

ENCLOSURE (B) 3

STUDIES ON THE SYNTHESIS
OF DIESEL FUEL AND ITS PREPARATION
FROM CRUDE PETROLEUM

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SUMMARY

This investigation was carried out to obtain the most suitable submarine diesel oil from crude petroleum by blending with other high cetane fuels. It was confirmed that the mixture, Tarakan crude oil 70%, acid-treated diesel oil 30%, was the most useful for submarine purposes.

I. INTRODUCTION

It was well known that such fuels as Fischer oil or shale oil had high cetane ratings in spite of their lower specific gravity. For submarine diesel engines a superior diesel fuel should have a cetane value higher than 40 and a specific gravity in excess of 0.9150 (15/40). The high specific gravity is important in connection with the ballasting requirements for submarines. Accordingly, various kinds of heavy fractions of petroleum diesel oils were blended with high cetane-rating light oils, and the properties of these mixtures were determined. This work was carried out by Nav. Comdr. Y. KANEZAKI, Nav. Eng. Lieut. S. SONODA and others, from April, 1938 to April, 1940.

II. DETAILED DESCRIPTION

Pertinent physical and chemical properties of various petroleum fractions were determined in order to ascertain which fractions of petroleum crude were suitable for submarine diesel oil. These results are given in Table I(B)3. Several blending tests were carried out in order to evaluate the suitability of the various blends for submarine use. The results are shown in Table II(B)3. The mixture, Tarakan crude 70%, acid treated Fushun shale oil 30% was found to be the most suitable for submarine purposes because the specific gravity, pour point and cetane value of the mixture were 0.915 - 0.920, below -5°C, and 37 - 40 units, respectively.

III. CONCLUSIONS

In Blending Tests No. 1 and 3 in Table II(B)3, the properties of every mixture were unsatisfactory for naval use.

In Blending Test No. 2 in the table, the mixture, Tarakan crude 70%, acid treated Fushun shale oil 30, was the best for submarine purposes.

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Table I(B)3
 PROPERTIES OF VARIOUS PETROLEUM FRACTIONS

I. Oha Fraction (Heckmann's vacc. Distill)							
Fraction (%)	Treatment	Sp.Gr. (1514°C)	Viscosity (R-1.30°C)	Flash pt. (°C)	Pour pt. (°C)	Aniline pt. (°C)	Cetane Value
F.D.~10	Distillates	0.8232	27.4	27.5	no	no	51.0
10~15		0.8581	29.5	72.0	no	no	42.4
15~20		0.8718	31.5	88.5	no	no	39.5
20~25		0.8805	33.3	107.0	no	no	37.5
25~30		0.8883		117.0	no	no	36.1
30~35		0.8970	37.2	133.0	no	no	34.4
35~40		0.9053	40.5	145.0	no	no	32.8
40~45		0.9153	45.6	159.0	no	no	30.8
45~50		0.9267	61.0	195.0	no	no	28.6
II. Kettleman Hill's Fraction of 36% Topped Residue							
F.D.~10	Distillates	0.8313	31.2	no	no	no	53.5
F.D.~20		0.8399	33.9	no	no	no	53.9
F.D.~30		0.8549	37.8	no	no	no	51.9
F.D.~40		0.8664	45.8	no	no	no	51.2
F.D.~50		0.8832	117.1	no	no	no	47.5
F.D.~60		0.9021	141.1	no	no	no	43.3

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Table I(B)3-Cont.
 PROPERTIES OF VARIOUS PETROLEUM FRACTIONS

III. Bshpein Fraction							
Fraction (%)	Treatment	Sp. Gr. (1514°C)	Viscosity (R-1, 30°C)	Flash pt. (°C)	Pour pt. (°C)	Aniline pt. (°C)	Cetane Value
F.D. ~ 50	Distillates	0.8136	no	no	-5.0	179.0	70.6
22 ~ 62		0.8518	no	no	-6.0	151.3	59.9
22 ~ 27		0.8018	no	no	below -20	137.9	51.7
27 ~ 32		0.8166	no	no	below -20	144.1	56.7
32 ~ 37		0.8293	no	no	below -20	148.5	58.2
37 ~ 42		0.8452	no	no	-17	150.1	61.4
42 ~ 47		0.8591	no	no	-7	154.9	64.7
47 ~ 52		0.8729	no	no	+2.0	157.9	69.5
52 ~ 57		0.8877	no	no	+8.0	159.4	67.1
57 ~ 62		0.9019	no	no	+14.0	159.4	31.7
IV. 200~360°C Fraction of Fushun Shale Oil							
F.D. ~	Distilled Amount	Sp. Gr.	Viscosity	Flash	Pour	Aniline	Cetane
240	5.0%	0.8125	no	no	no	48.2	49.3
240~260	19.1	0.8240	no	no	no	52.2	53.0
260~280	22.6	0.8300	no	no	no	56.5	55.0
280~300	21.1	0.8365	no	no	no	60.5	57.0
300~320	18.5	0.8420	no	no	no	65.4	59.0
320~340	9.7	0.8490	no	no	no	68.4	64.0
340 ~	4.0	0.8510	no	no	no	71.1	65.0
Crude	100.0	0.8360	no	no	no	61.0	56.0

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Table II(B)3
BLENDING TESTS

I. Shale Diesel - Tarakan Diesel					
Blending Ratio (%)		Treatment	Sp.Gr. (20/4°C)	Pour Pt. (°C)	Cetane Value
Shale	Tarakan				
100	0		0.8715	+4.5	52.0
80	20	Both	0.8790	+2.0	50.0
60	40	200~300°C	0.8890	-2.3	47.0
50	50	Distillate	0.8940	-4.8	46.6
40	60		0.8990	-7.2	44.5
20	80		0.9090	-11.5	40.0
0	100		0.9182	-19.5	35.0
II. Tarakan Crude - Treated Shale Diesel					
Tarakan	Shale				
100	0		0.9408	-38.0	33.7
80	20	Shale Diesel	0.9242	-10.0	37.0
60	40	treated with	0.9076	-1.0	40.1
50	50	dil H ₂ SO ₄	0.8911		
40	60		0.8845	-3.0	43.7
20	80		0.8740	-4.0	48.7
0	100		0.8508	-7.0	51.1
III. Tarakan Crude - Fischer's Condensate					
Tarakan	Fischer				
100	0		0.9408	-38.0	33.7
80	20	Fischer's	0.9074	-7.0	50.0
60	40	Condensate	0.8841	+5.0	58.6
50	50	topped Residue			
40	60	(200°C)	0.8407	+7.0	62.0
20	80		0.8073	+10.5	76.9
0	100		0.7740	11.0	94.6