Carbon - Monoxide Toxicity in Fatal Aircraft Accident A Case Report

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Abstract

ACCIDENTAL inhalation of carbonmonoxide is known to have caused many aircraft accidents. Post mortem examination including detailed toxicological investigations may help in the reconstruction of events before the crash which could provide strong evidence for a possible cause of an accident. A case report of Carbonmonoxide toxicity in a fatal aircraft accident is discussed. The importance and significance of carbonmonoxide contamination is brought out in brief.

Introduction

Accidental inhalation of carbonmonoxide (CO) is known to have caused many aircraft accidents. Anthony [1] has suggested that carbonmonoxide should be suspected when fumes suggestive of heater or exhaust are noted. In the case of an inflight fire, it must always be suspected. Stevens[11] has reported a case of fatal civil aircraft accident in which a defective heater was the source of carbonmonoxide contamination of the cockpit leading to crew intoxication and incapacitation. Mohler [9] has also mentioned a similar case where cockpit contamination with carbonmonoxide occurred because of a broken exhaust pipe from the heater. There are instances where exhaust gases have entered the cockpit through worn packings/seals around the collar rings. Townsend [12] has reported two cases of inflight fire which resulted in crew incapacitation due to high level of carbonmonoxide and were the cause of the accident. Smith[10] et al have also highlighted two cases of fatal aircraft accidents not complicated by post crash fire where significantly high level of carboxyharmoglobin were noted in the crew indicating carbonmonoxide intoxication inflight.

Sometimes fatal cases with post-crash fire are reported with high level of carbonmonoxide in the blood of the killed pilot/crew. No significance can be attached to such values from the point of view of accident causation unless it could be positively established whether the impact was survivable or not. In this paper, a case report of a recent fatal aircraft is presented in which accident reconstruction, based on toxicological findings, provided strong evidence to indicate the cause of the accident.

Circumstances of the Accident

A dual jet trainer Kiran aircraft with side by side seats with Flt Lt A as instructor in right hand seat and Lt. B as pupil in left hand seat took off at 1530 hours. The training exercise prescribed was low level navigational sortie. Both the pilots were flying with type G masks and MK-17F regulators at normal setting.

Soon after the take off, control tower lost contact with the aircraft and overdue action was initiated immediately. It was later found that the aircraft had met with an accident, killing both the occupants. The estimated time of accident was established as about 1545 hours, 15 mts. after the take off.

Crash Site Findings

A rough sketch of the relevant crash site findings including ejection seat, parachute pack, distribution

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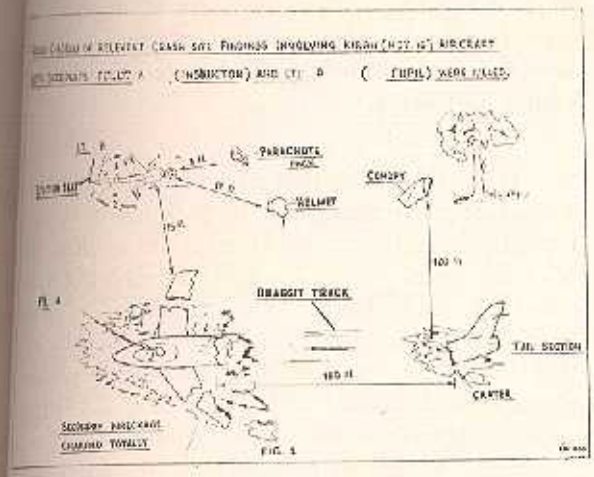
bodies of the two occupants and the helmet is shown in Fig. 1.



The aircraft was extensively damaged due to crash impact and posterash fire.

6. The body of instructor (Flt. Lt. A) was found in the wreckage and was completely charred alongwith the secondary wreckage. The body of the pupil, (Lt. B) was found lying close to the ejection seat and parachute pack but away from the wreckage. In the pupil's case the ejection seat firing mechanism had not been initiated, and it was established that the ejection seat got detached from the aircraft due to crash impact.

Autopsy Findings

The pupil's body showed no evidence of burns. His flying overall was badly damaged and torn. One boot, a glove, helmet and O_2 mask were missing. His head and face were also missing leaving behind damage to soft tissue from tongue downwards. The larynx was fractured. Thoracic cage was badly crushed and deformed with multiple fractures of ribs, sternum and thoracic vertebrae. The lungs were also lacerated at places due to fractured ribs. All the abdominal and pelvic organs were badly crushed and mutilated. Lower extremity was ampurated with severe crushing and lacerating injuries. Significant internal findings were :—

(a) Brain was missing.

(b) Tracheal mucosa was congested and contained some soot particles in its lower part. It also contained some blood but without any frothy blood stained fluid.

(c) Soot particles were also seen at the bifurcation of the trachea as shown in the photograph.

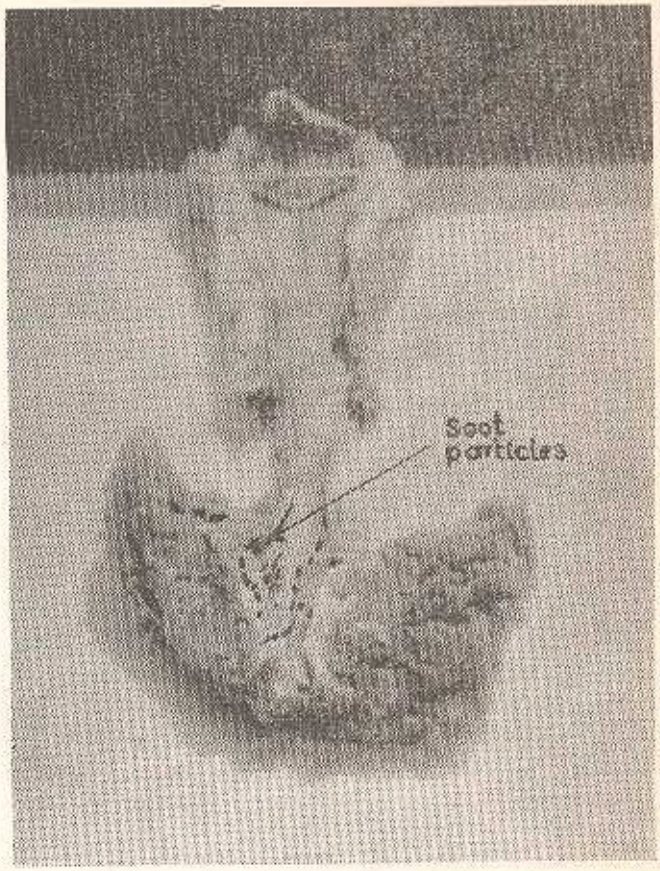


Photo 1
Section of the trachea showing soot Particles

(d) Heart showed a posterior rupture. Coronary arteries were patent.

(e) Both domes of diaphragm were ruptured.

(f) All abdominal viscera were severely crushed and lacerated.

(g) The most significant and characteristic finding was generalised moderate cherry-pink staining of the tissues/organs.

Flt. Lt. A (Instructor)

The body, without head and extremities was completely burnt and charred. All internal organs/tissues were severely heat-coagulated and were rendered unsuitable for deriving any information.

Toxicological Findings

Toxicological investigation could not be carried out on Instructor due to non availability of specimens

s a result of heat coagulation and destruction of all the body tissues. Toxicological investigations on the pupil for blood alcohol and blood carbonmonoxide estimation were carried out by gas-chromatography. (Dominguez, Christensem, Goldaum and Stembridge (1959). Results were :

Blood Alcohol — Nil

Blood Carboxyhaemoglobin — 42%

Medical History

Medical histories of both the crew-members were clean. Both were moderate smokers and had a satisfactory rest period during 24 hours prior to the accident.

Discussion

The injuries sustained by the pupil were of very severe nature and left no doubt whatsoever that he died instantaneously due to impact. His body showed no evidence of burns. Characteristic cherry-red staining of his tissues and presence of soot-particles in his respiratory passage established the fact that he inhaled smoke or fire fumes when alive. Therefore, eventhough he was found lying only 15 feet away from a burning secondary wreckage, it could be concluded with certainty that he could not have inhaled any smoke or fire fumes from the burning wreckage; having already died due to severe impact injuries. The presence of soot particles in the respiratory passages could only occur if the pupil had inhaled smoke or fire fumes prior to the crash impact which instantaneously killed him, i.e. inflight. This analysis established the fact that there was an inflight fire.

Significance of elevated carbonmonoxide content in Blood

Carbonmonoxide is a colourless, odourless, and non irritant gas and can be inhaled without the subject being aware of its presence. Fires of all types contain high concentration of carbonmonoxide and therefore, inhalation of fire fumes or smoke can lead to high levels of carbonmonoxide build up in blood in a short period of time resulting in serious adverse effects on flying performance or even complete incapacitation.

According to Judd[6] not more than 5% carbonmonoxide level in non-smokers and 10% in heavy smokers can be found. Blackmore[2] has reco... a carboxyhaemoglobin saturation in excess o... outside the normal range and will not be ... in blood taken within 24 hours of death. ... case the pupil's blood showed presence of 42% ... boxyhaemoglobin level. This is considered a ... cantly high level.

It is well known that a blood level of 42% ... monoxide can cause pilot incapacitation by ... confusion and unconsciousness in a short ... of time even at sea-level. The effects of ... monoxide and altitude are cummulative. Mi... land[7] has shown that a carboxyhaemoglobin ... tion of 16% at an altitude of 9000 ft produ... physiological altitude of 16,000 ft. Fig. 2. The ... shows that a concentration of only 0.08% ... monoxide at an altitude of 9000 ft. could ... these results, (Fig. 3). It has been stated in ... Flight Surgeon's Manual[3] that 0.64% carbon ... oxide contamination in air at sea level can cause ... consciousness and death in 10-15 minutes and ... air contamination with carbonmonoxide ... unconsciousness can occur immediately.

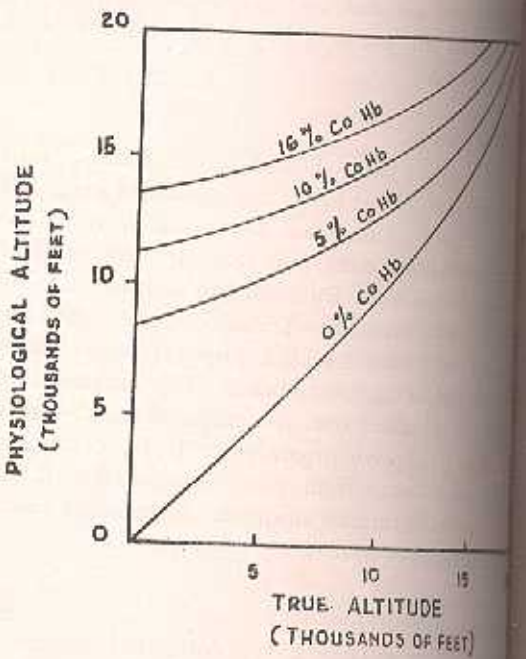


FIG. 2 EFFECTS OF CARBON MONOXIDE ... ALTITUDE TOLERANCE

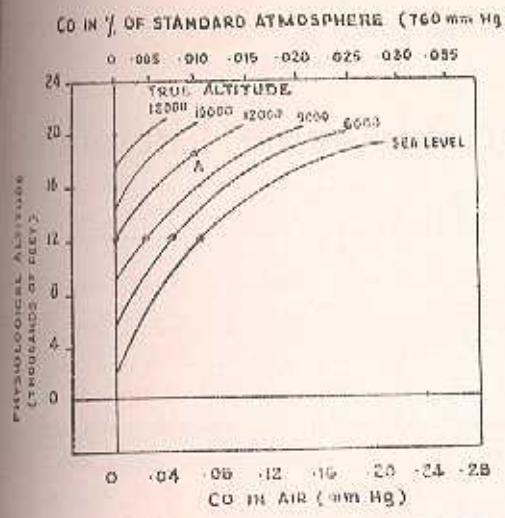


FIG. 3 THE RELATION BETWEEN PHYSIOLOGICAL ALTITUDE AND THE PARTIAL PRESSURE OF CARBON MONOXIDE IN AIR AT VARIOUS TRUE ALTITUDES WHEN EQUILIBRIUM WITH BLOOD HAS BEEN REACHED

Causes of the accident

Mk 17 F Regulator which is fitted in Kiran aircraft gives only air upto altitude of 8000 ft. through the oxygen mask at normal setting and therefore if cockpit air gets contaminated with smoke or fire fumes containing carbonmonoxide, it will be inhaled by the pilot. In this case both the Mk. 17F regulators were set to normal. It is most likely that there was contamination of the cockpit with carbonmonoxide due to an inflight fire and this carbonmonoxide was inhaled by the pilot resulting in his incapacitation. If 100% oxygen was breathed by the pilot in this case, it is quite certain that he would not have got incapacitated due to carbonmonoxide intoxication.

It is not known whether the instructor or the pupil was in actual control of the aircraft. In view of the exercise prescribed and the pupil being in the left hand seat, it could be assumed that the pupil was flying the aircraft. The cause of the accident was established to be due to pilot incapaciation as a result of carbonmonoxide intoxication by inhalation of smoke or fire fumes while in-flight. This postulation is based on the following facts :—

(*a*) Soot particles in the
(*b*) Generalised moderat
of tissues/organs.
(*c*) Blood carboxyhaemoglobin
(*d*) Instantaneous death from
sickness

Conclusions

The role of toxicological investigation in
lighted in this case report. The importance
brought out in brief.

It is well known that majority of our aircraft accidents are due to pilot error and it is quite likely that aviation toxicology may give a clue to some of these accidents. In this regard setting up of aviation toxicology cells for such investigations is well justified.

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