

PTI Technologies Inc.

Advanced Technology Filtration For A Better Crew And Passenger Experience

Aircraft Cabin Air International
Conference 2021
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Situation And Need – Our View

- ▶ Aircraft cabin air comes from two sources
 - 50% - “Fresh” Air (bleed air from engine / APU compressor section)
 - Exception is 787 – ram air
 - 50% - Recirculated Air from cabin
- ▶ The Recirculated Air is treated today – HEPA Filters
 - Removes particulates, viruses, bacteria, fungus
 - Does not handle gases/odors – need second media (activated carbon)
- ▶ However, “Fresh” Air really has no treatment except Ozone
- ▶ The “Fresh” Air component is the driver of air quality
 - Contains aerosols, VOC’s, particulates and ozone
 - Creates health/safety issues for flight crew
 - Degrades passenger experience
 - No filtration/removal and low ozone conversion at lower temperatures

An Effective Solution For Bleed Air Filtration Is Needed

Potential VOC's In Engine Bleed Air

1,1,1-trichloroethane
 1,1,2,2-tetrachloroethane
 1,1,2-trichloro-1,2,2-trifluoroethane (Freon-113)
 1,1,2-trichloroethane
 1,1-dichloroethane
 1,1-dichloroethene
 1,2,4-trichlorobenzene
 1,2,4-trimethylbenzene
 1,2-dibromoethane
 1,2-dichlorobenzene
 1,2-dichloroethane
 1,2-dichloropropane
 1,2-dichlorotetrafluoroethane (Freon-114)
 1,3,5-trimethylbenzene
 1,3-butadiene
 1,3-dichlorobenzene
 1,4-dichlorobenzene
 1,4-dioxane
 2,2,4-trimethylpentane
 2,3-dimethylpentane
 2-butanone (methyl ethyl ketone)
 2-hexanone (methyl butyl ketone)
 3-Methylhexane
 4,4'methylene bis(o-chloroaniline)
 4-ethyl toluene
 6methyl5heptene2one
 acenaphthene
 acetaldehyde ←
 acetone ←
 acrolein ←
 AHTN
 anthracene
 benzene ←
 benzo(a)anthracene
 benzo(a)pyrene ←
 benzo(b)fluoranthene
 benzo(c)pyrene
 benzo(ghi)perylene

benzo(k)fluoranthene
 benzyl acetate
 benzyl chloride
 biphenyl
 bromodichloromethane
 bromoform (tribromomethane)
 butyl benzyl phthalate
 carbon disulfide
 carbon tetrachloride (tetrachloromethane)
 chlorobenzene
 chloroform (trichloromethane)
 chrysene
 cis-1,2-dichloroethene
 cis-1,3-dichloropropene
 cis-permethrin
 cyclohexane
 decanal
 di-2-ethyl hexyl phthalate
 dibenzo (a,b)anthracene
 dibromochloromethane
 dibutyl phthalate
 dichlorodifluoromethane (Freon-12)
 diethyl phthalate
 ethanol ←
 ethyl acetate
 ethyl chloride (chloroethane)
 ethylbenzene
 fluoranthene
 fluorene
 formaldehyde ←
 heptane
 hexachloro-1,3-butadiene
 hexane
 hexyl cinnemal
 HHCb
 Indeno(1,2,3-cd)pyrene
 isoprene (2-methyl-1,3-butadiene)
 isopropyl alcohol

limonene
 m&p-xylene
 methyl bromide (bromomethane)
 methyl chloride (chloromethane)
 methyl isobutyl ketone (4-methyl-2-pentanone)
 methyl methacrylate
 methyl tert-butyl ether
 methylcyclohexane
 methylene chloride (dichloromethane) ←
 naphthalene ←
 nonanal
 octanal
 o-xylene
 PCB 11
 PCB 52
 phenanthrene
 phenethyl alcohol
 propene
 propionaldehyde
 Pyrene
 styrene
 Sumithrin
 tetrachloroethene
 tetrahydrofuran
 toluene
 trans-1,2-dichloroethene
 trans-1,3-dichloropropene
 trans-Permethrin
 trichloroethene
 trichlorofluoromethane (Freon 11)
 tri-m,m,p-cresyl phosphate
 tri-m,p,p-cresyl phosphate
 tri-m-cresyl phosphate
 tri-o-cresyl phosphate ←
 tri-p-cresyl phosphate
 tris(2-chloroethyl)phosphate
 tris(dichloro)phosphate
 vinyl acetate
 vinyl chloride (chloroethene)

Many Potential VOC's In Bleed Air – Complex Problem To Remove All

Situation And Need – Our View

- ▶ What are the challenges for effective solution for Bleed Air?
 - Which VOC's to remove – which possible ones to choose?
 - How to best remove aerosols (liquids, particulates)?
 - How to get better ozone conversion - especially at low temperatures?
 - Packaging filter for aircraft (footprint, weight, certification, life)?
 - How to make installation easy (new, existing)?
 - How to make cost effective to install, operate and maintenance?
- ▶ Fortunately, there is a solution
 - New technology for bleed air in Fuel Tank Inerting Systems (FTIS)
 - Simple design, lower weight, long life, economical costs
 - Handles aerosols, VOC's, and ozone in a single envelope
 - Combined with recirc filters – better cabin air quality
- ▶ Filter design tested – ready to fit to aircraft, working with partners

Technology Now Tested And In Hand For Bleed Air Solution

What's At Stake

- ▶ Our industry – flight crews
 - Contaminated air has impaired and incapacitated flight / cabin crew
- ▶ Our industry – passengers
 - Exposure to chemicals, fumes and ozone – public health risk
- ▶ Our industry - manufacturers
 - Idea of filtration now new – considered since 1950's but lack of solutions
- ▶ Air Accident Investigators globally and Law Courts
 - Contaminated air exposure - risk to flight safety, crew and public health
 - Understanding of chemicals present during these exposure events
 - Increased financial and legal liability
 - Call on regulators / Governments to mandate effective “bleed air” filters and contaminated air warning sensors on passenger aircraft

Call To Action – Solutions Needed For Crew And Passengers

PTI's Pedigree In Air Filtration

- ▶ Who is PTI Technologies
 - World leader in aviation/aerospace filtration for over 60 years
 - Filtration for all aircraft fluids – hydraulics, air/bleed air, fuel, water, lube
- ▶ Our experience and pedigree in air filtration
 - We have supplied air filtration for military aircraft since **the** 1980's
 - Special media developed to capture dangerous gases/chemicals/particulates
 - Continued development for military today – cabin air and breathing air
 - Developed / certified of air filtration for Space Launch System (gases)
 - Developed / certified / in-service HEPA Cabin Air Filters for airlines
 - Developed / certified / in-service engine / APU bleed air filtration
 - Developed / tested filtration combined with custom absorbents
 - Developed / tested patented FTIS filtration (Aerosols, VOC's, HEPA, Ozone)

PTI Has Pedigree And Technology For Bleed Air Solution

Aerospace Product Applications

Main Hydraulic Systems

- Multi-component Manifolds
- Pressure
- Return
- Case Drain
- System Fill

Environmental

- Cabin Air
- Electronic cooling
- Waste system
- Potable Water

Liquid Cooling Systems

- Avionics
- Radar
- Galley

Engine Filtration

- Fuel
- Main Lube
- Scavenge Lube
- Bleed Air

Electric Systems

- IDG Lube
- CSD Scavenge

Flight Control Filtration

- Rudder Control
- Elevators
- Ailerons
- Ground Spoilers
- Thrust Reversers

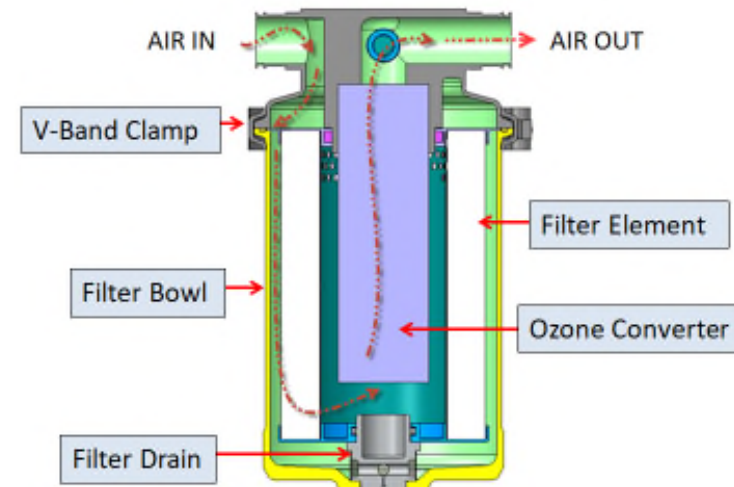
Auxiliary Power Unit

- Fuel
- Lube
- Bleed Air



PTI's Solution To Bleed Air Filtration

- ▶ Solution – Advanced Technology Filtration developed for FTIS
 - Removes Aerosols (Liquids, Particulates), Gases/VOC's, Ozone + HEPA
 - Incorporates multilayer media, active absorbent and ozone conversion
 - Proven patented technology and designs
- ▶ Tested to EN / ISO Standards
 - Aerosols (Liquids, Particulates)
 - Challenge Gases – single and mixed
 - Ozone conversion

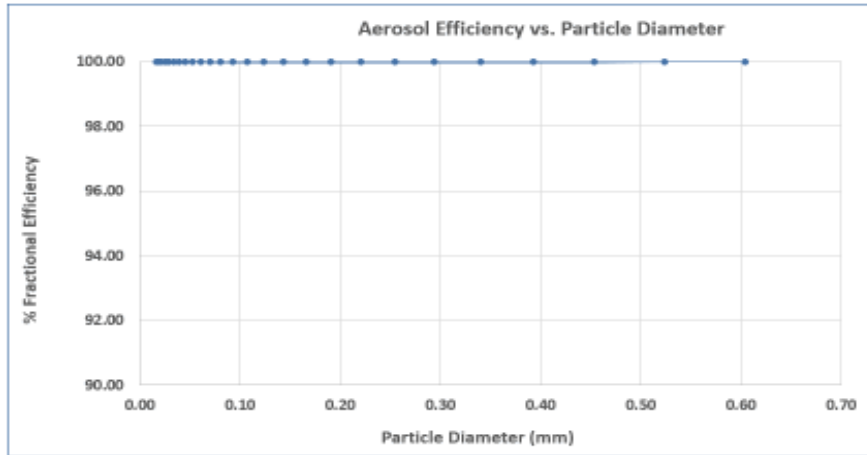


Bleed Air Filtration Testing – EN4618-2009

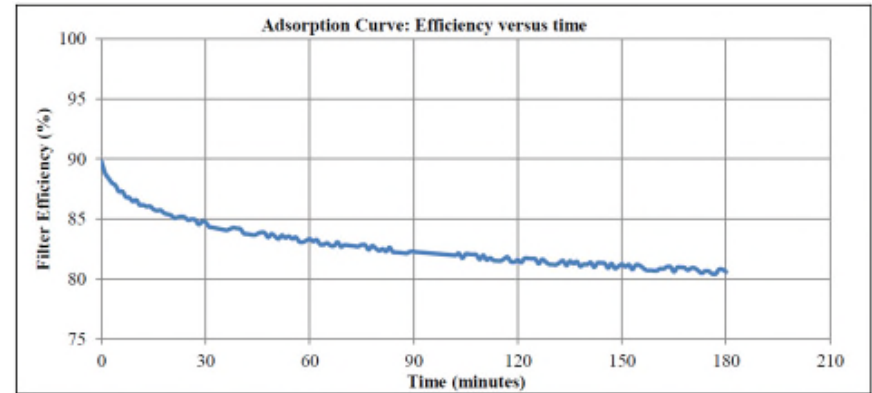
Category	Group	Compound	CAS No.	Bio-effluents	Cabin Interior	Solvents	External Conditions	Exhaust	Oils, Lubricants & Hydraulics	Fuel
Inorganic Compounds		Carbon Dioxide	124-38-9	☑			☑ ^a	☑ ^a		
		Carbon Monoxide ^a	630-08-0				☑	☑	☑	
		Nitrogen Oxides ^b	10102-44-0				☑	☑		
		Ozone ^a	10028-15-6				☑			
Inorganic / Organic Particles		Particles, aerosols		☑ ^a	☑ ^{a,c}		☑	☑	☑	☑
		Micro-organisms		☑ ^a	☑ ^a		☑			
		Endotoxins		☑ ^a	☑ ^a		☑			
Aliphatic Compounds	Alkanes	Methane ^b	74-82-8	☑				☑		☑
	Ketones	Acetone ^a	67-64-1	^d		☑			☑	
		Methyl Ethyl Ketone ^a	78-93-3			☑			☑	
	Aldehydes	Acetaldehyde ^a	75-07-0					☑	☑	☑
		Acrolein ^a	107-02-9					☑	☑	☑
		Formaldehyde ^a	50-00-0			☑ ^a	☑	☑	☑	☑
	Halogen Derivatives	Methylene Chloride ^a	74-87-3			☑			☑	
Aromatic Compounds		Benzene ^a	71-43-2					☑		☑
		Tricresyl Phosphate ^b	1330-78-5						☑	
		Toluene	108-88-3			☑ ^a		☑	☑	☑
Polycyclic Aromatic Hydrocarbons		Benzo (alpha) Pyrene ^b	50-32-8					☑		☑
		Naphthalene ^b	91-20-3					☑	☑	☑

Testing Results

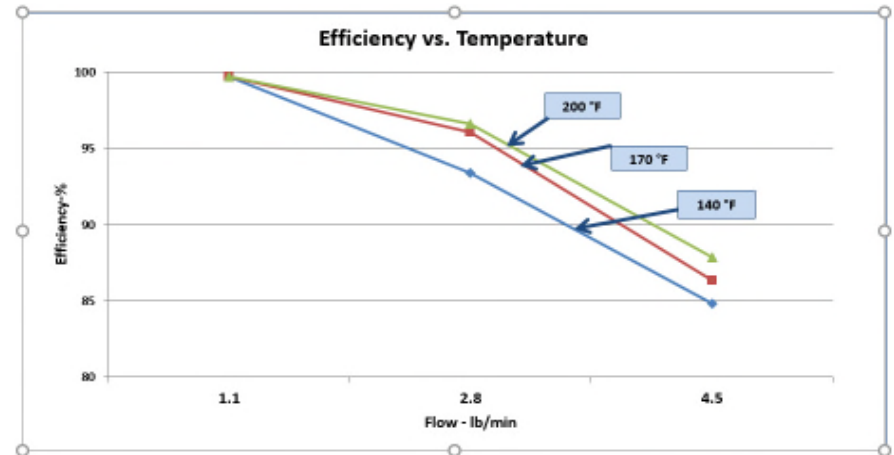
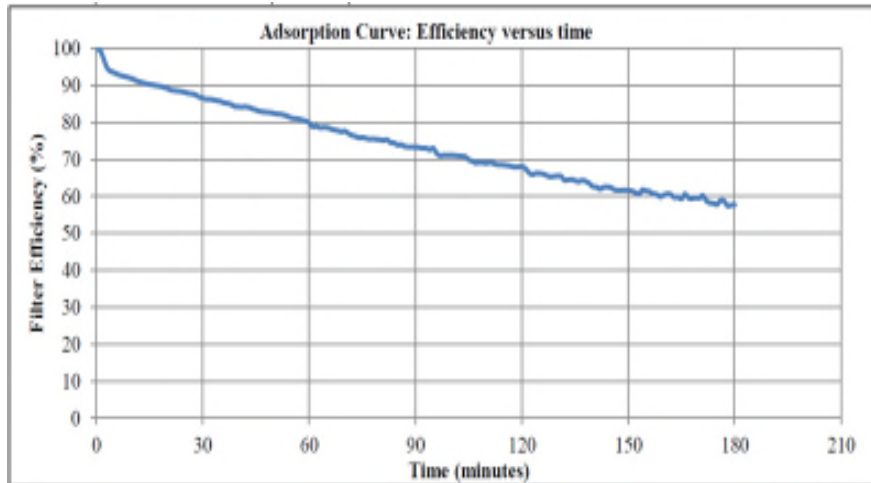
AEROSOLS (fine solid particles / liquid droplets)



OZONE



GAS ADSORPTION



What's Next

- ▶ Next step is to bring bleed air filtration in-service to airlines
 - Specifications (bleed air, filtration) to optimize design / performance
 - Prototypes / flight test program
 - Certification – STC and / or OEM
 - Retrofits / new production
- ▶ Need airline partners - collaborate on design/installation/test
- ▶ Need OEM support for simple solution
 - Certify across platforms
 - Create aftermarket support – documentation, manuals

Technology Is In Hand To Address The Bleed Air Filtration Need

For More Information / Partnering

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