CHEMICAL MONOGRAPHS, NO. VI; THE CHEMISTRY OF COAL; PP. 2-89

Published @ 2017 Trieste Publishing Pty Ltd

ISBN 9780649423668

Chemical Monographs, No. VI; The Chemistry of Coal; pp. 2-89 by John Braithwaite Robertson

Edited by Trieste Publishing Pty Ltd.
Cover @ 2017

www.triestepublishing.com

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EDITED BY A. C. CUMMING, O.B.E., D.Sc., F.I.C.

No. VI

The Chemistry of Coal

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THE progress of Chemistry is so rapid that it is becoming a matter of ever-increasing difficulty to keep abreast of the modern developments of the science. The volume of periodical literature is so enormous that few can hope to read, far less assimilate, all that is published. The preparation of summaries has therefore become a necessity, and has led to the publication of various well-known journals devoted to the abstraction of original papers. For obvious reasons, however, these do not fully supply the wants of advanced students and research workers, and it is now generally recognised that monographs on special subjects are also needed.

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THE CHEMISTRY OF COAL

BY

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NEW YORK

D. VAN NOSTRAND COMPANY

TWENTY-FIVE PARK PLACE

1919

PREFACE

THE literature dealing with coal and its chemical properties is of such an extent that an exhaustive record of the facts and theories contained therein would occupy volumes. All that is attempted in this monograph is to show the chief methods by which the problems of coal-constitution have been attacked, and to outline some of the more interesting results obtained. It is hoped in this way to indicate to those desirous of carrying out research work on coal and kindred substances lines along which investigation may lead to concrete conclusions. An attempt has been made to mention all the more important papers in the bibliography, as it was felt that to anyone contemplating serious research work on coals this section should be of value.

The methods described in the section on analysis are those which I have found in practice to be satisfactory, and I hope that this section will prove of value to those who have occasion to examine coals from the analyst's point of view.

J. B. R.

June 1919.

litigation followed as to whether this substance was a "gas- or cannel-coal" or a "bituminous shale," and seventy-six scientists were called as witnesses. Judgment was finally given for the lessees on the ground that the substance was "coal" in the popular or commercial sense of the term. An appeal was made to the House of Lords, and ultimately the matter was compromised.[1] The question of the nature of "Boghead" coal is still a matter of discussion.

Classification of Coals.—Before proceeding to discuss the chemical nature of coal, it is necessary to say a little on the classification of coal species and on the suggested theories of their origin.

The different varieties of coal grade into each other, so that a rigid separation into classes is impossible, but, in general, a coal may be placed in one or other of the following five divisions.

1. *Lignites or Brown Coals.*—These are all of geologically recent origin, and are probably a stage in the series of changes by which wood and other vegetable matters are gradually converted into true coal. In most lignites the texture of the parent substance is still well-defined. "Brown Coal" is a name often used distinct from lignites to signify a coal of older geological age which has become more compacted and has lost most of the evident vegetable structure. Lignites and brown coals are of rare occurrence in Britain, but are of importance on the Continent, in the Western United States, and in Australia.

2. *Cannel Coals* exhibit few traces of vegetable structure, are black or brown in colour, burn with

a bright, candle-like flame (hence the name), and have a conchoidal fracture. They are of importance in gas-making.

3. *Bogheads or Torbanites* are somewhat similar to cannel coals, but have a much higher percentage of ash, and resemble the oil-shales in the percentage of volatile hydrocarbons evolved on destructive distillation. They are of rather limited occurrence, being found at Torbanehill and Boghead in Scotland, in Central France, in New South Wales, and in a few other localities.

4. *Bituminous or Humic Coals* are very variable in character. They are the ordinary household coals. They burn with a smoky flame, but contain no "bitumen" as such, hence the alternative name is preferred by many writers. They have a rectangular, rather than a conchoidal, fracture, and can in this way be easily distinguished from the cannel coals.

5. *Anthracites.*—These are black or brown, and often have a shining lustre. They are hard—and break with conchoidal fracture. Analysis shows little hydrogen, oxygen, or nitrogen present, and the volatile matter is small in amount. Anthracites are thus difficult to ignite, but give more heat per unit than any other coal.

Classification by Analysis. — Many different schemes based on analytical results have been suggested. One of the best of these is that of Seyler,[2] who forms genera according to the hydrogen percentage and species according to the carbon percentage. Another method of classification is

based on the carbon-hydrogen (C/H) ratio. Various limits for the different varieties of coal have been given by different analysts. The United States Geological Survey has finally adopted the following limits:—

	C/H ratio.
Graphite . . .	∞ to ?
Anthracite . .	? „ 26
Semi-anthracite . .	26 „ 23
Semi-bituminous . .	23 „ 20
Bituminous . .	20 „ 11·2
Lignite . . .	11·2 „ 9·3
Peat . . .	9·3 „ ?

According to Seyler's scheme the following limits are obtained:[3]—

	C/H ratio.
Anthracitic genus . .	18·75 and over
Carbonaceous genus . .	16·6 to 24
Semi-bituminous genus .	15·0 „ 21·2
Bituminous genus . .	12·9 „ 19·0
Per-bituminous genus . .	13·8 and less to 16·2

It will be seen from these figures that a rigid separation of coals into distinct classes is quite impossible, but, at the same time, a working basis of classification is possible and desirable.

The Occurrence of Coal.—Coal is widely distributed throughout the world, and occurs in the stratified rocks of most of the geological epochs from the pre-Cambrian to the Miocene, and, if we accept peat as a form of coal, to the strata being laid down at the present day.

The oldest coals[4] are found in Devonian rocks in the polar regions, and are of the bituminous or