Abstract

In many explosion investigations, the presence of an explosive dust and the ability to rule out other fuels is used as justification that a dust explosion occurred. However in some investigations, it tends to be difficult to rule out other causes for an explosion or to definitively show that dust was the primary fuel. In other dust explosions, overpressure damage may be present in multiple connected process vessels or multiple areas of a building. In those cases it may be desirable to determine whether the flame front propagated through dust clouds from vessel to vessel or from one area of a building to another. Accurate determination of the cause and propagation of dust explosion event aids in analyzing the performance of explosion protection systems and in determining methods to prevent or mitigate future explosions.

In this paper, we review, propose and examine the use of dust residue analysis methodologies to determine whether dust participated in a combustion event. These techniques include scanning electron microscopy (SEM), differential scanning calorimetry (DSC), and thermal gravimetric analysis (TGA). These techniques are used to compare virgin dust and residues from small scale laboratory dust explosion testing. Results show that for some dusts these techniques can identify characteristic microscopic morphology and changes to thermal stability of residues that are indicative of involvement in a dust explosion. These techniques can be a tool in explosion investigations to evaluate whether dust was a significant fuel in the event. Additionally, these techniques can be used in dust explosion investigations to determine whether dust in specific vessels or specific areas of a facility were involved in the combustion event and to determine the extent of propagation of the flame front. Application of these techniques to an actual industrial explosion investigation are also discussed.