Microbial Contamination in Jet Fuel & Filtration

Protecting Fuel Quality and Mission Readiness

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Overview

- The Threat: Overview of Microbiological Contamination (MBC)
- The Consequences: Operational Impacts & Safety Risks
- The Solution Part 1: Identification Through Visual Inspection and Good Housekeeping
- The Solution Part 2: Proper operation of Engineered Controls– Filter Water/Separator will be used as the example
- Key Takeaways & Conclusion

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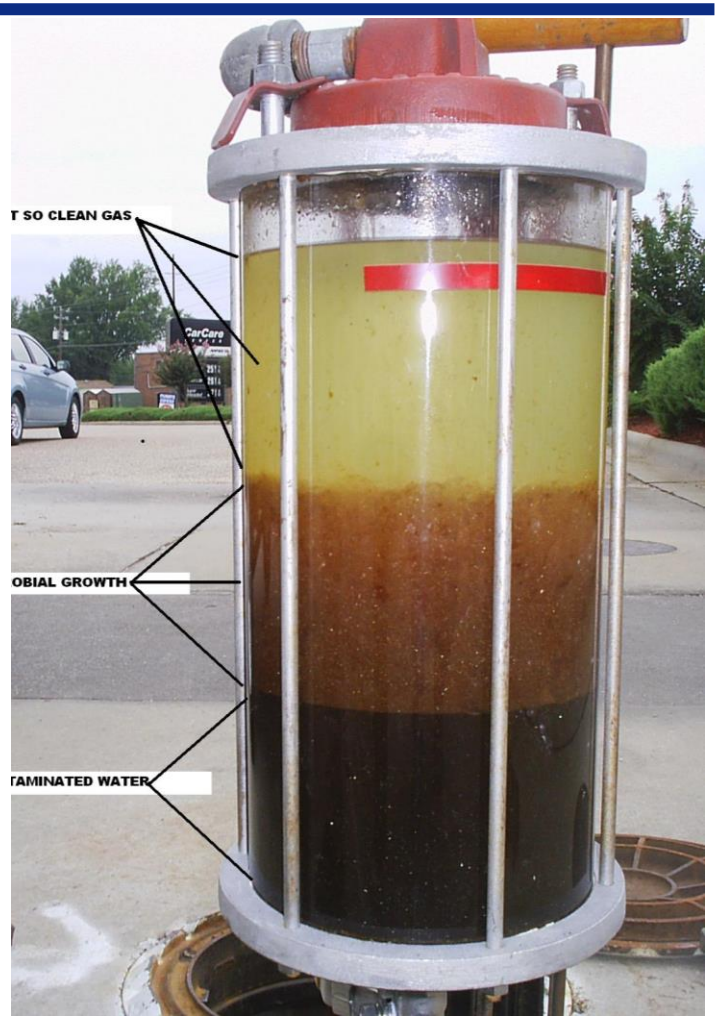
The Threat: What is MBC?

- MBC is the proliferation of microorganisms (bacteria, fungi) in fuel systems.
- Three elements are required for growth:
  - Fuel: A hydrocarbon food source.
  - Microbes: Ubiquitous in the environment.
  - Water: The essential growth medium.
- The Core: MBC requires water for growth...their growth and general activity is restricted to the water phase of fuel systems.
- The Punchline: If you control the water, you control the microbes. No water = no microbial growth.



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The Threat: Presence vs Active Contamination

- Microbes are Ubiquitous
  - Sensitive DNA tests such as the qPCR show that a low-level presence of microbes exists in all jet fuel samples, even those considered "clean."
  - For example, clean fuel tanks still contained thousands of bacterial cells per milliliter (e.g., 1.0E+04 to 1.0E+05 gene copies/mL).
- The Threshold: Presence vs. Contamination
  - A tank is only considered "contaminated" when microbes begin to grow actively. AFRL research identifies this threshold at 1 million (1.0E+06) gene copies/mL.
  - Below this level, the microbial presence is considered negligible or “clean”. Above it, there is a high risk of fuel degradation and system damage.
  - The key risk is that a low-level presence can proliferate into a major contamination event if conditions (like water presence) are favorable.

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The Consequence: Active Contamination Jet Fuel

- From Presence to Proliferation: The Problems
  - When microbial levels cross the contamination threshold, they form biofilms (slime) and cause significant operational issues.
  - Contamination often becomes evident at filter/separators because they act as a net, capturing microbes from the entire fuel system and providing a surface for them to colonize and grow.
  - When microbes migrate past the filters into aircraft fuel systems, they can lead to engine issues, jeopardizing readiness and the safety of the flight.
- Key Problems:
  - Biofouling & Clogging: Slime and biomass clog fuel filters and separators. The report notes this disables the coalescing action of filters, jeopardizing equipment and engines downstream.
  - Fuel Degradation: Microbes consume hydrocarbons as food and can change fuel composition.
  - Corrosion: MBC can cause corrosion of fuel storage and aircraft components.

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The Consequence: Aircraft Corrosion

- An Insidious Threat: This is one of the most severe consequences of unchecked MBC.
- The Mechanism (one example of many):
  - Microbes attack and degrade protective coatings and sealants inside fuel tanks.
  - Anaerobic bacteria (Sulfate-Reducing Bacteria or SRB) thrive underneath the biofilm, becoming highly corrosive.
  - The result is aggressive, localized pitting corrosion that can perforate aircraft tanks and ground storage facilities, compromising structural integrity.

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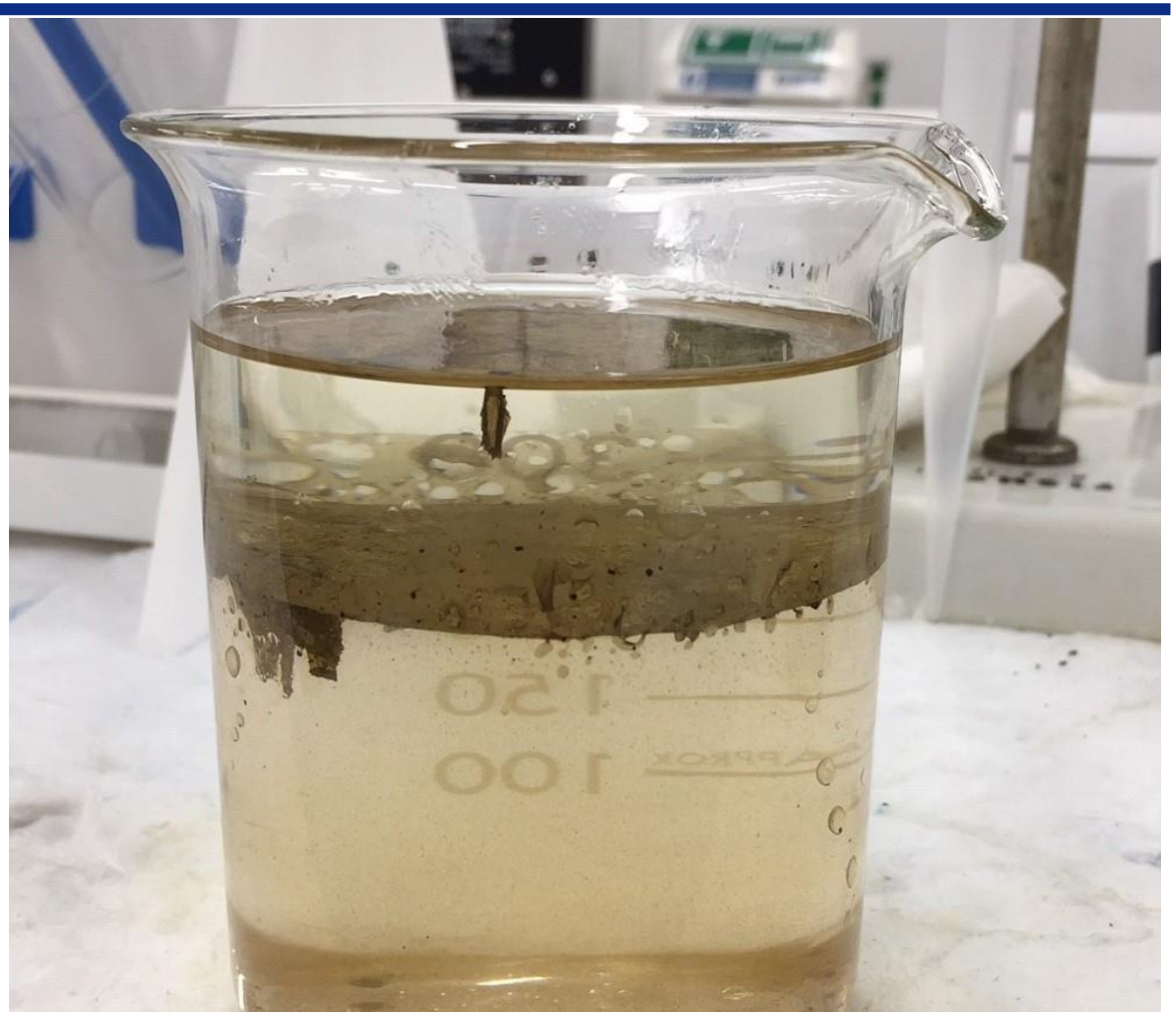
The Consequence: Aircraft Corrosion

Solution Part 1: Identification Through Visual Inspection

- The First and Often Only Method: One of the most effective ways to identify microbial contamination is through simple but vigilant visual inspection of sumps.
- Look at the Sump Sample:
  - A dark, hazy, or emulsified sample with sludge or a "rag layer" at the fuel-water interface is a direct indication of MBC.
- Focus on the FWS Sump Sample: The Filter/Water Separator sump is a critical inspection point as it concentrates water and contaminants from the fuel flow.



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Solution Part 1: Inspection Point of Filter Elements

- The Best Place to Look: The issue filter is the single best location to monitor the health of a fuel system because it acts as that "net."
- Key Visual Indicator (IATA): Look for brown or grey spots on the white coalescer elements, known as "leopard spotting" or "bruising."
- Actionable Mandate (IATA): *"Any level of 'leopard spotting' is grounds for further investigation and the elements should be changed immediately."*
- Trust Your Eyes: Do not be fooled if the filter appears to be working. A spotted coalescer is actively shedding microbes into clean fuel downstream.

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Solution Part 1: Good Housekeeping

- The Most Effective Prevention: "Remediation really begins with prevention. Because microbes require water, an intensive water removal program is important." (ASTM D6469)
- This means routine, aggressive draining of all system low points:
  - Storage Tank Sumps & Bottoms
  - Product Saver & Recovery Tanks
  - Low points, low points, low points—often overlooked
  - Filter/Water Separator (FWS) Sumps
- Go Beyond the Minimum: When large volumes of water are found, increase the frequency of sump operations to 2-3 times per day or more until the system is dry.

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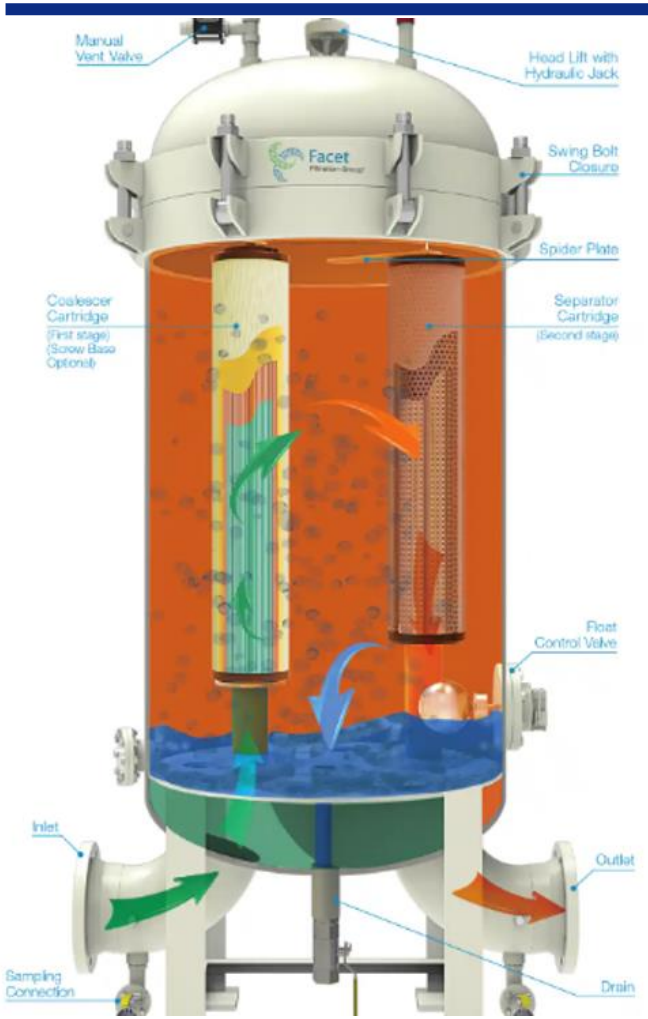
Solution Part 2:The Engineered Control FWS Stage 1: The Coalescer Element



- Flow: Inside-to-outside.
- Function 1 (Filtration): Captures solid particles like dirt and rust.
- Function 2 (Coalescing): Forces tiny, emulsified water droplets to merge (coalesce) into larger, heavier drops that can be separated from the fuel.

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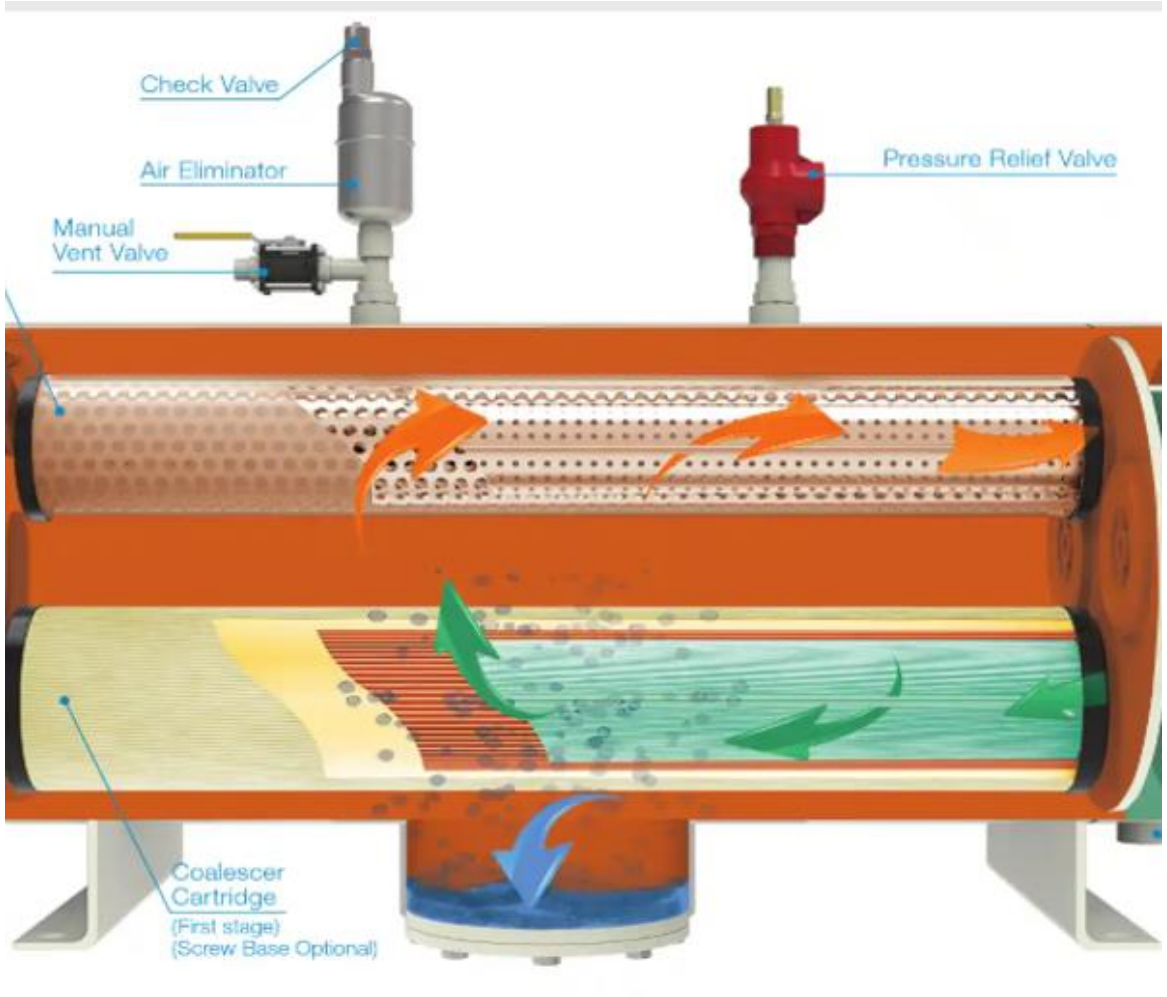
Solution Part 2: The Engineered Control
FWS Stage 2: The Separator Cartridge

- Flow: Outside-to-inside.
- Function: The separator surface is hydrophobic (repels water).
- Fuel is allowed to pass through, but the large water droplets formed by the coalescer are blocked and directed down into the sump for removal.



Solution Part 2: Engineered Controls Best Practices: Correct Filter Selection

- Requirement:
- Filters: Must be IAW the latest Energy Institute (EI) 1581 specification.
- Vessel: Must be IAW with EI 1596 specification
- Category M (Military) vs. Category C (Commercial):
  - Military jet fuels contain additives (surfactants) that can "disarm" standard coalescers.
  - Category M elements are constructed with advanced materials (e.g., fluoropolymers) specifically designed and tested to resist these surfactants and reliably remove water from military-grade fuel.
  - Using Category C filters with military fuel can compromise water removal, allowing contaminated fuel downstream.

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Solution Part 2: Engineered Controls
The Critical Role of Flow Rate

- The Problem with Low Flow: Operating an FWS at low flow rates (<50% of rated flow) is a significant risk.
- Mechanism of Failure:
  - Fuel velocity is too low to "push" the coalesced water droplets off the filter media and into the sump.
  - Water remains trapped on the filter element.
  - (IATA): The FWS, our primary defense, becomes an incubator for microbial growth.

Solution Part 2: Engineered Controls
The Critical Role of Flow Rate

Flow Rate	Context and Significance
< 25% of Rated Flow	Risk Zone. This is the documented threshold below which the risk of water stagnation and microbiological growth ("leopard spotting") significantly increases.
> 50% of Rated Flow	Recommended for Testing. This is the preferred flow rate for conducting weekly differential pressure checks to ensure accurate readings.
≥ 75% of Rated Flow	Operational Best Practice. This recommendation is for optimal, day-to-day performance, ensuring maximum efficiency and providing a large safety margin above the low-flow risk zone.

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FWS Data Plates

FILTER/WATER SEPARATOR
VESSEL DATA PLATE

VESSEL MANUFACTURER'S NAME/LOGO	VESSEL MANUFACTURER'S ADDRESS
VESSEL MODEL NUMBER:	
VESSEL SERIAL NUMBER:	
DATE OF VESSEL MANUFACTURE:	
VESSEL DESIGN CODE:	
COMPLIES WITH EI 1596	EDITION
VESSEL DESIGN PRESSURE:	
HYDROSTATIC TEST PRESSURE:	
MAXIMUM FLOW RATE (RATED FLOW):	
MAXIMUM OPERATING PRESSURE	
MAXIMUM DP ACROSS DECK PLATE:	
SUMP VOLUME:	
OPERATIONAL TEMPERATURE RANGE:	
VESSEL LID GASKET MATERIAL:	
VESSEL LID GASKET PART NUMBER:	
TORQUE FOR VESSEL LID NUTS:	
OPTIONAL DATA PLATE FIELDS:	

PLATE NOT TO BE REMOVED FROM VESSEL OR OBSTRUCTED

FILTER/WATER SEPARATOR
OPERATIONAL DATA PLATE FOR CURRENT CONFIGURATION

ELEMENT MANUFACTURER'S NAME/LOGO	ELEMENT MANUFACTURER'S ADDRESS
VESSEL SERIAL NUMBER:	
EI 1581 CATEGORY:	
EI 1581 TYPE:	
COALESCER MODEL NUMBER:	
QUANTITY OF COALESCERS INSTALLED:	
SEPARATOR MODEL NUMBER:	
QUANTITY OF SEPARATORS INSTALLED:	
MAXIMUM OPERATING FLOWRATE:	
MAXIMUM ACHIEVABLE FLOWRATE: (To be added by user/operator)	
COMPLIES WITH EI 1581	EDITION
COALESCER INSTALLATION TORQUE:	
SEPARATOR INSTALLATION TORQUE:	
MAXIMUM CHANGEOUT DP:	
SIMILARITY SHEET ID CODE:	
DATE ELEMENTS INSTALLED: (To be added by user/operator either on this plate or as a separate label on the vessel)	
OPTIONAL DATA PLATE FIELDS:	

The original Vessel Data Plate **must never** be removed. It provides the critical design pressure and temperature information for the vessel, which must be preserved for the life of the asset.

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Solution Part 2: Engineered Controls Best Practices: Operations & Maintenance

- Maintain Optimal Flow: Operate systems above 75% of rated flow where possible. This creates a "sweeping action" that prevents stagnation and moves water to the sump.
- Effective Sump Draining: Daily draining of sumps is critical to remove the water that the FWS has successfully separated.
- Visual Inspection: Routinely check coalescer elements for "leopard spotting"—brown or black spots of biomass that indicate the filter itself is contaminated and must be replaced.

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Summary: Key Principles of Filtration Readiness

- 1. Keep Water Out: Water is the enemy. A properly functioning FWS is your primary tool for removing it. Rigorous sump draining is non-negotiable.
- 2. Use the Right Tools: Always install the correct filters dependent on situation, e.g., EI 1581 Category M filters for military fuel systems to handle fuel additives.
- 3. Operate Correctly: Avoid low-flow conditions. Insufficient flow turns your filtration system into a breeding ground for MBC.
- 4. Be Vigilant: Conduct regular inspections and maintenance. "Leopard spotting" on filters is a clear sign of a problem that requires immediate action.

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Conclusion: Quality Readiness is Mission Readiness

- Microbiological contamination is a severe threat to fuel quality, asset integrity, and safety of flight.
- Water management is the fundamental principle of MBC prevention.
- Properly selected, operated, and maintained filtration systems are our most effective defense against water and, therefore, against microbial contamination.
- Report any and all visual indications of MBC to your Quality Representative.

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Questions?