USE OF VEGETABLE OILS AS FUEL IN COMBUSTION ENGINES: ENGINEERING OPTIONS

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Abstract. *Nowadays it is accepted that availability of fossil fuels is limited on the planet. Current daily average consumption of petroleum products indicates that the place of Diesel and gasoline as sole liquid sources for engine will soon decline in many remote places of developing or emerging countries. Natural or pure vegetable oils are famous for their interest as a diesel fuel substitute, easy to produce even at small scale level with very low impact on environment, they can be used pure or in mixture with diesel procuring the same power output with rather good efficiency. But they are also well known for their extremely high flashpoints and tendency for thermal or oxidative polymerisation, leading to the formation of deposits on the injector nozzles, a gradual dilution and degrading of the lubricating oil and the sticking of piston rings. As a consequence, long term operation of most pure plant or mixtures of pure plant oils with diesel eventually leads to engine breakdown.*

Two different types of constraints are encountered when using vegetable oils: physical differences, mainly viscosities ten to twenty times higher than the viscosity of fossil diesel fuel, siccativity (ability to harden) for some of them and high solidification temperature for the most saturated oils. And secondly, chemical differences due to triglyceride molecules which lead to incomplete distillation and therefore provokes the pyrolysis of residual droplets on combustion chamber walls. Initiation of the combustion is affected by the high viscosity of vegetable oils modifying the droplet size and the spray pattern. Combustion itself is not complete if the average temperature of the chamber is too low to pyrolyze and sublimate the partially distillated droplets. Options to use vegetable oils in compression ignition engines must solve both physical and chemical constraints. Adaptation to reduce the viscosity and restore the spray characteristics is a necessity to avoid eventual injection equipments breakdown and to respect ignition delay. Heating up the vegetable oil or blending it with diesel fuel is the easiest and cheapest mean to fulfill this requirement. Complete combustion can be guaranteed if the temperature of the chamber is sufficiently high. This is the case of most IDI (indirect injection) engines or of specially modified DI (direct injection) engines. Another possibility is to adopt a two-tanks electronically controlled system: the vegetable oil circuit is feeding the injection pump only when the average temperature of the chambers is high enough. Applicable to non modified DI engines provides a partial substitution of fossil diesel fuel during the high consumption periods. This option allows palm oil or castor oil to be used as fuel in standard diesel engines for transport and rural electrification in remote areas. In the near future more flexibility can be offered through a better understanding of combustion conditions and using the electronic controls, as there is for gasoline and FFV.