

ENCLOSURE (B) 10

ENGINE TEST OF AVIATION GASOLINE  
PRODUCED FROM THE UNTREATED  
PINE ROOT OIL

by

CHEM. ENG. LT. COMDR. T. NAKAYAMA

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ENCLOSURE 12110SUMMARY

Distillate of crude pine root oil, the distillation range under 185°C was tested in Kinsei single-cylinder test engine ~~as to whether it could be used as aviation gasoline without any treatment such as hydro- or catalytic cracking.~~ The volatility of the sample was very low, and the content of gummy substance was so much that it could hardly have been used in carburetors, and so it was decided to test it blended with ethyl alcohol. The essential results were as follows:

1. Maximum allowable boosts of the sample are shown in Table I(B)10.
2. Only Sample No. 1 passed the endurance test of about 17 hours, but the condition was not sufficiently satisfactory to permit its use in first class aviation engines.
3. Although the gum content of Sample No. 1 was over 350 mg/cc, no intake valve or ring sticking occurred during the endurance test.

I. INTRODUCTIONA. History of Project

These experiments were commenced in Feb. 1945 and were not completed. Aviation gasoline obtained by the catalytic or hydro-cracking of the distillate of pine root oil up to 300°C was sent to the First Naval Technical Depot at YOKOSUKA, and tested in full scale aviation engines of the first class, and found to give the same performance as the ordinary aviation fuel of the same octane rating. It was requested that the crude gasoline produced from the pine root oil be examined, by properties, single-cylinder engine tests.

B. Key Research Personnel Working on Project

Chem. Eng. Comdr. K. NAKATA  
Chem. Eng. Lieut. Comdr. T. NAKAYAMA

II. DETAILED DESCRIPTIONA. Description of Test Apparatus and Test Procedure

This is the same as that described in "Engine test of alcohol as aviation fuel".

B. Experimental Results

The properties of the distillate of pine root oil up to 185°C were as follows:

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Octane Rating .....	70
Distillation Temperature .....	(°C)
First drop .....	100°C
10% point .....	140
50% point .....	160
90% point .....	170
97% point .....	180

It had very poor antiknock value and volatility, so it could not be used in aircraft engines. To improve these properties, ethyl alcohol was blended in the fuel. At first, 80% ethyl alcohol blended fuel was tested. The properties of the mixture of alcohol and the distillate of pine oil were as follows:

Composition of mixture (by volume): Alcohol 80% and Distillate 20%  
 Octane Rating: 85 (C.F.R. Motor Method)  
 Gum Content: 350 mg/100cc of mixture  
 Distillation Temperature:

First drop .....	75°C
10% point .....	78°C
50% point .....	78°C
90% point .....	170°C
97% point .....	180°C

This blended fuel was tested by Kinsei single cylinder testing plant and the results were as shown in Table II(B)10.

This performance was almost equal to that of alcohol. Next, the effect of gum content was examined. An endurance test of about 15 hours was made under the following conditions: 2500 RPM, boost +150mm Hg, air fuel ratio 7--8 by weight, (fuel consumption 35-36 lit/hr) and about 50 horse power. After about 11 hours, the front ignition plug was found to be misfiring due to gum. Engine was stopped, the plug changed, and the test was continued until the prepared fuel was used up. After about 17 hours total running time, the test was stopped, and the interior of the engine was examined. No deposits were observed at the inlet valve, exhaust valve, spark plug, piston, piston ring etc., although the gum content was extraordinarily large compared with that of ordinary cracked gasoline. Next, the content of ethyl alcohol was reduced. Octane ratings of the mixtures of distillate 70%, alcohol 30%; and distillate 50%, alcohol 50%, were 75 and 80 respectively. Engine tests showed their maximum allowable boosts, -100mm Hg and 10mm Hg respectively. Thus, these mixtures cannot be used as aviation fuel because of their poor antiknock properties.

### III. CONCLUSIONS

Crude pine root oil itself cannot be used as aviation gasoline because of its poor volatility, low antiknock value, and tendency to form gum on spark plugs when the engine is operated for long periods of time at low temperature. If the crude pine root oil is added in small quantity (20% by volume) to ethyl alcohol, the blend can be used approximately the same as ethyl alcohol.

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Table I(B)10  
 MAXIMUM ALLOWABLE BOOSTS OF SAMPLE

Sample No.	Composition of Fuel (Vol.%)		Max Allowable Boost
	Distillate of Pine Root Oil	Ethyl alcohol	
1	20	80	+ 300mm Hg
2	50	50	± 0mm Hg
3	70	30	-100mm Hg

Table II(B)10  
 TEST RESULTS

RPM	Boost (mm Hg)	Fuel Consumption (lit/hr)	hp	Cyl. Temp.	Exhaust Temp.
2200	300	43	70	180	640
		42		195	650
		41		210*	650