

DOMESTIC COKE IN INDIA.

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The subject of 'Carbonisation of Coal' is dealt with separately in this *Symposium* and as it presumably covers the general question of low temperature carbonisation, such matters as the production of smokeless fuel by modern low temperature carbonisation processes are not dealt with in this short note.

Domestic fuels in India comprise five main substances, namely, cow dung cakes, wood, charcoal, gas coke and 'soft coke'. Of these the first three are ubiquitous, and the use of the last is to some extent limited either according to cost or according to suitability for the purpose for which it is required. The first temptation of the fuel technologist in India is to assume that all that is necessary to deal with the triple problem of the provision of a good domestic fuel is to replace cow dung, wood and charcoal with one or other of the easily-ignited cokes. The expression 'triple problem' is used as there are three important aspects of this matter that engage the attention of the enthusiastic scientist, namely—

- (a) desirability of saving cow dung and other waste animal products for fertilisation of the land,
- (b) desirability of providing inhabitants of cities with a comparatively smokeless fuel, and
- (c) designing stoves, *chulhas*, etc. and utensils suitable for use with the new type of fuel.

The author has for some years been personally concerned in the investigations of the Soft Coke Cess Committee into methods used for manufacture of soft coke, with a view to discover to what extent, within the financial limitations of the industry, those methods can be improved. Certain facts have been ascertained regarding the quality of the coal selected for manufacture of this form of domestic coke and of the product. The funds available did not permit of large-scale experiments being carried out and the author relinquished the funds a year or two ago pending a decision as to the sanctioning of expenditure for testing large-scale tar recovery processes. Preliminary results have, however, been published along with detailed information about the conditions obtaining in the heaps and the methods adopted for supervision of the process.

In the course of these investigations he has also had to examine cokes of the type sold by the city gas corporations and to compare these alternative domestic cokes with the so-called 'soft coke'.

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The problem of obtaining a comparatively smokeless fuel is one that brings in its train the equally important one of ensuring that the fuel shall be easy to use under ordinary domestic conditions. Unfortunately the one desideratum can be obtained only at the expense of the other. The reasons why some forms of carbon such as the various cokes are more easily ignitable than others have not yet been satisfactorily elucidated. For the time being the important, and easily understood, fact is that quite apart from the *form* of the carbon (*i.e.* whether 'amorphous' and dull black or graphitic and more or less silvery) its association with a reasonable amount of volatile combustible matter aids in ensuring ease of ignition. What minimum and maximum amounts of volatile matter are to be fixed has not yet been determined. Samples of city gas corporation cokes largely used for domestic purposes in India showed the presence of from over $2\frac{1}{2}\%$ of volatile to as much as just under 7%. Enquiries regarding the suitability of these cokes for ordinary domestic purposes have shown that although they have proved entirely acceptable as smokeless fuels their ignition has frequently presented difficulties. Comparison with a large range of soft cokes and practical experiments prove conclusively (as might, of course, be expected) that the larger the amount of volatile matter left in the coke, the easier it is to ignite. But when we examine soft cokes we see that we sometimes come across samples that prove to be undesirably smoky in the earlier stages of their combustion.

The problem, therefore, is to discover what compromise can be effected so far as volatile matter content is concerned and how it is to be attained. There is the associated problem of trying to recover part at least of the volatile matter that is at present allowed to go to waste and to pollute the atmosphere of the coalfields where soft coke is made.

The Indian soft coke industry has been built up, of course, on the utilisation of low grade coals and to that extent it may be regarded as fulfilling an important function in this country and going far towards assisting in conserving and fully utilising our coal resources. No pretence is made that the coals used for the purpose are of high grade or that the product is a high grade one either. Any attempt to compare soft coke as made at present in India with domestic smokeless fuel as manufactured by modern low temperature carbonisation plants is not only absurd but also a waste of time. And any proposal to replace the Indian soft coke industry wholesale by a large-scale low temperature carbonisation industry should be regarded with the greatest caution and circumspection until it is certain that these low grade coals are not going to be ousted from the market. In the opinion of the author the desire to recover distillation products should not be allowed to cloud the main issue, which is that India has millions of tons of low grade but quite useful coals whose conversion into a domestic fuel and whose utilisation in other directions must be encouraged, not only for the sake of those members of the mining industry whose living depends on it but also in the interests of the conservation of our fuel resources.

Now a large proportion of such low grade coals in India cannot be economically treated in a washery or other coal-cleaning plant. Visual X-ray examination of the lump coal conclusively proves this. Some of it, in fact quite a large proportion of it, does not, after crushing, coke so satisfactorily as the crushed coal or slack of the better seams, so that ultimate utilisation of this low grade coal in a modern coke plant does not necessarily (in the light of our present knowledge) offer any special attractions. The present system of coking large lumps has obvious advantages—the preparation prior to coking costs nothing and the product is in lump form and travels well by road and rail without undue loss by crushing and production of fines.

We may take it, therefore, that the present system of coking large lumps by a simple distillation process is likely, for some time yet, to remain as a feature of the coal industry, even though economically sound means may yet be found to recover part, if not all, of the volatile products, whose value as 'by-products' is, it is to be feared, somewhat over-estimated just at present. And that statement does not negative any proposal to establish a modern low temperature carbonisation industry, using either the same low grade coals or those of better grade.

It follows from the preceding remarks that the quality of the coals used for making soft coke is at present undoubtedly low. Ash contents of selected lumps taken at random have been found to vary from as little as 8 per cent to as much as 38 per cent, but both these extremes are unusual and a more normal range is from about 12 to about 25 per cent, with an average nearer 16 or 17 per cent. Such coals will, on distillation, yield cokes of correspondingly high ash content. For example, a typical coal, such as is used, containing say 16% of ash will, on coking under normal high temperature conditions (*i.e.* at about 950°C.), yield a coke containing as much as 21% of ash, and as the temperature in a soft coke heap is not anywhere near that temperature but closer to 400°C., less volatile matter is likely to be driven off, there is a slightly larger production of coke and the ash content is, therefore, less and in fact likely to be about 19 per cent in the instance quoted. The average ash content of a large range of No. 1 soft cokes has been found to be about 22 per cent. It should be remembered, of course, that there are many qualities and grades of soft coke and that it is sometimes a difficult matter to correlate the designations of the various grades in different districts. These grades are not necessarily grades in respect of quality only. In one district the expression 'No. 1 Soft Coke' is applied to large lumps of the best quality. No. 2 soft coke is of inferior quality but quite saleable at lower prices. But there is a grade known as No. 1½. This consists of small size or rubble soft coke of good quality. Its quality may be better than that of No. 1 or not so good, *i.e.* its quality is not between those of Nos. 1 and 2. (Incidentally it may be remarked that there is a preference in towns for soft coke of the above 'No. 1½' grade whereas country consumers prefer the large lump coke, No. 1 or No. 2.) It is inevitable that even quite large lumps of very inferior shaly coal get into

the heaps and these may prove not to have coked at all well. Such very low grade coal may emerge from the coking process as 'stony soft coke' and even this low grade material finds a sale, but as it is not so largely used for ordinary domestic consumption it is not dealt with in this note. (Some concerns specialise in the manufacture of stony soft coke.) In other districts these appellations are not necessarily applied to exactly the same respective types or qualities of soft coke. On the whole, however, the above descriptions apply.

Reference has been made above to the acceptability of gas coke as a smokeless domestic fuel. The word 'smokeless' was emphasised, because such cokes, while being acceptable on the score of their relative smokelessness, are not necessarily completely satisfactory in other respects. The difficulty of ignition has been referred to but another difficulty may arise, namely, that of providing a comparatively 'soft' fire for some kinds of cooking. When making a domestic coke it is not necessarily always desirable to aim at producing a 'first class' article, so far as ash content is concerned, and it is the comparatively high ash content of soft coke that actually offers certain advantages over the better quality gas coke. Soft coke manufacturers aim, so far as the domestic market is concerned, at replacing as far as possible cow dung and other natural and local forms of fuels commonly used for cooking. Most of the fuels that it is desired to replace burn with a steady quiet flame or even merely glow, and within a short distance of the flame or glowing mass the temperature may not be excessively high. This feature of these indigenous fuels renders them specially suitable for the preparation of a large range of Indian foodstuffs. In fact a complaint that has occasionally been levelled against the use of the best soft cokes is that the fire is too hot. (The same complaint has been reported against gas cokes.)

It is here that consideration of high ash in a coal assumes an aspect different from the normal. For many domestic purposes in India a moderately high amount of ash is actually an advantage, because in the course of time after the fire has been prepared the accumulation of ash aids in damping the fire down and in producing a moderately hot glowing mass rather than a bright red-hot mass resembling a miniature furnace. For example, when frying with *ghee* and for boiling milk a moderate heat is essential, whereas for cooking rice, although many hold that a moderate heat is preferable, considerations of time make a hot fire desirable. Even for cooking some *dals*, owing to the difficulty experienced in softening the grain right through to the centre, long continued boiling over a moderate fire is preferred. On these grounds, it will be clear that a domestic coke for use in India need not be of good (low ash) quality and it may even with advantage contain quite a high percentage of ash.

Domestic smokeless fuel should be not merely comparatively smokeless but also free from an undue amount of substances likely to produce objectionable fumes in burning. Some Indian cooking vessels are so constructed that the gases resulting from the combustion of the fuel can gain direct access to the

food. It is obvious that there is a strong possibility of certain constituents becoming 'fixed' in the food and imparting to it an objectionable taste.

It is reassuring to be able to report, from the results of experiments carried out in the course of the investigations, that soft coke made with low sulphur Jharia coals (and nearly all Jharia coals have very little sulphur) has been proved to impart no flavour to any food cooked by it; other indigenous fuels have not all passed the test so satisfactorily.

