



## WiFE on Demand: Emissions Mitigation Technology

**WiFE** stands for **W**ater **i**n **F**uel **E**mulSION. A proven technology, adding water to diesel dates back to the early 1900s and there are hundreds of patents issued on water-diesel blends. Aqueous emulsions have been studied for at least 30 years as an alternative to conventional gasoline and diesel fuels. The cooling effect of the presence of water in an engine has been known to reduce emissions, specifically nitrous oxides (NO<sub>x</sub>) and particulate matter (PM).

### Why is Our WiFE on Demand Technology Making the News?

Sea to Sky's WiFE on Demand is innovative and a step above the competition functionally in that it provides the benefits of water in fuel emulsion's pollution mitigation on demand so that the technology can be used when required for environmental legislative hot spots, yet still allows full engine power to be restored as required by turning WiFE off for ship maneuvering and ocean passage. It is also the first water in fuel emulsion technology for marine vessels that recycles oily waste water from on board for safe use in the combustion process which saves the ship owner money and benefits the environment.

### Benefits to Air Quality

- A reduction in nitrous oxides (NO<sub>x</sub>) in a one-to-one relationship with the emulsion's water content (25% water content = 25% NO<sub>x</sub> reduction)
- A reduction of PAH-generated particulate matter equal to 2 to 3 times the emulsion's water content (25% water yields 50% to 75% reduction of PAH-generated particulate matter)
- Up to a 5% reduction in carbon dioxide
- Possible reduction in sulfur oxides

### Key Features of WiFE on Demand

- Provides the flexibility of being "on demand" so that a vessel's needs for both emission reduction and engine power can be met simultaneously. WiFE can be suspended when more power and torque are required, such as in docking situations.
- Can be used on an as needed basis with up to 50% water added to the fuel.
- Uses recycled waste water from on board the vessel, eliminating the costs, hassle and environmental concerns related to the disposal of a vessel's waste water on shore.
- Eliminates the need and extra expense of purchasing separate pre-emulsified fuel since the emulsion is formulated on board the vessel. This eliminates the impact of the increased fuel
- water content on the ship's range associated with pre-emulsified fuels, since that same amount of primary fuel can be stored.

- Can be used with a variety of fuels including diesel #2, marine diesel oil (MDO) and heavy fuel oil (HFO).
- Reduces the need for cylinder oil because water in fuel emulsification creates better lubricity (slipperiness) inside the combustion chamber, and this in turn also reduces the emissions caused by cylinder oil burning in the hot combustion chamber.
- Even without adding water, the fuel homogenizer improves the consistency of combustion, thereby reducing emissions.

## How it Works

Fuel and water are carried by separate lines into a mixing chamber called a homogenizer/emulsifier which is essentially a large funnel. Inside the funnel is a rotor that spins with a very small clearance next to the funnel's walls. The spinning rotor sucks in the fuel and water, mixes them together and squeezes the mixture out of the funnel with water present in the fuel as tiny droplets. The water droplets, as small as one micron in diameter, are fully contained within the fuel. [That is the definition of an emulsion – one liquid (in this case, water) suspended inside another liquid (in this case, fuel).]

The mixture is immediately injected and atomized within the engine's combustion chamber. The heat inside the combustion chamber causes the water droplets to vaporize into steam. Creating the steam uses up energy and lowers the peak combustion temperature. The lower combustion temperature, in turn, reduces nitrogen oxides (NO<sub>x</sub>).

At the same time, when the water droplets vaporize, they produce "micro-explosions" inside the surrounding fuel droplets. The micro-explosions expose more of the fuel's surface area to the air, which increases combustion. Just as a block of ice melts (i.e., releases energy) faster when it's shattered into small chips, the fuel burns (releases energy) more completely after it has been shattered by the micro-explosions.

The micro-explosions also release the water's two elements – hydrogen and oxygen. The additional oxygen inhibits the formation of the compound called PAH (polycyclic aromatic hydrocarbons). During combustion, PAH is not burned completely; the unburned PAH becomes particulate matter (PM). By reducing the amount of PAH, the additional oxygen also reduces the production of PM. The reduction is on the order of two to three times the water content of the water in fuel emulsion (i.e., a 20% water content would reduce PAH-generated particulate matter by 40% to 60%).

Even without adding water, the fuel homogenizer improves the consistency of combustion. Bunker fuel typically consists of an uneven mixture of heavy fuel oil, asphalt-related substances and lighter marine diesel oil. When the mixture is burned, the combustion is unstable, which increases engine stress and results in higher emissions. The smoothed mixture created by the homogenizer burns evenly, with reduced emissions.

Breathe easy – the coast is clear.

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