Mechanisms for spontaneous combustion events in low intrinsic reactivity coals and carbonaceous shales

J Theiler[1] *and BB Beamish*[2]

1.

(AAusIMM) Senior Mining Engineer, CB3 Mine Services Pty Ltd, Darra Qld 4076. Email: j.theiler@cb3mineservices.com

2.
(MAusIMM CP (Min)) Managing Director, B3 Mining Services Pty Ltd, Kenmore Qld 4069. Email: basil@b3miningservices.com

ABSTRACT

The R_{70} self-heating rate index provides a measure of the intrinsic reactivity to oxygen of carbon in coal and shales at temperatures between 40-70°C. It has been routinely used for nearly 40 years by the coal industry to rate spontaneous combustion propensity for hazard assessment. Low propensity, and hence low intrinsic reactivity, is assigned to R_{70} values less than 0.5°C/h. Despite this rating, spontaneous combustion events have occurred at mines that fit this low propensity category. Adiabatic oven incubation testing has shown that under normal mine conditions at ambient temperatures, self-heating leading to thermal runaway is not possible for coals or carbonaceous shales with this low intrinsic reactivity. However, there are two possible mechanisms that can alter this outcome. Firstly, if reactive pyrite is present then the oxidation reaction of the pyrite with water and oxygen can act as an initiator of self-heating. This raises the temperature to the point where the carbon oxidation reaction takes over producing thermal runaway to ignition if sufficient carbon is present. Secondly, if an external heat source comes into contact with the coal or carbonaceous shale it can have the same effect of raising the temperature to the point where the carbon oxidation reaction rate is sufficient to sustain self-heating. This paper presents examples of both these mechanisms.