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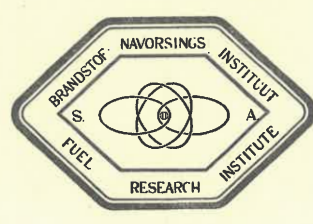
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FUEL RESEARCH INSTITUTE
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BRANDSTOF-NAVORSINGS-INSTITUUT
VAN SUID-AFRIKA.

SUBJECT:
ONDERWERP: RESEARCH ON COAL CLEANING IN PROGRESS IN BRITAIN

AND ON THE CONTINENT.

DIVISION:
AFDELING: ENGINEERING.

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RESEARCH ON COAL CLEANING IN PROGRESS IN BRITAIN AND ON
THE CONTINENT.

During the period May to October 1951 a tour was made of Britain and the principal coal producing countries on the Continent in order to study the coal preparation methods employed. The principal objects were to gather data relating to the practical operation and application of the various coal cleaning processes and methods of screening, breaking and handling of coal. In addition an attempt was made to become acquainted with research work in progress in this field. Research activities at the various organisations visited, with special reference to coal cleaning, are summarised in the present paper.

Generally speaking, the organisations concerned with coal preparation, who should, therefore, be interested in improving the performance of the equipment, may be divided into 2 groups, viz.:

- (a) The designers of the equipment from a sales point of view.
- (b) The purchaser of the equipment (or his representative) from an economic point of view.

At first sight it would appear that competition would provide sufficient incentive for the former group to undertake the bulk of the research necessary and that only problems of a particular or local nature need be undertaken by the customers. To what extent this state of affairs actually exists in the various countries may now be considered.

BRITAIN.(a) The Designers.

There are, as far as is known, about 12 principal concerns engaged in the design of coal preparation plant. In most cases the concern manufactures the equipment as well. In some instances, the manufacture of coal preparation plant is its sole function while in other cases this branch of its activities is relatively a sideline. Six of the more important of these organisations were visited and their research activities are summarised below.

Nortons Tividale.

This company is solely concerned with the manufacture of coal preparation plant and has been functioning for several years. The only washer employed is a Baum type jig of their own design. As far as could be ascertained, no true research work on laboratory scale has ever been conducted on this jig - it has simply developed by trial and error on full scale plant. The impression was also gained that the functioning or operating principle of the jig was not too clearly understood. Nor did it appear that the more generally accepted principles of coal preparation in general were fully appreciated. While it was stated that one of the directors "knew his stuff," not one of the gentlemen who were available for discussion gave evidence of having had a scientific training and being capable of conducting research.

While on a tour of the works, the coal cleaning laboratory was visited. This was relatively poorly equipped, only for float and sink analysis of samples and for the usual ash and moisture determinations etc. It was understood that the laboratory was being extended and modernised and that the installation of a 50/tons/hr jig test plant was seriously being considered.

Clearly, virtually no research work is in progress.

Blantyre Engineering Works.

This company has for many years been solely engaged on the manufacture of coal preparation plant. They manufacture a Baum type jig of their own design. This jig has apparently also been developed by trial and error on full scale plant and no research work was in evidence.

Fraser and Chalmers.

This is a firm of general engineers and the coal preparation department is only a relatively small section. The Chance washer is manufactured. A test unit of about 6 feet diameter was originally erected and carefully studied but was dismantled during the war. They make a point of sending a competent engineer to study all plants erected by them and have access to all data on Chance washers available in the U.S.A. No laboratory scale research is apparently in progress at the moment but is probably no longer necessary. The coal preparation engineers all appear to have originated as draughtsman but appear to have a sound knowledge of the subject.

Simon Carves.

They are also a firm of general engineers but the coal preparation department is an important one and now appears to be well organised. Originally they only manufactured a Baum type jig which was apparently also developed by trial and error in practice and basic fundamentals of its operation do not appear to be too clearly understood. As the world became more Heavy Medium minded they studied this type of washer and eventually produced the slipper type bath as installed at Blesbok. They now have a coal preparation development section, staffed by scientifically trained engineers, who have developed a new Heavy Medium washer with an improved magnetite circuit. A pilot plant of this washer has been erected in their laboratory and is being thoroughly tested.

In addition/.....

In addition to the development section they have a large research department which carries out the initial laboratory scale investigations for the whole firm, (e.g. this research department is investigating properties of suspensions for the coal preparation department but have not yet made much progress.) Acceptance trials on washers etc. are a joint effort on the part of the research and development sections.

The impression was gained that the development of plant was now really being tackled in a businesslike manner.

Mitchell Engineering Co.

A firm of general engineers in which coal preparation is steadily increasing in importance. The Ridley-Scholes Heavy Medium washer is designed and manufactured by this firm. A small commercial plant was first erected and was used for the initial development trials and recently one large plant was erected and several more are on the drawing board. From discussions with one of the inventors of the process, and now chief designer, it was concluded that the basic principles were not too clearly understood, particularly the properties of Heavy Medium suspensions. Any research work appears to be on the full scale trial and error basis.

Colliery Engineering Ltd.

This firm is a licensee of the Dutch State Mines for the Cyclone, Barvoys and Hoyois washers and as such have access to all their technical data. However, they have a small laboratory and are conducting their own research on the operating characteristics of the cyclone and on the properties of suspensions etc. They only design plant and do not manufacture themselves.

Of the firms not visited, Acco and Coppee are subsidiaries of a French and a Belgium firm respectively and have access to their technical data.

Of all the/.....

Of all the known coal cleaning processes only 3 have survived and are at present being installed in Britain, viz.:

- (1) Baum jig.
- (2) Heavy Medium washers.
- (3) Froth flotation.

From the firms visited, the general impression gained regarding the progress of research on these processes may be summarised as follows:

Very little true research has been or is being done on the Baum jig and the operating principle of this machine is not very clearly understood in Britain. The various makes of Baum jig employ roughly the same operating principles (e.g. air and water adjustments, type of air valve, frequency of stroke etc.) but differ mainly with respect to the nature of the automatic shale discharge device, on which they obtained an exclusive patent. It has apparently been appreciated that the performance of a Baum jig can be improved (or the advent of the Heavy Medium washer and the high price of coal has made it essential to improve efficiency) and there has been a tendency in recent years to try different types of refuse ejector with this object in view. No attempt appears to have been made, however, to look to the operating stroke etc. for any improvement. This attitude is probably mainly due to the fact that British coal is extremely simple to wash in general and the jig, even when not operated in the best possible manner was able, and in many instances is still able to give an acceptable result. In addition, the development of these machines is in the hands of "practical" men who are rather conservative in outlook and are inclined to view "science" with suspicion.

In the case of Heavy Medium washers, the position is somewhat better and an attempt is being made to understand the operating principles. But even here much could be done.

None of the firms visited manufacture their own Froth Flotation equipment and consequently they do no research in this connection. The impression was gained, however, from discussions at collieries/.....

at collieries that the manufacturers of Froth Flotation plant still have much to learn about this process. In many instances mineral type cells have merely been modified for coal and their performance is not entirely satisfactory.

On the whole, one is inclined to feel that research on coal cleaning has been somewhat neglected in Britain in the past.

The Purchaser.

Prior to nationalisation, research on behalf of the purchaser was mainly done by the Fuel Research station, Greenwich. While all the equipment has now been dismantled, it is understood that work on a semi-pilot plant scale was done, principally on Baum jigs but it was difficult to ascertain what the scope of the investigations were. A limited amount of research was also carried out by the larger colliery groups, e.g. Powell Duffryn who investigated Froth Flotation amongst other problems. Coal preparation was mainly in the hands of persons who do not appear to have fully appreciated the implications of the scientific aspects of the problem. As a result, coal preparation equipment was largely purchased on the basis of personal fancy rather than on the merits of the particular plant. It is not, therefore, uncommon to find a certain type of plant mainly concentrated in one area, e.g. there are mainly Chance washers in Wales and it is unusual to find one else where, despite the fact that this washer is relatively efficient. In such circumstances, the persons in charge were probably not sufficiently informed to recognise the need for research. The coal owners were also inclined to be secretive and did not readily exchange information. Thus several washers of a particular type which may not have been as successful as desirable could be sold - to different companies - and a certain amount of "trial and error" development was possible.

This situation/.....

This situation has completely changed with nationalisation and the N.C.B. is now virtually the only customer. The coal preparation engineers of all the areas in a division have regular meetings in order to exchange information and the Divisional Engineers have regular meetings to discuss the suitability of types of plant etc. The general policy is to instal at least one example of a new plant in the country - if it is a success, others will follow, if not, the mistake will not be repeated without full knowledge of the circumstances. Thus, in effect, a type of full scale "research" is being conducted. This should act as an incentive to the manufacturer to conduct preliminary research to ensure that a new process will not be a failure. It may be some time, however, before the manufacturers react fully to these changed conditions, but it is bound to affect their attitude towards scientific research.

In the N.C.B. organisation a scientific section has been provided. Thus there is a laboratory for each area and a larger laboratory for each /division, staffed by scientific personnel. In principle, the area laboratory undertakes work of purely local interest on all subjects and the divisional laboratory undertakes work for which its area laboratories have no facilities. Clearly, a detailed study of the operation of, say, a Baum jig is beyond the scope of the area and divisional laboratories and, as regards coal cleaning, they generally confine their activities to the testing of a new process which has been put in operation and to comprehensive tests on existing plant, in collaboration with the coal preparation engineers, in order to gather data to assist in the general study of the theories of coal cleaning. There are exceptions, however. In some cases the scope of the work is more general, e.g. one divisional laboratory is studying the operation of the cyclone. In order to investigate the general problems (e.g. the correct operation of a process) a central
 research/.....

research establishment has comparatively recently been erected at Cheltenham. Up to the present, this establishment has been busy equipping the laboratories and the research programme is not yet in full swing. Clearly, the urgent problems have to be tackled first and in the coal cleaning department the cleaning of fine coal is regarded as being of prime importance. In view of this fact Froth Flotation is the main item on the programme. Since it is apparently felt that the existing types of Froth cell are not satisfactory, they are concentrating on the development of a new type of froth cell which it is hoped will be more suitable for coal. A new type of dry cleaner for large coal is also being studied as it would reduce costly labour required for hand picking.

Due to the high price of coal and the relative shortage of coal in Britain every coal particle must be recovered almost irrespective of cost and the general policy is to instal Heavy Medium washers for coal larger than about 1" and Froth Flotation is used for $-\frac{1}{2}$ mm. coal. However, the Baum jig is the best of the proved processes for dealing with the intermediate sizes and it is not, therefore, being overlooked in the general research programme of the N.C.B. Consequently, two eminent coal preparation engineers from Britain were sent to the U.S.A. to study the Jeffrey jig cycle. This method of jig operation impressed these engineers to such an extent that it was decided to convert one of their jigs to this cycle for test purposes. Although it was not authoritatively stated, there is reason to believe that these trials have indicated that the Jeffrey jig cycle is superior to conventional British practice. One may only conclude from this that British Baum practice has become obsolete and that this is mainly due to a short sighted research policy in the past on the part of the manufacturers.

EUROPE.France and Saar.(a) The Designers.

As far as is known P.I.C. is the only concern in France engaged in the design and manufacture of coal cleaning equipment at present. Foreign contractors are also extensively employed to design and manufacture plant.

For many years P.I.C. only manufactured piston jig plants (although their British subsidiary, Acco, manufactured Baum jigs) but since the war they have developed a new Heavy Medium washer, the Drew Boy, in order to compete in the Heavy Medium field. They are also installing Baum type jigs in their latest plants but these are similar in design and operating principle to conventional British Baums.

This firm has a large well equipped laboratory in which crushing, screening and cleaning problems, etc. are investigated by scientifically trained personnel. As far as possible, the policy is to test all new ideas and improvements to old ideas on Pilot plant scale before being put into practice. As regards cleaning, the present research programme includes the testing of a new Heavy Medium washer for fine coal (similar to cyclone principle), the Drew Boy and magnetic separators, a new Froth Flotation cell and reagents, all on a full or semi Pilot plant scale. In addition, laboratory scale work is in progress on the properties of suspensions but this has not yet advanced too far.

The impression was gained that the development of their plant was being tackled on really scientific lines and that good quality products were the result.

It was interesting to observe that a study of Baum jigs was not included in their programme. This is probably due to the fact that the high price of coal and the great shortage of coal in France has made it essential for every combustible particle to be recovered, almost irrespective of cost, and it is impossible/.....

for a jig to compete with Heavy Medium (especially as Heavy Medium can now be applied to fine coal) and as a result the jig is rapidly becoming obsolete in France (this applies in a general way to the whole of Europe). Research on jigs is not, therefore, warranted especially as it is appreciated that the efficiency of a jig can never equal that of Heavy Medium.

(b) The Purchaser.

As in Britain, the coal industry is nationalised and there is only one customer. A central research establishment (Cerchar) has been erected and a large coal preparation department has been provided. Comprehensive tests are continuously carried out at washeries in order to gather performance data for research purposes. In addition, the operation of specific processes and allied problems are also being studied. At present, the cyclone washer and a modification of it is being studied. A cyclone pilot plant of about 30 t./hr. capacity has been erected at a colliery and is being subjected to trials. A thorough study of jig washers on both a laboratory and pilot plant scale is also being made. The information gained will be used to modify existing jig washeries which can not be replaced by Heavy Medium for some time.

HOLLAND.

(a) The Designer.

As far as is known, coal washeries are not manufactured in Holland. However, the Dutch State mines have developed several processes (principally Heavy Medium type) for which they hold patents and then grant licences to firms in other countries. The Dutch State Mines have a large research laboratory in which several problems are investigated. They are at present engaged on problems such as

- (1) Cyclone washer (pilot plant scale)
- (2) Properties of suspensions.
- (3) Modification of existing piston jigs to improve performance.

(b) The Purchasers./.....

(b) The Purchasers.

The coal industry is not nationalised and with the exception of the Dutch State Mines, no research work worthy of mention was observed.

BELGIUM.(a) The Designers.

Cöppee and Cribla are the only designers, the former manufactures but the latter does not. These firms are mainly licencees of foreign concerns and no original development work was mentioned.

(b) The Purchasers.

The coal industry is not nationalised but a central research establishment, Inichar, has recently been formed. The financing of Inichar is on the same basis as F.R.I. The laboratories are at present being equipped and practical work is about to start. The following is on the coal preparation programme.

- (1) Cyclone washer.
- (2) Froth Flotation.
- (3) Screening of fine coal.
- (4) Properties of suspensions.
- (5) Comprehensive washing tests at collieries.

GERMANY (RUHR).(a) The Designers.

Humboldt, Wedag and Schuchterman - Kremer - Baum are the principal firms concerned with coal preparation plant. Humboldt have a large laboratory equipped with piston jigs, Froth Flotation etc. but it requires to be modernised. They are at present concentrating on the development of a new Heavy Medium washer of which there is a pilot plant (and one commercial plant) in operation. Wedag have an

excellent/.....

excellent "Pilot Plant" laboratory equipped with crushers, magnetic separators, piston jigs, froth flotation, dedusters and a cyclone plant (they are licencees of Dutch State Mines.) Schuchterman-Kremer-Baum do not appear to have a laboratory although they are developing a new Heavy Medium washer and an improved Baum jig. They apparently work on the trial and error principle.

(b) The Customers.

It is understood that a few central laboratories functioned before the war but the present position is a bit obscure. A new laboratory is at present being equipped by the Deutsche Kolenbergbauleitng and coal preparation problems will be investigated.

CONCLUSIONS:

From the above it will be clear that although the designers of plant should carry out the bulk of the research, particularly as regards processes, they have in many instances neglected this in the past and the customer has been forced to take steps in order to look after his own interests. As a result of this policy, the jig, the most numerous of all washers, is probably the least understood of all and many improvements should be possible. The error of this policy has apparently been recognised and genuine steps are being taken to develop new processes (viz. Heavy Medium washers) on more scientific lines. Since jigs are rapidly becoming obsolete in the countries visited, there is little incentive for the designers to study this process. The customer on the other hand would like to improve his knowledge of the process and, particularly in France, is beginning to look into the matter.

RESEARCH PROGRAMME OF THE FUEL
RESEARCH INSTITUTE:

On account of the low price of coal in South Africa, the jig is in many instances able to compete with Heavy Medium washers/.....

washers on an economic basis, despite the difficult nature of the washing problem as compared with that overseas. If the efficiency could be improved, the jig would be an even more attractive proposition for several years to come. In addition, many jigs in relatively good condition are at present in operation in the country, mostly treating a type of coal which is entirely foreign to the designer. In these circumstances, coupled with the lack of knowledge of a jig overseas there is definite scope for research work which should benefit the South African coal industry in the long run.

In the case of Heavy Medium washers, with the possible exception of the cyclone, it does not appear that much investigational work is required. However, the properties of suspensions should be studied in order that South African raw materials can be assessed for suitability as medium. Furthermore/^{such}a study would enable the Fuel Research Institute to be of assistance in operational problems which will undoubtedly arise in practice. (It would also be a great advantage to have a Heavy Medium test plant for large coal in order to conduct washing tests for collieries prior to the purchase of a washer.) As regards the cyclone, the main problem remaining to be studied is the separation of fine coal from medium. This question does not appear to be very clearly understood and a study of magnetic separation is suggested.

While there is little doubt that it will be some time before Froth Flotation will be an economic proposition for the cleaning of fine coal in South Africa, the possibility of using Froth Flotation for recovering fine coal from waste may be considered, e.g. recovering of coal from the washery slurry in a coking coal area.

The carrying/.....

The carrying out of large scale tests at collieries should continue in order to gather the data which is absolutely necessary for a clear understanding of the general washing problem.

In addition to the above, the problem of water clarification and associated problems will undoubtedly have to be tackled some time in the future.

(Sgd.) P. J. van der Walt
SENIOR RESEARCH OFFICER.

PRETORIA.

14th November, 1951.
