Eucalyptus Oil and Its Application to Compression Ignition Engine

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Introduction

The flash point of eucalyptus oil is higher than the ones of gasoline and kerosine. The viscocity of eucalyptus oil is also higher. Those kinds of fuels will be quite desirable and hopeful for compression ignition engine such as the diesel engine with fuel injection system.

In this paper some of the experiments on diesel engine performance using the blended fuel of eucalyptus oil and gas oil is described.

1. Experimental installation and method.

Table. 1 Properties of gas oil and eucalyptus oil

Fuel	Gas oil	Eucalyptus oil
Specific gravity (15/4℃)	0.8373	0.9160
Viscosity (cst 30℃)	2.50	2.07
Flash point (℃)	77.5	54.0
Lower calorific value (kcal/kg)	10170	9280
Cetane index	57.84	0.30

Table. 2 Results of A.S.T.M. distillation test

Fuel	Gas oil	Eucalypus oil
	(℃)	(℃)
Flowing point	−10.0	
First point	202.0	166.0
5 (VOL. %)	228.0	170.0
10	242.0	170.5
20	257.0	171.0
30	267.5	171.0
40	274.0	171.5
50	280.5	171.5
60	289.0	171.5
70	298.0	171.5
80	309.5	171.5
90	324.0	172.0
95	335.5	172.0
97	339.0	173.0
End point	340.0	179.0
	(Vol. %)	(Vol. %)
Extraction	98.0	99.0
Residue	2.0	1.0
Loss	0.0	0.0

1-1 Fuels for engine test.

Table 1 shows the physical and chemical properties of gas oil and eucalyptus oil. Table 2 shows the results of the distillation test based A.S.T.M. (American Society for Testing materials Specification) for gas oil and eucalyptus oil respectively.

Figure 1 shows the A.S.T.M. distillation curves of the both fuels. The distillation curve for eucalyptus oil showed flat line caused due to 1.8 cineol mostly, but the gas oil distillation curve formed slope line because of many kinds of hydrocarbon involved.

1-2 Tested engine

Table 3 shows the detailed specification of the tested engine, Model Yammer Diesel SS60CG 4 stroke cycle water cooled diesel engine.

1-3 Experimental apparatus

Figure 2 illustrates the diagram of the experimental apparatus. The engine was connected with the electric dynamometer for measuring the engine output. Engine torque was measured with strain gage through slip ring,

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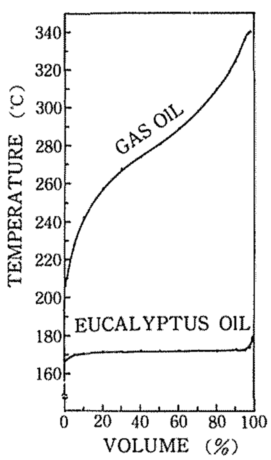

Fig. 1. －A.S.T.M. Distillation curve

Table. 3 Engine details

Continuous Rating Out put	(ps/rpm)	5.0/2400
Maximum Out put	(ps/rpm)	6.0/2400
Maximum Revolution	(rpm)	2600
Lubricating system		Pump type
Crank case capacity	(l)	2.2
Cooling water capacity	(l)	2.0
Dry weight	(kg)	73

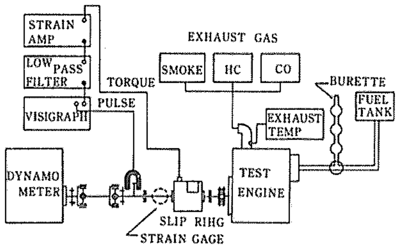

Fig. 2. Diagram of experiment apparatus

which was mounted on the connecting shaft.

The engine torque was recorded by the oscillograph recorder through the strain amplifier and lowpass filter.

The exhaust gas was analyzed and measured by HC, CO measuring equipment. The smoke value of exhaust gas was measured by the Bosch's smoke meter. Fuel consumption rate was measured by the fuel measuring burette.

2. Cetane index of gas oil and eucalyptus oil.

Cetane index was calculated as follows,

$C = 0.49083 + 1.06577(x) - 0.0010552(x)$ ·········(1)

where C : cetane index

$x = 97.833(\log A)^2 + 2.2088B\log A + 0.01247B^2$

$-423.51\log A - 4.7808B + 419.59$

A =9/5(distillation temperature at 50%(℃))+32

B = API degree by JISK2249 method.

API(American Petroleum Institute Specification)

specific gravity =141.5/d−131.5

where

d = density ratio compared with the one pure water at 60°F

tc =5/9(tF−32)

tc : temperature in centigrade

tF : temperature in Fahrenheit

tF =60°F

tc =5/9(60−32)=15.56(℃)

Gas oil =0.8373(15/4℃)→0.8370

Eucalyptus oil =0.916(15/4℃)→0.9157

B { API degree of gas oil = 141.5/0.8370−131.5=37.5561529
API degree of eucalyptus oil = 141.5/0.7159−131.5=23.0265916

A { Gas oil =9/5x280.5 32=536.9
Eucalyptus oil =9/5x171.5+32=340.7

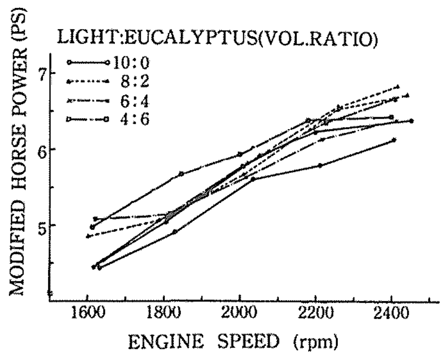

Fig. 3. —Modified horse power curve

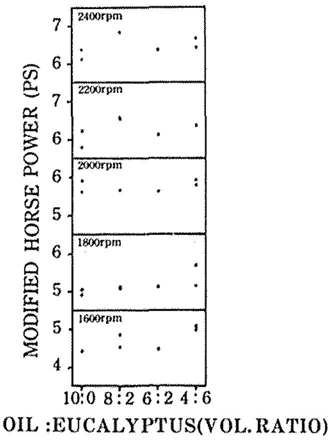

Fig. 4. —Relationships between blend ratio and modified horse power

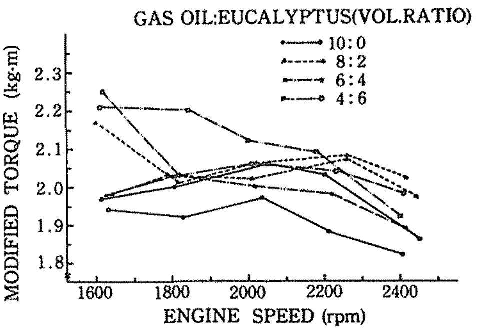

Fig. 5. —Modified torque curve

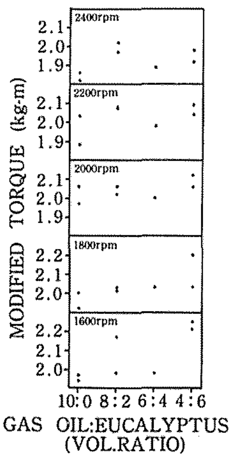

Fig. 6. —Relationships between blend ratio and modified torque

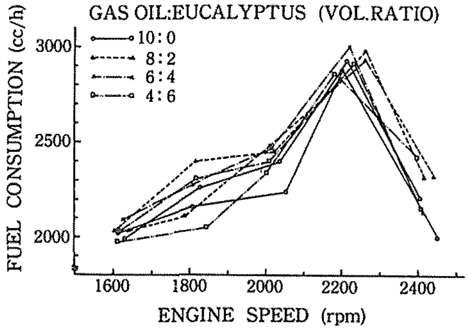

Fig. 7. —Fuel consumption curve

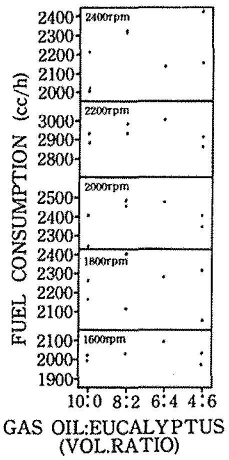

Fig. 8. —Relationships between blend ratio and fuel consumption

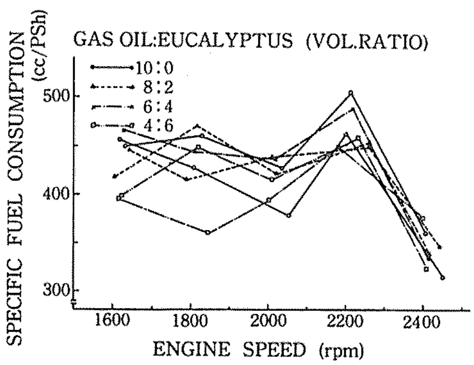

Fig. 9. —Specific fuel consumption curve

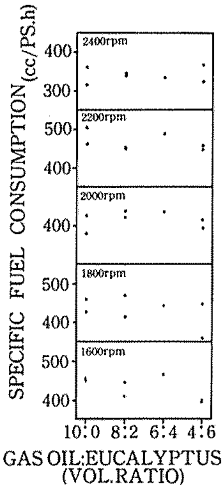

Fig. 10. —Relationships between blend ratio and specific fuel consumption

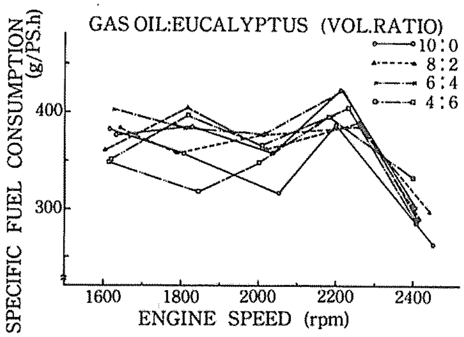

Fig. 11. —Specific fuel consumption curve

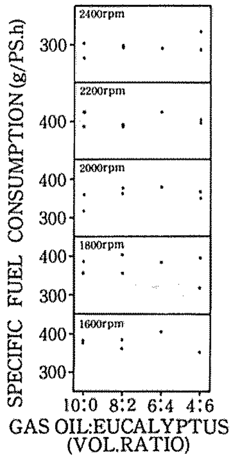

Fig. 12. —Relationships between blend ratio and specific fuel consumption

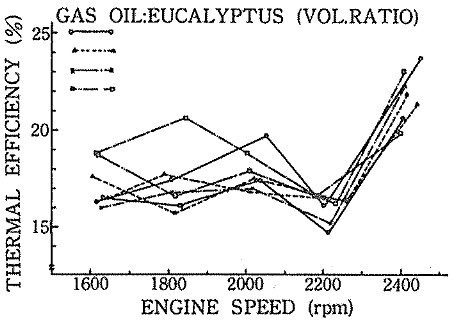

Fig. 13. —Thermal efficiency curve

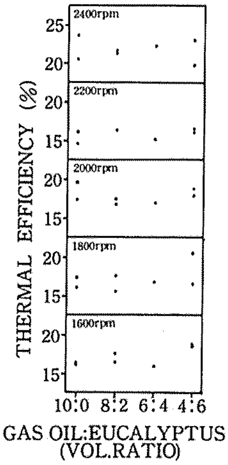

Fig. 14. —Relationships between blend ratio and thermal efficiency

Cetane index of eucalyptus oil
x =−0.171521
C =0.30

3. Experimental results.

3-1 Engine output horsepower

Figure 3 shows that the engine output performance curve operated by use of the blended fuel with gas oil and eucalyptus oil. For the engine output, the similar results were obtained for four kinds of blended fuels. It can be found from figure 4 that the more engine output increased, the better the blended ratio of eucalyptus oil to gas became.

Table 6 shows the assembled results of the data from figure 2 to figure 13. When the eucalyptus oil blended in gas oil, the engine torque was increased.

3-2 Fuel consumption

Fuel consumption was reduced in case of the eucalyptus oil blended in gas oil.

Table. 4 Differences of engine performance between gas oil and eucalyptus-light oil blend fuels

Range of revolution		1600(RPM)			2400(RPM)			Whole		
Gas·Oil : Eucalyptus	(VOL. Ratio)	8 : 2	6 : 4	4 : 6	8 : 2	6 : 4	4 : 6	8 : 2	6 : 4	4 : 6
Specific gravity		+ 3	+ 3	+ 5						
Lower calorific value		− 2	− 3	− 5						
Cetane index		−20	−40	−60						
Modified horse power		+ 6	+ 1	+14	+ 8	+ 2	+ 5	+ 5	+ 1	+ 6
Modified torque		+ 6	+ 1	+14	+ 8	+ 3	+ 6	+ 5	+ 2	+ 7
Fuel consumption		+ 1	+ 4	− 1	+10	+ 1	+ 9	+ 4	+ 4	+ 1
Specific fuel cosumption	(CC/PS/H)	− 5	+ 3	−12	+ 1	− 1	+ 4	− 1	+ 2	− 5
	(G/PS/H)	− 2	+ 6	− 8	+ 4	+ 2	+ 9	+ 2	+ 6	− 0
Thermal efficiency		+ 4	− 2	+14	− 3	+ 0	− 3	− 1	− 2	+ 5
Exhaust temperature		+10	− 5	+ 7	0	+ 2	− 2	+ 2	+ 1	+ 0
Exhaust smoke density	(Permeability)	+ 0	− 0	+ 0	+21	− 9	+16	+ 4	− 1	+ 3
	(Reflexive)	0	0	− 0	+ 8	− 1	+ 4	+ 1	0	+ 1
HC density		−13	+ 8	−23	−73	+38	+89	−17	+ 8	−14
CO density		− 6	− 3	− 4	−33	−33	+XX	− 7	− 2	+ 1

Gas oil=100% ((Blend fuel)−(Gas oil))%

4. Conclusion

a) Eucalyptus oil shound be one of the hopeful alternatives for diesel engine.

b) The blending ratio of eucalyptus to gas would be less than E40/G60(Eucalyptus 40 to gas oil 60 volume ratio), the knocking tendency was recognized in case of higher blended eucalyptus oil.

c) The value of E20/G80 would be a desirable blending ratio for diesel engine.

d) Ignition improving agent will except for the engine startability, in case of using eucalyptus oil for diesel.

Acknowledgements

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References

1) JIS Hand Book "Petroleum-1980", April, 1980 Nippon Kikaku Kyokai.
2) Sakuzo Takeda et. al.; Power and Machinery in Agriculture, Asakura-shoten, 1975.
3) The Hand Book of Agricultural Machinery ; Corona-sha, 1969.
4) Sakuzo Takeda ; Studies of Eucalyptus oil and its Application to Spark Ignition Engine ; The Bulletin of the Faculty of Agriculture, Mie University, No.60, 1980, pp.93-99.

和 文 要 約

ユーカリ油の圧縮点火機関への応用

竹田策三・伊藤信孝・笠井公人・久永孝之

ユーカリ油は燃料として引火点および粘度が高い。このような燃料は燃料噴射装置を有する，圧縮点火機関用燃料として有望である。本研究は，ユーカリ油，軽油を用い，Y社製水冷4サイクルディーゼル機関の出力特性を実験した。軽油中のユーカリ油混入量40%までは，機関出力，燃費率に大きな相違は認められないが，ユーカリ油混入率60%以上では低負荷時に爆発むらがみられ爆発音もやゝ高かった。2000 rpm 付近までは，混合比に関係なくトルクは，ほぼ一定，それ以上ではユーカリ油混合量大なるほど数%トルクの増加が認められた。

燃費率はユーカリ油混入の場合，軽油に比して大きな相違は認められない。以上を総合し，ユーカリ油の軽油中への実用的な混合割合いは20～40%である。またユーカリ油混合割合が多くなるに従い，燃料のセタン価が低下するので，セタン価向上剤の添加が，ユーカリ油混合の場合考慮されるが，今後の実験でその効果を確めたい。