BRIQUETTING OF COAL.

By A. N. MUKHERJEE, *Dr.-Ing., B.Sc., A.I.S.M., By-product Plant, Giridih, E.I.Ry.*

Introduction.

Briquetting is the name given to an agglomeration of small coal, coke breeze, charcoal dust or bog turf together with some binding material consisting chiefly of coal tar or pitch. According to Menzel,[1] the oldest record states that the ball-shaped compressed coal originated in China. Hugh Platt[2] described in 1603, in a pamphlet, a new compressed fuel manufactured in the year 1594 in the neighbourhood of Lükeland in Germany, made of coal dust, saw dust and oak tan-bark, with cow dung as binding material. The first coal briquette factories were:—

In France, 1842, at Bernard, near St. Etienne.
In England, 1846, at Newcastle-on-Tyne.
In Germany, 1861, at Mühlheim-on-the-Ruhr.

In Europe, during the past 60 or 70 years, the briquetting industry has been developed and at present it has impressed its importance among the world's industries. In the U.S.A., the expansion of the industry, with its increasing value in economising waste products, has been brought into notice very recently because the U.S.A. has been so amply endowed with excellent mineral fuels that very little attention was given before to the utilisation of coal waste, screenings and other combustible matter in their manufacture into briquettes.

Evidently, this industry is in its most advanced condition in countries possessing large areas of inferior qualities of coal or with broad localities of peat bogs and where fuel is high-priced. It has also been largely developed in the countries in which by-product coke oven plants are in use producing coal tar which can be used in its crude form or distilled to pitch, thus contributing the important binding material in the manufacture of briquettes. It may be noted in this connection that in most of these countries in which the briquette industry has been developed the price of coal is very high. To insure a market for the briquette products, the price must be considerably lower than that of good coal in the several briquette-producing countries.

At the time, Germany[3] is the largest producer of briquettes and with the development of this industry there has been invented many varieties of briquetting machines. Briquettes form the principal domestic fuel of Berlin and other cities and districts in Germany. They are used in locomotives and other steam fires and are employed for heating in various processes of manufacture. German briquette factories are divided, in respect to the crude material employed, into two general groups: those that make household briquettes

from brown coal (lignite) or carbonised peat, and those that produce the so-called 'Industrie Briquette' using as basic material coal dust or slack household briquettes, as made in Germany from brown coal or peat, and used in grates, heating stoves, cooking stoves and ranges. They are cheaper in Germany ton per ton than good bituminous coal. Industrial briquettes are used in Germany for firing locomotives and other steam boilers, for smelting and reverberatory furnaces and for many other kinds of industrial use.

The manufacture of coal briquettes known as patent fuel is not conducted on a very extensive scale in Great Britain. In the establishment of briquetting plants in the U.S.A. and also in Canada the same degree of success has not materialised as in Europe. This is mainly due to the difference in the available fuels and their method of utilisation in Europe.

France, Belgium, Austria, Hungary, Netherlands, Norway, China and Japan have also taken up the manufacture of briquettes in a small way.

Fuel briquetting has for its aim the accomplishment of the following objects:—

(1) The utilisation of the fine material (slack coal) unavoidably made in the mining and handling of coal.
(2) The creation of a good hard fuel to burn practically without smoke or odour.
(3) The concentration of the greatest number of heat units into the smallest space practicable, by cleaning and compressing material of inferior heating value.

In the mining of coal, a large proportion of the output of a mine is often necessarily dust, slack or culm, of which a certain amount is wasted. In the case of coking coals, the slack is generally charged into ovens, but dust of other coal is usually wasted.

The advantage of using fuels that burn without smoke or odour is very great, especially in big cities where dense trailing clouds of smoke coming out of the chimneys of mills and factories pollute the atmosphere. To appreciate the advantage of using the briquette or patent fuel, one should contrast some American cities or English towns with those of Germany where the briquette is largely used for industrial and domestic purposes.

The third object—that of obtaining concentrated fuel—is very important from a national point of view in a country in which large deposits of inferior quality of coal occur. This coal can be very economically used in the manufacture of briquettes which will burn practically without smoke and produce more calories of heat than produced by the raw fuel.

Briquettes are made in various shapes and forms. They are made in sizes varying from 20 pounds each to a size that takes several to make a pound. Industrial briquettes are usually of a square or oblong form, convenient to be packed or built up into a pile like bricks. The domestic briquettes are generally

of smaller sizes varying from ½ pound each to 2 pounds and they are of egg-shape or oval-shape.

The fuel briquette should satisfy the following specifications: it must be hard, homogeneous in density and size and only very slightly hygroscopic and should burn almost without smoke or odour; the breakage caused by handling should not exceed 5%; it should ignite readily and retain its shape when completely burnt.

Methods and Costs of manufacturing Briquettes.

Briquettes may be made of any one of the following materials: Coal slack, screenings, or dust; anthracite screening or culm; coke breeze or small coke; lignite coal; charcoal; peat or torf; petroleum. The method of manufacture may be divided into two general groups:

(1) *Briquetting with binding material*, where the coal or coke must be compressed with bonds in order to manufacture briquettes. The binding materials used for binding together the small particles of fuel employed in making briquettes are various, amongst them being: asphalt, coal tar, pitch, petroleum, molasses, magnesia cement, starch paste, etc.

The most common binder used is pitch in its various forms. The hard pitch [4] used for briquetting should contain 75% to 80% of carbon and only ·25 to ·5% of ash. Though tar and soft pitch are also used as binders, they have many disadvantages which do not apply to the same extent to hard pitch. The presence of the light and heavy volatile hydrocarbons in the tar and pitch creates smoke and smell when this binder is used in briquettes; also, the point of distillation of soft pitch is about 400 degrees fahrenheit, while that of hard pitch approximates 800 degrees fahrenheit. Thus briquettes made with soft pitch have to be kept cool or they will soften and, by sticking together, form large lumps. Among the other organic binders, the most important are starch paste and sugar molasses; but these have not as yet attained more than local importance.

The most suitable inorganic binder is magnesia cement, which is both cheap and abundant. The use of 5% [5] of this material is said to produce a stronger briquette than that made by any other binder; when 5% of this binder is used, the quantity of ash added amounts to but 2·5%. The process of using magnesia cement is very simple and cheap, as no drying is required and the only fuel expended is that for power. The briquettes harden gradually at the ordinary temperature, and after from 6 to 10 hours are strong enough to be stored or handled; in a few days they are capable of standing a pressure of from 7,000 to 22,000 pounds per square inch. But on account of the higher ash content it is not preferred in the market wherever good hard pitch briquettes are available.

The manufacture of briquettes includes coal crushing, wasting, and drying processes.[6]

First, the coal must be thoroughly cleaned and separated from all extraneous matter; the cleaner the product, the higher the value of the briquettes.

Drying is done in some instances in drying furnaces. These furnaces being especially employed for coal that is of a semi-bituminous nature, because it becomes slightly softened and in such cases the pitch is introduced either immediately before or after the coal has passed through the furnace thus reducing the quantity of pitch required.

The next process is crushing the coal. This is done either by rolls, stone breaker or other disintegrator. It is very important that the coal should be reduced to a uniform size. The most satisfactory results are obtained from coal of an even size ($\frac{1}{8}$ inch) or from slack. The finer the coal the greater is the quantity of pitch required to agglomerate it.

When the wet or melted pitch process is employed the pitch is commonly mixed with 10 to 15% tar. In cases where the dry pitch process has been adopted, the pitch is broken in a mill or cracker, then added in suitable quantity to the coal and the mixture is passed through a disintegrator. An intimate blending of the two ingredients is thus ensured. The mixture whether it has been heated in a furnace or not is finally heated in a heater or pugmill to render it perfectly pasty. The heat is obtained either by a steam jacket, which is called the 'dry heat system', or by direct injection of the steam into the mixture which is called the wet steam process or by a combination of the two. The temperature of the paste in the moulds of the press should not be lower than 70 degrees centigrade nor higher than 90 degrees centigrade. The amount of pitch required as binding material varies with its quality, character, and quality of coal and its shape of division and with other circumstances which cannot be well determined except by experiment. On the Continent the average is 5 to 9% and in Great Britain 8 to 10%. The average amount of water present in the paste should not be less than 3% and not more than 5%.

The presses used for briquetting are of various types. There are two general types which are mostly in use: the press with open mould and the press with closed mould. The closed mould type is divided into two classes: tangential press and plunger press. A large number of these presses are in operation making briquettes of all sizes. The pressure used depends on the quality of coal and binding material employed. If the coal is soft and large, a light pressure will suffice. If a fine coal is used, the pressure ought to be heavy. Light pressure can be used for molasses, as well as when a great amount of pitch is used for agglomeration.

(2) *Briquetting without binding material.*—This process consists in manufacturing compact briquettes from coal dust or slack coal by pressure; such coal must contain 5 to 12% of water and high bitumen or resin content. Considerable attention has, in recent years, been devoted to the briquetting of coals without binder or with a small proportion of binder and presses that would give these results with a reasonable pressure have been designed.

A notable briquetting process was patented by E. R. Sutcliffe [7] (British patent No. 5108). This invention consisted in reducing the coal to a very finely divided condition, as would pass through a 200 mesh and compressing the raw material so as to produce a hard homogeneous and stonelike briquette. In this process homogeneous briquettes from blends of coal have been made without the aid of a binder, subjecting the coal to a pressure of about 10 tons per sq. inch. The briquettes are subsequently carbonised at temperatures varying from 400 degrees to 1,200 degrees centigrade. The advantages to be derived from briquetting, as a preliminary to carbonising and gas-making, are many. Improvements in heat conductivity, the prevention of expansion and sticking troubles and increased yield of volatile products are some of the advantages accruing from briquette carbonisation.

Some instructive experiments on carbonisation of briquettes were carried out at the works of the South Metropolitan Gas Company. The briquettes from a blend of 75% of Durham coal with 25% of coke breeze were carbonised at high temperature and the results compared with those obtained when using 100% of the same Durham coking coal. The results shown in the following table were obtained :—

Yields from Durham coal and briquetted mixtures.[8]

Yields.	Ordinary coal.	Briquetted mixtures.	
		A	B
Gaseous therms per ton of coal ..	74·7%	68·2%	71·1%
Tar therms per ton of coal ..	16·1%	31·1%	27·5%
Total volatile therms per ton of coal	90·8%	99	98·6%

The total yield of therms as a result of briquetting has increased nearly 9 per cent.

Cost of making Briquettes.[9]

The cost of making briquettes or patent fuel varies greatly, according to the location of the plant and the kind of material used. Plants are usually equipped as follows: One set of chain elevators; one pitch cracker; one mixer for mixing the coal and the pitch (or any other binding material) in the proper proportion; one disintegrator for pulverising the coal and pitch; one vertical heater; one briquette machine; steam engine; other necessary arrangements for driving the various items of the plant. The average capacity per day of

the plant depends entirely on the number of machines in use. In some plants not more than 40 to 50 tons of briquettes are made per day of 10 hours; while in more elaborately equipped plants 100 to 120 tons of briquette are turned out in the same number of hours. The estimated cost of manufacturing briquettes including raw material, labour, and interest on money invested, is about 25 shillings per ton in England and 9 to 10 marks in Germany.

Briquetting of Coal in India.

Briquetting of coal is not done in India. In many parts of our coal-producing districts, immense stocks of unused fine coal has been wasted. This material affords, when washed, the best substance for the manufacture of briquettes, especially for domestic purposes. Next to the slack coal waste, the waste of coke breeze at the coke plant offers very desirable material for the manufacture of briquettes. About 2 to 3% of breeze is made in the manufacture of coke. As India produced in the year 1935, 1,759,036 tons of hard coke, the amount of breeze at the low estimate of 2% would be 36,000 tons of clean coke dust for briquetting. All or nearly all of this is at present wasted. It is quite probable that this coke breeze could be secured for the removing of it from the coke works or at most at a mere nominal price. Briquettes could therefore be made at a moderate cost. These briquettes would be very nearly smokeless, the only smoke-producing substance being the pitch used as binding material.

Much of the inferior quality coal of India could be manufactured into briquettes with a minimum percentage of the binding material.

The reason sometimes given by our industrialists for not turning their attention to the manufacture of briquettes in India is the scarcity of pitch and the cost of manufacture which will be higher than the price of other fuels available in India. It should be noted that almost any resinous or tarry matter may be used as binding material for making briquettes. Molasses acts as a good binder and is available in large quantities in India at a very moderate price. At present it is either wasted at the sugar plant siding or sold at a nominal price.

The estimated cost of manufacture of briquettes in India including raw material, labour and interest on capital invested, will be about 3 or 4 rupees per ton. The cost of a briquette plant with a capacity of 40 tons per day of 10 hours will be approximately 7,000 pounds in India.[10]

It is to be hoped that immediate attention will be paid to the utilisation of the inferior quality of coal of India, slack coal and coke breeze, which have very little demand in the market and are wasted, for the manufacture of briquettes. The briquette industry will not only solve the problem of economic utilisation of the neglected fuel resources of our country but it will also solve the smoke nuisance problem of our cities.

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