Colliery Engineering

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Wallsend

At their Rising Sun pit the Wallsend & Hebburn Coal Co. Ltd. have erected what is probably the most complete coal preparation plant in the world

Wallsend has been in every sense a household word ever since, in 1756, the High Main seam was first exploited by the famous colliery which bears this name. It has always been a synonym for outstanding quality; so much so, indeed, that it is utilised by coal producers whose pits are pitched many leagues away from the Roman station of Segedunum, that marked the "wall's end," or eastern terminus of Hadrian's historic line of fortifications that stretched across the country from Solway to Tyne. It is thus singularly fitting that a colliery with such a tradition should take pains to preserve a reputation for quality by installing one of the most complete coal-preparation plants in the world. For not only does this plant provide for both the dry-cleaning and wet-washing of the product but also for the dedusting of the coal, the washing of the dust by flotation, filtration, thermal drying, water clarification, blending and mixing, and dry and wet screening. As will be seen later, provision has been made for the plant to be operated with an unusual degree of elasticity, and the final products can be arranged to meet an exceptionally wide range of market requirements. In addition, nothing is wasted; the washery water is clarified and the recovered solids sent to the market, while the dust is washed, dried and so improved in quality that it can properly be mixed with the better coals. The elimination of the effluent problem is nowadays an important matter as there is a growing tendency for river conservancy boards to exercise much stricter supervision as regards the discharge of effluents.

The architectural treatment of the buildings is a further point that well deserves to be brought to notice. As will be seen from the general views on this page, a very fine effect has been achieved by grouping the different structures as a harmonious whole, and the flush reinforced concrete faces, roof parapets, continuous glazing and the skirtings to the Waring filters give the entire mass a satisfying sense of unity. Prof. R. A. Cordingley, F.R.I.B.A., whose advice was sought, was responsible for this truly finished appearance. The reinforced concrete work was designed by The British Reinforced Concrete Engineering Co. Ltd. and was carried out by Messrs. Henderson Brothers of South Shields. The buildings are finished in white and are floodlit at night, forming an effective advertisement for Wallsend products.

One of the problems to be faced in the design of the plant* was that although all the coal to be handled will ultimately be won from mechanised faces, a certain amount of the output is still derived from hand workings, so that complete data

were not available. An extension of machine-mining methods inevitably means an increased proportion of fine coal and, more often than not, a higher dirt-content in this product. In some cases such high-ash coal can usefully be consumed in the colliery boiler plant, but as the Rising Sun pit is completely electrified this outlet was not available, nor was it possible to dump it as the risk of having a burning spoil heap in a densely populated district was not to be contemplated.

The plant as a whole was designed and erected by The Birtley Co. Ltd. and is capable of handling a normal throughput of 160 tons per hour of 4 in. to zero coal, representing between 85 and 90 per cent. of the colliery output. At this point the reader might very well be referred to the flow-sheet diagram reproduced in Fig. 1. from which the ramifications of the plant can readily be followed. The run-of-mine coal is subjected to a preliminary screening in existing 4 in. mesh jiggers, whence the undersize falls to a belt conveyor and is delivered by means of a further 36 in. trough belt to the top of a 500-ton bunker. This structure is built of reinforced concrete, and is divided by a central partition into two compartments of 250 tons capacity each. The value of this storage capacity lies in the steady feed it affords to the various cleaning units, which are thus able to operate under optimum conditions. Cascades are provided to prevent breakage, as will be gathered from the sectional drawing in Fig. 13. One compartment serves as a "peak eliminator," as it were, during normal operation of the plant, while the other, in addition to providing storage capacity in case of emergency, can also be used to accommodate foreign coal for treatment during a third shift. When the compartment is used for this purpose, the foreign coal is fed to the ground bunker from railway wagons and will be handled by means of a bucket elevator; as yet, however, this elevator has not been installed.

Jig washer for large

The coal is drawn off the bunkers by means of jig feeders, discharging to the belt which links up both compartments. It is fed on to a pair of balanced jigging screens which cut the 4 in. to zero material at any desired size between 1 in. round hole and 1 3/8 in. square. For convenience the two sizes will be referred to in this description as 4 in. to 1 in. and 1 in. to zero. The oversize is taken by a troughed conveyor to a two-compartment wash-box, this being of the Birtley jig type with plungers driven by eccentrics which can be adjusted to regulate the throw. A Mackley centrifugal pump delivers the water by eccentrics which can be adjusted to regulate the inlet of each compartment regulating the flow. A proportion of this water is constantly by-passed to the Birtley-Henry plant for clarification. Automatic discharge of the refuse is effected by a valve which is mechanically driven from the main washer shaft, the speed being controlled by a float resting on the dirt bed. An elevator discharges the refuse to a conveyor which removes it to the main refuse bunker. A second wash-box, similar in design but having three compartments, is provided to wash a proportion of the ½ in. to zero dedusted coal when desired, the washed coal in this case being delivered to a dewatering screen.

The 4 in. to 1 in. washed coal is passed to balanced dewatering screens and then to an external screen-house where it is sized into cobbles (4 in. to 3 in.), trebles (3 in. to 2 in.), doubles (2 in. to 1 in.) and undersize. The three sized products are loaded direct into wagons by means of rubber-belt loading booms, which can be operated independently by pushbutton control. Alternatively, the whole of the coal from this wash-box can, after dewatering, be delivered to the main clean-coal conveyor and mixed with the dry-cleaned smalls, and subsequently with the hand-picked large. As a further alternative any one or two of these sized washed products can be loaded into wagons, and the balance returned to the main clean-coal conveyor and mixed with the unscreened coal. This is effected by reversing the requisite loading booms and feeding back the products to a belt conveyor which runs parallel to the washed-coal sizing screens. This arrangement enables, say, one or more wagons of washed cobbles to be filled for landsale without interfering with the preparation of a cargo of unscreened coal.

Dry-cleaning plant

To return now to the undersize from the primary screens, i.e., the 1 in. to zero coal, this is raised to the head of the dry-cleaning plant by a continuous bucket elevator and separated into 1 in. to ½ in. and ½ in. to zero by two "Type 400" Hummer screens (Fig. 2). The oversize is fed through a mild-steel surge bunker to a "Super Vee" pneumatic separator, while the undersize is taken by a Redler conveyor to the head of the dedusting plant. The deduster consists of a pair of Birtley aspirators which removes the below 1/32 in. material, the remainder passing to two "Type 72" Hummer screens which divide it into ½ in. to 1/8 in. and 1/8 in. to 1/32 in. The oversize from the screens is fed via a storage bunker to a "Super Vee" separator, while the undersize is distributed over two bunkers by means of a scraper conveyor and subsequently fed to two further "Super Vee" separators.

Air for the four separators is provided by centrifugal fans, one for each unit, situated on the ground floor. A system of mild-steel trunking collects the dust-laden air from the separators and discharges it into three reinforced-concrete Waring filters, the necessary suction being provided by an 85,000 cu. ft. per mm. fan situated on top of the raw-coal bunkers.

The middlings are recirculated, while the refuse and clean coal from all four separators join, respectively, the common refuse conveyor and the cleaned-coal conveyor. Alternatively, the cleaned coal can be taken to one of the external screening units, of which there are two, one for the dry products and one for the wet.

When arranged with a 1 3/8 in. mesh in the preliminary jiggers the dry-cleaning plant is capable of turning out five sizes: 1 3/8 in. to 1 in., 1 in. to ½ in., ½ in. to ¼ in., ¼ in. to 1/8 in., and 1/8 in. to zero. This sizing is effected by high-speed horizontal jigging screens for the material down to and including ¼ in., while the cut at 1/8 in. is made on a "Type 400" Hummer. Each size is delivered to a 20-ton hopper, provided with telescopic loading chutes in the case of the four larger sizes. The aspirated dust can be delivered to the duff bunker if required, or the whole of the dry-cleaned smalls can be by-passed direct into this bunker without passing over the screening plant at all.

Elmore plant and water clarification

The alternatives to which the ½ in. to zero product can be subjected are of particular interest. Fifty per cent, can be diverted from the dry-cleaning plant as soon as it has passed through the aspirators and taken to the three-compartment washbox, whilst the whole of the dust removed by both aspirators can be treated in an Elmore vacuum flotation plant. The concentrate from here (together with the drainage from the dewatering screens for the washed smalls) is taken to a Birtley-Henry water clarification and filtration plant, which recovers the solids in the form of a filtered cake and returns clear water to the washery. The solids, together with all, or any proportion, of the washed and dewatered smalls are then fed to a Büttner dryer, fired by the aspirated dust from the filters. This dry coal is then taken to a blending plant in which it is cooled and mixed with any proportion of washed smalls which have not been through the dryer. The small quantity of filter dust not required for the dryer may also be added at this point.

Two Elmore cones are provided, the feed to each being regulated by means of a rotary feed table drawing from the raw-dust hopper. From the feed tables the dust enters a mixer where flotation reagents are intimately mixed with the wash water, the resulting pulp being drawn to the top of the vacuum cone. Here the reduced pressure liberates the dissolved air and the concentrate overflows at the top. The tailings are drawn off by a special valve, by means of which the operation of the plant can be exactly controlled. The concentrates go to the main Birtley-Henry plant, while the tailings, with about 75 per cent, of the water, flow to a further Birtley-Henry unit from which the filtered tailings are mixed with the other refuse

from the dry-cleaning plant, both the wash-boxes and the main colliery screens.

In the Birtley-Henry process the fine solids are first rendered alkaline by adding lime and then flocculated by adding a small quantity of flocculating agent. This agent is made by allowing a hot diluted solution of caustic soda to react on a diluted suspension of frozen starch granules for a few seconds before mixing the "caustic starch," as it is called, with the wash water to be treated. Normally about 200 parts per million of lime are required, 14 of soda and 7 of starch. The slaked lime is introduced continuously into the wash-box launders by a specially designed feeder, thus ensuring that the coal is initially wetted with the limed water. To add the caustic starch agent a portion of the circulating water is by-passed to a mixing tank, from which it is drawn to the thickener tank by a pump working on the snore. The agitation resulting from this treatment disseminates the reagent throughout the suspension and causes the solid matter to flocculate immediately, the solids being deposited and the clear water overflowing to the main pump sump for recirculation in the washery. The solids are collected into the conical bottom of the thickener tank by a slow-moving rotary scraper, and pass into the sludge sump, where there is a sufficient concentration to give good filtration. The thickened solids are then discharged by gravity to a group of three filters of the rotary bucket type (Fig. 9), each having a capacity of 5 to 6 tons per hour. The solids are drawn against the dished filter gauzes by air suction, a slight positive pressure, introduced at a suitable point in the cycle, serving to discharge the resulting cake into a scraper conveyor. The conveyor serves the dryer, and thence this material is passed to the blending plant.

The rotary filters, the refrigerator for the starch and reagent tanks, and the electrical equipment are compactly housed in a compartment under the thickener tank.

A smaller filtration unit is also in operation for the clarification of the water from the Elmore plant, but in this case lime only is used to precipitate the solids.

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* Other conditions affecting the design of the plant were discussed by Col. Kenelm C. Appleyard in a paper (to which we are indebted for many of the data incorporated in this article), read before the Institution of Mining Engineers in July, 1935 p. 37. Transactions, I.M.E., Vol. xc, Part 1.

Drawings and Photographs accompanying the article