Opportunities for Cokemaking Research

Introduction

The reliable prediction of coking performance remains an important yet elusive goal, largely because the properties of coals that affect their coking performance are not adequately captured by the measures currently used to characterise coals. Recently two approaches have been used to identify the way forward:

1. Mechanistic understanding of coke formation
2. Review of the literature to understand what has been forgotten or not pursued because of technological limitations in the past

Mechanistic model of cokemaking

This approach is summarised in Fig 1. The approach has been to work from right to left. Firstly, to understand the structural features that give coke its properties, then how these features are formed in the plastic layer and finally how that formation is controlled by the chemistry and "structure" of the coal charged to the coke oven. This should allow identification of the key coal properties to characterise and the development of more robust, practical coking models.

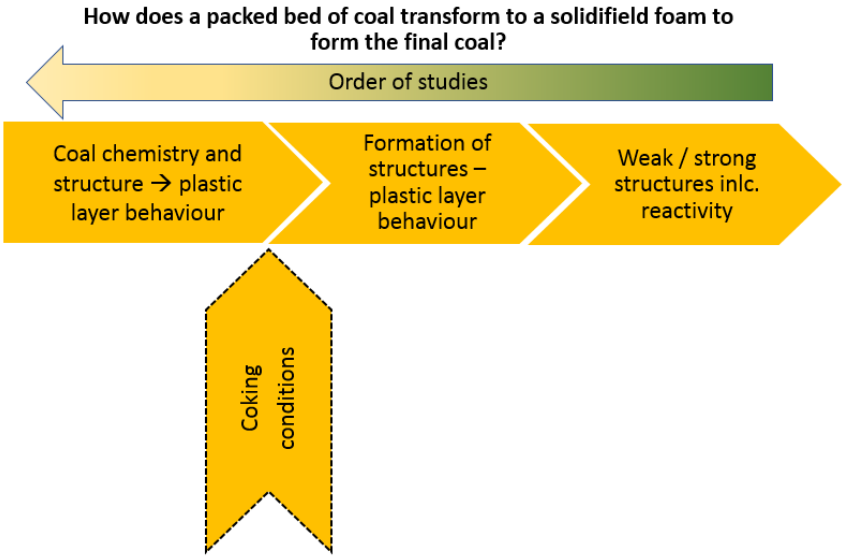

Fig 1: Towards better understanding of coking

Substantial progress has been made on the first 2 items, including the development of the first pass at a mechanistic model implemented on a computer. Items flagged as needing more attention are:

- Tightening of the link between coke microstructure and macro strength through understanding the distribution of features and stress within cokes
- Better characterisation of inerts, particularly their pore structure and their role in structure development and bonding to the reactive components, interactions and gas flow within coke
- Impact of associations of macerals in particles on coke behaviour
- Understanding the chemical and physical changes in the plastic layer that link coal properties to coking performance
- Performance of coke under BF conditions and linkage back to coal properties.

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Review of previous projects – gaps and opportunities for future research

ACARP and NERDDC have funded extensive research related to coking behaviour of coal over many years. A summary of the work has been completed to identify "gems" that may have been overlooked. A number of study areas have been identified which may lead to improved coking understanding, including:

- The use of abraded coke particles to better characterise the strength between textural boundaries in coke
- The chemistry of resinite and maybe other minor components in coals. Some resinite has anthracene and phenanthrene structures which could promote coking performance, while others have polystyrene-like structures which could interfere with coking performance.
- Effect of inert size on coke strength, and mechanistic reasons for differences between coals, identification of coals that benefit by careful control, and the range of particle size effects are significant for
- Critical review of coal oxidation and its impact on both coal laboratory carbonisation properties and on coking. There are also other important aspects that need to be better understood, such as the mechanism of oxidation and the role of humidity.
- Understanding the fundamental reasons why can low fluidity Australian coals produce good quality coke but low fluidity coals sourced from America and Europe cannot. In turn, this understanding will assist in development of more widely applicable coke property predictive models.
- Characterisation of individual coal rank for incorporation into blend models, noting limitations of blend average MMR and VM_{daf}.
- Fusible inertinite
    - Does inclusion of fusible inertinite improve predictions of coke strength?
    - What if fusible inertinite contributes differently to fusible vitrinite?
    - Different definitions of fusible inertinite give different %fused values.
    - Is reflectance cut-off the best indicator?
    - Does investigation of fusible inertinite hold the key of why Australian coals are different?