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THERMOGRAVIMETRIC ANALYSIS AND ITS APPLICATION FOR ESTIMATING THE COMBUSTION PROPERTIES OF COAL FROM THE STUDY OF SMALL SAMPLES

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ABSTRACT

The mass dispersion of a 300 mg coal sample, which is heated at a constant rate of temperature increase, is sampled and stored as a data string, along with the sample and furnace temperatures. The data are processed to produce mass dispersion, DTG and D2TG curves. From this information quasi proximate analysis indexes* are computed along with several others which derive from the curve features. The indexes are used as a group, to select from a specially prepared data bank, standard reference information from all S.A. coals which compare best with those of the sample. The anticipated combustion characteristics of the sample are estimated by analogy with the standards and by analytical calculations.

INTRODUCTION

At the NICR, equipment was developed with the objective of optimizing TGA technique for characterizing the coals, in terms of their thermal dissociation features. Fundamentally, the equipment resembles that which was originally used by Wagoner[1,2]; but differs extensively in construction, usage and interpretation. The system is completely digitized and automated in such a way that all experimental control, reduction and interpretation are done by standard computers, either mini or mainframe, with provision for personal interception at various stages and using high level software The main unit is very flexible and useful for overall TG research and specific assigned programmes can also be extracted as well as PROMs prepared for use with microprocessor controlled units.

EQUIPMENT OUTLINE AND RECORDING FEATURES

The functions of the research unit is outlined in Figure 1.

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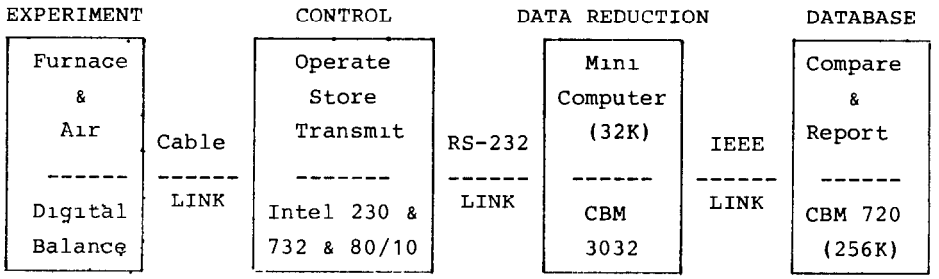
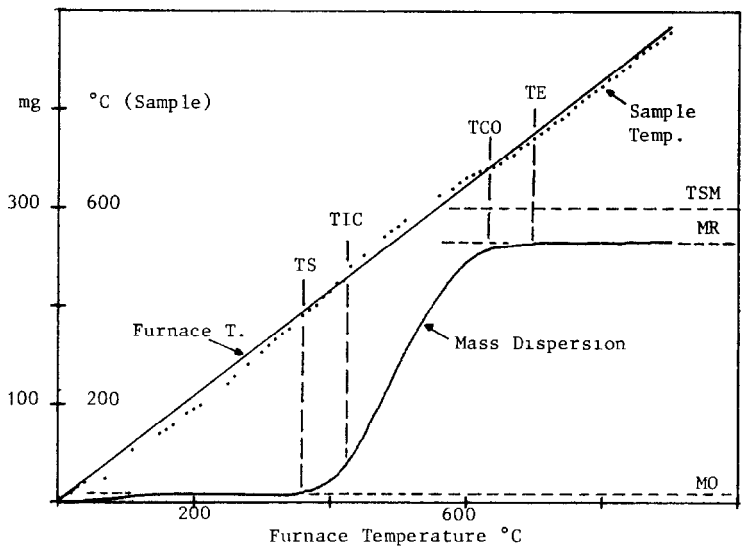


FIGURE 1

The furnace has a temperature range from 20 to 1000 degree Centigrade with an accuracy of 2 degree Centigrade. The mass balance has a resolution of 0,1 mg and a sampling response of 1 sec. Recording of variation in the mass occurs at 15 sec intervals, providing about 220 data readings for each parameter observed.

DATA REDUCTION AND PRESENTATION

A typical mass dispersion curve together with the rise in temperature is shown in Figure 2.



TGA MASS DISPERSION AND SAMPLE TEMPERATURE CURVES

FIGURE 2

The relation between the sample temperature curve and the ambient furnace value, which is a straight line, shows the point at which the temperature of the disintegrating sample exceeds that of the furnace. The two intersections TIC and TCO represent those temperatures before and after which the sample does not liberate heat into its environment, and indicate fairly closely the relatively effective exothermal domain of the high carbon samples. It also follows from the data obtained that at this stage, the volatiles are expelled without ignition, which occurs when TIC is reached. Carbon which remains after TCO represents the fraction which can be burnt only at the expense of heat supplied by the test furnace or the coal itself in practice. Since these temperatures represent mass values at their intersections with the dispersion curve, it is possible to compute several parameters which characterize the coal from the information thus obtained.

DISCUSSION

The DTG and D2TG data are used to delineate the various segments of the dissociation curve in terms of the fractions into which the particular sample decomposes. These segments are related to the overall disintegration behaviour of the sample and the mathematical expression of this association is used as basis for the computer algorithms. After all parameters have been completed, including percentages for moisture, volatiles, carbon, ash and calorific value, the overall results are used to select standard reference information from other coals which are stored in the data bank for comparison and assessment. Figure 2 shows how the total sample mass (TSM), mass residue (MR) and moisture (MO) are determined. The intersections of temperatures TS and TE, which define the start and end of decomposition, are shown in relation to TIC, the carbon ignition point, and TCO, the cut off temperature for the reaction.

REFERENCES

1. C.L. Wagoner, Burning Profiles for Solid Fuels. American Society of Mechanical Engineers, August 1967
2. C.L. Wagoner, Further Development of the Burning Profile. Journal of Engineering for Power, April 1973