Opportunities for Cokemaking Research

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. The mechanistic approach to understanding coke formation has formed a useful framework for research.

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.

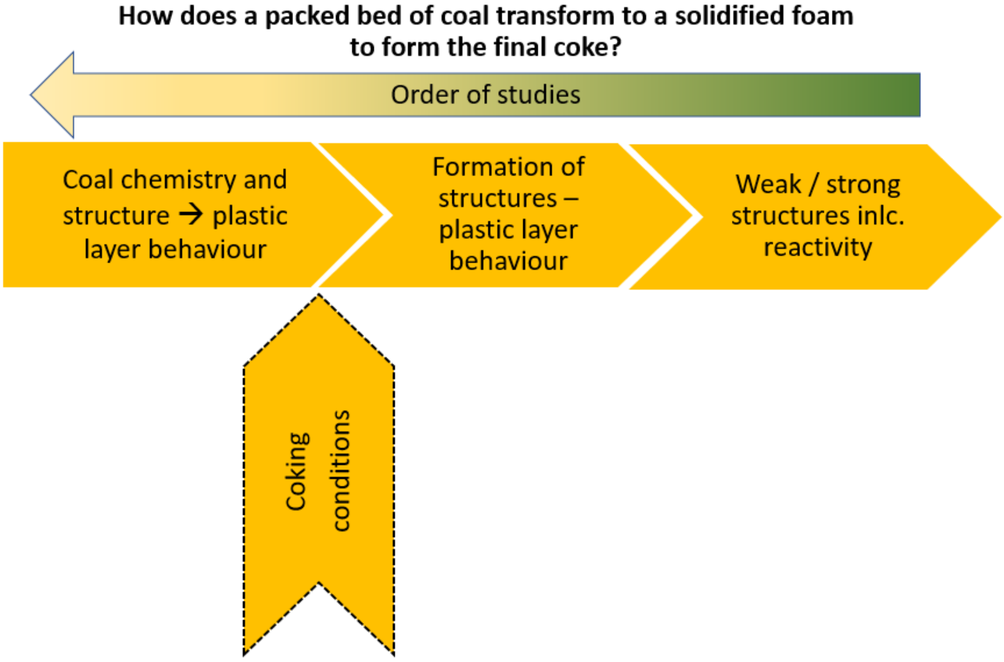

Fig 1: Towards better understanding of coking

Substantial progress has been made on the first 2 items. Detailed investigations into the nature of coke breakage have identified that the boundaries between coke constituents play a major role in determining the abrasion resistance of a coke. Studies of the heterogeneity of coke reactivity in individual particles have shown that the role of inertinite-derived material in determining reactivity is complex and not always deleterious.

In a review with the ACARP Technical Market Support Committee (Oct 2017) items were flagged as needing more attention:

- 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 other 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
- Testing coke under BF conditions. The model presented in Figure 1 takes coal to coke, but coke changes further in a blast furnace

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Opportunities for Cokemaking Research cont…

Other areas whose study which may lead to improved coking understanding are:

- The use of abraded coke particles to better characterise the strength between textural boundaries in coke
- Critical review of coal oxidation and its impact on coking. There are also other important aspects that need to be better understood, e.g., its mechanism, the role of humidity.
- Why can low fluidity Australian coals produce good quality coke but low fluidity coals sourced from America and Europe do not?
- What is the best way to classify inertinites so that both their positive and negative contributions to coke strength and reactivity can be assessed? For instance,
    - Does fusible inertinite contribute to coke strength and reactivity differently to fusible vitrinite? (That is, should we lump fusible inertinite with vitrinite as one measure in models of coke property prediction?)
    - Is reflectance cutoff the best indicator of fusible inertinite?

A major remaining challenge is to integrate all of these findings to produce an overall model of coke formation that can result in testable predictions. This is necessary so we can more readily identify the coal properties associated with beneficial behaviour.

Reducing the carbon intensity of steelmaking processes is an admirable but formidable goal. Coke is essential for blast furnaces but efforts to reduce net carbon requirements in the steelmaking process will continue. This will include high hydrogen and possibly low nitrogen BF practices. The impact of these changes on coke (and coal) quality requirements is unknown.

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