Alternative Engineering Solutions

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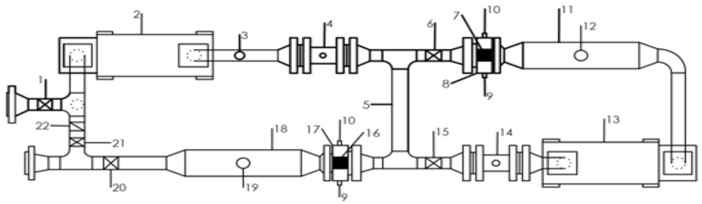
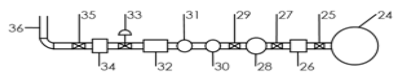
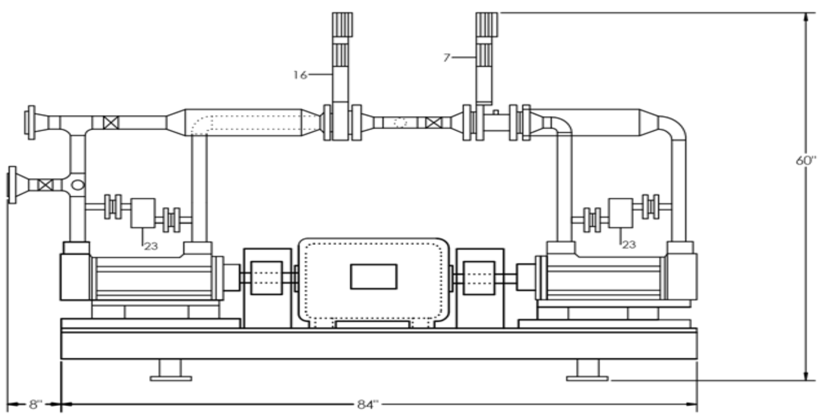
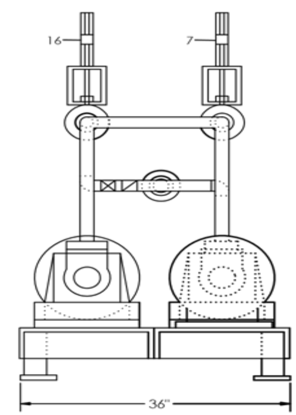
LEGEND

Item	Description
1	Inlet valve from purifier outlet
2	Homogenization system supply pump
3	Transducer
4	Supply flow meter
5	Circulating line
6	Inlet valve to low pressure homogenization chamber
7	Low pressure compensating valve actuator
8	Low pressure compensating valve
9	Water injection inlet
10	Recyclable fluids
11	Low pressure homogenization chamber
12	Low pressure homogenization chamber transducer
13	High pressure homogenization pump
14	High pressure pump discharge flow meter
15	High pressure pump outlet valve
16	High pressure compensating valve actuator
17	High pressure compensating valve
18	High pressure homogenization chamber
19	High pressure homogenization chamber transducer
20	Homogenization system outlet valve to service tank
21	Isolation valve
22	Check valve
23	High pressure relief valve
24	Potable water tank
25	Valve, water tank outlet
26	Pump suction strainer
27	Pump suction valve
28	Pump
29	Pump outlet valve
30	Pressure regulator
31	Pressure switch
32	Flow meter
33	Metering valve
34	Solenoid valve
35	Check valve
36	Potable water to compensating valve 9









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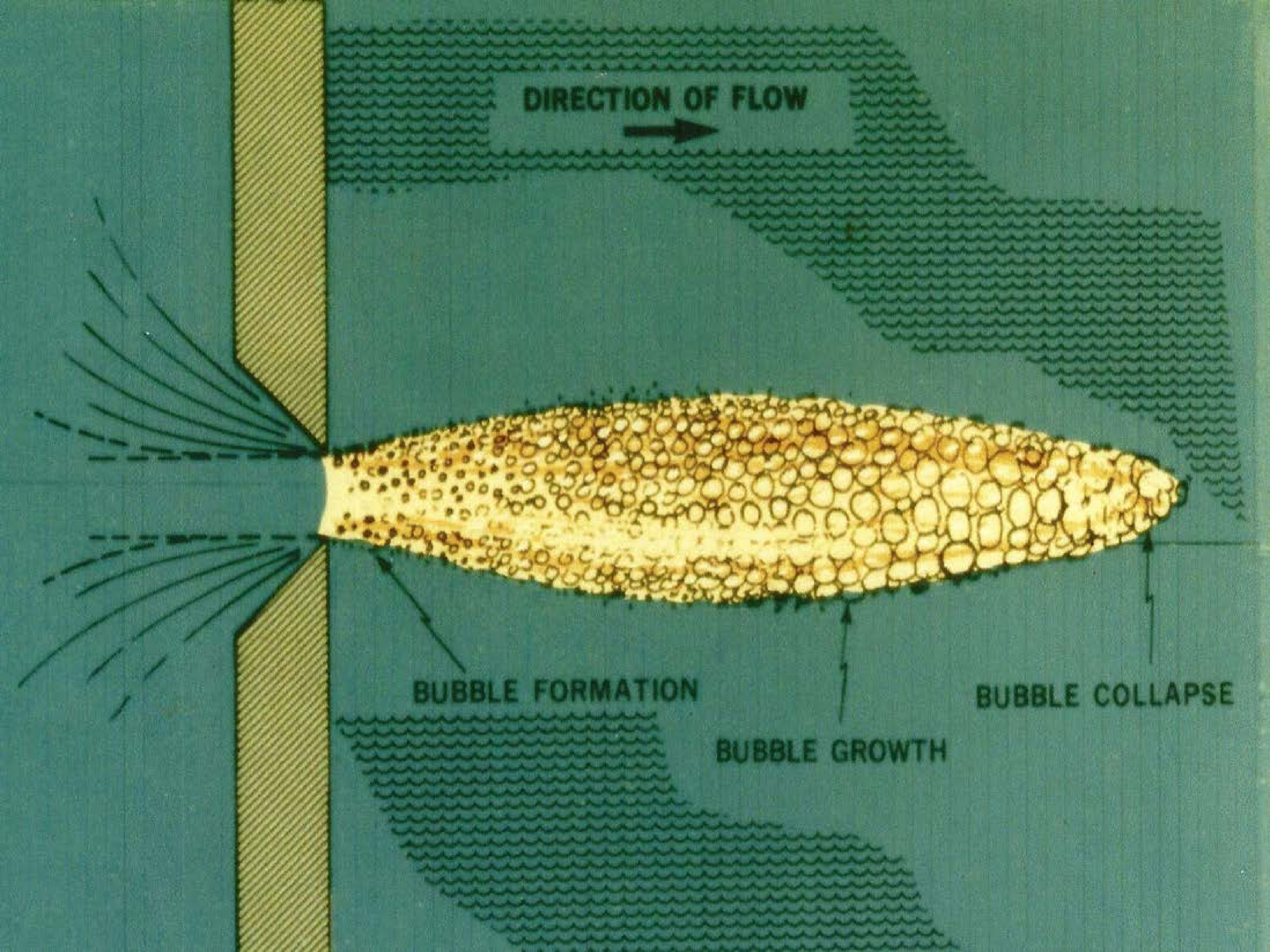
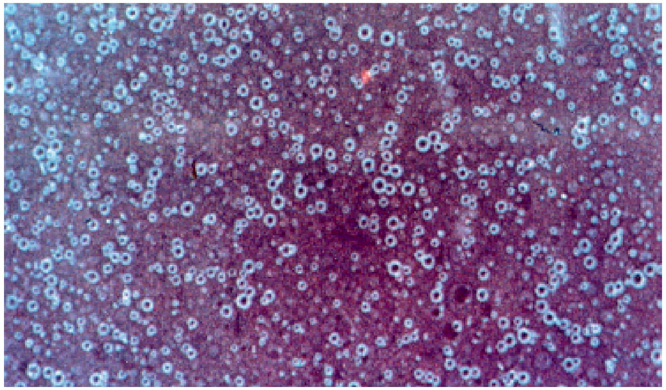
TITLE OF DRAWING: Dual Fuel Homogenization System	PROJECT NUMBER: 14-020	DRAWING NUMBER: SS-GA-004-1	REV	SHEET: 1 OF 1	


DIRECTION OF FLOW
BUBBLE FORMATION
BUBBLE COLLAPSE
BUBBLE GROWTH

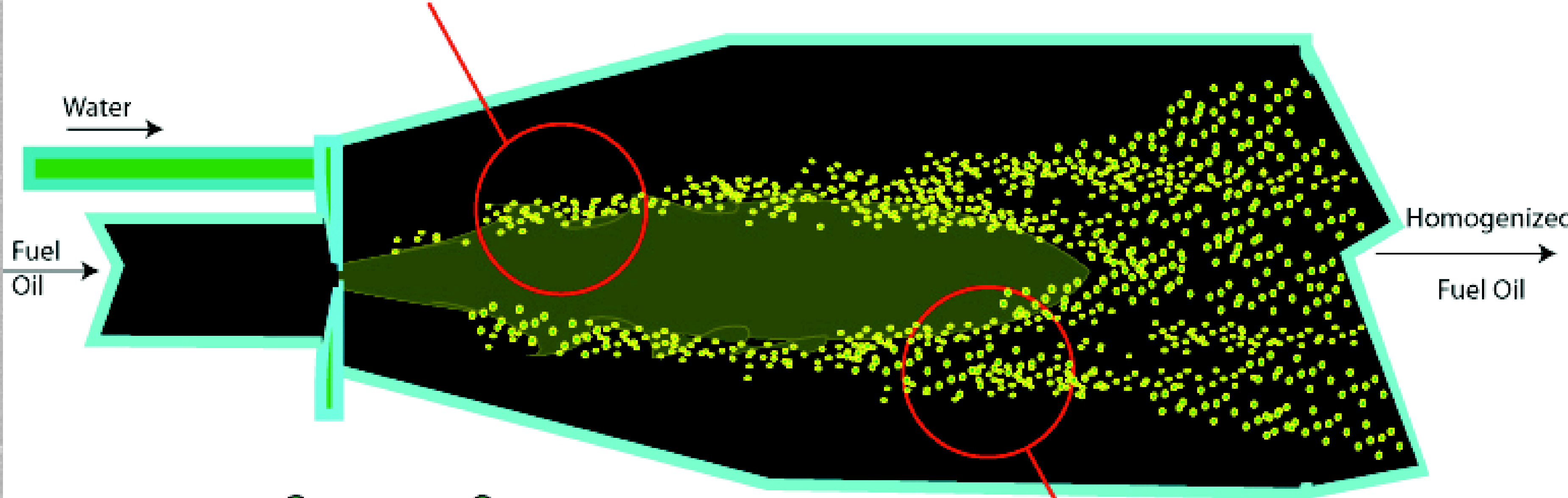
Homogenized # 6 oil injecting 7% water
With controlled water droplets size at 4 to 7 microns

This photograph is an oil sample from a 1,600,000 lb/hr Utility boiler (216 MW) consuming 218 GPM of #6 fuel oil injecting 15.4 GPM of water with the aid of a microscope at 400 power. The white objects are water droplets.

Note: The absence of water droplet concentration near the center of photograph is due to pressure applied on cover slide to compress the #6 oil thin enough for light to pass through.



The sudden drop in pressure through the orifice accelerates the fuel and water mix. The resulting shear between the high velocity fuel/water mix and the near static fuel results in waves of cavitation. The cavitation results in two things. It breaks the pockets of water into small droplets and the large molecules of some of the fuel into smaller molecules. Three physical factors are in play: 1. The size of the orifice. 2. The velocity of the fuel as it enters the chamber. 3. The difference in viscosity between the water and the fuel oil.



These small droplets will go through the same process twice to insure that they are all within the optimum size range of 4-7 microns.

Cavitation

A Graphic Cross Section

How this technique results in the homogenization of #6 fuel oil and water.

- #6 Fuel Oil
- High Velocity Oil and Water
- Water
- Water Droplets in Fuel Oil

Shepherd Media

DUAL FHS DRAWING SS-GA-004-1 OPERATION

1 Fuel from purifier will enter homogenization system through valve 1 to pump2.
2 Transducer 3 will start pump 2 when pressure is increased to 15 psig.
3 Transducer 3 will maintain discharge pressure at 300 psig.
4 Pump 2 discharge fuel will pass through supply flow meter 4, inlet valve 6 and low pressure compensating valve 8 into low pressure homogenization chamber 11.
5 When fuel pressure is increased to 15 psig in low pressure homogenization chamber transducer 12 will start pump 13 and send its signal to low pressure compensating valve actuator 7 to maintain 30 psig in homogenization chamber 11.
6 Pump 13 will increase fuel pressure to 300 psig discharging it through flow meter 14, outlet valve 15 through high pressure compensating valve 17 into high pressure homogenization chamber 18.
7 When fuel pressure in high pressure homogenization chamber is increased to 30 psig transducer 19 will signal high pressure compensating valve actuator 16 to maintain 30 psig.
8 Flow meter 14 in conjunction with supply flow meter 4 will control speed of pump 13 to deliver 120% by volume as compared to flow meter 4.
9 The 100% fuel required for the system will pass through valve 20 to service tank.
10 The 20% excess fuel will circulate through line 5 to low pressure compensating valve. Note: In the event that pump 2 and/or 13 discharge pressure is reduced to 250 psig the PLC will secure both pumps.

Water injection

1 Potable water pass through outlet valve 25, suction strainer 26 and pump suction valve 27to pump 28.
2 Water pump 28 will increase pressure to 125 psig discharging it through pump outlet valve 29, pass pressure gauge 30, pressure switch 31 and flow meter 32 to metering valve 33.
3 Metering valve 33 will control water injection through solenoid valve 34, check valve 35 and line 36 to compensating valve inlet port 9 at inception of cavitation.
4 Flow meter 4 will control volume of water injection.
5 When water pressure is increased to 100 psig the solenoid valve34 will open and when pressure is reduced below 100 psig the solenoid valve 34 will close preventing oil from entering water system.
6 Water tank filling line is fitted with a vacuum breaker to comply with the health code.
7 In the event that the tank water level is reduced to low level the PLC will secure water pump.

Controlled in-line cavitation

Controlled in-line cavitation is the precise reduction of line pressure, increasing velocity attaining its vapor pressure creating gaseous bubbles. Cavitation generates eddies that produce disruption of oil globules. The high velocity gives liquid a high kinetic energy that is disrupted in a very short period of time. Increased pressure increases velocity. Dissipation of this energy leads to a high density (energy per volume and time). Resulting diameter is a function of energy density.

To understand the mechanism, consider a conventional homogenizing valve processing milk at a flow rate of 20,000 lb/hr at 14 Mpa (2100 psig). As it first enters the valve, liquid velocity is about 4 to 6 m/s. It then moves into the gap between the valve and the valve seat and its velocity is increased to 120 meters/sec in about 0.2millisec. The liquid then moves across the face of the valve seat and exits in about 50 microsec. The homogenization phenomena is completed before the fluid leaves the area between the valve and the seat, and therefore homogenization is initiated and completed in less than 50 microsec. The whole process occurs between two (2) pieces of steel in a steel valve assembly. The product may then pass through a second stage valve similar to the first stage. While most of the oil globule reduction takes place in the first stage, there is a tendency for clumping or clustering of the reduced oil globules. The second stage valve permits the separation of those clusters into individual oil globules.

In the case of ENRJ International's fuel homogenization system the cavitation (homogenization) chamber's diameter is designed to prevent the cavitation forces contacting metal due to rapid erosion of boundary surfaces. The destructive effect of cavitation on solid surfaces may be explained as follows. When cavitation bubbles form in a low pressure region the growth is explosive with high bubble wall velocity. The growth time interval is too short for much air or gas to come out of solution so that the bubbles are filled primary with vapor. On subsequent collapse in the high pressure region, the liquid particles rush toward the center of the bubble virtually unimpeded and form a very high velocity jet. Impingement of this jet and the resulting pressure waves on a solid boundary cause very impulsive forces. It is estimated that the surface stress caused by the impingement is of the order of 14,000 to 15,000 pounds shear sufficiently high to cause fatigue failure of material in a relatively short time. Some investigators hold that the explosive formation of the bubbles, inter-crystalline electrolytic action, and the collapse of the bubbles all are factors contributing to the observed destruction of oil globules.

ENRJ'S Dual Fuel Homogenization System passes the oil through additional cavitation processes to ensure that all molecules are adequately reduced and separated thereof to prevent agglomeration.

ENRJ injects a small volume of caustic water, by volume of fuel consumed controlling water droplet size at 4 to 7 microns with 100% dispersion. The micro-explosions of water droplets at combustion expand the oil to a larger burning area creating secondary atomization. This increases the probability of oil and oxygen molecules colliding creating a more complete combustion reducing fuel consumption and sulfur dioxide emissions.

Brief History of Dual Fuel Homogenization System

I invented, patented and developed the Homogenization System in the early 80's. We were in the ship repair business in New Jersey at that time with a good reputation that helped sell 19 systems in 18 months. We sold the first one to the S/S J.A.W. Iglehart because I did all of their turbine consulting. We built a demo, invited potential customers Wednesday of each week for demonstration, injection and control of water droplet size at 4 to 7 microns with 100% dispersion. We sold the demo. Then we built the next demo ordered various size pumps and built several systems on speculation. We sold all of them some orders were conditional on shipping time, a week or ten days. When we sold the first one to Atlantis Agencies (Hess Oil) the S/T Seal Island was in route to Singapore for annual repairs, we had to ship the Homogenization System in 10 days. I traveled to Singapore for the installation and start up. The Chief Engineer informed me that the system paid for itself in route from Singapore to Valdez, AK. (approximately 45 days). We sold our last system to the Maritime industry 9/11/84. At that time the United States ship owners started to build diesel powered ships and restricted capital funds for steam ships. Due to the fact that a diesel engine consumes approximately half the volume of fuel that a steam ship does and the price of HFO at that time our system was not attractive

The Homogenization System was put in storage until we left the ship repair business. Then we started marketing it in the utility and industrial manufacturing community competing with natural gas. We built a demo invited prospective customers and sold the first demo to General Foods Evercane sugar plant in Clewiston, FL. Built another demo and continued to sell 10 additional systems.

In 2005 we upgraded the Homogenizer to a Dual Fuel Homogenization System using IMO three screw pumps, premium motors and VFD's, Halliburton turbine flow meters, Emerson transducers, Wittenstein (alpha Gear) valve actuators and Allen Bradley PLC. All system parameters are displayed on a HMI in control room. This system is ABS and USCG approved that will reduce fuel consumption 4% to 6%.

We employ controlled in-line cavitation (homogenization) to reduce all large oil globules to smaller molecules. While most of the globule reduction occurs in the first cavitation there is a tendency of clumping and clustering. Therefore, we pass the HFO through a second controlled process to permit the separation of those clusters into individual oil molecules. In addition we inject a small volume of potable water at inception of cavitation controlling water droplet size at 4 to 7 microns with 100% dispersion. The micro-explosion of water droplets during combustion expands the oil to a larger burning area increasing the probability of oil and oxygen molecules colliding creating secondary atomization that increase burnout times by a factor of six.

When water droplets are sized at 4 to 7 microns with 100% dispersion during our process the water droplets will not agglomerate, separate of change in size. We have samples for more than 15 years to attest to this. Our second selling feature after the demo was the ability to inject water at a specific ratio to fuel oil, control droplet size, take a sample for the prospective customer to view and photograph it to take back to their principals. One of our microscopes is fitted with a camera.

Due to the spike in HFO prices, ECA requirements and ships dedicated HFO users we are returning to the Maritime market.

We are offering to provide a Dual Fuel Homogenization System, install and monitor to quantify it in the maritime community. The system may be paid for from fuel savings. The installation of our system will not impact the ship's schedule.