

- synthetic jet engine oils containing organophosphates such as TCP “are harmful compounds” as they exert a toxic activity.... and as such should be avoided as far as possible
- Need to:monitor what is at the outlet, what is the exposure, what is the composition of the complex mixture & large scale epidemiological survey
- Need to use less toxic or non toxic substances in engine oils
- „beta-naphthylamine which is a proven human carcinogen of high potency” is in the oil
- It is the active metabolite that is of concern whether it is digested, inhaled or absorbed.

Tim van Beveren: Would you inhale heated engine oil?

Prof. Dr. Henschler: Me? No, never, I've no experience. I was very much surprised to read these reports.

Tim van Beveren: You did research back 60 years ago. You initiated research, you found that there is a high toxicity. What does it tell you now 60 years later? It seems that people do not draw the right conclusions?

Prof. Dr. Henschler: It tells me that they haven't picked up the recommendations of careful toxicologists. I have always recommended to keep emission exposures as low as possible and look for better alternatives, so it was much of a surprise to me to be informed of those types of incidents.

Additional comments :(SM) immediate & chronic effects being seen could be related to other TCP isomers (Meta/para) & synergistic mixture of chemicals

Aviation industry quotes on TCP: selected examples only

UK HOL Inquiry 2000: final report: "The absence of confirmed cases of tri-ortho-cresyl phosphate (TOCP) poisoning from cabin air and the very low levels of TOCP that would be found even in the highly unlikely worst case of contamination from oil leaking into the air supply lead us to conclude that the concerns about significant risk to the health of airline passengers and crew are not substantiated."

CAA Cabin Air Quality 2004:

- " The occupational exposure limit for tricresylphosphate should be interpreted in the light of the ortho isomer of tricresyl phosphate (TOCP) being the most toxic "
- TCP isomers were extracted using organic solvents and the levels of ortho-, meta- and para-TCP isomers were higher in the used ducting than in unused ducting, used and unused oil. TOCP levels were low and the levels of the meta- TCP isomer were greater than the levels of the other two TCP isomers.
- Some additional compounds were found in Phase 2, including the ortho isomer of tricresyl phosphate (known as TOCP), but toxicological review of these previously unrecorded chemicals indicates that they are most unlikely to be present in sufficient concentration to have a physiological effect and, in any case, the specified symptoms were not the same as those associated with exposure to TOCP.
- In the previous studies of pyrolysed oil carried out at DERA Pyestock [1] no triorthocresylphosphate (TOCP) was detected because the GC-MS method used was very much less sensitive than the GC-FPD method used in this study. Given the established toxicity of TOCP and the “worst case scenario” (i.e. assuming all of the TCP present is as toxic as TOCP) an “average” 70kg man could eat approximately 7000 kg of pyrolysed oil per day for 74 days and still be free of the organophosphate induced delayed neuropathy (OPIDN) associated with TOCP
- it is inconceivable that the TOCP in pyrolysed oil or in the ECS duct lining could cause OPIDN in aircraft crew or passengers. Very little toxicological data was available for the
- Calculation of Dosage of Oil required to produce Organosphosphate Induced Delayed Neuropathy (OPIDN) from Tri-Orthocresylphosphate Content

Studies of the chronic toxicity of TOCP have shown that the most sensitive species known (chickens) can be fed 20 mg.kg⁻¹(body weight; BW).day⁻¹ without showing signs of OPIDN. Signs of toxicity were observed at 60 mg.kg⁻¹(BW).day⁻¹. Given the TCP content of the pyrolysed oil supplied to Dstl by QQ Pyestock and used in the previous analysis of oil pyrolysate as 0.19 µg.g⁻¹ oil (table1, Appendix A) **Assuming all the TCP has the same toxicity as TOCP (over estimating the toxicity by 100 times)**. TCP content of oil 0.19 µg.g⁻¹ \equiv 0.19 mg.kg⁻¹ oil \equiv 0.19 x 10⁻³ g.Kg⁻¹ (oil) dosage without OPIDN 20 mg.Kg⁻¹.day⁻¹ \equiv 20 x 10⁻³ g.Kg⁻¹ (BW).day⁻¹ Therefore, oral dosage of oil without OPIDN effect is given by 20 x 10⁻³ g.Kg⁻¹(oil).day⁻¹ / 0.19 x 10⁻³ g.Kg⁻¹(BW).day⁻¹ = 105 Kg(oil).Kg⁻¹(BW).day⁻¹ Assuming a 70 kg body weight for the average human subject. The total dosage that would not induce OPIDN would be 105 x 70 = 7350 Kg.day⁻¹. An average man would therefore be able to ingest 7 metric tonnes of pyrolysed oil per day for 74 days without effect.

UK HOL Inquiry 2007:

“The Global Cabin Air Quality Executive claimed that TOCP was in fact the least toxic of the ortho isomers, with DOCP being five times more toxic and MOCP 10 times more toxic than TOCP. However, we have had no confirmation of this one way or another.”

NRC: The airliner cabin environment and health of passengers & crew: 2002: “ One of the most toxic components of TCP is tri- o- cresyl phosphate (TOCP)”

TNO 2007: Incident Response Monitoring Technologies for Aircraft Cabin Air Quality: ASHRAE Research Proposal 1306 TRP. Part 1 technology Review: Draft Report. 2007-A-R0420/B, 19 April 2007. Havermans J, Houtzager M et al. Project # 034. 68369.

“Tricresyl phosphate (TCP) exists in three isomeric forms; ortho, meta and para. The commercial product is a mixture of the three forms with as little of the highly toxic ortho isomer (TOCP) as possible”

Rolls Royce (UK House of Lords evidence 2000):

“ Historically the higher TCP toxicity was caused by the presence of a specific chemical isomer – Tri-ortho cresyl phosphate (TOCP), indeed some decades ago industry and military oil specifications... required that TOCP levels be restricted to less than 1% in TCP. Further industry improvements now mean that all current TCP used in the formulation of aviation lubricants contain far less than 0.1% of TOCP as a contaminant.. Hence the TCP supplied for adding to aviation lubricants is classified as harmful not toxic..... As TCP concentration in working oil is 1-3%, the harmful classification does not apply to the final lubricant mixture.”.....Tricresyl phosphate (TCP) is used in the oil system of aero engines to prevent waer in the transmission system of the engine and are essential to maintain current levels of safety and reliability. The toxic element of TCP (=TOCP) has been reduced over the years so that aero-engine oils are now essentially non toxic (circa ppb).

Medical Toxicology Unit (Guys & St Thomas Hospital), UK - (House of Lords evidence 2000)

“Tri-ortho cresyl phosphate (TOCP) occurs as a contaminant in industrial grade tricresyl phosphate, which contains predominantly the meta and para isomers.. Modern mixtures contain less than 1% of the ortho isomer (Gosselin 1984). The ortho isomer is by far the most toxic of the 3 isomers, followed by TMCP and TPCP in decreasing order of toxicity.”

Airbus: M Geoffrey Thomas, Airbus Industrie: Evidence to 2000 UK House of Lord Inquiry, UK: 20/6/00 : Q 461

“.... it is clear that there are some toxic additives added to the oil and these, according to my understanding from the oil manufacturers are in the order of 0.3%: TCP is at 3% and the toxic part is a tenth of that.... We did a calculation yesterday afternoon.... We said if in a failure of an engine, all the oil went into the compressor, how much of that oil would then go into the cabin and then how much of that would be toxic.? By a reasonable distribution 10% of the leaking oil would go into the air conditioning..... 1.2grammes of toxic parts representing a

concentration versus air of 5ppm. I do not know what that means, I would like a public body to tell me what it means.”

UK HOL Inquiry 2000: final report; 4.39 Calculations by **Airbus** Industrie (Q 461 and refined in subsequent correspondence) showed that the worst-case scenario of the total discharge of an engine’s lubricant into the engine would result in about 0.4 kg of oil passing into the cabin ventilation systems. Assuming that the oil contained 3% TCP, of which 0.1% was TOCP, the peak cabin atmosphere TOCP level would be about 0.025 mg/m³, reducing as a result of normal ventilation thereafter. The peak level would be a quarter of the workplace limit of 0.1 mg/m³ (and less than a tenth of the emergency workplace limit of 0.3 mg/m³). Contamination at much lower levels would result in visible smoke and odour which would normally result in the crew switching off the ventilation feed from the affected engine.

See Airbus quote at end of document.

Professor M Bagshaw: The Aerotoxic Syndrome. Sept 2008:

“ The toxic effect of the ortho isomer, TOCP is impairment of the neuromuscular and peripheral nerve synapse; It has no effect on brain or cognitive function

Professor M Bagshaw: The Aerotoxic Syndrome: European Society of Aerospace Medicine(EASM) 2008:

“Tricresylphosphate (TCP) has previously been detected at very low levels in cabin air. The focus of some toxicologists on the ortho isomer (TOCP) is because only this form (<01% of TCP lubricant) produces delayed polyneuropathy after conversion in the body to a toxic cyclic phosphate.

Dr. David Ray, Nottingham University Medical School, United Kingdom Independent member of the UK Committee on Toxicity of Chemicals in Food, Consumer products and the Environment (COT): Presentation to IATA Air travel and health conference, Geneva, Oct 2008: Cabin air quality: the UK Committee on Toxicology’s review of the available evidence:

“What about TOCP monitoring?: This will be included in the measurements requested by the COT. Tricresylphosphate (TCP) has previously been detected at very low levels in cabin air. The focus of some toxicologists on the orthoisomer (TOCP) is because only this form (<0.1% of TCP lubricant) produces delayed polyneuropathy after conversion in the body to a toxic cyclic phosphate:..... There is no point in removing one potentially suspect chemical (e.g. TOCP) if the real culprits remain, or it is replaced with something worse.”

Craig P, Barth M. Evaluation of the hazards of industrial exposure to TCP: A review and interpretation of the literature. 1999 Mobil -Journal of Toxicology & environmental health, part B, 1999

" Although TOCP is not the most toxic triaryl Phosphate isomer, it is an appropriate surrogate because other aryl phosphate esters have been compared to it in a variety of investigations."

Mobil evidence to Australian Senate Inquiry, 2000 (Mackerer, Ladov); “In the TCP additive TOCP levels are calculated to be <5ppb, mono ortho cresyl phosphate ~3070ppm and di-ortho cresyl phosphate ~6ppm. These values are reduced by 33 fold after dilution in the oil”

Mobil; evidence given by J C Plummer (Mobil Oil Australia) to Australian BAe 146 cabin Air Quality Senate Inquiry: 7/10/99: Another concern we have is the highlighting in the overview of TOCP... the discussion is not relevant with respect to MJO because potential maximum concentration of this impurity in the product is around 1ppm.

Mobil: E Ladov, Product Stewardship & Toxicology to Mr J Plummer, Mobil Oil Australia, 30/4/98: scientists have known for many years that commercial tricresyl phosphate (TCP), an antiwear additive used in all major synthetic jet engine lubricants, had the potential to produce adverse nervous system effects, particularly if swallowed. The conventional wisdom was that the harmful agent was triorthocresyl phosphate (TOCP), a contaminant in TCP known to be harmful to the nervous system..... the industry and the military have had specifications for over 35 years requiring that TOCP levels be restricted to less than 1% in tCP. About 10 years ago Mobil scientists discovered that commercial jet engine oils containing TCP were still potentially harmful under ingestion eventhought |TOCP levels

were restricted to less than 1% in TCP..... Mobil began an extensive research program to identify TCPs that were essentially devoid of neurotoxic components but still were effective as antiwear additives. The new additive is in our new generation jet engine oil, Mobil Jet Oil 291.

Mobil Oil Australia: Fax from M Webb (EH&S Manager) to D Lewis Ansett Australia 23/5/97: "As can be seen on the MSDS for tricresylphosphate, the ortho isomer (which is the form for which there are health issues) is present in at levels less than 0.5% in the tricresylphosphate. The percentage of tri-ortho-cresylphosphate in Mobil Jet Oil II is therefore very low; most probably less than 0.02%."

SM comment: A variety of Mobil related published papers are well aware of the increased toxicity of MOCP & DOCP over TOCP based on the Henschler work, however studies undertaken by Mobil suggest there is no hazard in breathing MJO containing TCP with OCP isomers as stated by the manufacturer. Additionally as can be seen above TOCP is seen as an appropriate surrogate as it is the isomer that has been studied. (Craig P, Barth M.)

**Airbus: 27JAN09 aktualisiert, 08JAN09 Erstveröffentlichung
Ölgeruch A340-600 Trent 500**

"The subject of oil contamination of the aircraft bleed system by engine or APU, leading to cabin and flight deck fumes (and supposed by some to be toxic) has a long history. All aircraft that use engine or APU bleed air to supply the air-conditioning system have the potential to supply air to the flightdeck and cabin that is contaminated with oil due to failures within an engine and APU. However, Airbus do not believe there is any scientific evidence to show that such oil fumes have toxic effects on crew or passengers. We do note that large oil leakages leading to a haze or smoke can be unpleasant on the flightdeck (which generally receives more fresh air than the cabin in relation to its size) and the FCOM procedure under these circumstances instructs the pilots to use oxygen.

Certain individuals and groups have claimed that engine and APU oil contain substances that can cause toxic effects on humans. The substance identified within aviation engine oils about which these claims are usually made is TRI-ORTHO-CRESYL PHOSPHATE (TOCP).

TCP is an anti-wear additive used for many years in aviation oils, it typically forms 1 to 3% of the oil. One component of TCP is Tri-Ortho-Cresyl Phosphate (TOCP). TOCP in high concentrations is indeed toxic. However, TOCP forms a very small part of the TCP additive, typically less than 0.1% of the TCP additive. With a little bit of mathematics you can see that the TOCP content of aviation oil is extremely small. In 2000, Airbus was invited to provide evidence to a UK Government inquiry into aircraft cabin health and safety matters. Airbus along with other aircraft manufacturers submitted evidence which included the calculation of a worst case scenario oil leakage into the aircraft air supply and the resulting level of TOCP in the cabin/flightdeck air. The calculation concluded that in the worst case scenario (total engine oil loss through the engine !), the level of TOCP was well below typical health and safety limits. Please see the following extract:

"4.39 Calculations by Airbus Industrie (Q 461 and refined in subsequent correspondence) showed that the worst-case scenario of the total discharge of an engine's lubricant into the engine would result in about 0.4 kg of oil passing into the cabin ventilation systems. Assuming that the oil contained 3% TCP, of which 0.1% was TOCP, the peak cabin atmosphere TOCP level would be about 0.025 mg/m³, reducing as a result of normal ventilation thereafter. The peak level would be a quarter of the workplace limit of 0.1 mg/m³ (and less than a tenth of the emergency workplace limit of 0.3 mg/m³). Contamination at much lower levels would result in visible smoke and odour which would normally result in the crew switching off the ventilation feed from the affected engine. "

The conclusion that the report comes to in relation to this matter was:

"The absence of confirmed cases of TOCP poisoning from cabin air and the very low levels of TOCP that would be found in even the highly unlikely worst case of contamination from oil leaking into the air supply lead us to conclude that the concerns about significant risk to the health of airline passengers and crew are not substantiated. "

27JAN09 aktualisiert, 08JAN09 Erstveröffentlichung

SAE E-34: Aviation propulsion Lubricants committee: A review on the relationship between gas turbine lubricants and aircraft cabin air quality: Committee members incl: S Marshman, S Lee,.... (2002)

“ Tricresyl phosphate is a mixture of isomers of which the tri-ortho cresyl phosphate is the most toxic”

UK: House of Lords: January 2008:

14 Jan 2008 : Column WA238

Aviation: Air Contamination

Lord Tyler asked Her Majesty's Government:

Which of the tricresyl phosphate (TCP) isomers they consider is the most and second most toxic isomer of TCP. [HL1111]

The Parliamentary Under-Secretary of State, Department of Health (Lord Darzi of Denham): The Government have not undertaken a specific comparative toxicological assessment of tricresyl phosphate isomers.

Lord Tyler asked Her Majesty's Government:

Whether they consider mono-ortho-cresyl-phosphate (MOCP) more or less toxic than triorthocresyl phosphate (TOCP); and when this toxicity was first accepted. [HL1112]

Lord Darzi of Denham: The Government have not carried out a specific comparative toxicological assessment of mono-ortho-cresyl-phosphate and triorthocresyl phosphate.

House of Commons -27 Apr 2004 :

Column 888W

TRANSPORT

Aviation

Mr. Tyler: To ask the Secretary of State for Transport (1) whether the investigation by the Civil Aviation Authority into cabin air quality considered the presence of (a) mono-ortho, (b) di-ortho and (c) other toxic isomers of tricresyl phosphate other than the ortho isomer in engine oil; and whether it considered evidence for a link between repeated low-level exposure to organophosphates and chronic neurotoxicity; [168647]

(2) whether the investigation by the Civil Aviation Authority into cabin air quality took evidence from (a) doctors and (b) other medical experts who have studied the cases of crews and passengers affected by contaminated air exposure on commercial jet aircraft; [168648]

(3) whether unions representing cabin crew members were consulted during the preparation of the recently published Civil Aviation Authority Report on cabin air quality. [168649]

Mr. McNulty: The investigation carried out by the Civil Aviation Authority (CAA) into cabin air quality focused only on substances found in air conditioning ducts of a certain type of aircraft. The study was commissioned to investigate the safety implications arising from potential incapacitation in flight crew as a result of contaminated cabin air. As such the CAA did not consider the presence of other substances and effects on low-level exposure. This was a specific piece of scientific research; therefore it was not appropriate for the CAA to seek views, either from medical experts or other stakeholders. The Aviation Health Unit is currently considering the extent to which further research should be commissioned into the presence in the cabin air of organophosphates and their effect on passengers and crew.

Comment: TOCP found in aircraft air conditioning ducts during CAA 2004 investigations

UK House of Commons, January 2006

30 January 2006 : Column 18W

Cabin Air Supply

Mr Jenkins: To ask the Secretary of State for Transport if he will ask the Civil Aviation Authority to investigate organophosphate contamination of cabin air supply on commercial aircraft; and if he will make a statement.

Ms Buck: The House of Lords Select Committee on Science and Technology did an investigation, which reported in November 2000 and said:

“The absence of confirmed cases of tri-ortho-cresyl phosphate (TOCP) poisoning from cabin air and the very low levels of TOCP that would be found in even in the highly unlikely worst case of contamination from oil leaking into the air supply lead us to conclude that the concerns about significant risk to the health of airline passengers and crew are not substantiated.”

In 2004 the Civil Aviation Authority (CAA) published research into fume events by the Defence Science and Technology Laboratory Porton Down and the (then) Defence Evaluation and Research Agency. That concluded that

'no single component or set of components can be identified which at conceivable concentrations would definitely cause the symptoms reported in cabin air quality incidents'.

But acids were found which could act as irritants, and as a result CAA brought in specific troubleshooting and maintenance actions to minimise the potential for fume events.

UK House of Commons, January 2006

26 Jun 2006 : Column 32W

Aeroplanes (Air Quality)

Mr. Maples: To ask the Secretary of State for Transport (1) what recent research he has (a) commissioned and (b) evaluated on contaminated air in airliners; [80119]

(2) what recent assessment he has made of the effect on safety of contaminated air in airliners. [80147]

Gillian Merron: The House of Lords Select Committee on Science and Technology did an investigation, which reported in November 2000 and said:

“The absence of confirmed cases of tri-ortho-cresyl phosphate (TOCP) poisoning from cabin air and the very low levels of TOCP that would be found even in the highly unlikely worst case of contamination from oil leaking into the air supply lead us to conclude that the concerns about significant risk to the health of airline passengers and crew are not substantiated.”

UK House of Commons, January 2006

Thursday 22 February 2007

Aviation: B-naphthylamine

Lord Tyler asked Her Majesty's Government:

What discussions have taken place with the Civil Aviation Authority concerning the presence of B-naphthylamine in synthetic jet oil; and what level of B-naphthylamine is permitted in aircraft cabin air; and [HL1960]

What is their response to advice from ExxonMobil that B-naphthylamine is present in their Jet Oil II product. [HL1961]

Lord Bassam of Brighton: There have been no discussions with the Civil Aviation Authority on this substance. The department is not aware of the presence of B-naphthylamine in aircraft cabin air. The Government are not aware of such advice from Exxon. We are aware, from the ExxonMobil safety data sheet for Mobil Jet Oil II, that the oil contains N-phenyl 1 Naphthylamine.