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BSB/akf

HEADQUARTERS
AIR SERVICE COMMAND
UNITED STATES STRATEGIC AIR FORCES IN EUROPE
A.P.O. 633

B13

Director of Technical Services

In reply
refer to: ATS/BSB/P22m-1

AAF - 586

21 September 1944

mx-512

Subject: 100/150 Grade Fuel

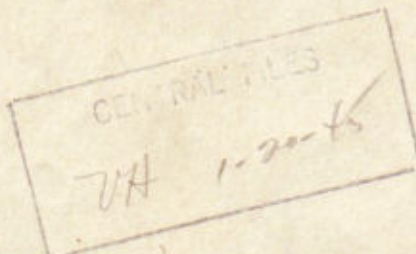
To: Director, Air Technical Services Command, Wright Field, Dayton, Ohio.
Attn: Major John Duckworth, Power Plant Laboratory.

1. Enclosed for your information is copy of provisional specification prepared by the Ministry of Aircraft Production covering 100/150 grade fuel.

B.S. Bailey
B. S. BAILEY
Capt., A. C.

Noted: *H.G. Bunker*
H. G. BUNKER
Col., A. C.
Director of Technical Services

1 Incl:
MAP fuel specification.



Classification cancelled
or changed to

AUTH: *CD 356*
By *CD 356*
Signature and Grade

Date *11-1-45*

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Archives of M. Williams
222-9

MINISTRY OF AIRCRAFT PRODUCTION

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(PROVISIONAL SPECIFICATION HDE/F/300) ISSUE No. 1
Date of Issue 1.9.44.

Grade 100/150 FUEL FOR AERO ENGINES

1. Description.

- (a) The fuel shall consist completely of hydrocarbons except as otherwise specified herein.
- (b) Mono-methyl-aniline and/or xylidines (C.S) may be present in total amount not exceeding 2 per cent by volume. The amine content shall be determined by the method described in Appendix I.
- (c) The fuel shall be clear, free from undissolved water, sediment and suspended matter.
- (d) The colour of the fuel shall be noticeably brown. A satisfactory shade is obtained when 8 milligrams per Imperial gallon of oil red dye, International colour index 258 and 3 milligrams per Imperial gallon of oil yellow dye, International colour index 19, are added to the fuel containing 7.2 millilitres of T.E.L. per Imperial gallon in the form of 1T Mix Ethyl Aviation Fluid.
- (e) Lead content - the fuel shall contain tetraethyl lead in the form of 1T Mix Ethyl Aviation Fluid in concentration of not less than 7.1 nor more than 7.25 millilitres of T.E.L. per Imperial gallon, when determined by the method described in Appendix II.

2. Distillation.

(a) The limits of the distillation range of the fuel shall be as specified in Table I.

(b) The distillation loss shall not exceed 1%.

Table I.
(Distillation Range)
Temperature

75°C (167°F)
105°C (221°F)
150°C (302°F)

Fuel Evaporated
per cent
10 (min)
50 (min)
90 (min)

3. Cold Test.

Neither cloudiness nor deposition of solid crystals shall take place when the fuel is cooled to minus 60°C (minus 76°F) by the method described in Appendix III.

4. Gum.

The existent gum content shall not exceed 7 milligrams per 100 millilitres of fuel when determined by the method described in Appendix I of DED.2473.

5. Sulphur.

(a) Corrosive sulphur shall not exceed one milligram per 100 millilitres of fuel.

(b) Total sulphur shall not exceed 0.05 per cent by weight.

6. Vapour Pressure.

The Reid vapour pressure at 37.8°C (100°F) shall not exceed seven pounds per square inch.

7. Knock Rating.

(a) The weak mixture knock rating of the fuel shall be either

- (i) not less than 99 octane number when determined by the C.F.R. motor method, or
- (ii) not less than 100 octane number when determined by the C.F.R. A.F.D. 10 method.

(b) The rich mixture knock rating shall be not less than 120 per cent of the rating of reference fuel S $\frac{1}{1.25}$ ml. T.B.L./U.S. gallon, when determined in accordance with U.S. specification AN.VV.F.748a with latest amendments but modified in the following respects.

- (i) Air flow measurements are not required.
- (ii) The mixture response curve of both reference fuel and test fuel(s) shall be presented on a graph in which specific fuel consumption values (lbs/I.H.P. hr) are plotted as abscissae and indicated mean effective pressures as ordinates.
- (iii) The rich mixture rating of the fuel shall be determined at the specific fuel consumption at which the reference fuel gives its maximum mean effective pressure.

8. Water Tolerance.

The fuel shall be substantially immiscible with water when tested by the method described in Appendix IV.

9. Inhibiter.

The only inhibitor permitted in the fuel shall be 2,4,4,6-B and this must be present to the extent of not less than 0.25 pounds nor more than 1.1 pounds per 4,200 Imperial gallons.

10. Aromatic Content.

The aromatic content, after removal of the aromatic amines by washing with 5N hydrochloric acid (see Appendix IA) shall not exceed 25 per cent by weight.

11. Methods of Test.

Except where otherwise stated the methods of test, described in the Institute of Petroleum handbook "Standard Methods for Testing Petroleum and its Products" fifth edition and such modifications thereto as are promulgated by the Institute, shall be used. The required tests are enumerated in Appendix V.

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47977

APPENDIX I

METHOD FOR THE DETERMINATION OF TOTAL AROMATIC AMINES IN AVIATION GASOLINE WHERE THE NATURE OF THE AMINE IS NOT KNOWN OR WHERE THE GASOLINE IS DARK IN COLOUR.

PRINCIPLE

The amines are extracted from the fuel by shaking with dilute hydrochloric acid. This acid is made alkaline with caustic soda, thus liberating the amine, which is then steam distilled into a graduated receiver in which its volume is measured.

ACCURACY

The method will reproduce results to $\pm 0.1\%$ by volume of amine when working with 100 ml. of sample (e.g. if the sample contains 2% by volume of aromatic amine, the results will be between 1.9 and 2.1%).

APPARATUS

100 ml. Pipette
250 ml. separating funnel
25 ml. measuring cylinder
Apparatus for the Determination of the Dilution of Crankcase Oils. (A.S.T.M.D.322-35 or I.P. 23/42T).

REAGENTS

Hydrochloric Acid - 5N
Caustic Soda Solution - 10% w/v
Phenolphthalein - 1% w/v. in ethyl alcohol

METHOD

100 ml. of the sample is placed in a 250 ml. separating funnel, shaken for 5 minutes with 25 ml. of 5N hydrochloric acid, allowed to stand and separated. The sides of the separating funnel are then washed down with 10 ml. of water and the washings separated. This extraction and washing procedure is carried out twice more, with a final additional rinsing of the separating funnel with 25 ml. of water, making a total volume of 130 ml. of aqueous extract.

The combined extracts are filtered directly into the flask of the distillation apparatus through a filter paper previously wetted with water and the filter washed three times with water.

Two drops of phenolphthalein indicator solution are added to the contents of the flask, which are then neutralised by the addition of 10% w/v. caustic soda solution until pink in colour. Finally an excess of 50 ml. of caustic soda solution is added.

A few fragments of porous pot are dropped into the flask and the trap tube and water cooled condenser fitted.

47977

The contents of the flask are then boiled over a bunsen flame of suitable size when the amine distills over in the steam, is condensed and collects as an upper layer above the water in the graduated limb of the trap tube which is graduated from 0-12.5 ml. in steps of 0.1 ml.

When there is no further increase in the volume of the upper layer in 30 minutes, the source of heat is removed, the apparatus is allowed to cool and the volume of the upper layer read at 15-20°C, as the difference between the bottom of the upper and lower meniscus of the amine layer.

Increased accuracy may be obtained, if necessary, by taking a larger volume of sample e.g. 500 ml. and increasing the volume of hydrochloric acid in proportion.

B ALTERNATIVE METHOD FOR THE ESTIMATION OF TOTAL AROMATIC AMINES IN AVIATION GASOLINE WHERE THE NATURE OF THE AMINE IS KNOWN.

(Perchloric acid method)

INTRODUCTION.

(1)
This method, adapted from that of Bandel and Blumerich, consists of direct titration of the aromatic amines with 0.1.N perchloric acid in the presence of glacial acetic acid. In this way the tertiary in addition to primary and secondary amines are estimated.

This method is not recommended for very dark coloured gasolines and is not applicable to a gasoline containing an unspecified amine since a knowledge of the molecular weight and specific gravity of the amine involved is required.

REAGENTS.

1. Indicator. Methyl violet consisting of a 0.01% wt. solution of the solid in glacial acetic acid.
2. 0.1.N Perchloric acid in glacial acetic acid.

(a) Preparation

Weight out accurately from a Lunge-Rey pipette about 4 gms. of perchloric acid into a 250 ml. conical flask; add 20 mls. distilled water and 0.5 mls. phenolphthalein solution (0.5% in 50% alcohol) and titrate with 1.0.N. sodium hydroxide solution.

- (1) Bandel & Blumerich, Angew Chem. 1941, 54 374.

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Then:- Acidity calculated as % wt. perchloric acid

$$= A\% = \frac{\text{mls. } 1.0 \text{ N NaOH} \times 10.05}{\text{wt. of acid taken (gms.)}}$$

and:- $(100-A) = \% \text{ of water in perchloric acid.}$

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Weigh out accurately in a tared 250 mls. beaker that amount (B gms.) of the perchloric acid containing 20.10 gms. of 100% perchloric acid (HClO_4) and transfer to a 250 mls. separating funnel using 50 mls. of A.R. glacial acetic acid (free from oxidisable impurities) to wash out the beaker.

Then, weigh into a 50 mls. conical flask:-

$$B \times \frac{(100-A)}{100} \times 5.667 \text{ gms. redistilled acetic anhydride.} \\ \text{(b.p. } 137-139^\circ\text{C)}$$

Cool the flask in a bath of ice and salt and add the acetic acid/perchloric acid solution drop by drop from the separating funnel, finally wash out the latter with 20 mls. glacial acetic acid which are added to the contents of the flask. Transfer the contents of the flask to a 2L. measuring flask, dilute to the mark with glacial acetic acid and mix well.

(b) Standardisation

Weigh out accurately 1.325 gms. A.R. sodium carbonate, previously dried at about 300°C for 5 hours, into a 200 mls. beaker: cover with a clock glass and cautiously add 50 mls. glacial acetic acid, taking care to avoid loss by spurling. Transfer the solution to a 250 mls. measuring flask, dilute to the mark with glacial acetic acid at 20°C and mix well.

Pipette 50 mls. of this solution of sodium acetate into a 250 mls. conical flask, add 1 ml. methyl violet indicator solution and titrate with the glacial acetic acid/perchloric acid solution prepared under 2(a) until the colour of the indicator changes from blue to green.

Let $C = \text{vol. (mls.) of titrant required, then the strength of the perchloric acid solution} = 0.1 \text{ N} \times F \text{ where } F = \frac{50}{C}.$

PROCEDURE.

Pipette into a 250 ml. flask that volume (normally 10 mls.) of the gasoline under test which contains 0.1 - 0.2 gms. of amine (x) and dissolve in 20 mls. of glacial acetic acid. Add 1 ml. of methyl violet indicator solution and titrate with the standardised perchloric acid until the blue colour completely disappears. This is the end point regardless of the final colour which may be either green or pink.

Ernst

47977

Let:- D(mls.) = vol. of perchloric acid solution required.
 V(mls.) = vol. of gasoline taken.
 M = molecular weight of amine.
 S = specific gravity of amine.

then:- Total bases in gasoline (% vol/vol) = $\frac{D \times F \times M}{V \times 100 \times S}$

Reproducibility.

± 2% of the amine content.

(x) The method may also be used for the examination of neat amines. In this case accurately weigh out 0.1 - 0.2 gms. of the amine and proceed as described using the formula:-

Total bases in neat amine (% vol/vol or wt/wt) = $\frac{D \times F \times M}{W \times 100}$

where W(gms.) = wt. of amine taken.

*per crate
sheet issued*

APPENDIX II

METHOD FOR THE ESTIMATION OF T.E.L. IN AVIATION, GASOLINE WHEN AROMATIC AMINES ARE PRESENT.

Principle.

The amines are first extracted by means of dilute HCL and the T.E.L. is then estimated in the amine free spirit by the I.P68/44 or 96/44 method.

*HCL per crate
sheet issued*

Apparatus.

50 or 100 ml. pipette
 125 or 250 ml. separating funnel.

Reagents.

hydrochloric Acid - 0.2N
 Volatile solvent - Mixed hexanes or other lead free
 petroleum spirit of similar volatility.

Method.

Sample the gasoline by the I.P68/44 or 96/44 method prescribed for T.E.L. estimations using either a 50 or a 100 ml. sample.

Place the sample in a 125 ml. separating funnel if 50 ml. has been taken or in a 250 ml. one if the sample is of 100 ml.

Add 50 ml. or 100 ml. (according to the quantity of fuel sample) of the 0.2N hydrochloric acid and shake vigorously for 30 seconds. Allow to separate and drain off the acid layer. Repeat the acid extraction and drain off the acid. Wash with 50 ml. of water and drain off the water as completely as possible. Run the gasoline into the vessel which is to be used in the first stage of the T.E.L. estimation, rinsing out the separating funnel three times with 5 to 10 ml. of the volatile solvent and adding the rinsings to the gasoline sample.

From this point proceed with the T.E.L. estimation by either of the methods described in I.P58/44 or 96/44.

47977

APPENDIX IIIMETHOD FOR CARRYING OUT THE COLD TEST.

A convenient quantity of the sample shall be dried by shaking with anhydrous sodium sulphate and standing in contact with the drying agent for at least one hour. It shall then be filtered and 200 ml. of it placed in a 250 ml. volumetric flask and the latter stoppered with a well fitting glass or rubber stopper.

The flask shall then be placed in a cooling bath maintained at a temperature of minus 60° ~~0~~ ⁷ 10 for a period of 45 minutes. The level of the sample shall be at least 5 cm. below the level of the cooling liquid. The sample shall be agitated at approximately 5 minute intervals during the cooling. At the expiration of the 45 minutes the flask shall be removed from the bath, shaken vigorously for a few seconds and the contents examined visually for signs of cloudiness and/or solid crystals.

APPENDIX IVMETHOD FOR THE DETERMINATION OF WATER TOLERANCE.

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Eighty ml. of the sample shall be shaken in a glass stoppered measuring cylinder with 20 ml. of distilled water and then allowed to settle for five minutes. At the end of this period the fuel and water layers shall be clear and sharply defined and neither layer shall have changed in volume by more than two ml.

APPENDIX V.SCHEDULE OF STANDARD TESTSI.P. Serial Designation

Normal Sampling	51/44(T)
Distillation	28/42
Sulphur (Corrosive)	65/42
Sulphur (Total)	107/45(T)*
Vapour Pressure	69/44
Peak Mixture Knock Rating	
(a) Motor Method	44/44(T)
(b) A.F.D. 10 Method	42/42(T)
Aromatic Content	3/42

* Details of this method will appear in the 1945 edition of the I.P. Standard Methods. In the meantime they may be obtained on application to the Secretary of the Institute of Petroleum.

R.D.E./F
1.9.44.

Y. 47977

Capt. Baile

ERRATA SHEET

Provisional Specification RDS/F/300 Issue No.1
Date of Issue 1.9.44.

Grade 100/150 Fuel for Aero Engines.



⁶
~~Page 8.~~ REAGENTS. 2(a) Preparation.
 For 100% perchloric acid (HClO_4)
 read: 100% perchloric acid (HClO_4).

⁷
~~Page 10.~~ (x)
 For Total bases in neat amine (% vol/vol or wt/wt) =

$$\frac{D \times F \times M}{100}$$

read: Total bases in neat amine (% vol/vol or wt/wt) =

$$\frac{D \times F \times M}{W \times 100}$$

APPENDIX II. Principle

For dilute HCL
 read: dilute HCl

⁸
~~Page 12.~~ APPENDIX IV.

For Eight ml. of the sample
 read: Eighty ml. of the sample

RDS/F(c)
18.9.44

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