Feature Article

Flying into Volcanic Ash!

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The recent volcanic eruption in Iceland shut down several airports in much of Europe. Clouds of volcanic ash could pose dangers for flying aircraft.

THERE is no place in the world where you can see a combination of volcanic eruptions and glaciers, except of course, Iceland. The spectacle was on display in full flow in the middle of April recently. On 14 April 2010, volcanic ash clouds drifting from Iceland’s spewing volcano under the Eyjafjallajokull glacier (situated in Southern Iceland) forced closure of air space over northern Europe. It was the second time in less than a month that the volcano under the Eyjafjallajokull glacier erupted and the first major eruption since 1821, since when it has lain dormant.

The expelling dust and ash made it extremely difficult for operation of aviation traffic, and the phase of low visibility continued to trouble British airlines for the next few days. The 10-km-high plume of ash affected millions of air travellers, with much of Europe shutting its airports, including Britain, Ireland, Denmark, Norway, Sweden, Finland and Belgium. The worst affected was the British Aviation Industry, as all flights to Heathrow Airport in London came to a total halt. Germany and France closed some of their major airports. The number of flights cancelled worldwide was about 6000.

However, this is not the first time that such an incident has occurred.

Looking Back
About 28 years back, on 24 June 1982, British Airways Jumbo Jet (B747) aircraft piloted by Capt. Eric Moddie with 155 passengers on board took off from Kuala Lumpur during late night for Perth. The aircraft was flying over the Indonesian island of Java at an altitude of about 12,000 metres and most passengers had comfortably dozed off.

Suddenly an acrid odour sneaks into the cabin, and an eerie bluish light spread over the wing tips and wing edges. The radio communication signals are interrupted by a humming noise. Next, the outer most engine on the right hand side stops working and the aircraft starts losing attitude. Capt. Moddie is totally clueless as more engines start failing one by one, and the aircraft starts dipping. With all the four engines inoperative, the pilot has no hope in sight to avoid falling and crashing on the ground.

In a desperate bid for survival, the flight crew makes a number of attempts to restart the engines. Finally they are able to restart the fourth engine after 16 minutes and the remaining three engines soon after. But as the aircraft starts gaining altitude, the second engine starts surging (losing power with violent vibrations). Capt. Moddie is forced to discontinue and makes an emergency landing at the Halim International Airport, Jakarta (Indonesia).
Volcanic eruption in Iceland

Cloud of ashes reach far off

Volcanic eruption in Alaska

Spread of Volcanic ashes in Europe
The gravity of volcanic eruptions near the Java island, which nearly caused two aviation catastrophes, drew worldwide concern and the International Civil Aviation Organization (ICAO), the monitoring body of world aviation, created a study group of Volcanic Ash Warning (VAW) on 28 September 1982.

Effect on Aircraft

An aircraft is likely to suffer damage due to an encounter with volcanic ashes. Such damage may be in the form of abrasion of various aircraft parts like wind shields, leading edges, landing lights, blockage of pitot system (that indicates aircraft speed), and even damage to pressurization and air-conditioning systems.

In addition, aviation fuel that is stored within the fuel tanks located inside the wings gets affected due to the absorption of minute particles of volcanic ashes and other compounds that are soluble in the fuel (consisting of refined kerosene) like lead, zinc and copper. Contaminated fuel causes deterioration in flight performance. The ashes deposited on the windshield result in impaired vision for the flight crew and also abrade wing leading edges, ailerons, stabilizers etc. Electrical discharges produced during such encounters may also cause structural damage to the aircraft. Moreover, lack of oxygen in the volcanic cloud may cause inadequate supply of proper air inside the cabin for passengers, creating breathing problems and even suffocating the passengers. It may be mentioned here that the atmospheric pressure requested, filtered and pressure regulated and then supplied into the passenger cabin for pressurization and air-conditioning of the cabin.

However, it is the engines fitted on the aircraft that experience the maximum problems during such encounters with volcanic ashes. This may be in the form of erosion of compressor blades, stations due to abrasive silica dust that causes engine surge, and melting and ash deposits on turbine parts causing loss of engine power. Engine overheating may also be experienced due to clogging of cooling vents by solidified cloud droplets, clogging of filters and damage to various engine parts. Even the engine oil (used for lubrication of engine bearings etc.) may get contaminated causing engine overheating. Due to all these reasons, engines start falling one by one.

Obviously, such engine failures cause severe problems for aircraft operation. A commercial airline may be fitted with two engines (e.g. Boeing B-737, B-757, B-767, B-777, Airbus A300, A310, and A320) or three engines (e.g. Boeing B-727, Lockheed L-1011, Mc Donnell Douglas MD-11, DC-10) or four engines like Boeing 747, Airbus A-340, Mc Donnell Douglas MD-90, and MD-12 etc. Although these aircraft are designed in such a way that failure of one engine normally does not create any serious safety problem, the situation gets complicated when more than one engine starts failing. For example, if both engines of an Airbus (A300 or A320) fail then the aircraft would become powerless and crippled. Pilots in such cases may be compelled to force land the aircraft at the nearest available area.

Hazardous Volcanoes

The eruptions of volcanoes are most unpredictable. Sometimes a sleeping volcano starts emitting gases after a very long gap. For example, El Chichons of Mexico erupted on three successive occasions after remaining inactive for 600 long years. Similarly, the volcano of Barren Island in Andamans in India became active after 107 years in March 1991 and remained active till 1994. So, it is quite difficult to predict such eruptions.

The eruption of volcanoes is caused due to the sudden release of forces, which have been accumulating gradually within a geological system as a result of slow drifting of plates on which the continent rests. The largest concentration of active volcanoes is in the northern hemisphere along the zones where continental plates either join (such as Japan, Andes, Alaska) or drift apart (e.g. Iceland, Red Sea). Approximately two third of earth’s volcanoes are located in the Northern Hemisphere. On an average 30 to 60 volcanic eruptions are taking place every year, out of which about half of them were previously earlier inactive.

With every eruption a large amount of gases (including sulphur...
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dioxide, hydrogen sulphides, sulphuric acid etc) along with dust or ash (fine particles of pulverized stones) are released. These materials may rise vertically or even move laterally. For example, during the powerful eruption of Mt. St. Helen’s in Washington State, USA on 18 May 1980, it was estimated that it had ejected about one cubic kilometre of dust in the atmosphere. Out of that about 25% fell back on earth within a few kilometres, and finer particles (known as aerosols) mixed with volcanic clouds and drifted to great distances.

Similarly, the eruption of El Chichons (Mexico) in March/April 1982 emitted huge quantity of sulphuric ash and gases in the atmosphere upto 26 km in the form of a huge fog-like cloud. This cloud was further transmitted by summer winds at a considerable speed and by the end of April 1982 it had travelled round the earth! Aeroplanes might encounter a volcanic ash cloud at a distance of even 2000 km from the volcano where it originated within a period of 24 hours.

Volcanic clouds consist of powdered form of very old rocks having silica, calcium, potassium and sodium, all very abrasive in nature. The volcanic gases are made of 60% to 99% water vapour along with sulphur, chlorine, fluorine, carbon, nitrogen, and traces of about 100 other elements like bromine, caesium, rubidium, lead, copper, zinc, chrome, cobalt, manganese, bismuth, gold, silver, radon, polonium etc. The initial temperature of these gases is 1000°C to 1200°C. However, the temperature suddenly drops to about 20°C within a few hundred metres on coming in contact with atmospheric oxygen. The cooler contents of the gases then get converted into fine droplets of corrosive acid.

Since the chemical composition of clouds varies from volcano to volcano, it becomes extremely difficult to keep a track of these clouds. Detection of volcanic cloud is extremely difficult, both from the aircraft as well as from the satellites. These clouds are normally of triangular shape, but their colour varies from white or brownish to bluish tinge depending upon the ratio of water content and ash. Even weather radars fitted on the aircraft are not able to detect the presence of volcanic clouds. Thus, the pilot is not able to identify a volcanic cloud (particularly during night hours) and may penetrate the cloud quite imperceptibly because in most cases no turbulence of any kind occurs.

These volcanic clouds resemble normal cumulonimbus clouds (associated with thunder storm and rain) and so mostly it is very difficult to detect them even from conventional weather satellites. It may be possible to identify them through weather satellites in case observations are made immediately after the eruption. However, after a lapse of time, they are indistinguishable from ordinary clouds.

Preventive Measures

The gravity of volcanic eruptions near the Java island, which nearly caused two aviation catastrophes, drew world wide concern and the International Civil Aviation Organization (ICAO), the monitoring body of world aviation, created a study group of Volcanic Ash Warning (VAW) on 28 September 1982. In addition, the World Meteorological Organization (WMO), International Air Transport Association (IATA), engine and aircraft manufacturers and various other agencies also assured fullest cooperation in the matter and themselves formulated a number of measures for avoidance/prevention of the hazard. Countries have made their own rules and regulations, so that flights flying through those countries are able to take evasive action.

Several advisory instructions are available for the benefit of pilots, aircrafts operators and other related agencies. The first and foremost is that all countries must pass information about the eruptions and possible ash clouds in the vicinity of their Air Traffic routes by means of NOTAM (or ‘Notice to Airmen’). Through these NOTAMs, the information of operational importance is disseminated to all concerned aviation agencies by the quickest means. These countries must also advise the alternate routes to be flown so that the active volcanoes can be avoided.

It was also agreed that the volcanic activities would be monitored by means of various satellites and the dates of eruptions would be supplied to all concerned. Moreover, if any pilot notices signs of volcanic clouds or eruptions along the flight route, he or she must immediately send alert messages to ground stations for further necessary action.

Further, the event of any aircraft inadvertently encountering a volcanic eruption the pilots were advised to follow certain flight procedures:

- Reduce the engine thrust lever to ‘idle’ (if the altitude permits) to provide extra stall margin and to lower the engine temperature.
- Leave the vicinity of volcanic ashes as quickly as possible.
- If necessary switch off the engines to avoid ingestion of volcanic matter and then restart them as per established procedures.
- Try again immediately in case of failure of engines to start, bearing in mind that the restart may be impossible while the aircraft is in volcanic cloud. Moreover a restart of engines is possible only when the relative air speed and altitude are in the permissible operational range.

A number of other precautionary procedures have also been developed and circulated to make flying safe for aircrafts unfortunate to encounter such conditions.

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