# COKE SIZE DEGRADATION AND THE INFLUENCE OF SOME STRUCTURAL FACTORS

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## Introduction

In the traditional blast-furnace route of iron making, the technique of coal injection at the tuyeres has become of greater significance in recent years. This coal injection has enabled a reduction to be made in the proportion of coke in the burden and this has focused attention again on the role of the coke in supporting the bed and in maintaining bed permeability to the upward flow of gases and the downward flow of liquids. Permeability is related to coke size distribution, a uniform coke size leading to a highly-porous, high-permeability bed. Conversely, degradation of the coke within the blast furnace stack, especially to produce small coke capable of blocking the interstices between the larger particles, adversely affects the bed permeability.

Two modes of coke size degradation can be envisaged; volumetric breakage of lumps into two or more large pieces and abrasion producing fine coke. Volumetric breakage can result from compressive forces exerted on lumps within the stack as they support the burden, the breakage resulting from the extension of pre-existing fissures present in the feed coke lumps. Fissure size, distribution and density will therefore be important. The effect of abrasive forces induced when coke lumps rub together or against other burden materials as they move down the blast-furnace stack, will be to remove asperites from the rough angular surfaces. This process will be influenced by the thickness and rugosity of the carbon material forming the pore walls.

The overall aim of this study is thus to develop means of assessing the structural parameters likely to influence coke-size degradation in the blast furnace. The work described in this paper was aimed at developing methods of measuring parameters describing the fissures in metallurgical coke lumps in order to derive a characteristic fissure index.

## Experimental procedures

To measure the number and size of fissure in coke lumps an image analysis system based on a macroviewer was used. The images for this assessment were obtained by cutting through coke lumps with a diamond tipped saw, smoothing the sections so revealed using a carborundum pad on a metallographic polishing machine, highlighting the fissures with a white paste and tracing the outline of the lump periphery and of any fissures onto tracing paper. Using the TV camera on the macroviewer of the image analysis system, this traced image could be converted into a video image of a quality suitable for measurement purposes. Measurements were made of area, length, breadth and periphery of the lump and the length and perimeter of the fissures. The length of a feature is its maximum dimension whilst its breadth is the maximum dimension perpendicular to the length. The ratio of the perimeter to twice the length was used to obtain a shape factor for each fissure.

## Results

Preliminary examination indicated that fissures could be classified as a) straight, b) curved or more rarely, c) branched or crossed. This examination revealed the value of the shape factor in differentiating between fissures of similar length.

Samples of four metallurgical cokes of different strength have been examined. They were sized by hand placing on square mesh sieves, the number of coke lumps in the various size ranges differing markedly between the sieve sizes and between cokes. There was a wide variation in the number of fissures per lump, Figure 1, for any one lump size and also with the mean fissure length, Figure 2, although for two of the cokes a gradual increase of the length with lump size can be discerned. The pore shape factors also show considerable scatter although they do not appear to vary by much in the size ranges up to 70mm, Figure 3.

Comparison of the data collected for the four cokes indicates that the strongest coke (as measured by the industrial micum index) contained slightly more fissures and these were longer than those in the other cokes. This is contrary to what brittle fracture theory would suggest and clearly more data for a wider range of cokes is required to further our understanding of the role of fissures in coke breakage.

## Conclusions

A method of imaging fissures in coke lumps has been developed to enable an image analysis system to be used to characterise the fissures. Examination of a limited range of metallurgical cokes indicated that the strongest coke also had more longer fissures. Present results therefore provide little indication of the role of fissure characteristics in controlling coke breakage.

## Acknowledgements

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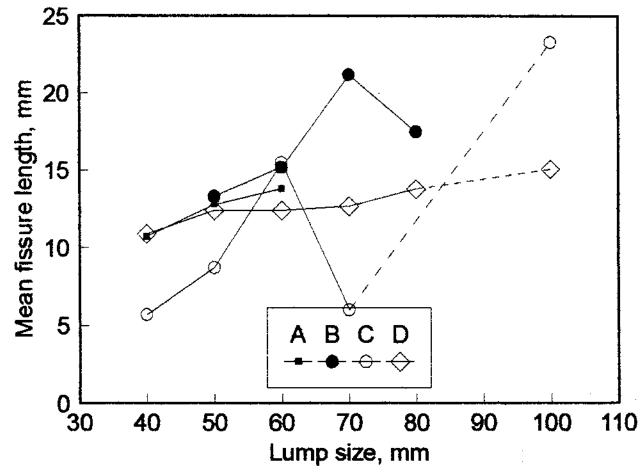


Fig. 2. Fissure length as a function of lump size

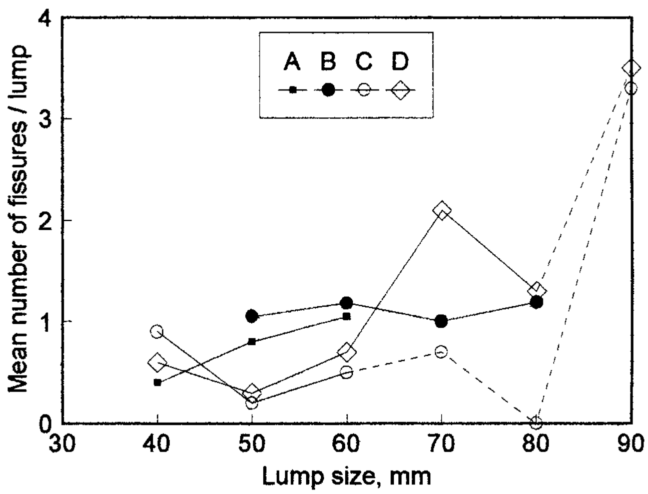


Fig 1. Number of fissures as a function of lump size.

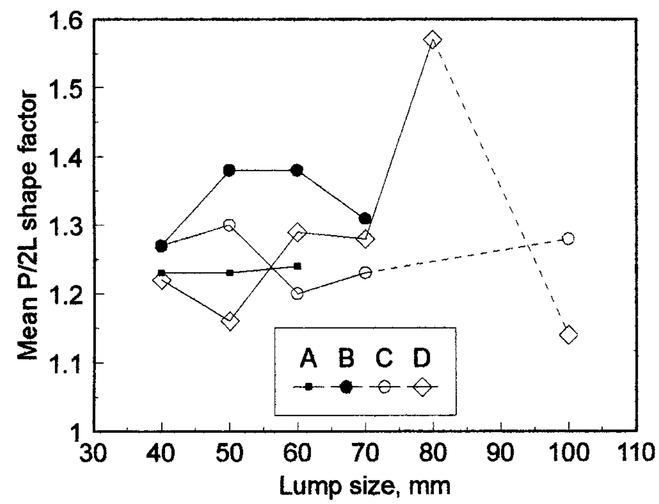


Fig. 3. Shape factor as a function of lump size