PREFACE

The auto-oxidation of coal at ambient temperatures leading to heating and fires has always been a problem in coal mines, in storage dumps on the surface and during transportation in ships. In mines, the confining geometry, the presence of combustible matter in abundance, the ventilating current, the formation of explosive atmospheres, and the liberation of carbon monoxide make spontaneous heating more hazardous..

In Chapter 1, the occurrences of mine fires due to various causes, including spontaneous combustion, in India and in the Jharia coalfield in particular, have been given, bringing out the immensity of the problem. The scope of the present work has been outlined which consists in determining the comparative susceptibilities of 18 coal samples collected from 6 important seams, using some well known techniques. The influence of coal properties affecting spontaneous combustion forms an important part of the work.

Chapter 2 presents the literature survey on spontaneous combustion reviewing its mechanism, contributing factors, evaluation of susceptibility, and the experimental techniques used for such studies. On the basis of a logical approach to the heat-up of coal leading to

spontaneous combustion, and ultimately to flame, the following experimental techniques have been selected for the present studies :

1) Crossing Point Method
2) Chemical Method
3) Flammability Method
4) Differential Thermal (DTA) and Thermogravimetric (TG) Analyses.

Since DTA and TG techniques show the entire phenomenon right from the initial stage to complete combustion, it has been visualised to incorporate the results obtained from the above methods in the DTA/TG curves to facilitate a better interpretation of the effect of temperature on the decomposition of coal.

Chapter 3 deals with the details of the set-ups and procedures adopted in the present work. The effect of cryo-treatment of coal on spontaneous combustion has, also, been incorporated to see whether such a treatment would reduce the liability to spontaneous combustion through possible contraction leading to the close-up of the pores.

Chapter 4 deals with the collection, preparation, and analyses of samples. The collection of samples underground in airtight containers and grinding and sieving in the laboratory were carried out under an inert atmosphere

of nitrogen to maintain the coal samples as near as possible to the as-mined state. The analysis of coal includes proximate and ultimate analyses, calorific values, caking and swelling indices, Hardgrove grindability indices, specific gravity and crushing resistance, petrographic analyses, ash analyses, and analyses of mineral matter by X-ray diffraction.

Chapter 5 gives the data, results and discussion on the eighteen samples collected from six seams of the Jharia coalfield.

In the case of crossing point set-up, experimental conditions were optimized and the effect of various parameters on the crossing point and amongst themselves were studied. Since the heat-up curve of coal shows the result of the entire phenomenon of oxidation of coal, the three stages, namely, the regime up to the perceptible self-heat generation point, that between this and the crossing point, and at the crossing point, have been considered in predicting the susceptibility to spontaneous combustion.

The effect of the same variables of coal as discussed under the crossing point experiments, were also, studied on the puff and flammability temperatures. The effects were found to be similar which led to a correlation between the crossing point-, puff-, and the flammability temperatures. The relationship between the ignition temperatures and seam sections from floor to roof show approximate linearity

and parallelism. The temperatures of the top sections, gave a lower value compared to the lower sections of the seams. The indices, 'Modified Liability Index(New)' based on the crossing point method and the 'Susceptibility Potential' based on the puff method showed similar trends. The rate of decomposition and the reactivity based on thermogravimetric data have been considered.

On the basis of the above results, a certain order of susceptibility of the seams to heating has been suggested which agrees well with the field observations.

The Jharia coals used in the present work are of coking variety and the entire phenomenon of oxidation, plasticity formation, and decomposition can clearly be seen from the DTA/TG curves. The ignition temperatures determined by the three techniques agree well with the phenomenon observed in the DTA/TG curves.

The study of the effect of 'chilling' and 'exposure after chilling' on the crossing point showed an increase in the crossing point with 'chilled samples' while with the samples 'chilled and exposed' some amount of reversal has been observed. This suggests that judicious chilling may reasonably reduce the risk of spontaneous combustion.

Chapter 6 summarises the findings from the study.

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