

APPLICATION NOTE

Real-time inline lubricant monitoring marine engines

**INSTRUMENTS FOR
CLEANER APPROACHES**



Real-time inline lubricant monitoring marine engines

Sea transport has been the largest carrier of freight throughout recorded history. Rapidly changing & harsh conditions offered by sea state, delivery timing, freight loads & necessary autonomy require from marine engines — vessel's heart — outstanding reliability and operating performances.

Four-stroke Marine Diesel engine

Lubricant aging surveillance

Product	CACTUS
Mech. configuration	Bypass main lubrication line – NPT fittings
Measurements	Viscosity, Density, Water activity, Temperature, Particles
Software integration	ModBus to SCADA
Acquisition rate	1Hz then 1/30Hz
Certifications	ATEX

Viscosity increase	Oil oxidation
	Presence of soot & combustion originated materials
	HFO leakage to lube oil
	Filtration system lack
Viscosity decrease	LFO leakage to lube oil
	Degradation of additives / polymers

Proper engine operations rely on lubrication quality. Several parameters such as viscosity, water activity, density, temperature and particles content impact fluid's health. Among all, lube viscosity is the most important property of the oil. Indeed, viscosity is fundamental to providing optimum film strength, with minimal frictional losses, preventing metal-to-metal contact, scuffing, micro-welding and wear of sliding surfaces.

Piston & gearbox oils characterization

Prior to ship embedment, an extended set of experiments were performed with CACTUS onto both piston & gearbox oils. The first tests - performed at Avenisense - were quickly followed by an extensive performance characterization program conducted by a global lubricant manufacturer. Results showed an excellent match with ASTM methods for both viscosity & humidity measurements.

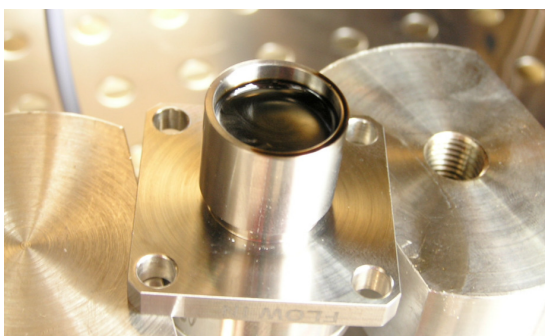


Fig 1 - Open-air in oven lab setup with used oil just tested

The green light for boarding.

Measuring kinematic viscosity - not assuming it

CACTUS delivers both dynamic viscosity & density in real-time, providing access to kinematic viscosity. This *true* kinematic viscosity output is based on actual measurements - not on density assumptions - best reflecting real conditions.



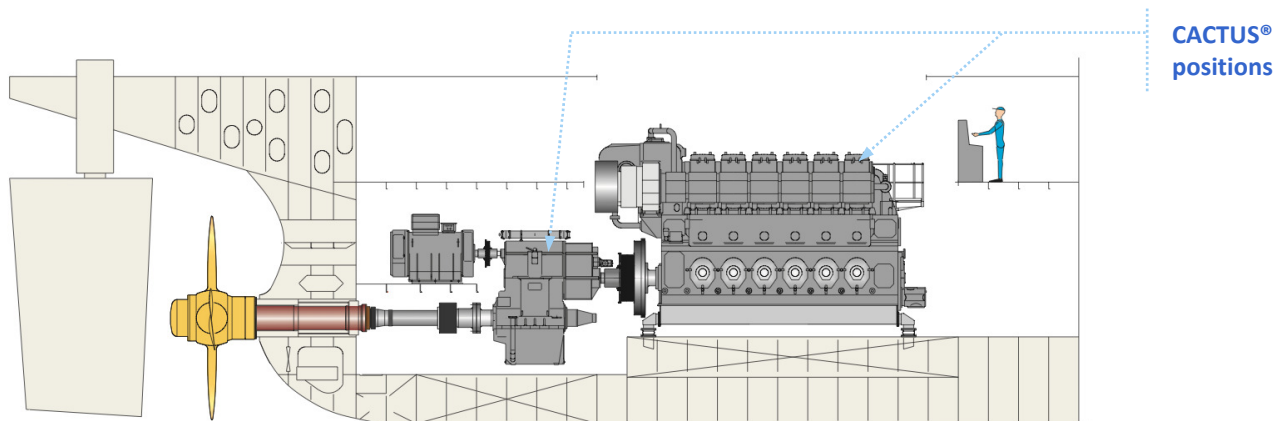


Fig 2: Four-stroke propulsion package (6L48/60B engine, reduction gear, VBS1460 propeller) - Courtesy of MAN

Detecting oil changes while engine operates

Installed onto the main lubrication line of a four-stroke engine, tied to the crankcase, operating up to 90°C at the heart of a highly vibrating environment, CACTUS detected with success physicochemical changes implied by lubricant's aging, water activity & evolving particles concentration. Increases up to 25% were observed on viscosity (see figure 1), out of engine manufacturer specifications. This flagged the appropriate time for oil change. Through regular sampling, results from the lab might have come too late, pushing technicians to operate the engine out of its specifications.

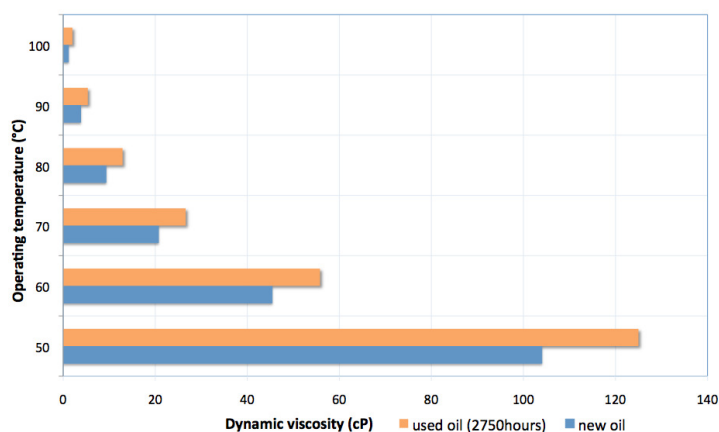


Fig 3a - influence of aging on lube viscosity (at different operating temperatures)

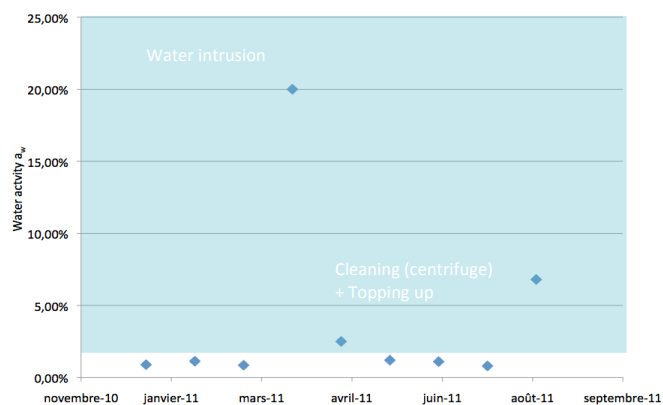


Fig 3b - Water activity measurement changes during the test

Achieved performances

Viscosity	0,8% @ 400cSt
	1,1% @ 30cSt
Density	0,9% av.
Water activity	3% av.

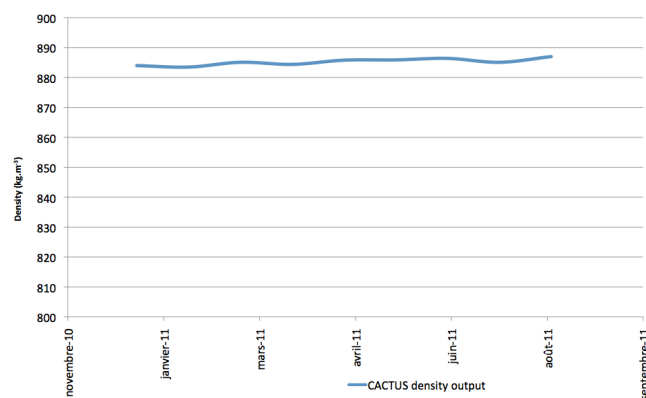


Fig 3c - Density increase with particles content



Benefits

An unrivaled cost of engine ownership

Extended service intervals	Insitu monitoring increases operations time
Reduced Maintenance costs	Lower lube consumption
Reduced failure risk through detection	Water intrusion
	Soot contamination
	Filtration issues
Optimized power delivery	Best load vs. fuel injection
Environmental friendly	Smaller lube waste

When field measurements meet lab analysis

CACTUS outputs both raw & compensated measurements at 15°C, thanks to its immersed temperature probe. Operators checked sensor output against ASTM 445 methods, through periodic sampling. Results (figure 2) confirmed CACTUS excellent reproducibility & accuracy during operations.

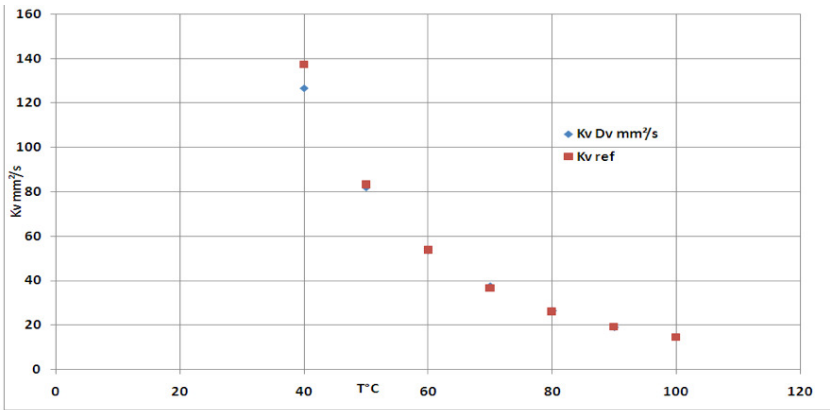
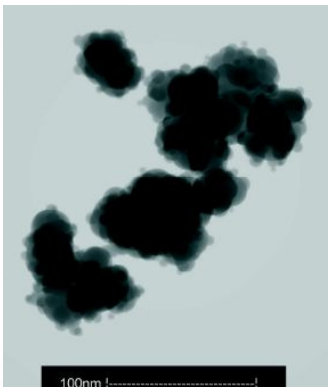


Figure 4 - Typical comparison between CACTUS output and ASTM



Robust against wear & soot



Long term exposure to lubricant showed sensor capability to be cleaned by the flow, preventing deposit formation from oxidized, cracked, or polymerized portions of the fluid.



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