Paper Number: 1455

Alleviation of slagging in a pulverised fuel boiler through selective mining and coal blending: a case study from Leigh Creek, South Australia

Creelman, R.A.[1], Ward, C.R.[2] and French, D.[2]

[1] A&B Mylec Pty Ltd, Rockhampton, Queensland, Australia
[2] University of New South Wales, Sydney, New South Wales, Australia. D. French@unsw.edu.au

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Sub-bituminous coal of Late Triassic age from the Telford Basin at Leigh Creek is used as feedstock for the 544 MW Port Augusta pulverised fuel (pf) power station. In 2001, the power station changed its mode of operation from being cycled in load over 24 hour periods, to being operated continuously at high load. This change resulted in an increase in slagging of the furnace that began to adversely affect operational performance.

A chemical and mineralogical study of the slag showed that iron and, more significantly, sodium were responsible for the observed slagging behaviour. Consequently, a systematic study was undertaken of the mineral matter in each coal seam used in blends from the Leigh Creek mine, with the aim of identifying the mineralogical culprits responsible for ash deposition.

Three coal-bearing sequences occur in the Leigh Creek Coal Measures, which are named the Lower, Main and Upper Series, with the main source of coal for the power station being the Main and Upper Series. A 10-20m thick seam is mined in the Main Series and a number of seams varying in thickness from 1 to 6m in the Upper Series. The mined sequences range from lignite to sub-bituminous coal with a low to moderate ash yield (5 to 30% (ar)) and an *in situ* moisture content averaging 31% (ar). The ash chemistry of the coal seams is variable, with iron contents ranging from 1.42 to 13.83 wt%, calcium from 1.04 to 16.59 wt% and sodium from 0.95 to 10.73 wt%. Sulphur contents range from 0.79 to 14.84 wt%. This variation is reflected in the nature of the coal mineral matter, with calcite contents ranging from 0.0 to 11.3 wt% and siderite from 0.0 to 10.7 wt%. Bassanite, an artefact of the low temperature ashing process used to isolate the mineral matter, ranges in concentration from 0.0 to a maximum of 62.0 wt%. Although no sodium-bearing minerals were detected by X-ray diffraction analysis, sodium and sulphur contents exhibit a strong positive correlation (R^2=0.85) to each other, suggesting that sodium may be present as an amorphous sulphate.

Although monitoring of iron content at the Leigh Creek coal mine has reduced the potential for iron-based slagging, another approach was required for addressing sodium based slagging. A Sodium Index was developed:

$$\text{Sodium Index} = \frac{Na_2O}{(Al_2O_3+CaO+K_2O+Na_2O)} X\ 100$$

To take into account the role of calcium, the Sodium Index was further refined to produce the Feldspar Index:

$$\text{Feldspar Index} = \frac{(Na_2O + CaO)}{(SiO_2 + Al_2O_3 + CaO + K_2O + Na_2O)} X\ 100$$

Coals with a Feldspar Index of less than 30 showed no slagging propensity; coals with values between 30 and 40 were marginal in performance and coals with a Feldspar Index greater than 40 were most likely to cause problems. Through judicious blending of the mined coals and the use of the Feldspar Index as a coal quality monitor the risk of ash deposition has been substantially reduced.