Australian Standard™

Coal and coke—Analysis and testing

Part 1: Higher rank coal—Total moisture

Standards Australia

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Australasian Institute of Mining and Metallurgy

Australian Coal Association

Australian Coal Preparation Society

Australian Institute of Energy

Bureau of Steel Manufacturers of Australia

Coalfield Geology Council of N.S.W.

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Coal and coke—Analysis and testing

Part 1: Higher rank coal—Total moisture

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PREFACE

This Standard was prepared by the Standards Australia Subcommittee on Coal Evaluation, under the supervision of the Committee MN-001, Coal and Coke, as a revision of AS 1038.1—1992, *Coal and coke—Analysis and testing*, Part 1: *Higher rank coal—Total moisture.*

The Standard contains a method for determination of free moisture and three methods for the determination of the residual or total moisture content of higher rank coal, viz. distillation method (Method A), drying in nitrogen (Method B), and drying in air (Method C).

This revision confirms the methods for the moisture determination after test work was undertaken to confirm representivity of 10 g subsamples at 4 mm top size for the determination of residual moisture.

The term 'informative' has been used in this Standard to define the application of the appendix to which it applies. An 'informative' appendix is only for information and guidance.

CONTENTS

FOREWORD

A detailed historical review of the investigations into the form and occurrence of water in coal, covering a period from the early 1800s to 1945, has been reported by Gauger*. In this review, the development of direct methods for determining moisture in coal such as distillation in solvents (xylene or toluene), and the indirect methods of drying in air and/or nitrogen, were examined. These investigations have formed the basis of the methods now standardized in various forms by ISO, BS, ASTM, and AS and other standards organizations. Subsequent studies have tended to focus on a more rigorous scientific understanding of the form of water in coal, or alternative/more rapid methods for its determination (such as microwave drying or analysis by Nuclear Magnetic Resonance (NMR) spectroscopy).

In simple terms, water occurs in coal in three general forms:

(a) Free moisture (sometimes referred to as surface moisture or adherent moisture)—has the physical properties of ordinary water and occurs on the surface of coal or in the large diameter pores.

(b) Residual moisture (sometimes referred to as bound or inherent moisture)—has a lower vapour pressure than free moisture and occurs in the small diameter pores of the coal.

(c) Water of constitution—which is primarily chemically-bound water as water of crystallization or as water derived from hydroxyl groups occurring within the mineral matter of the coal.

A method for the determination of water of crystallization is given in AS 1038.22. This Standard covers the determination of total moisture in higher rank coal and its parts, viz., free moisture and residual moisture.

Whilst the total moisture and residual moisture of a given coal are related to coal rank there are many factors which determine the actual values including local mining conditions, the presence of extraneous mineral matter such as clays, and the treatment of the coal post mining. Therefore the moisture characteristics of a given coal (total, residual and free moisture) are semi-empirical parameters and the values for a given coal may vary according to the test method used for its determination.

The free moisture in coal is always determined indirectly by drying in air under normal ambient conditions. Residual moisture may be determined directly by distillation using toluene (boiling point 110.8°C) using the British Dean and Stark apparatus, or by drying in air or nitrogen at 105–110°C.

In the distillation method, the important test variables that have been standardized include:

(i) Temperature.

(ii) Duration of heating.

(iii) Nature of the immiscible liquid and volume used.

(iv) Mass of sample.

(v) The design of the apparatus.†

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* GAUGER, A.W. *Condition of water in coals, Chemistry of Coal Utilisation*, Vol 1 Chap. 17, John Wiley & Sons, 1945, pp 600-626.

† CRAWFORD, A. Determination of the moisture content of the 'analysis sample', *Fuel*, v 36, 1957, pp 7-25.

In the drying methods, important test variables include:

(A) Temperature of heating.

(B) Duration of heating.

(C) Density of the coal layer.

(D) Rate of change of atmosphere.

(E) Effect of nitrogen or air.

(F) Effect of different materials for the containers.

(G) Exclusion of moisture from the air dry sample.

Strict adherence to the methods described in the respective standard methods is therefore essential in obtaining reliable test data.

Other values of moisture commonly determined in the analysis of coal include moisture-holding capacity (AS 1038.17), and moisture in the analysis sample (AS 1038.3). It should be noted that moisture-holding capacity is not equivalent to total moisture, and that residual moisture is not equivalent to moisture in the analysis sample.

STANDARDS AUSTRALIA

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SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

This Standard sets out methods for the determination of total moisture, free moisture and residual moisture in higher rank coal. The methods are as follows:

(a) Drying in air at ambient temperature for free moisture.

(b) Distillation (Method A), for residual or total moisture.

(c) Drying in nitrogen at 105–110°C (Method B), for residual or total moisture.

(d) Drying in air at 105–110°C (Method C), for residual or total moisture.

Methods A and B are applicable to all higher rank coals. Method C is applicable only to higher rank coals that are known not to be susceptible to significant oxidation.

Where the sample is visibly wet, determination of residual moisture by Method A, B or C is preceded by the determination of free moisture.

NOTES:

1 A comparison of the ISO, BS, ASTM and AS Standard methods for determination of total moisture in coal and its parts is presented in Appendix A.

2 Options for sample preparation and determination of total moisture in accordance with this Standard are presented in a flowchart in Appendix B.

1.2 REFERENCED DOCUMENTS

The following documents are referred to in this Standard:

AS
1038 Coal and coke—Analysis and testing
1038.16 Part 16: Assessment and reporting of results

2096 Classification and coding systems for Australian coals

1243 Safety in laboratories (series)

2508 Safe storage and handling information cards for hazardous materials (series)

2706 Numerical values—Rounding and interpretation of limiting values

4264 Coal and coke—Sampling
4264.1 Part 1: Higher rank coal—Sampling procedures

ISO
589 Hard coal—Determination of total moisture
1988 Hard coal—Sampling