For example, preparation of small coal (minus 6 mm) costs four times more in capital investment and five times more in operating expenses than preparation of coarse coal (plus 6 mm). The minus 6 mm size fraction in western Canadian coals represents between 50 and 80% by mass of run-of-mine coal. New preparation plants usually are designed at an early stage of development of a property before the start-up of mining activities. Underestimating the amount of fines influences the preparation plant performance; consequent overloading of fines circuits in the plant causes operating problems and losses of fine coal to discard. A recent performance evaluation study of Canadian washeries showed that yield losses in the fine circuits were approximately 10 times those occurring in the coarse coal circuits.

SULPHUR REDUCTION

Increasingly stringent sulphur emission regulations are forcing the coal industry to search for means to reduce sulphur content. Sulphur reduction in coal can be achieved by partial removal of pyritic sulphur depending on the pyrite's particle size and distribution. Organic sulphur can only be removed by thorough chemical cleaning but at much higher cost than that of the available coal preparation technology. Maritimes coals are known for their high sulphur content (2-6%). Pyritic sulphur represents 30-70% of the total sulphur and in most cases is finely disseminated and crushing and/or grinding is required to liberate it. However, a decrease in particle size of the coal corresponds to an exponential increase in preparation cost.

COAL PREPARATION TECHNOLOGY

Coal preparation involves three basic methods:

a. Size separation
b. Density separation
c. Surface-dependent separation

All preparation equipment involves one or more of the above methods. Equipment selection for different applications is dependent on particle size. Figure 1 shows the ranges of application of different cleaning and dewatering devices. The following is a brief description of equipment used for size reduction, cleaning and dewatering.

SIZE REDUCTION

Crushers are used to reduce the run-of-mine to a particular top size that allows sufficient liberation of coal from reject particles at acceptable cost. Mechanical size reduction methods employ impact, attrition, shearing, compression or any combination. In Canadian washeries run-of-mine coal is reduced to 200, 50 or 38 mm top size depending on coal characterisitics. Also, after cleaning and dewatering, coarse fractions of clean coal product may have to be crushed to a top size of 50 or 38 mm depending on market requirement. Crushers commonly used for coal are described below.

Rotary Breaker

The breaker consists of a cylindrical drum with holes of the required top size. The drum rotates at low speed and size reduction results from the impact of coal falling upon itself and on the fact that the coal is usually softer than shale, stone etc. Any stones, shale or logs that are too large to pass through the holes are discharged as refuse at the far end of the breaker. The rotary breaker therefore partially scalps rock, timber and metal pieces besides crushing the raw coal. Because of the relatively mild breaking action, the production of fines is minimized. However, for harder coals this mild breaking action can result in some coal being lost with rejected materials.

Impactors

This category includes hammer mills which use the impact of rotating steel bars to reduce the coal to the desired size. However, the resulting combination of impact, attrition and shear forces produces a large amount of very fine coal particles and is not recommended when a minimum of fines are required. Hammer mills are usually used before utilization e.g., power plant feed preparation. A special type of impact mill is the vertical-axle cage mill, a grinder that reduces the production of very fine coal to a minimum.

Granulators

The granulator applies a combination of impact, shear and compression and produces a minimum of fines. It is commonly used for size reduction of friable coals fed to preparation plants.

Roll Crusher

This type of crusher may be either the single or double roll type and uses compression and shear for reducing size. In most cases the rolls are equipped with teeth of two sizes: long teeth to split coarse pieces and smaller teeth to make the proper size reduction. The roll crusher can be adjusted to handle changes in the top size of the feed.

CLEANING EQUIPMENT

Heavy-Medium Bath

The heavy-medium bath is a practical extension of the laboratory float and sink test. The raw coal is introduced in the bath which is filled with a medium consisting of water and magnetite. The heavy impurities sink and the lighter coal particles float to the top of the heavy medium vessel. Refuse particles are reclaimed from the bottom of the vessel by a scraper or other means and clean coal is skimmed off the top of the bath. The finest particle size treated in the heavy medium bath is usually about 10 mm.

Heavy-Medium Cyclone

The heavy-medium cyclone has a cone angle of approximately 20°. The medium in which the separation occurs consists of water and magnetite. The raw feed and medium are introduced tangentially into the cylindrical section of the unit where a vortex is created with a central air-core due to the rotational (centrifugal) force induced. Heavy impurities move down the conical section wall and out the cyclone apex. The low-density coal particles move towards the central air core and out the top of the cyclone through the vortex finder. The top size normally treated in the heavy medium cyclone is 50 mm with a bottom limit of 0.5 mm. There are few applications for treating particles smaller than 0.5 mm in the heavy medium cyclone.

Water-Only Cyclone

The water-only cyclone (WOC) differs from the heavy-medium cyclone primarily in the angle of the cone(s) which can range from

75 to 135°. The WOC also has a larger overflow discharge orifice (vortex finder). The most common WOC's in use are the Compound Water Cyclone with a tricone, and the one of Dutch State Mines with a 75° cone. The coal slurry is introduced tangentially and under pressure into the cylindrical section of the cyclone. Centrifugal force separates the particles in proportion to their mass; and accoridng to their relative density in some models (Compound Water Cyclone), where an autogenous hindered-settling bed is formed, as in a jig (3). As the slurry moves downward into the conical section of the cyclone, the centrifugal force acting on the particles increases exponentially as they are dragged closer to the air core by the water current, most of which exits through the vortex finder. Heavy, high-ash particles move outward and downward along the wall whereas the lighter, coaly particles move inward towards the air core in an upward "vortex current" surrounding this central air core and thus report to the clean coal product. The most popular application for water-only cyclones in Canada is encountered in washing the minus 0.6 mm fraction. The size ranges for WOC application is between 50 and 0.1 mm.

Jig

Jigging is the oldest separation method used in coal preparation. Because of its simplicity and good economics (low cost) jigging is still highly regarded in modern technology and today the largest percentage of coal in the world is being cleaned by jigs. Jigging is a process of stratification which results from an alternating expansion and compaction of a bed of particles by a pulsating fluid flow. The particles' rearrangement results in layers of particles which are stratified according to increasing relative density from the top to the bottom of the bed. Jigs are commonly used for washing coarse coal at or above 1.5 relative density of separation. The size range for jig applications in Canada is between 100 and 10 mm.

Concentrating Tables

The table employs the principle of flowing a mixture of coal and water over a series of riffles on a deck which is shaken rapidly to effect a separation of the coal by relative density and particle size. The frequency and amplitude of stroke and the transverse slope are adjusted to suit the material being treated. The shaking motion of the deck combined with the cross current of water stratifies the particles by density similar to the action in the jig. The table is effective in removing pyritic sulphur and fine refuse down to 0.3 mm. Only one plant in Canada employs tables to clean the minus 2.4 mm size fraction.

Froth Flotation

Froth flotation relies primarily on coal surface characteristics. The fine raw coal (minus 0.6 mm or less) is mechanically agitated in a liquid containing controlled amounts of water, air and chemical reagents. The reagents cause selective adhesion to air of coal particles that float to the top, and simultaneous adhesion to water of heavier high-ash particles that settle to the bottom. The components thus segregated are diverted to clean coal and refuse circuits respectively. Ordinary flotation is used mainly to reduce the ash content of the fine coal fraction. It is not as effective for reducing sulphur content since it does not discriminate well between coal and pyrite particles. In Canada froth flotation is mostly used to recover clean coal from coal slimes (minus 0.15 mm). Some coal is frequently lost to the reject because of coal oxidation, overloading of the flotation circuits or becuase of the presence of oversize coal particles in the feed that are too heavy to be lifted by the air bubbles.

DEWATERING

Water content of coal and reject must be reduced before these products leave the plant. Removal of water from fine coal and reject is usually more difficult than from coarse particles. Water content is reduced by mechanical and thermal drying processes. Oil can be used as a means for reducing the moisture content of fine coal during the mechanical dewatering process.

Mechanical Dewatering

Vibrating screens: Dewatering coarse material on vibrating screens is simple whereas dewatering fines (minus 2 mm) can be difficult and expensive. Screens can be used to dewater fine coal down to 0.15 mm size.

Centrifugal driers: These driers are mechanical devices which through rotational speed, develop centrifugal forces to cause separation of the solid and liquid components of a slurry. Centrigures are of two general types. Screen-type machines separate the liquid from the particles by forcing it to pass through the screen and the solids retained on the screen surface. The other type, the solid bowl centrifuge, separates the solids from the liquid by centrifugal sedimentation.

Filters: Filters function by applying suction or pressure to a slurry causing free water to be drawn through a fine mesh screen and the suspended solids that are retained on the filter surface. The multiple disc filter is by far the most widely used because it is considered less expensive to purchase and install than the drum type. Filter presses are used to separate liquids from solids through the application of 689 to 1379 kPa pressures to a series of plates separated from each other by a filter medium. Filters in general are used for dewatering minus 0.6 mm or finer materials.

Thickeners: Thickeners are not strictly dewatering devices, however, they are associated with dewatering operations. Two types of thickeners are in general use. Static thickeners employ the effect of hindered settling and compaction of settled solids; sludge blanket clarifiers use bed filtration in combination with hindered settling and compaction of settled solids. Thickeners are usually used in conjunction with centrifuges or filters.

Thermal Drying

Thermal drying reduces moisture content of coal below that achieved by mechanical dewatering in centrifuges and filters. Usually, thermal drying is used to reduce clean coal moisture to 4 to 8% surface moisture. Thermal drying is capital intensive and costs are high to generate the required heat to reduce moisture.

LEVELS OF COAL PREPARATION

Phillips described the levels of coal preparation as the intensity of work done on a raw coal, which in turn is determined by marketing considerations and by coal washing characteristics (4). Six levels of preparation are generally identified (4). At one end, Level 1 employs no preparation at all while at the other end, Levels 4 to 6 call for multistage beneficiation. Higher levels of preparation are expected to improve clean coal quality but they also increase the cost of preparation and reduce thermal recovery. Phillips stated that "It would clearly be of interest to achieve the goals with the least possible effort to ensure that preparation costs are kept below the coal's higher market value" (4).

COAL PREPARATION ECONOMICS

Generally speaking, total cost of preparation is about 14% of mining, handling and beneficiation combined. However, mining costs of western Canadian coals are often favourable. Preparation is therefore a major rather than an auxiliary function in the control and costing of Canadian coal production.

From the economic point of view, cost attributed to preparation and beneficiation must be offset by corresponding benefits. Preparation is required to produce a product with specific qualities that can compete on the market. Environmental and economic facts also influence the decision on preparation and its level. Distance between mine and market is important too. To determine the major costs assignable to preparation, the following methodology is followed:

1. Identify important factors influencing the cost of coal preparation.
2. Quantify and compare relative preparation cost elements as a function of level of preparation.

FACTORS INFLUENCING COAL PREPARATION COST

1. Annual production (TPY) and processing capacity: The larger the capacity of the plant and the higher the utilization rate, the lower

the cost of preparation per tonne.

2. Level of preparation: The higher the level, the higher the cost of preparation.
3. Raw coal properties: Amounts of high ash material, coal washing characteristics such as near-density material, ash distribution and amounts of fines influence the cost of preparation.
4. Clean coal properties: Clean coal ash, sulphur and surface moisture would influence the choice of level of preparation and recovery achieved and in turn the cost of preparation.
5. Refuse characteristics: The lower the yield and the higher the refuse amounts, the higher the disposal cost. The means of disposing fine refuse would also influence the preparation cost.
6. Coal handling facilities: Coal handling, crushing and blending directly related to preparation can influence the preparation cost.
7. Plant location: whether close to the mine, to consumer or both. For example, disposal cost may be cheaper in one location than another.

BENEFICIAL EFFECT OF COAL BENEFICIATION ON POWER PLANT OPERATION

An Electrical Power Research Institute (EPRI) investigation ofthe impact of coal cleaning on the cost of new coal-fired power generation plants showed net electricity generation cost savings for most new, large plants when coal cleaning was used (5). Additional savings realized through the improvement in plant availability resulted in an estimated additional saving of $1.5 million per year.

The principal objectives of coal preparation, other than controlling size consist are to lower the ash content and to decrease the sulphur level. The effects of coal beneficiation on power plants are summarized as follows:

1. Lower non-combustible content will increase thermal content of clean coal and result in the following benefits:
    a. Grinding Cost: reduction of mineral matter with abrasive characteristics would lower maintenance cost of the grinding system.

b. Reduction in ash and sulphur content would result in lower fly ash and sulphur (SO_2) released to the environment and in turn reduce the size and cost of the flue gas treatment system and lower the maintenance cost of the boiler.

2. Burning coal that does not fluctuate in heat value as in the case of cleaned coal improves combustion efficiency.
3. Blending requirements and costs before burning are reduced due to lower variability in clean coal quality.

These benefits have to be compared with loss of heat value in the reject produced by the cleaning process.

PRESENT PREPARATION TECHNOLOGY FOR CANADIAN THERMAL COALS

In Canada, the only coals being upgraded for thermal use fall in the bituminous category; subbituminous coals and lignites are subjected only to level 1 preparation where little or no upgrading is applied (4). The preparation of thermal coals is similar that of metallurgical coals. However ash levels in clean coal for thermal use (10 - 15% ash) are generally higher than those for metallurgical use (7 - 10% ash). Thermal coals destined for central Canada or export market are usually beneficiated to achieve 23,000 kJ/kg or more in the clean coal. The thermal recovery calculated from raw and clean coal thermal values and yield is usually 85% or higher. The cost of preparation is estimated between $4 to $8 per tonne of clean coal. The following is a brief summary of levels of preparation used for different Canadian thermal coals:

1. Rocky Mountains coals: three plants are in operation. Cleaning is usually focused on plus 10 mm coarse coal; the minus 10 mm raw coal fines are blended with the coarse clean coal. This is possible because most mountain coals show a decrease in ash content with decrease in particle size (relatively low ash particles tend to be more friable than those with higher ash contents). Levels of preparation applied range between 3 and 4.

2. Foothills coals: one plant is in operation and at least two plants are presently in the development stage. Foothills coals are frequently interbedded with soft shales and bentonitic clays that are

released during washing. The amount of minus 0.6 mm in the raw coal is 20 - 30% of which approximately 50% is minus 0.04 mm as clays. The cost of dewatering fine reject is usually high. Levels of preparation applied range between 4 and 5.

3. Plains subbituminous coals and lignites: presently all mining is for local power generation and no upgrading is required. Studies are underway to find ways of reducing moisture content and upgrading coal quality by dry cleaning (6). Cleaning would be required only if low rank coals were to be transported to a distant market. However, it is expected that there is little possibility for export before 1990. Levels of preparation presently applied include only crushing and sizing and thus are between 1 and 2.

4. Eastern coals: Two plants are in operation. Preparation is mainly required to reduce sulphur content to 2% or less. However, some coals such as Minto coal contain over 2% organic sulphur and the pyritic sulphur is so finely disseminated that it is not easy to remove by density separation. Levels of preparation applied at Cape Breton operations range between 3 and 4.

TRANSPORTATION IN RELATION TO COAL PREPARATION

Preparation is commonly considered for thermal coal destined to distant market to reduce transportation costs. Canadian bituminous thermal coals are usually moved a considerable distance either to central Canada or to the west coast for export. Transportation costs can represent up to 50% of the total cost per tonne (7). Although the Canadian unit train system is considered to be one of the world's most efficient, existing, rail capacity would not be sufficient to handle any future expansion in coal production (8). The high transportation cost and limited rail capacity have been important factors leading to considering other modes of transportation; slurry pipeline transportation seems to be a logical alternative to keeping transportation costs down in the future (8). However, present slurry pipeline technology is geared to having a power plant at the delivery end of the pipeline. This is not the case for exported coal. Dewatering and drying cost of fine pipelined coal represent about 50% or more of total pipelining cost (9). Ship loading, unloading and stockpiling of the fine coal would cause problems in handling and in dust generation. An alternative would be to consider a system that can integrate preparation, transportation and combustion. This system is outlined in the next section.

FUTURE COAL PREPARATION TECHNOLOGY

The challenges facing the Canadian thermal coal industry are:

1. other sources of energy
2. international competitors, and
3. environmental regulations.

All of these, in one way or another, are related to coal preparation and transportation. Presently, the cost of burning oil for power generation is about 2.5 times that of burning coal. However, oil is still preferred over coal in some cases because of ease of handling and storage and limited emissions of harmful gases such as SO_2 during burning. Wide application of coal for power generation is feasible only after meeting environmental concerns, economic realities related to other sources of energy (e.g. nuclear energy) and international competitors. Transportation distances of Australian and South African coals from mine to sea port are much shorter than those for Canadian coals. As a result, transportation cost within Canada is a factor in the ability of coal industry to compete on the international market.

Deep cleaning of thermal coals to less than 8 - 10% ash requires reduction of average particle size to a degree farther than is presently practiced to liberate more high ash and, if applicable, more pyritic sulphur particles. Reduction in average particle size would cause exponential increase in dewatering and drying costs which already represent up to 50% of the total preparation cost. A method that can utilize coal slurry with minimum dewatering may improve the chances of deep cleaning without a significantly increased preparation cost. Dense coal slurry technology presents the possiblity of significantly lowering ash or sulphur contents without having to pay for dewatering and drying costs of fine clean coal.

An integrated technology of beneficiation, transportation and combustion of Canadian thermal coals may make coal not only economically viable as compared to oil (which it presently is) but also environmentally acceptable for utilization and competition on the export market. Such an integrated system would rely on existing coal cleaning technology to upgrade the plus 0.15 mm by density separation processes as a first stage, thus to benefit from the low cost of these processes and also, as much as possible to remove most of impurities as coarse particles. The clean coal product from the density separation processes would then be ground to about 50 um as wet coal before applying any deep cleaning process to reduce impurities to the required level (2 - 6% ash and less than 1% sulphur). The clean coal slurry would be partly dewatered to form a dense slurry with some chemical additive to make a stable slurry for storage and transportation through a pipeline. The dense slurry can be handled in a way similar to heavy oil in a pipeline or ship and utilized for combustion also as a slurry without dewatering.

The integrated system would require extensive R & D before becoming a reality. The Department of Energy, Mines and Resources is presently cooperating with Cape Breton Development Corporation, the Nova Scotia and New Brunswick Power corporations and Boliden Mineral of Sweden to produce a dense coal slurry (Carbogel) for full scale combustion tests. Work is also underway on a research contract with Techman Engineering of Calgary, Alberta on the feasibility of pipelining dense coal slurry presently being produced in a pilot plant deep cleaning facility at Victoria Junction in Sydney, Nova Scotia.

The new pilot plant facilities that are presently being installed at the Coal Research Laboratory in Devon, Alberta, will be used to develop processes for deep cleaning. These facilities will be used to evaluate the feasibility of deep cleaning by applying up-to-date processes, then grinding the clean coal for further cleaning by processes that are not presently used by industry. Optimized processes based on new process control technology and other tools of applied research will be tested in the pilot plant facilities before sending mobile plants for on site evaluation of new developments.

REFERENCES

1. Butcher, S.G. and Wright, P.L. "The purpose and practice of coal preparation in Canada"; Coal: Phoenix of The '80's - Proceedings 64th CIC Coal Symposium; Halifax, N.S.; May 1981.

2. Mikhail, M.W., Patching, T.H. and Parsons, I.S. "Evalution of a procedure for predicting coal size degradation"; Proceedings of the XIV International Mineral Processing Congress; Toronto, Ontario; October 1982.

3. Williams, D. G. "Coal cleaning"; Coal Handbook; p. 272-276; Ed. Robert A. Meyers, New York (1981).

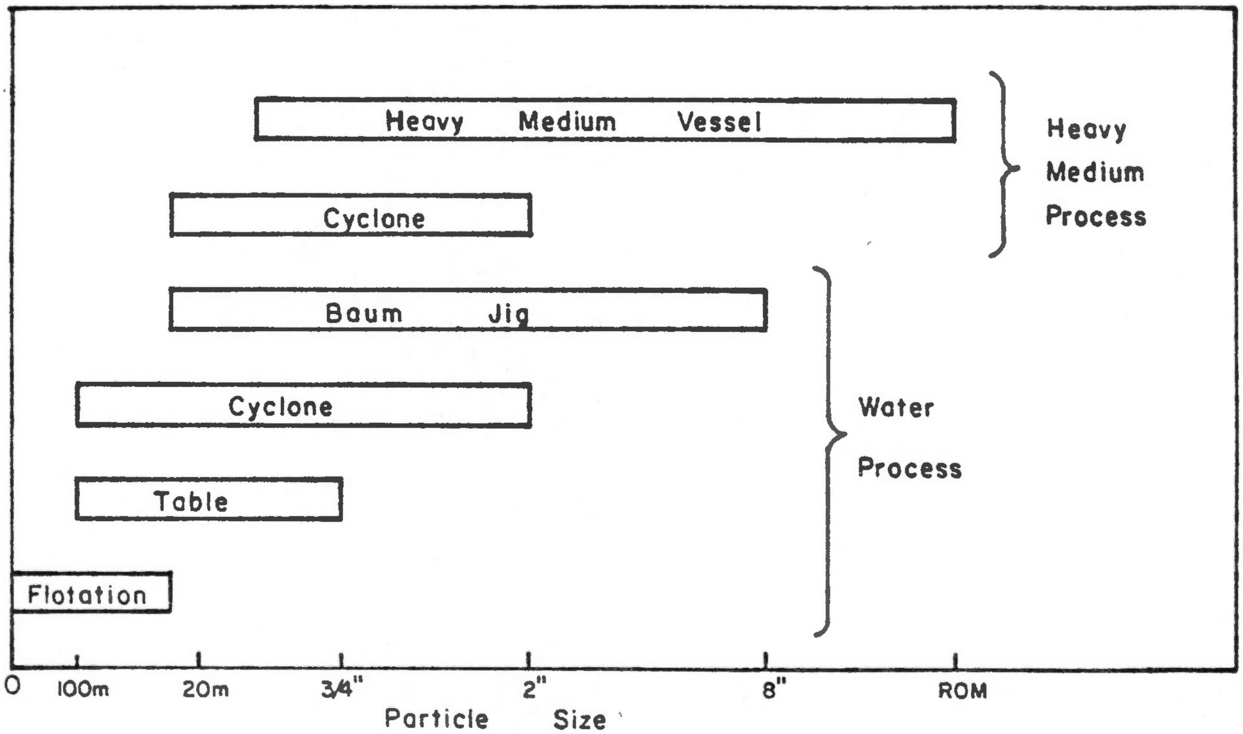
4. Phillips, P.J. "Coal preparation for combustion and conversion"; Electrical Power Research Institute - EPRI AF-791; p. 2-46; May 1978.

5. Karlson, F.V. "Development of Coal Cleaning Technology"; Mining Engineering; p. 1367; Vol. 34 No. 9; September 1982.

6. Butcher,S.G. "Beneficiation of Western Canada's Low Rank Coals"; Proceedings of Sixth International Conference on Coal Research; London, England; October 1982.

7. Skubnik, M. and Whalley, B.J.P. "A Consideration of Coal Slurry Transportation for Canada"; Division Report EPR/ERL 81-12(OP); CANMET, Energy, Mines and Resources Canada: February 1981.

8. Demcoe,P. and Danzinger, W.A. "Potential for Water slurry transport of Alberta Coal to Pacific Tidewater"; The Canadian Journal of Petroleum Technology; p. 65 - 70; July - August 1982.



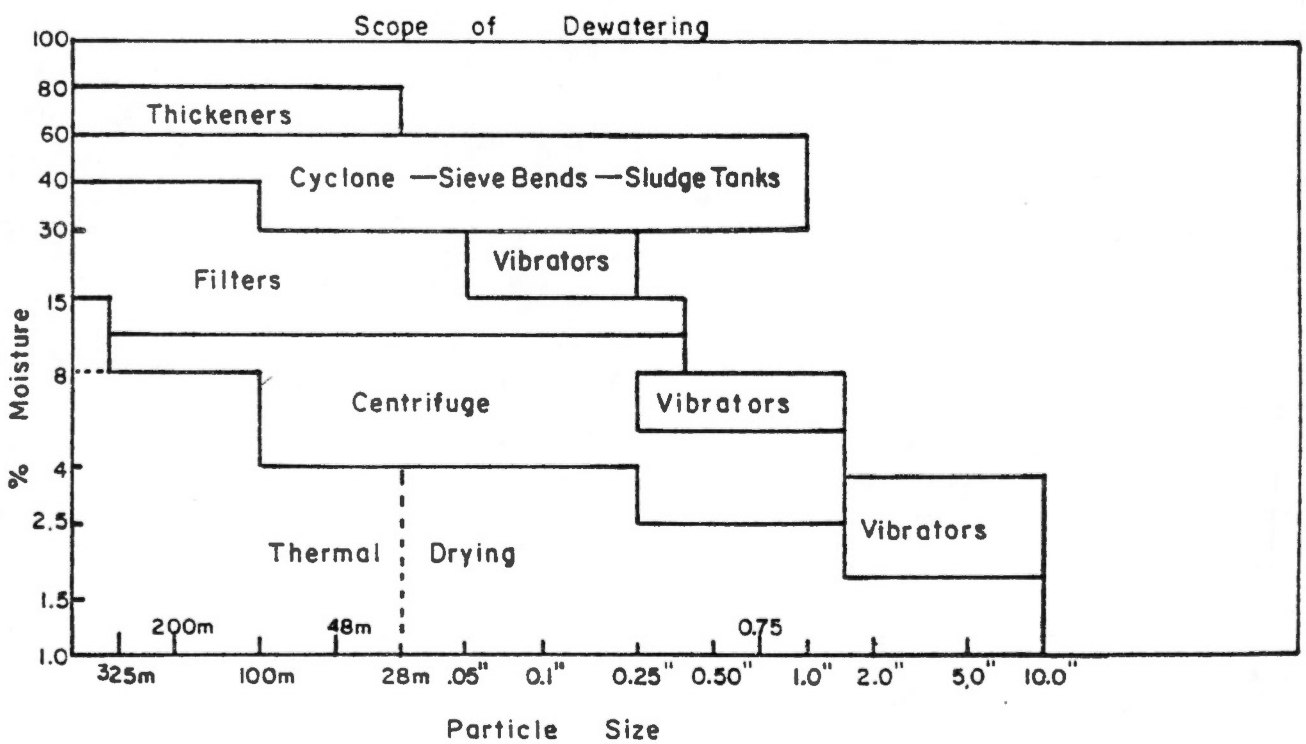


Fig. 1 - Cleaning and dewatering equipment application in relation to particle size.