HP Gas Dolphin: LPG additive for Fishing boat O/B engines

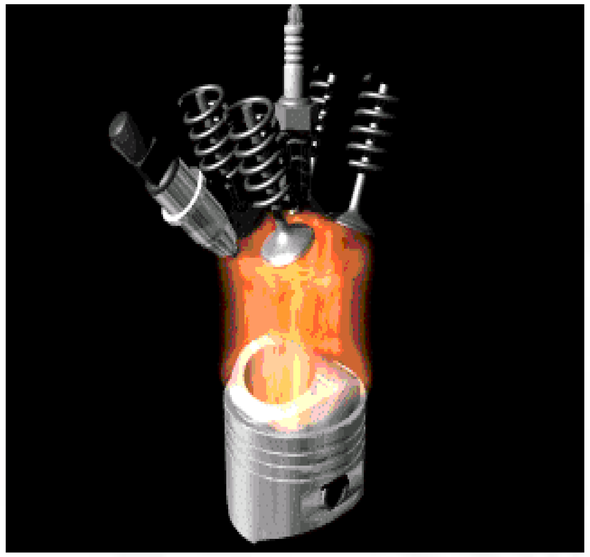
Advantages of LPG

- LPG burns cleaner with less carbon build up, coking or deposit formation
- Engine wear is reduced and life of components such as piston rings and bearing are improved
- LPG yields 40% less HC, 35% less NOx, 50% less CO compared to gasoline
- LPG typically has higher RON, 100-105, compared to standard gasoline
- LPG typically has a slightly higher Brake Specific Energy Consumption (BSEC) compared to gasoline due to high calorific value

Disadvantages of LPG

- Decrease in power output due to low volumetric efficiency.
- LPG displaces 15 to 20% greater volume than gasoline.
- Power output decreases by 5 to 10%
- (BFSC) is higher for LPG compared to gasoline especially at lower RPMs and lower loads
- Flame propagation speed of LPG is faster than that of gasoline at lean or stoichiometric equivalence ratios. However at rich ratios, the speed of gasoline is superior

LPG Combustion in SI engine



$$P = \frac{V_d \cdot p_{me} \cdot N}{n_c}$$

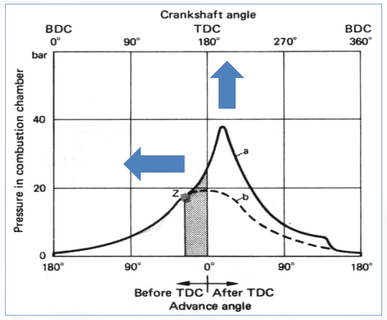
P = power output in watt

p_{me} = mean effective pressure in Pascal

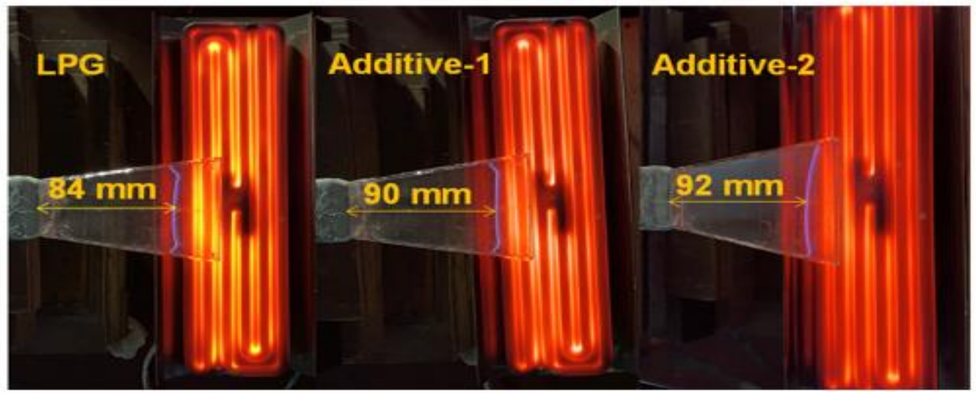
V_d = displacement volume in cubic metre

nc = number of revolutions per power strok

N = number of revolutions per second



Evaluation



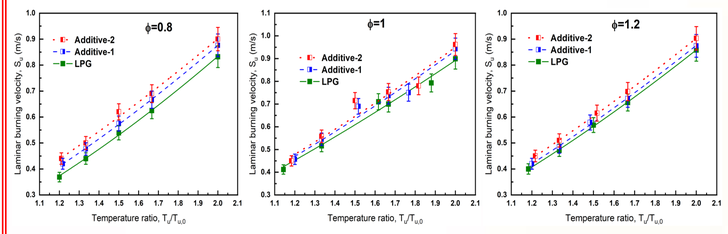
Fuel	Distance from inlet, x (mm)	Inlet temperature, T_{in} (K)	Mixture temperature, T_u (K)	Laminar burning velocity, S_u (m/s)
LPG	84	312	485	0.71
Additive-1	90	312	530	0.75
Additive-2	92	312	545	0.78

$$S_u = U_{in} \times \left(\frac{A_{in}}{A_f}\right)\left(\frac{T_f}{T_{in}}\right)$$

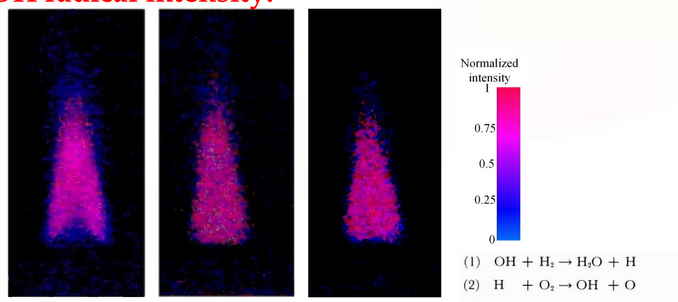
A_{in} : Channel area
U_{in} : Mixture velocity at inlet
T_f : Unburnt mixture temperature
A_f : Channel area at the flame position
T_{in} : Inlet mixture temperature

Performance of In-house Additive

Laminar Flame velocity:



OH radical intensity:



(1) $OH + H_2 \rightarrow H_2O + H$
(2) $H + O_2 \rightarrow OH + O$
(3) $O + H_2 \rightarrow OH + H$
(4) $H + H + M \rightarrow H_2 + M$

OH chemiluminescence of LPG, additive-1 and additive-2 at U_{in} = 1 m/s & ϕ=1.

Benefits

- Homogenous Additive
- Additized LPG was shown to improve LBV by 10%
- Additive has shown markedly improved performance over a wide temp range at engine relevant conditions (φ<1)
- Additive improves Mean Effective Pressure and Maximum Torque
- Environmentally benign

Commercialization

- HP Gas Dolphin was launched in March'2022