

# **PTI Technologies Inc.**

## Advanced Technology Filtration for a Better Crew and Passenger Experience

David Conrad

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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 cinnamal  
 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

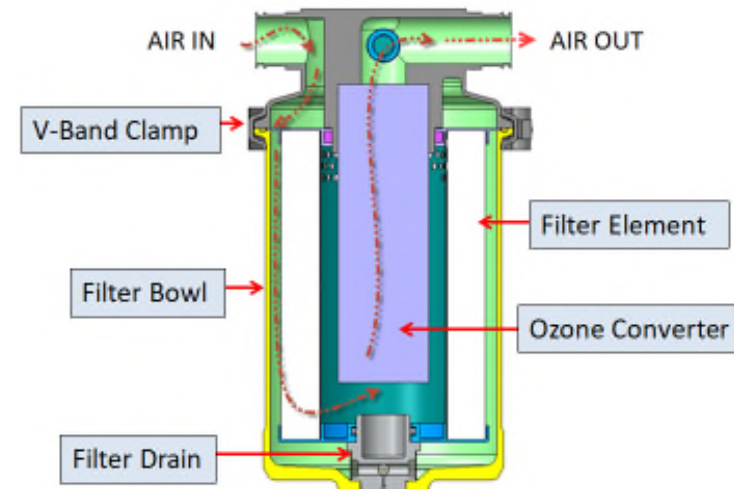
## Auxiliary Power Unit

- 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



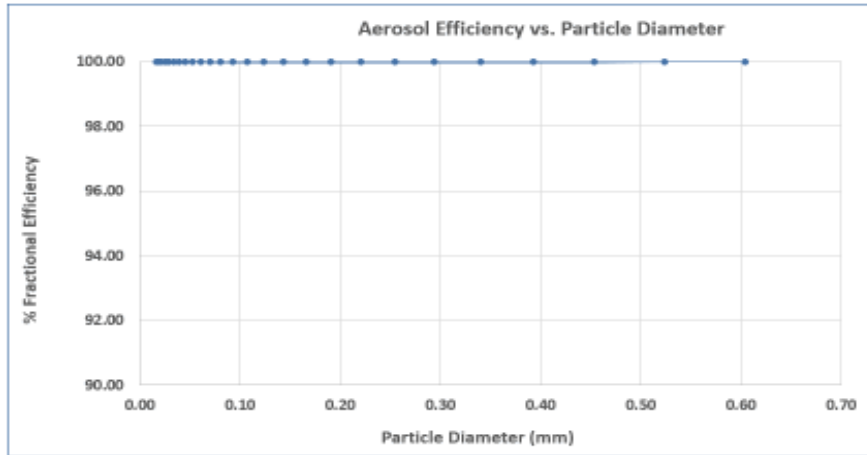


# Bleed Air Filtration Testing – EN4618-2009

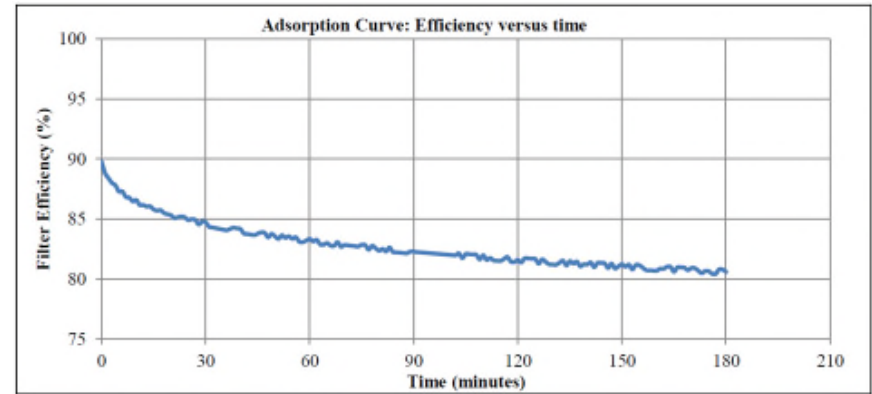
Category	Group	Compound	CAS No.	Bio-effluents	Cabin Interior	Solvents	External Conditions	Exhaust	Oils, Lubricants & Hydraulics	Fuel	
Inorganic Compounds		Carbon Dioxide	124-38-9	☑			☑ <sup>a</sup>	☑ <sup>a</sup>			
		Carbon Monoxide <sup>a</sup>	630-08-0				☑	☑	☑		
		Nitrogen Oxides <sup>b</sup>	10102-44-0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

# Testing Results

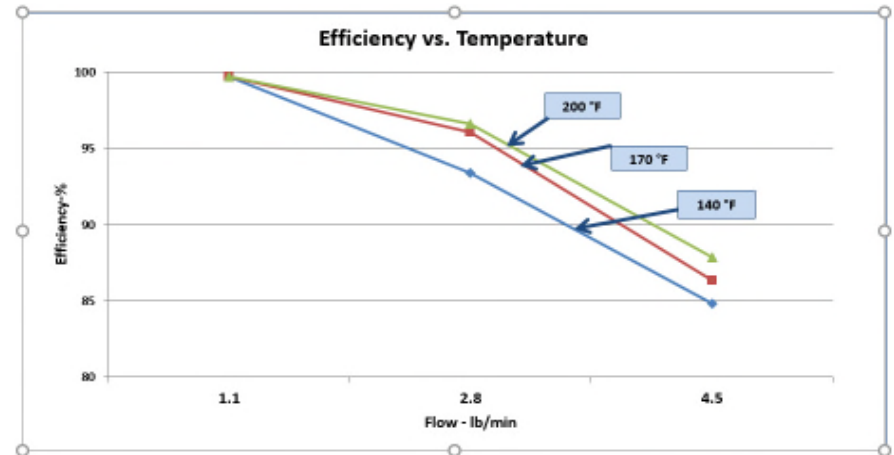
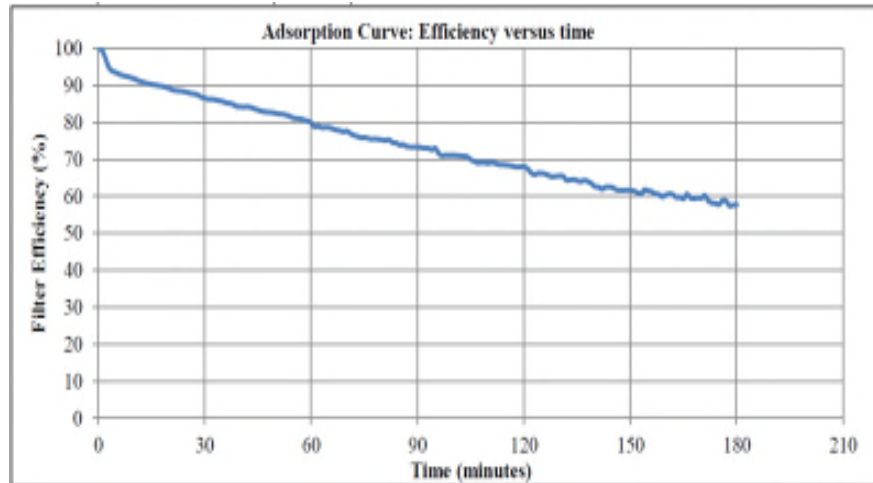
## AEROSOLS (fine solid particles / liquid droplets)



## 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

### **CONTACT:**

David Conrad, VP, Business Development

[dconrad@ptitechnologies.com](mailto:dconrad@ptitechnologies.com)

+1 (805) 604-3844