Validation Testing of Commercial-Off-the-Shelf Acoustic Sensor for Oil Spills

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Introduction

Underwater acoustic sensing shows promise in being a reliable way to detect oil and its thickness in aquatic environments.

The goal of this project is to assess the precision and accuracy of an **AQUAscat 1000R** commercial off the shelf (COTS) acoustic sensor in detecting marine diesel floating on the water's surface during emergency response situations. Responders need to know the diesel's thickness to determine the type of clean-up technique to use.

Acoustic Sensor

Figure 1. AQUAscat 1000R.

The AQUAscat 1000R (Figure 1) is a high frequency acoustic backscatter sensor with **4 external transducers** of frequencies 0.5MHz, 1MHz, 2MHZ, and 4MHz. The on-board acquisition system performs a phase-preserving decimation, resulting in a complex signal samples and range **resolution of 1.25mm thickness**. The nearfield distances were exceeded for all of the transducers, (Table 1).

A stand was designed to hold the 4 transducers level with one another and pointed directly up at the water's surface (Figures 2 and 3).

Frequency (MHz)	Rayleigh Distance (cm)
0.5	10
1	11
2	6
4	1

Table 1. Nearfield Distances.

Figure 1. Transducer stand side view.

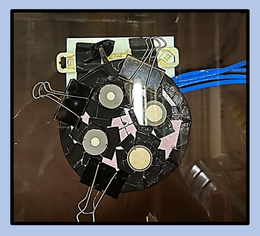
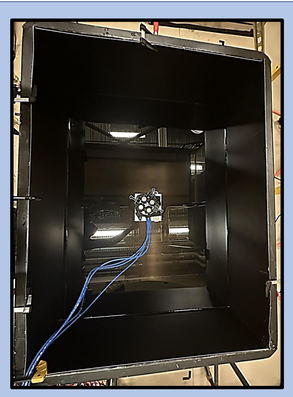


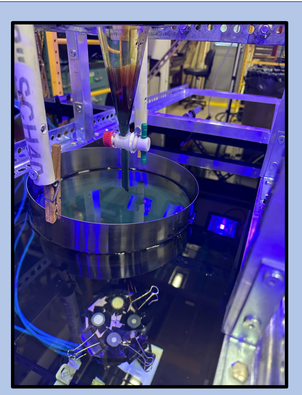
Figure 2. Transducer stand plan view.

Procedure

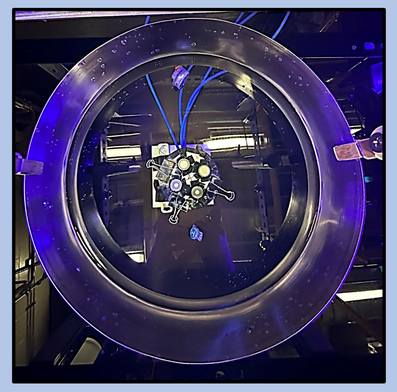


Step 1. Fill the tank.

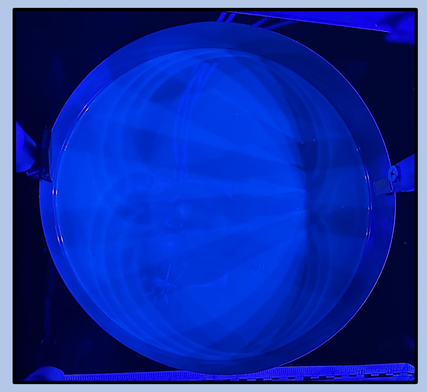
Step 2. Install oil distribution/containment system.



Step 3. Inject oil.



Step 4. Collect acoustic data.



Step 5. Apply UV lights for imaging diesel distribution in ring.

Conclusion

- AQUAscat 1000R shows promise in being able to identify marine diesel slick thicknesses in controlled lab experimentation.
- Further analysis for MC20 crude oil data that was collected will be conducted to determine if the AQUAscat 1000R was able to precisely and accurately detect its slick thicknesses.

Next Steps

- Analyze MD and MC20 sound speed and density at different temperatures using an oscilloscope for more accurate sensor data calculations.
- Analyze other oil types using the AQUAscat 1000R.
- Analyze the AQUAscat 1000R performance at detecting oil:
  - under ice,
  - with non-stationary surfaces, and
  - while oil disperses.
- Report findings to US Coast Guard responders regarding potential use of ROV and AUV mounted COTS for determining slick thicknesses during spills.

Results

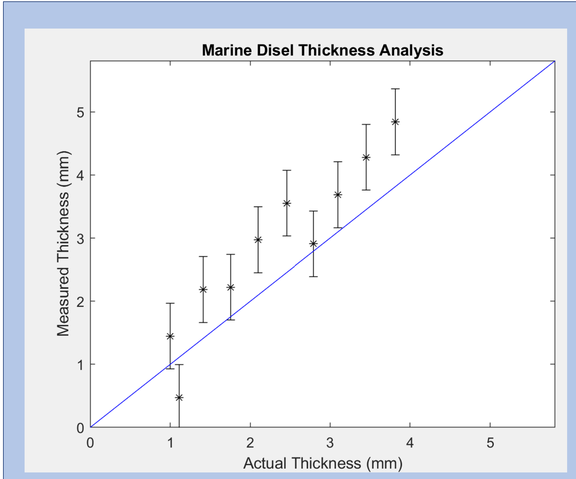


Figure 3. Actual vs Sensor Measured Thickness using 2MHz Transducer.

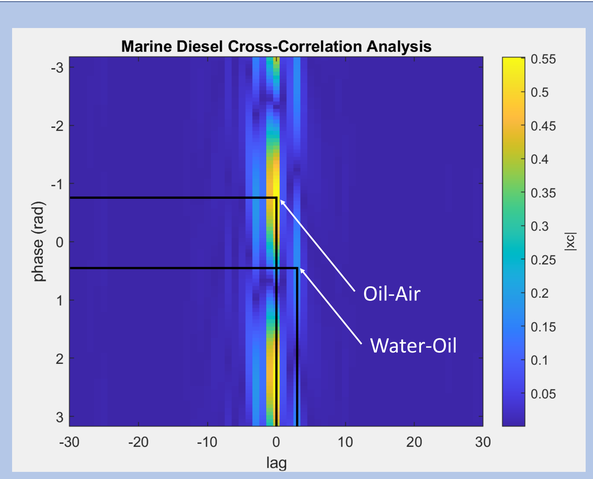


Figure 4. 2800um Slick Cross Correlation Analysis of 2MHz Transducer.

Assumptions:

- Marine Diesel sound speed = 1250 $\frac{m}{s}$ @ 25°C
- Marine Diesel density = 0.85 $\frac{g}{cm^3}$ @ 16°C

Acknowledgements

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References

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https://www.engineeringtoolbox.com/fuels-densities-specific-volumes-d_166.html
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All images taken by Sara Berg.