ENCLOSURE (B) 5

STUDIES ON THE PROPERTIES OF DIESEL FUEL OILS

by

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LIST OF TABLES AND ILLUSTRATIONS

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SUMMARY

Physical and chemical properties of representative diesel oils used by the Japanese Navy and of twenty degree fractions of each of those fuels were measured. It was shown that the fraction near 320°C has the maximum cetane rating, independent of the initial oil, and that there is no acceptable relation between cetane value and other physical and chemical properties.

This work was done by Ass't Eng. S. IKAZAKI.

I. DETAILED DESCRIPTION

The properties of the diesel oils used in this experiment are given in Table I (B)5 through Table VI(B)5.

Physical and chemical properties of 20 degree fractions from each crude oil are shown in Table II(B)5 through Table VI(B)5. Spontaneous ignition temperatures were measured as follows with the apparatus shown in the Figure 1(B)5. 0.1 grams of sample are taken in the quartz reaction vessel and the air displaced by pure oxygen. The vessel is heated at the rate of 2°C per minute, maintaining mercury head constant at P, and the break of the temperature-pressure curve is measured as spontaneous ignition temperature.

From the above experimental results, the cetane value, spontaneous ignition temperature, U.O.P. Characterization Factor (Watson, Nelson and Murphy, Ind. Eng. Chem., Vol 27, P. 1460), Diesel Index (Backer and Fischer, S.A.E.J., Vol. 35, P. 376), and Viscosity Gravity Constant (Moore and Kaye, Oil & Gas J., Vol. 33, P. 108), were plotted against the mean boiling points as shown in Figure 1 (B)5 through Figure 6(B)5.

It is shown that the fraction near 320°C has the maximum cetane rating, independent of the initial oil, and that there is no acceptable relation between cetane value and other physical and chemical properties.

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Table I(B)5
PROPERTIES OF DIESEL OILS USED

	Fischer Kogasin	Kettleman Hills crude	Oha crude	Tarakan crude	Shale diesel base stock
Sp. Gr. (15/4)	0.7665	0.8440	0.9464	0.9388	0.8570
Vis. R.W.I. 30° sec	32	38	707	131	42
Pour pt. (°C)	+3	-12	-15	-38	0
Flash pt. (°C)	30		18	93	97
Conradson Carbon (%)	0.0	2.59	5.13	2.08	0.13
Sulfur (%)	0.04	0.32	0.40	0.29	0.40
Aniline pt.	88.0				60.3
Cetane Value	86.7	40.5	27.1	29.5	58.3

Table II(B)5
PROPERTIES OF FRACTIONS FROM FISCHER KOGASIN

Fraction (°C)	Mean B. P. (°C)	H/C ratio	d_4^{15}	Vis. 30°C Sec.	V.I.	Pour Pt. (°C)	Flash Pt. (°C)	O.C. (%)	S (%)	Cetane V	Aniline Pt. (°C)	Spontaneous Ign.temp.
150-160	162	2.13	0.7354	26.8	100		14.0	trace	0.028		69.6	
160-180	175	2.14	0.7419	27.6	95	-50.0	27.0	trace	0.031	68.0	71.8	223
180-200	191	2.14	0.7470	28.7	93	-40.0	42.0	trace	0.026	70.5	74.8	224
-100 (at 10mm)*	207	2.11	0.7546	29.2	92	-31.0	64.0	trace	0.026	72.7	78.2	221
100-120	230	2.11	0.7636	30.9	90	-18.5	79.0	trace	0.030	74.7	83.2	220
120-140	257	2.11	0.7720	33.2	87	- 6.5	95.0	trace	0.029	79.7	89.2	222
140-160	286	2.10	0.7804	35.9	84	6.0	115.0	trace	0.032	86.0	95.2	221
160-180	319	2.08	0.7719 /40	40.4	82	18.5	138.0	trace	0.044	91.0	99.4	222
180-200	346	2.07	0.7786 /40			27.5	159.0	0.002	0.038	87.5	104.8	235
200-220	372	2.05	0.7868 /40			31.0		0.002	0.036	87.5	110.4	248
200-240		2.04	0.7934 /40			33.0		0.010	0.043		115.5	

* All the following fractions are at 10mm.

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Table III(B)5
PROPERTIES OF FRACTIONS FROM KETTLEMAN HILLS CRUDE

Fraction (°C)	Mean B.P. (°C)	H/C ratio	d_4^{15}	Vis. 30°C Sec.	V. I.	Pour Pt. (°C)	Flash Pt. (°C)	C.C. (%)	S (%)	Cetane V.	Aniline Pt. (°C)	Spontaneous Ign. temp.
150-170	140	1.94	0.7709	26.3	96				0.06	34.0	50.6	
170-190	161	1.90	0.7900	27.5	96		19.0		0.05	37.0	51.4	243
190-210	187	1.87	0.8050	28.5	94		32.5	0.007	0.06	41.2	53.6	242
-100 (at 10mm)*	208	1.83	0.8222	31.1	87	-55.0	58.0	0.009	0.05	43.2	54.2	242
100-120	239	1.81	0.8362	32.2	87	-38.0	82.0	0.014	0.08	50.2	60.2	240
120-140	260	1.80	0.8455	34.4	86	-25.5	99.0	0.026	0.13	53.4	63.6	240
140-160	284	1.78	0.8535	35.5	82	-12.5	114.0	0.034	0.16	56.4	66.6	237
160-180	312	1.77	0.8623	45.6	77	-1.5	129.5	0.081	0.22	58.0	73.0	238
180-200	340	1.75	0.8765	62.5	60	9.5	144.5	0.120	0.30	57.0	69.2	246
200-220	365	1.72	0.8940	97.5	44	14.3	158.0	0.162	0.34	55.0	78.5	252
220-240	380	1.71	0.9098			24.0	171.0	0.232	0.34	53.4	82.0	252

Table IV(B)5
PROPERTIES OF FRACTIONS FROM OHA CRUDE

Fraction (°C)	Mean B.P. (°C)	H/C ratio	d_4^{15}	Vis. 30°C Sec.	V.I.	Pour Pt. (°C)	Flash Pt. (°C)	C.C.	S (%)	Cetane V.	Aniline Pt. (°C)	Spontaneous Ign. temp. (°C)
-100 (at 10mm)*	211	1.79	0.8557	32.0	91				0.12	33.5	52.0	
100-220	238	1.78	0.8629	33.2	89	-65.0	75.0	0.022	0.14	36.0	53.0	242
120-140	262	1.73	0.8747	35.7	85	-53.5	94.0	0.048	0.17	38.6	57.6	243
140-160	283	1.71	0.8852	40.5	79	-40.0	109.0	0.036	0.19	40.0	54.4	241
160-180	299	1.67	0.8919	46.5	72	-31.0	120.0	0.036	0.26	41.5	56.4	242
180-200	315	1.63	0.9016	52.3	68	-23.5	132.5	0.076	0.29	42.7	63.8	237
200-220	339	1.63	0.9136	80.3	50	-13.0	149.6	0.167	0.29	40.0	59.2	249
220-240	359	1.60	0.9258	147.2	30	-6.5	160.5	0.210	0.32	39.0	58.4	254

* All the following fractions are at 10mm.

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Table V(B)5
PROPERTIES OF FRACTIONS FROM TARAKAN CRUDE

Fraction (°C)	Mean B.P. (°C)	H/C ratio	d_4^{15}	Vis. 30°C Sec.	V.I.	Pour Pt. (°C)	Flash Pt. (°C)	C.C. (%)	S (%)	Cetane V.	Aniline Pt. (°C)	Spontaneous Ign. temp. (°C)
-100 (at 10mm)*	212	1.78	0.8616	31.2	90		56.0	0.018	0.05	31.7	51.2	246
100-120	238	1.73	0.8807	34.5	86		80.0	0.025	0.06	32.5	51.4	246
120-140	259	1.70	0.8934	37.5	82		100.0	0.024	0.08	33.5	51.4	245
140-160	283	1.70	0.9046	43.3	76	-48.0	117.0	0.022	0.12	34.7	50.6	238
160-180	307	1.61	0.9164	53.9	65	-30.0	137.0	0.030	0.15	36.5	50.0	242
180-200	333	1.54	0.9353	84.7	47	-14.5	157.5	0.038	0.23	36.5	47.4	251
200-220	358	1.50	0.9534	180.8	27	-4.5	177.0	0.042	0.29	34.0	47.6	258
220-240	380	1.46	0.9656	551.6	13	4.5	197.0	0.046	0.32	31.5	38.3	262

Table VI(B)5
PROPERTIES OF FRACTIONS FROM SHALE DIESEL BASE STOCK

Fraction (°C)	Mean B.P. (°C)	H/C ratio	d_4^{15}	Vis. 30°C Sec.	V.I.	Pour Pt. (°C)	Flash Pt. (°C)	C.C. (%)	S (%)	Cetane V.	Aniline Pt. (°C)	Spontaneous Ign. temp. (°C)
-100 (at 10mm)*	206	1.80	0.8115	29.1	93	-42.5	62.0	0.010	0.45	46.0	43.3	240
100-120	241	1.77	0.8271	31.7	90	-23.3	93.0	0.013	0.42	50.3	54.0	236
120-140	264	1.80	0.8341	34.4	86	-12.0	111.0	0.025	0.43	55.3	55.4	241
140-160	285	1.80	0.8410	37.1	84	-2.9	125.5	0.026	0.77	59.1	60.2	239
160-180	308	1.79	0.8491	41.3	79	-.1	141.0	0.031	0.41	61.3	63.4	238
180-200	339	1.75	0.8658	50.3	70	10.3	153.0	0.033	0.37	64.0	65.0	234
200-220	366	1.70	0.8805 /20	69.8	56	13.2	179.5	0.040	0.57	60.0	64.0	242
220-240	387	1.70	0.8929 /20	106.7	45	6.5	185.0	0.067	0.40	54.9	64.8	271

* All the following fractions are at 10mm.

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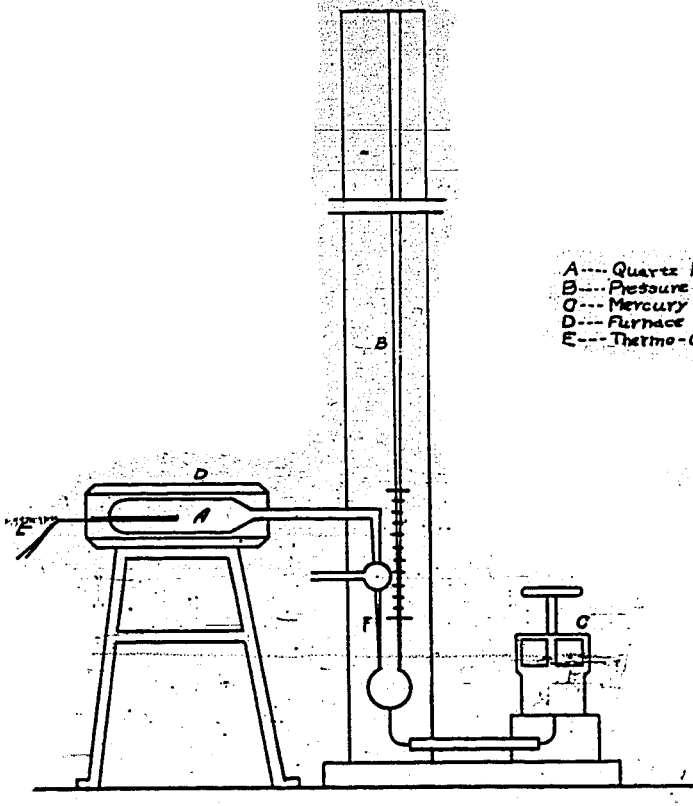

Figure 1 (B)5

APPARATUS FOR MEASURING SPONTANEOUS IGN. TEMP.

ENCLOSURE (B)5

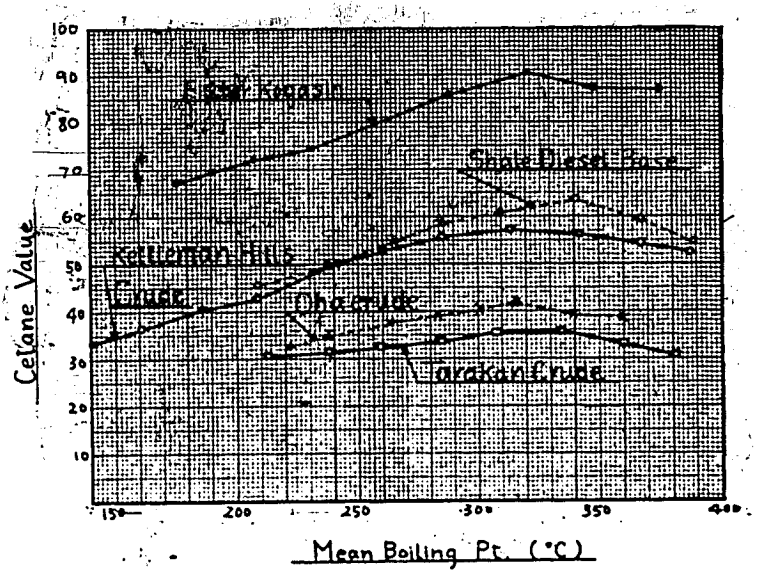

Figure 2 (B)5
RELATIONSHIP BETWEEN MEAN BOILING POINT AND CETANE VALUE

ENCLOSURE (B)5

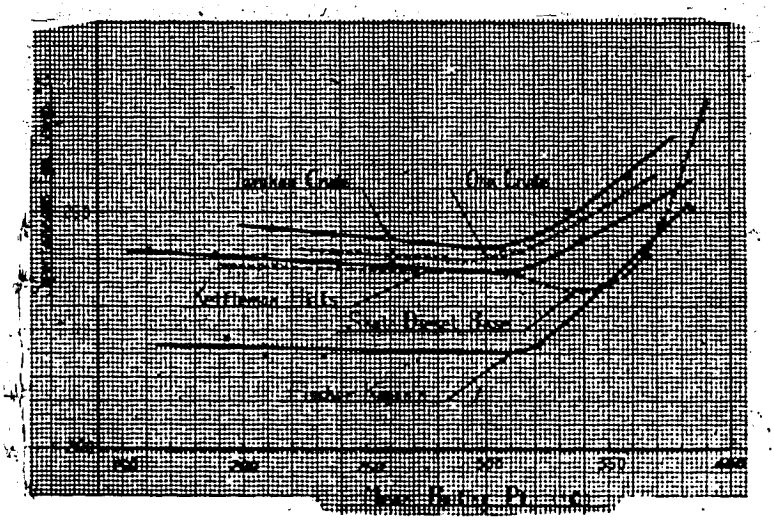

Figure 3 (B)5
RELATIONSHIP BETWEEN MEAN BOILING POINT
AND SPONTANEOUS IGNITION TEMPERATURE

ENCLOSURE (B)5

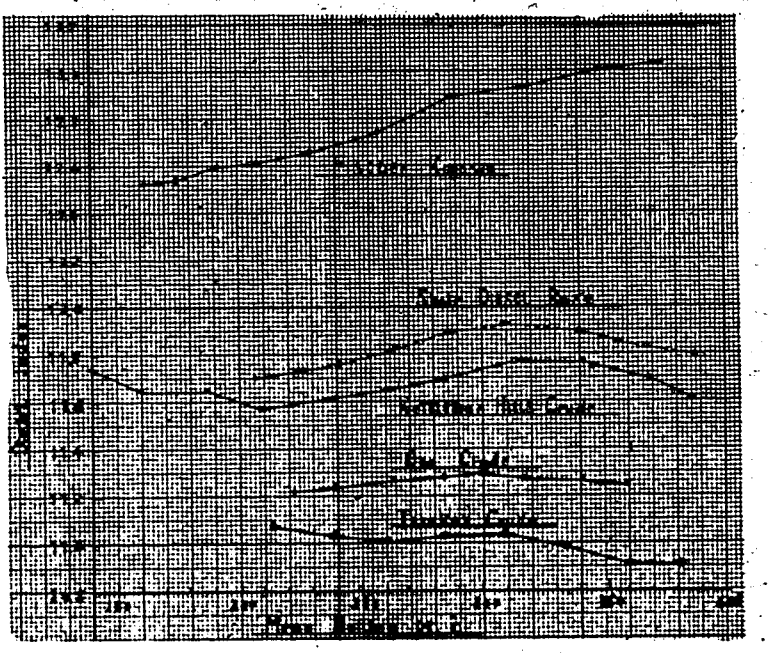

Figure 4 (B)5
RELATIONSHIP BETWEEN
MEAN BOILING TEMPERATURE AND DIESEL INDEX

ENCLOSURE (B)5

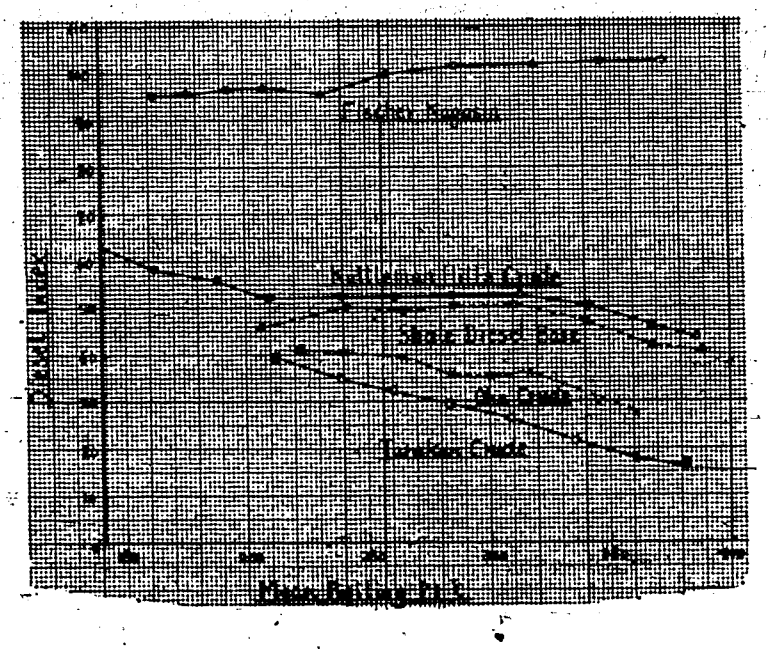

Figure 5 (B)5
RELATIONSHIP BETWEEN MEAN BOILING POINT AND DIESEL INDEX

ENCLOSURE (B)5

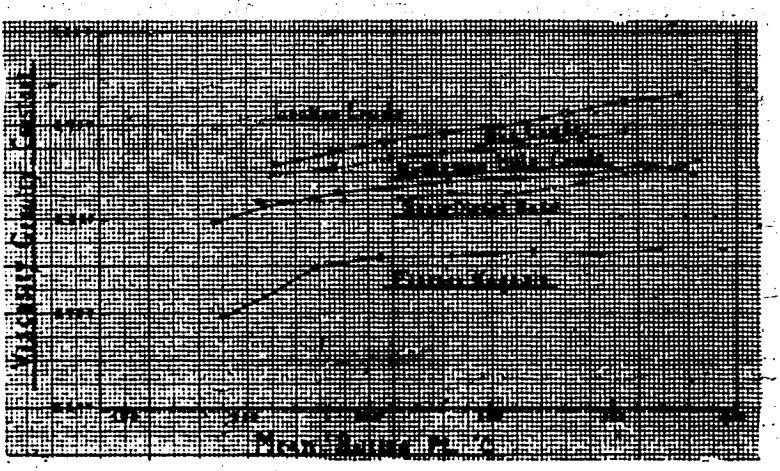

Figure 6 (B)5
RELATIONSHIP BETWEEN MEAN BOILING POINT
AND VISCOSITY GRAVITY CONSTANT