

Marine Heavy Fuel Oils – Problems and Alternatives

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In the combustion chamber of an internal combustion engine thermal energy is released in order to increase the pressure. In principle, all substances with an exothermic oxidation can be burnt as long as flowability, lubricity and combustion without excessive acid and ash formation are given. A variety of different combustibles have been burnt in diesel engines during the last 100 years.

The dominating fuels were crude oil products. Until the 1950s only distillate fuels were used. In 1948 John Lamb proved that it was possible to burn boiler fuels, i.e. residual fuels, in the slow speed engines of tankers. It was not until the 1960s when the reliable HFO operation with acceptable wear results was possible with two-stroke and later medium speed four-stroke engines.

1 Some problems related to heavy fuel oil quality

After the oil crisis of the 1970s there was a dramatic change in the oil refining. As a consequence the residues consist of the very heavy components only with a concentration of contaminants like sulphur, metals and problematic hydrocarbons.

The increasing number of operational problems led to the first effective fuel specification ISO 8217, which strengthened the buyer's legal position.

Frequent operational problems were caused by catalytic fines from FCC processes in refineries which ruined engines within some 100 running hours. These aluminium and silicon oxide particles are extremely abrasive. Even with catalyst contents far below the maximum limit of 80 ppm engines have been severely damaged because the fuel pre-treatment system was poorly designed, installed or operated.

In the discussion about the continuous deterioration of HFO quality it should be kept in mind that only around 1 per cent of all analysed samples are seriously outside the specification and could cause severe engine damage.

HFO contaminations with used lubricating oils, acids and chlorides have been reported in the past. Since the 1990s operational problems have occurred due to severe contaminations with polypropylene, polystyrene and polyethylene. These waste products caused severe fuel filter plugging and deposits on pump elements and pistons.

Further operational problems are related to the stability and compatibility as well as the ignition and combustion quality of heavy fuel oils.

2 Alternative fuels

During the last 100 years many different hydrocarbons have been tested in diesel engines more or less successfully. From the economic and environmental point of view it does not make much sense to burn biofuels in engines of seagoing vessels. Under social aspects these vegetable based products should be used as diesel fuels in isolated cases only.

Gaseous fuels are excellent energy sources, but only for gas carriers, supply vessels and some ferries.

Against this background there is no feasible fuel alternative for the majority of merchant ships. We have to stick to oil products also in the next 20 years. However, the proven oil reserves are limited and the worldwide oil consumption will increase continuously. Most of the oil reserves are located in politically unstable areas and therefore serious conflicts are most likely. The prices of oil products will remain on a very high level.

Unconventional oil sources such as tar sand and oil shale as well as the liquefaction of coal are further options in case of rising energy prices.

The general conditions of the bunker market will gradually change due to environmental aspects and economic forces. There will be a great demand for low sulphur fuels, because the "Sulphur Emission Control Areas (SECA)" will be extended significantly worldwide. The hydrodesulphurization of residual fuels is extremely expensive and requires very high investments for development, installation and operation.

The international oil industry has to decide whether to convert the refineries in order to further reduce the outlet of residual fuels. With respect to the future availability of marine heavy fuels it should be taken into consideration that there are refineries without any liquid residue. In a long-term perspective a shortage of bunker fuels cannot be excluded. In the foreseeable future marine heavy fuel oil, which in the past cost only around two-thirds of the crude oil price, will lose much of its attraction as a cheap source of energy.

Horst Rulfs graduated and obtained his doctor's degree at the Technical University of Hanover. After joining the Deutsche BP he was section manager involved in technical services and research. In 1984 he was appointed Professor at the Hamburg University of Technology in the Institute of Thermal Power Plants and Marine Engineering. Prof. Rulfs has additionally been working for more than 30 years as a consultant investigating engine damage cases.