AIRCRAFT CABIN AIR
International Conference 2019

IMPERIAL COLLEGE LONDON
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Congress on Poisoned Aircraft Cabin Air

First Solutions to the Problem Become Visible

From 17 to 18 September 2019, the "International Aircraft Cabin Air Conference 2019" took place at Imperial College in London. Reason for the conference: The aircraft cabin air is contaminated by leaking engine oil. This has sometimes led to significant health problems for pilots and flight attendants and has resulted in periodic incidents in air traffic. Contaminated air in the cockpit can threaten flight safety due to pilot failure. 30 speakers reported and discussed the latest technical and medical findings with 120 other participants. It's about the air we all breathe in passenger airplanes. Technical solutions were presented. Discussed were filters and converters to improve the air quality and sensors for air measurement. The problem of contaminated cabin air is complex and covers the fields of medicine, occupational medicine, toxicology, technology, air law and labor law. The strategic behavior of the industry was also analyzed. A tactic of obfuscation and delay is generally observed here. For proactive companies, on the other hand, new business areas are opening up.

Prof. Scholz of HAW Hamburg started his technical lecture with an incident on Thursday, August 22, 2019, 21:16 UTC. MAYDAY MAYDAY MAYDAY. The crew of an Airbus A321neo (N218HA) from **Hawaiian Airlines** sends out an emergency call on the flight from Oakland to Honolulu (HA47): "Fire in the cargo hold!" Immediately after the descent was initiated, the **cabin had filled with biting smoke**. The pilots put on the oxygen masks and now breathe pure oxygen. In this way, they are protected from the smoke and can guide the aircraft safely. A few minutes later, the smoke detectors in the cargo hold respond. The pilots activate the fire extinguishing system in the cargo hold. While the pilots are protected by their oxygen masks, all passengers and cabin crew members in the cabin are exposed to the toxic smoke. The pilots do not release the oxygen masks for the passengers for fear of providing the fire with even more oxygen.

Smoke in the cabin on the flight from Oakland to Honolulu (HA47) (Glen Westenskow)

Immediately after landing, emergency evacuation follows. The passengers leave the plane via emergency slides. After just 30 seconds, all passengers are safely on the ground. Seven passengers are taken to a hospital. The cargo hold is being investigated, but no trace of a fire is found. A few hours later Hawaiian Airlines reports that the **reason for the smoke was a faulty engine seal**.

Emergency evacuation after safe landing of flight HA47 in Honolulu (Sam Chui)

Nearly identical incidents had occurred previously: on 5 August 2019 it hit an Airbus A321 (G-MEDN) from **British Airways** on the flight (BA-422) to Valencia and on 10 December 2018 an Airbus A320 (VT-ITR) from **Indigo** on flight (6E-237) to Calcutta. In the latter flight, the flight attendants distribute wet cloths through which passengers should breathe. The flight attendants thus followed a recommendation of the aircraft manufacturer. A damp cloth is unsuitable as a filter against nerve gas. However, protection can be provided by a professional breathing mask with a suitable filter. However, breathing mask are not available on board.

Passengers breathe through cloths on the flight 6E-237 to Calcutta to protect themselves from smoke
(Rohit Khemka)

The aforementioned extreme failures, where the cabin is full of smoke from leaking engine oil, are just the tip of the iceberg. On many flights, only a **smell of "dirty socks"** is detected. The smell comes from the base stock of the oil. The oil escapes from the seals at the bearings of the engine shafts. In this way, it gets into the very hot air of the engine compressor and is directed from the air conditioning system finally into the cabin. This occurs regularly by design in small quantities, increased by wear of the seals and in large quantities in a partial or complete failure of the seals (as in the three examples mentioned). When the oil gets into the hot air, it pyrolyzes (burns) into a large number of potentially dangerous chemical products. This results in the development of Volatile Organic Compounds (VOC) and Ultra Fine Particles (UFP). Particularly problematic is the additive tricresyl phosphate (TCP) in the oil. TCP becomes dangerous at the latest when it comes into contact with very hot air in the engine. Less dangerous isomers of TCP can then turn into highly toxic isomers. **TCP damages the nerves and leads to paralysis.**

Judith Anderson of the Association of Flight Attendants analyzed databases of the US FAA with data from the years 2002 to 2011. She looked at events with fume/smoke or smell on the plane caused by oil. The databases were the FAA Accident Incident Data System (AIDS) and the Service Difficulty Reporting System (SDRS). Anderson detected more than **3,000 events with contaminated air from the engine**, with more than 1300 of them explicitly due to oil. However, the FAA reported to the US Congress in a report from 16 August 2013, only 18 such events and could not find the internal report with the evaluation on demand. The FAA thus supports the concealment tactics of the aircraft manufacturers when it come to the issue of cabin air contamination.

Iceland Air reported extremely dirty air ducts from oil on the B757 aircraft with Rolls-Royce RB211-535 engines (see picture). Iceland Air showed exemplary proactive behavior. The airline introduced an internal reporting system to better understand the events and the acute health effects on the crew. Rolls-Royce is proud of the long times that the RB211-535 engine can remain on the aircraft without any major overhaul. However, this leads to components that wear out so much that it comes to oil leakage, as Rolls-Royce confirmed after examining an engine of Iceland Air. These oil leaks (and potentially resulting damage to crew health) are accepted for the benefit of low maintenance costs.


An oil-contaminated air duct and air outlet, Boeing 757 (Iceland Air)

BASF's combined **ozone/VOC converter** can be retrofitted to the Airbus A320, A330/340 and A380 aircraft with minimal effort. Ozone/VOC converter could help with the problem described here. However, little is reported of their use, although the ozone/VOC converter have been on the market since 2005. Pure ozone converter are used by airlines where they are legally required, but they do not help against VOC.


Ozon/VOC converter (BASF)

Due to the increasing pressure from pilots and flight attendants, a few airlines voluntarily use **carbon filters** against the VOCs. These are offered for aircraft of the A320 family. The simple use of the filters is possible because they are integrated into existing filters that are already present in the recirculation path of the cabin air in the aircraft. In the recirculation only a limited effectiveness can be achieved. An existing pollutant concentration can only be lowered to about 60% of the value without carbon filter. (This with a measured effectiveness of the filter of 70%.)

Carbon filter installed in the recirculation path of the cabin air (Pall)

The filter manufacturer Pall is therefore working on the **certification of carbon filters** for aircraft of the A320 family, which are installed **in the supply line to the cabin** and thus capture the entire air flow. In combination with the filters in the recirculation, an existing pollutant concentration could be lowered to approximately 18% of the value without carbon filter. The certification will take at least a year and the introduction at interested airlines will be quite slow, because the installation is more demanding than a simple filter change.

Cabin air, which is completely free of oil vapor, can only be **provided by separate compressors**, which have an air intake at the fuselage. Such a compressor should be equipped as far as possible with air bearings. The Boeing 787 flies with such a clean system and saves fuel in addition. Just waiting for new airplanes is not enough, because they would need to be designed and built with this system and would subsequently need to replace the old airplanes in operation. As such the problem of contaminated cabin air would only be solved after decades.

Certification rule CS-25.1309(c) for passenger aircraft requires air sensors on board. These sensors do not exist despite the requirement. **The responsible pilots would then - if necessary, on their own initiative - bring air sensors on board** that warn in case of toxic cabin air based on certain marker substances. Suitable markers, for which there are also affordable sensors available, could be carbon monoxide (CO), formaldehyde (HCHO) and Ultra Fine Particle (UFP). "Detection does not have to be perfect to be useful. If we insist on perfect technology, it will never happen" explains Prof. Jones, Kansas State University. But for legal reasons alone, the industry will do everything possible to prevent regular air measurements in the aircraft. Those who could sue the industry for damaged health should be deprived of the evidence. It's not just one case in court. There are hundreds.

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Links

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Presentation of Prof. Scholz:	http://bit.ly/2me1b3P (PDF)
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This conference summary in German:	http://bit.ly/2kSj480 (PDF)