Straight Used Cooking Oil as a Fuel in HGVs – Fuel Injector Deposit Analysis

Christian A Michelbach, Nicola J Wood and Hu Li

Introduction

This work was undertaken in collaboration with United Biscuits in an attempt to fuel their distribution fleet on straight (unprocessed) used cooking oil as a replacement to fossil derived diesel fuel. Used Cooking Oil fuel was supplied by Olleco Co. This work follows from a comprehensive life cycle analysis undertaken at the University of Leeds concluding transesterification processing of cooking oils to biodiesel constitutes 57% of total CO_2 emissions of used cooking oil derived biodiesel use[1].

We have investigated the effect of straight used cooking oil on fuel injector deposit formation in Euro VI Heavy Goods Vehicles.

Methodology

2 x Fuel Injectors removed from HGV after 6 months running on SUCO

Injectors disassembled

Injectors cleaned with toluene and acetone

SEM and EDX analysis

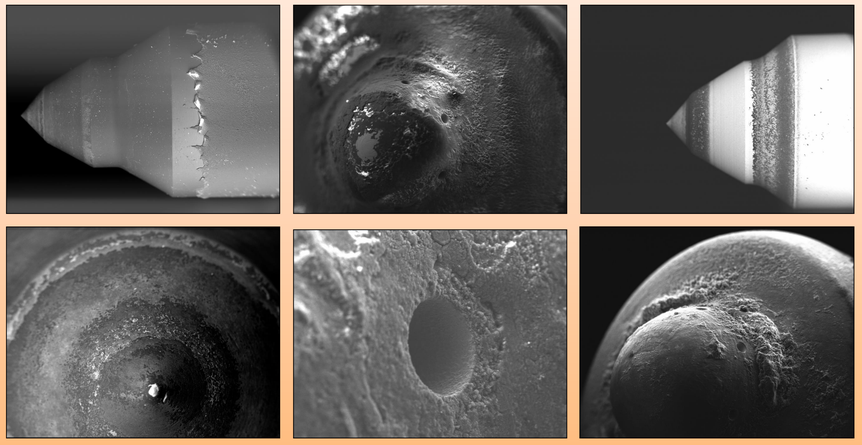
Deposit samples taken from injectors

Samples analysed by FTIR

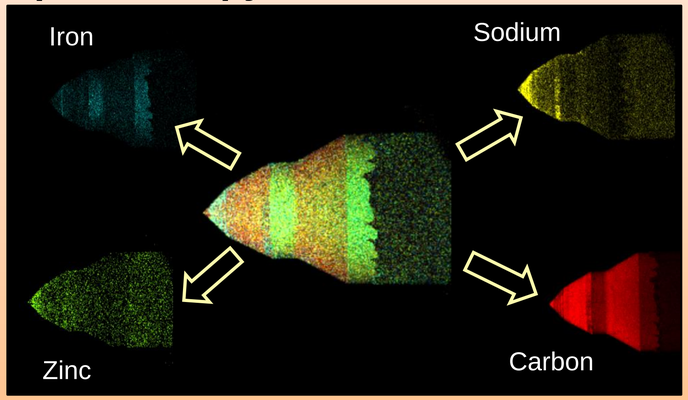
SEM – Scanning Electron Microscopy

SEM images of the needle show clear deposit build up in bands around the tip of the injector needle. This indicates a change in deposit composition, either elementally or structurally. An unusual deposit around the shaft of the needle can also be seen. While thin (approximately 20 µm), the shaft deposits are a likely cause of issues within the injector nozzle chamber, where the clearance between the nozzle wall and needle is only a few µm. Shaft deposits are not present in previous EURO V needles.

Injector holes remain mostly clear and unblocked except for ridged internal deposits.

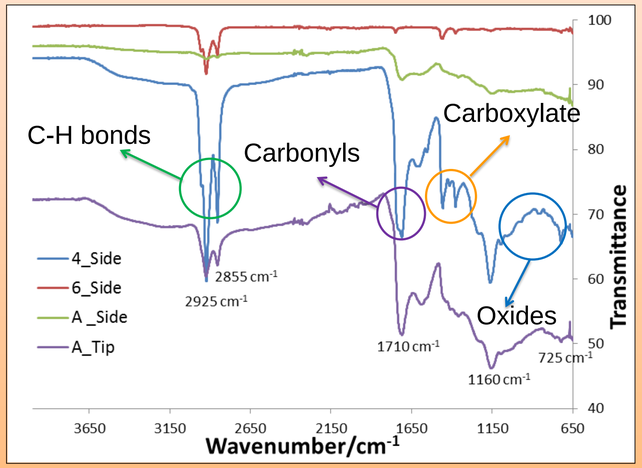


EDX – Energy Dispersive X-ray Spectroscopy



The deposits are mainly carbon based however there are large amounts of sodium and zinc present particularly at the tip of the injector.

FTIR – Fourier Transform Infrared Spectroscopy



FTIR confirms the presence of sodium carboxylate and zinc oxide salts in the deposit. This indicates deposit formation due to metal contamination in the fuel.

Conclusions

- We propose that the thick layer of shaft deposit is the most likely cause of poor driveability.
- EDX indicates Na and Zn play a key role in injector deposit formation.
- FTIR validates EDX findings by highlighting the presence of carboxylate salts and metal oxides in deposits.
- Further processing of fuel is strongly recommended. This will reduce the amount of trace metals present in the fuel (particularly Na and Zn).

Contact Us
Christian Michelbach: pmcam@leeds.ac.uk
Nicola Wood: pmnjw@leeds.ac.uk
Dr. Hu Li: fuehli@leeds.ac.uk

EPSRC Centre for Doctoral Training in Bioenergy
Energy Building
University of Leeds
LS2 9JT, UK

United Biscuits

EPSRC Pioneering research and skills

UNIVERSITY OF LEEDS

1. Li et al (2014) SAE Int. J. Fuels. Lubr. 7(2): 623-630