Rapid Screening Device - RSD™
Technical Application Note 14
Application of Oxidation & Ignition

Introduction

Two features of the RSD are (Figure 1) thermocouple in the sample and (Figure 2) flexible sample chamber. These features allow the RSD to be used in a flow of gas; eg air or oxygen. The screw top sample containers is easily modified with a gas inlet and interior metal gauze to allow for gas flow through a powder or liquid.

It is simple within the RSD configuration to set up a gas flow system where the gas (passing through a metal coil prior to entering the sample cell) will be pre-heated to the sample cell temperature. In addition, with a restriction and a T-piece on the gas exit, it is possible to get gas flow at an elevated pressure and to simultaneously measure pressure.

The results reported here are for simple oxidation and ignition temperature delumination of a coal sample. Tests have been carried out in air and pure oxygen.

Experimental

Conditions: British House Coal Grade IV. Crushed and sieved through a 1 mm metal gauze. Oxygen and air direct from cylinder (BOC Ltd). Sample Containers: standard THT re-useable design

Test 1: 8g of coal; air at 250 ml/min; 5°C/min; ambient to 200°C. No reference was used in this test.

Test 2: 1g of coal; air at 100 ml/min changed to 300 ml/min at 285°C; 5°C/min; ambient to 320°C. For a reference sample a similar sample holder with 1 gm of calcined aluminium oxide was used in this test.

Test 3: 1g of coal; oxygen at 200 ml/min; 5°C/min; ambient to 200°C; 5°C/min. A similar sample holder with 1 gm of calcined aluminium oxide was used.

Discussion

All figures are screen images from the RSD-RAP in data analysis software package.

Test 1 illustrates how the RSD will observe exothermic oxidation of coal clearly. Figure 1 shows the RSD heater temperature and at a lower linear temperature the control thermocouple output. This shows the linear ramp. The lowest temperature is that recorded inside the sample cell. The large sample takes a significant time to be heated. Since there is no reference, a user-defined template (Figure 2) has been constructed and is used to get the temperature rise of the sample that is caused by the oxidation. There is oxidation onset at 95°C (Figure 3). With increasing temperature, the oxidation heat output increases. This maybe the onset of a large sample mass and significant air flow. There is no ignition of the sample.

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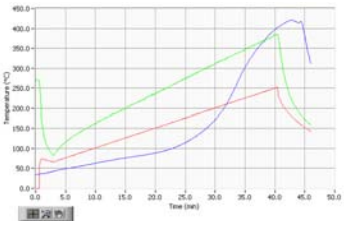

Figure 1

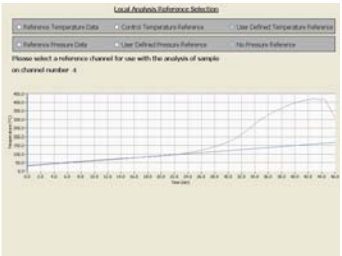

Figure 2

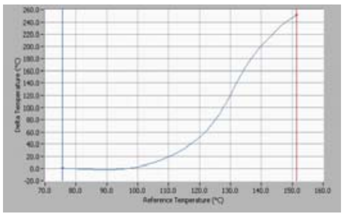

Figure 3

Test 2 is included to indicate the effect of flow rate on heat release by oxidation (Figure 4). At the slower flow rate, the heat release gets approximately to equilibrium (240°C—280°C). When the flow rate is increased the heat release increases. At the slow flow, the onset of oxidation is observed at a higher temperature.

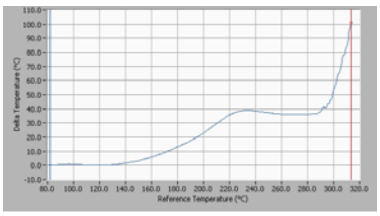

Figure 4

Test 3 is in oxygen and shows ignition of the coal sample (Figure 5). The thermal lag with the smaller sample mass is less than that observed in Test 1 and the use of a reference (here and in Test 2) means that the reference can be directly used to give ΔT data. The ΔT data (Figures 6 and 7) show ignition at 155.3°C and onset of oxidation heat release at 95°C. This onset of oxidation temperature agrees well with that observed for the high flow air test (Test 1).

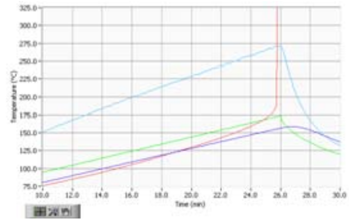

Figure 5

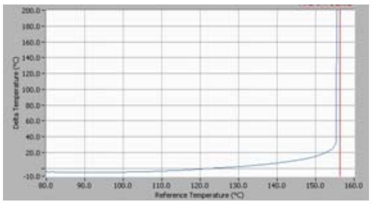

Figure 6

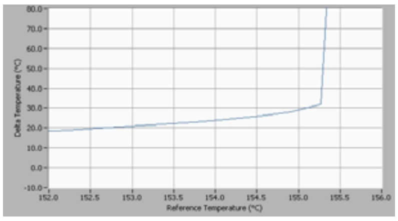

Figure 7

Conclusions

*The RSD can be used with a flow of air or oxygen.

*The RSD is suitable for investigating oxidation exothermic reaction.

*The RSD will determine the ignition temperature of coal.