ENCLOSURE (B) 32

STUDIES ON THE INFLUENCE OF MOISTURE ON OCTANE VALUES

by

Chem. Eng. Lieut.
Masuo UEHARA

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LIST OF TABLES AND ILLUSTRATIONS

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SUMMARY

Studying the influence of atmospheric moisture on octane value of gasoline with tetra ethyl lead, we derived the correcting formula as follows:

$$\Delta N = M^a - b$$

Where ΔN is Increase of octane value from that of gasoline in the air containing 5gm water in cubic meter dry air.

M is Humidity of air represented by gm water per cubic meter dry air.

a,b are Constants, and when the percentage of tetra ethyl lead added is between 0.07% and 0.1% to gasoline, a is 0.4505 and b is 2.065.

I. INTRODUCTION

A. History of Project.

The octane value of the same gasoline was noticed to be different in summer and winter , and this was considered to be effected by the atmospheric moisture.

Previously, J.R. MacGregor had discussed the same subject in S.A.E. Journal Vol. 40, No. 6 and the writer came to the conclusion that the moisture of air has an influence on the octane value of leaded gasoline, and, therefore, the present study has been carried out to get the correcting formula.

Date of the beginning: June 1942
Date of conclusion: June 1943

II. DETAILED DESCRIPTION

A. Description of Test Apparatus.

1. Humidity controller: The apparatus shown in Fig. 1(B)32 was used in the experiment, (1) and (3) are 0.16 m^3 cylindrical tanks which are enclosed in wood casings, the space between being filled with wool.

Cylinder (1) is filled with cracked ice and cylinder (3) serves as surge chamber.

Intake air heater, (8) and steam generater, (6) are installed in the pipe between the cylinders (1) and (3).

2. Engine hygrometer: The units shown in Fig. 2(B)32 was used and was recognized as satisfactory in the reports of MacGregor.

Also, it was found that the hygrometer, Fig. 2(B)32, was practically perfect from our preliminary examinations. The wick surrounding the

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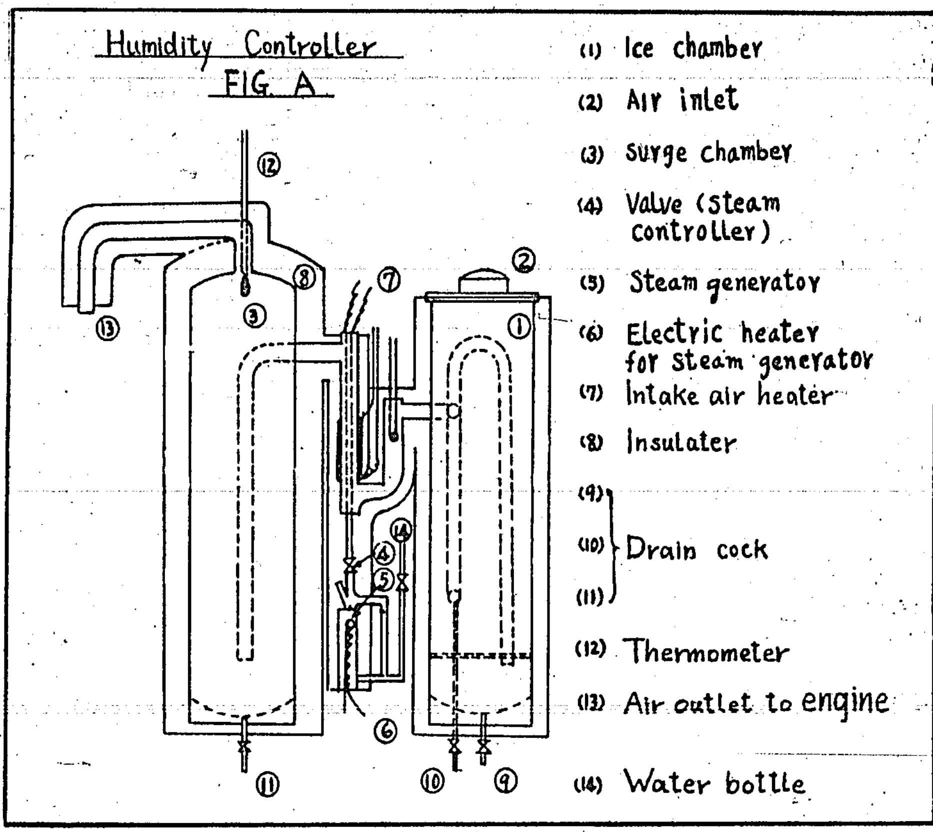

Figure 1(B)32
HUMIDITY CONTROLLER

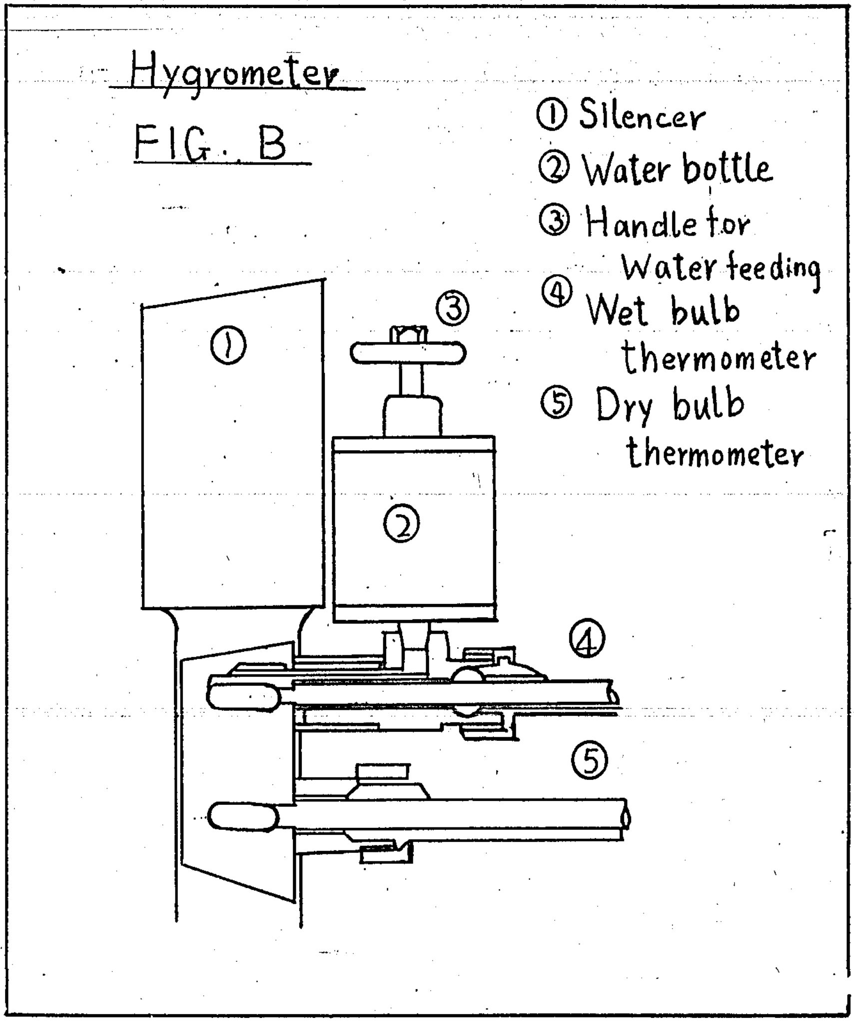

Figure 2(B)32
HYGROMETER

~~wet bulb is moistened continuously by water supplied from water~~ bottle (2). The water is conducted from the bottle through a small tube projecting into the air stream, and displaced slightly by the thermometer bulb. The projecting portion of this tube has several small holes drilled radically through it to permit the escape of water at various points.

3. Determination of knocking: The engine we used was C.F.R. engine, made in U.S.A.

B. Description of Test Procedure.

1. Samples: The samples which were used for the experiment are in table A.

Table I(B)32
TEST SAMPLES

Sample	Source	Paraffinic H.C.	Aromatic H.C.	Unsaturated H.C.	Naphthenic H.C.
K - I	Straight run (Bahrein)	79.68	6.62	1.16	12.54
S - I	K-I 80 I.O 20	84.40	5.72	0.92	9.00
S - II	K-I 60 I.O 40	88.55	5.82	0.65	4.98
S - III	K-I 25 I.O 75	92.16	4.23	0.48	3.12
Commercial Iso-octane		95.50	3.98	0.52	0
S - IV	K-I 80 Benz 20	63.74	25.29	0.92	10.03
S - V	K-I 52 Benz 48	41.43	51.44	0.60	6.52
S - VI	K-I 30 Benz 70	23.90	71.98	0.34	3.76
Benzol	Chemical pure	0	100	0	0
N - I	Straight run (Oha)	53.76	3.68	0.32	42.24
Catalytic Cracked Fuel		41.16	12.33	3.68	42.80

Standard fuel was Normal Heptane and commercial Iso-octane, Octane No. 99.3 which, it was found, could be used the same as Iso-octane.

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2. Experimental procedure: The octane value of the samples were determined by the C.F.R. Motor method under that condition in which the moisture of engine intake air was controlled by the apparatus shown Fig. 1(B)32.

C. Experimental Results.

Table II(B)32
OCTANE VALUE OF PARAFFINIC FUEL
(T.E.L. : Tetra Ethyl Lead, added)

Sample	T.E.L. (%)	Absolute Humidity ($g\ m^3$)	Octane No.
K - I	0.00	7.0	42.6
		12.0	42.6
		25.0	42.6
	0.01	5.6	46.6
		18.2	46.8
		29.0	46.9
	0.03	5.6	54.0
		18.6	55.1
		19.8	55.5
		29.2	56.4
	0.05	5.4	60.0
		14.1	61.5
		22.4	61.8
		31.8	63.0
	0.07	5.9	64.7
		13.1	66.2
		18.2	66.8
		32.5	57.1
	0.10	6.0	69.0
		12.5	70.0
		24.0	71.5
	0.20	6.5	72.0
		11.7	73.5
		16.8	73.8
		25.1	75.2
		33.3	75.7
S - I	0.00	5.3	56.5
		17.5	56.8
		29.3	56.7
	0.05	6.5	75.7
		19.1	76.7
		29.3	77.8
	0.10	6.0	79.4
		7.5	79.8
		17.0	80.8
		21.4	81.5
		32.2	81.4
		33.0	82.6
	0.20	6.0	83.4
		11.3	84.6
		17.6	85.3
		28.5	86.6
S - II	0	6.0	73.5
		20.8	73.4
		32.5	73.7
		34.5	73.5
	0.05	7.5	86.0
		19.5	87.2
		29.0	88.0
	0.10	5.5	91.5
		14.0	93.0
		21.0	93.2
		27.5	93.7
		30.5	93.8
	0.20	6.0	96.4
		25.0	99.0
		40.0	100.7
S - III	0	5.5	86.8
		12.8	87.0
		14.1	87.0
		25.9	87.0
	0.01	6.9	91.0
		9.0	91.2
		19.8	91.8
		28.7	92.4
	0.02	5.5	95.5
		18.8	96.9
		32.0	97.5
	0.05	5.8	99.8
		19.6	101.7
		29.7	102.2

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Table III(B)32
OCTANE VALUE OF AROMATIC FUEL

Sample	T.E.L. (%)	Absolute Humidity (g m^{-3})	Octane No.
	0	5.6 6.4 16.2 18.1 27.4	49.8 49.7 49.6 50.0 50.0
	0.02	7.4 17.8 24.3	61.0 61.3 61.9
S - IV	0.05	5.4 20.1 23.3	67.2 67.7 68.0
	0.10	5.6 18.1 28.9	72.4 74.0 75.0
	0.20	5.6 18.3 22.8	74.0 75.2 75.8
	0	6.0 20.0 29.0 30.0	71.4 72.0 72.0 72.0
	0.05	6.0 10.0 12.0 19.5 30.5 33.0	80.5 81.3 81.4 82.0 83.1 83.2
S - V	0.07	6.0 20.0 35.5	81.9 83.0 84.5
	0.10	5.5 17.5 24.0 29.0 30.5	83.8 84.8 85.4 85.6 85.9
	0.20	5.5 17.0 30.0	85.5 87.1 88.8
	0	5.7 19.4 27.1	80.3 80.9 81.3
	0.02	9.2 16.3 25.1	83.0 83.3 84.0
S - VI	0.04	5.8 14.4 18.9 30.2	85.4 85.5 86.5 86.9
	0.07	5.8 17.3 25.6	86.0 87.5 88.0
	0.10	6.0 17.5 24.6	87.0 88.6 89.2
	0.20	5.4 19.2 25.6	89.3 90.7 91.4

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Table IV(B)32
OCTANE VALUE OF OTHER FUEL

Sample	T.E.L. (%)	Absolute Humidity (g m^3)	Octane No.
N - I	0	5.4	73.7
		10.4	74.0
		13.6	74.2
		21.4	74.5
	0.05	5.5	85.1
		18.0	86.4
		20.0	86.6
		34.0	87.3
	0.10	5.3	88.9
		9.7	89.5
		10.2	89.8
		14.5	90.0
		23.4	91.0
	0.20	6.0	93.5
		14.0	95.4
		32.5	96.2
Catalytic cracked gasoline	0	5.4	76.0
		19.8	76.2
		22.6	76.3
	0.05	6.1	84.2
		19.8	85.3
		27.1	86.0
	0.10	5.5	87.8
		16.4	88.7
		25.3	89.2
	0.20	5.5	91.7
		17.7	92.5
		27.7	94.4

III. CONCLUSION

From the experiment, we found the following results:-

A. The influence of moisture on the difference of octane values of unleaded gasolines was within 1 octane number.

B. The influence of moisture on the octane value of leaded gasoline was remarkable.

The difference amounted to 3 octane when it was leaded 0.2% in the case of increasing moisture from 5 gm per cubic meter dry air to 25 g m^3.

C. The correcting formula, when the percentage of lead was from 0.07% to 0.1%, could be shown as follows:

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$$\Delta N = M^{0.4505} - 2.085$$

When ΔN, increase of octane value from that of the gasoline at the moisture of 5 gm/m^3 dry air.

M. Moisture of atmospheric air in gm per cubic meter dry air.

The curve calculated from this formula and plot of experimental results is shown in Figure 3(B)32.

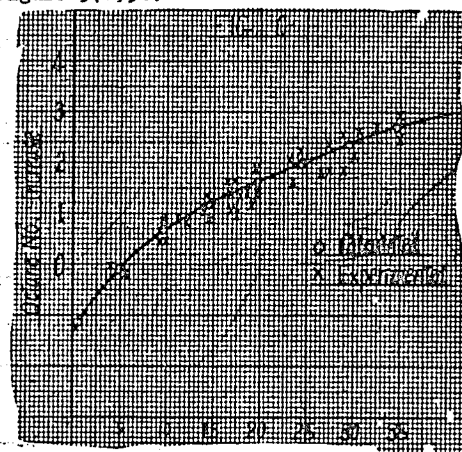

Figure 3(B)32

ABSOLUTE HUMIDITY g/m^3

Add: Humidity control not used except experimentally.