



## SALMON OIL BASED BIODIESEL: PRODUCTION REVIEW, FUEL-RELATED PHYSICAL PROPERTIES AND ENGINE TESTS

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### ABSTRACT

Norwegian salmon oil extracted from processing wastes (guts) was used to produce biodiesel with a commercial batch processor. This biodiesel was then used in engine at Turku University of Applied Sciences and at the University of Applied Sciences Novia. In these tests, the aim was to measure: engine performance and fuel consumption, particle and gaseous emissions, and engine vibration and sound. The pressure in the engine cylinder was also analyzed. Based on these tests, the engine performance was good with all fuel blends and B100. The emissions usually decreased compared to conventional diesel fuel (DFO) when salmon oil based FAME (B100) was used. The alteration of fuel blend also influenced the combustion pressure.

Keywords: Biodiesel, FAME, Renewable energy, Salmon, Higher Heat Value, Combustion pressure



Fig. 1. Biodiesel processor 200, Preseco Oy Finland

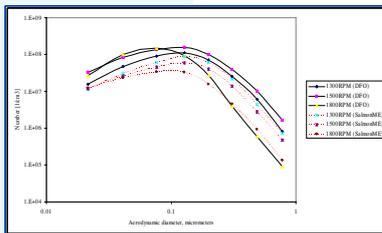


Fig. 2. Variation of particle emissions with engine speed, load 100%, DFO and salmon oil based FAME

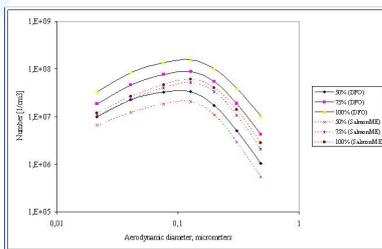


Fig. 3. Variation of particle emissions with load, 1500 RPM DFO and salmon based FAME

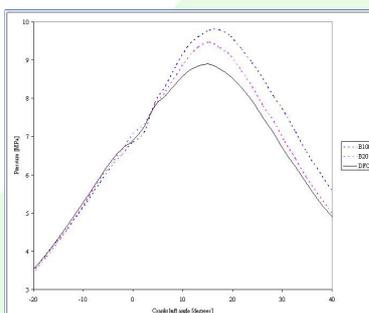


Fig 4. Cylinder pressure vs. crankshaft angle for 1800 RPM and 100% load

### INTRODUCTION

This study concentrates on biodiesel which is produced through transesterification from Norwegian salmon oil that is a by-product of food industry. This oil can be considered as waste because the manufacturer isn't able to use all of it as a component of their own product.

In detail, this study concentrates on

- The process of producing high quality biodiesel from salmon waste oil with batch processor (Fig. 1.)
- Fuel properties as a reference to EN 14214 standard
- Engine performance when using salmon methyl ester and its blends with regular DFO
- Combustion pressure changes with different biodiesel concentrations in DFO
- Particle emissions when using pure salmon methyl ester
- Possible differences in engine vibration with different fuels and fuel blends

### RESULTS AND CONCLUSIONS

- Engine and esterification tests indicated that salmon oil is suitable raw material for alkaline-catalysed transesterification. The biodiesel produced was suitable for high-speed diesel engines used in this test.
- The measured fuel properties of salmon oil based FAME were mainly within the limits set by the EN 14214 standard. The main problem with salmon methyl ester is the iodine value that exceeds the value determined by the standard. This may cause problems in long term usage of pure salmon methyl ester via e.g., clogging of the fuel nozzles.
- The performance of test engines were stable with every fuel blend used and with pure salmon methyl ester. This suggests that engine operation is not restricted by the use of salmon methyl ester as a blend with DFO. The fuel consumption increased due to lower heating value of salmon methyl ester.
- With salmon methyl ester, the particle emissions decreased compared to DFO. The load and engine speed had an influence to particle emissions (Fig. 2 & Fig. 3., respectively)
- The peak pressure in combustion process was determined for all biodiesel-DFO blends and for pure salmon methyl ester. There was increase in the peak pressure and pressure rise rate when salmon methyl ester was a component in the fuel (Fig. 4.). Any clear correlation with the peak pressure increase and salmon methyl concentration was, however, not detected.
- The sound emissions of test engine did not decrease noticeably although this has been said to occur when biodiesel is used.
- The results suggest that there were some changes in combustion process when biodiesel or biodiesel blends were used. Further investigations of engine vibrations and sound emissions should be conducted. The combustion changes should be measured within a broader frequency range. Also, long term tests with salmon methyl esters should be considered.

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