

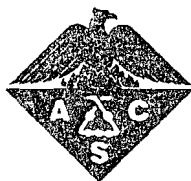
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ASSESSMENT OF COAL REACTIVITY DURING PREHEATING BY THE
RELATIONSHIPS BETWEEN STRUCTURAL AND PLASTIC PROPERTIES.
CHEMOMETRIC ANALYSES.

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ABSTRACT

Relatively little attention has been given to determine the coal structural changes induced by industrial preheating process. In this work, a series of ten coking coals was characterized, before and after industrial preheating, by FTIR and Synchronous UV Fluorescence (SF) spectroscopies and by petrography and plastic properties (e.g. mean Reflectance and Gieseler maximum fluidity, Fm). Specific structural indices derived from FTIR and SF data were defined and used in Principal Component Analysis to determine the effects of coal preheating on structural changes and to classify coals on the basis of plastic and petrography characteristics. Predicted models of plastic and petrography properties were established from FTIR and SF indices using Multivariate Linear Regression. For example, Gieseler Fm and volatile matter content, two main parameters for coal blending, can be estimated from the FTIR and SF indices for wet and preheated coals. Thus a better insight into reactivity of coking coals and a valuable estimation of their properties can be accounted.

INTRODUCTION

Recently, reserves of good coking coals have become less available and comparatively more expensive. Resources are extended by using coal blends with different coking properties and/or selective additives. Coal preheating technology has emerged as a technique to overcome some of these problems. This technology, preheating of coal at about 200°C in an inert atmosphere, in combination with the dry cooling of the resulting coke, is now incorporated into the operation of the Jumbo Coking Reactor (JRC, European Eureka Research Project)¹.

Most studies of preheating have focused on advantages in terms of technological improvements to coke quality and productivity, together with widening the range of coals suitable for coking compared to conventional wet gravity charging². Industrial preheating produces a decrease in the volatile content of the preheated coal compared to the original coal due to a devolatilization of the coal particles, accompanied by coal particle pore formation³. However, relatively little attention has been given to determining the structural changes induced in coals by industrial preheating process. These chemical transformations can be accurately evidenced by routine or more sophisticated analytical techniques.

The small molecules, trapped in the pores of coal macromolecular structure, have been defined as the mobile components in coals, and they are extractable using organic solvents⁴⁻⁵. Brown and Waters⁶ have shown that the mobile component extracted with CHCl₃ plays an important role in the development of coking ability. Previous studies have shown that UV Synchronous Fluorescence (SF) spectroscopy is interesting for qualitative and quantitative analysis of aromatic compounds present in the extractable organic matter⁷⁻⁸. Furthermore, a new ranking parameter for coals which present a large range of petrographic and chemical characteristics has been established from SF data⁹. Despite of the non applicability of this ranking parameter for coals comprised in a similar range, this technique can be used to determine the structural changes related to aromatics in the extractable phase¹⁰⁻¹². Moreover, structural information of coal residue can be assessed by Fourier transformed infrared (FTIR) spectroscopy¹³⁻¹⁵.

It may be assumed that the nature and the extent of the chemical transformations associated with the preheating process depend on the initial composition of coal i.e. its origin and its rank. In order to evidence the effects of initial composition on the rank and the coking properties of coals, a coal series was preheated and analyzed by FTIR and SF spectroscopies before and after preheating. This paper presents the results of the analysis of the different coals and emphasizes the effect of origin-preheating pair on the plastic behavior of coals, using chemometric analyses.

EXPERIMENTAL

A series of international coking coals (H) was selected for the industrial coal preheating process (Table 1). Coal preheating was carried out in the 2t/h INCAR pilot plant -Precarbon process- at 210 ± 10 °C under an inert atmosphere¹⁶. A coal sampling was performed: the wet coal before