**Introduction**

- In 2004, Environmental Protection Agency (EPA) conducted potable water quality tests onboard U.S. commercial aircraft.
- 15% of commercial airlines failed EPA’s potable water quality standards as a result of positive tests of total coliform.
- Regulations are created to enforce safe, potable water onboard aircraft through the Aircraft Drinking Water Rule.
- Secondary potable water treatment system onboard commercial aircraft is desired due to EPA regulations.

**Candidate Technology Requirements**

- Small, lightweight, and robust.
- Tolerates temperatures of 1°C to 55°C.
- Withstands high vibrations and turbulence.
- Low maintenance and no consumables required for operation.
- UV LEDs as a disinfection treatment technology meet all desired criteria.

**Project Scope**

- Design, optimize, and test a point-of-use UV/LED water treatment reactor for aircraft lavatory sinks.
- Design parameters include minimizing head loss, minimizing cost, optimizing fluid dynamics, and maximizing irradiance.
- Analyze current reactor’s fluid dynamics and disinfection effectiveness.

**Analysis of Current Reactor**

*Figure 1: Fluid Flow through Reactor*

The current reactor design was run through a computational fluid dynamics program (Figure 1). An overall high fluid velocity and an uneven distribution of water particles flowing through the reactor chamber indicated that this reactor would be inadequate for UV disinfection of bacterial contaminants.

*Figure 2: Particle Tracking Through Reactor*

UV disinfection effectiveness of the reactor was found by analyzing the reactor’s t_37/HRT ratio. t_37 is the time for which 10% of the water particles traveled through the reactor. The hydraulic residence time (HRT) is the average time it takes water particles to travel through the system. A t_37/HRT < 0.3 indicates reactor is short circuiting and disinfection effectiveness is very poor. A t_37/HRT = 0.4 indicated short circuiting was a problem associated with this reactor design\(^1,2\).

**Three Reactor Designs**

- **Figures 3 and 4: Single and Double Baffle Serpentine Reactors**

These basic serpentine reactors serve as a starting point because they have been used in large-scale municipal infrastructure, and have been proven to minimize short circuiting.

- **Figures 5 and 6: Three and Four Spirals Reactors**

These cork screw reactors maximize path length through a reactor and minimize short circuiting. They also most effectively achieve plug flow fluid dynamics characteristics. Plug flow minimizes mixing between sections of water moving through the reactor and ensures effective disinfection.

- **Figures 7 and 8: Standard and Large Baffled Chamber Reactors**

These reactors model work towards achieving the simplest geometry design and minimizing capital cost. A baffle placed in the chamber will work towards slowing the fluid velocity while evenly distribution water particles throughout the reactor for effective disinfection.

- **Conclusions and Future Work**

- In process of iteratively designing and optimizing a UV/LED water treatment reactor through Solidworks and ANSYS Fluent.
- Future design will provide clean potable water for aircraft lavatory sinks that will protect public health during use.

**Acknowledgements and References**

- Discovery Learning Apprenticeship Program: Sharon Anderson
- Zodiac Aerospace, Award OCG61888 *Patent Number 9,260,323
- Mortenson Center in Engineering for Developing Communities