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Insight of the fusion behavior of volcanic ash: Implications for Volcanic ash Hazards to Aircraft Safety

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The interaction of volcanic ash with jet turbines during via ingestion of ash into engines operating at supra-volcanic temperatures is widely recognized as a potentially fatal hazard for jet aircraft. In the past 12 years, more than 60 modern jet airplanes, mostly jumbo jets, have been damaged by drifting clouds of volcanic ash that have contaminated air routes and airport facilities. Seven of these encounters are known to have caused in flight loss of engine power to jumbo jets carrying a total of more than 2000 passengers. The fusibility of volcanic ash is believed to impact strongly its deposition in the hotter parts of jet engines. Despite this, explicit investigation of ash sintering using standardized techniques is in its infancy. Volcanic ash may vary widely in its physical state and chemical composition between and even within explosive volcanic eruptions. Thus a comparative study of the fusibility of ash which involves a standard recognized techniques would be highly desirable.

In this work, nine samples of fine ash, deposited from co-pyroclastic offrom nine different volcanoes which cover a broad range of chemical composition, were investigated. Eight of them were collected from 2001-2009 eruptions. Because of the currently elevated level of eruptive activity and its potential hazards to aircraft safety and the remaining one sample was collected from a 12,121 ± 114 yr B.P. eruption. We used the method of accessing the behavior of deposit-forming impurities in high temperature boiler plants on the basis of observations of the change in shape and size of a cylindrical coal ash to study the fusion phenomena as well as determine the volcanic ash melting behavior by defining four characteristic temperatures (shrinkage temperature, deformation temperature, hemispherical temperature, and flow temperature) by means of heating microscope instrument and different thermal analysis methods. Here, we find that there are similar sticking ability and flow behavior of different volcanic ashes at four characteristic temperatures and there are good linear correlation with different chemical composition. The melting dynamic between different characteristic temperature is strongly controlled by viscosity of the molten volcanic ash. Our analyses allowed us to estimate the probability of the deposition behavior of volcanic ash ingested into the high-temperature sections of jet engines and yielding a standard protocol for high temperature ash characterization.