Preliminary Specifications for Aviation Fuel Gas. TL 147

Ministry for Aircraft and Supreme Commander of the Air Force.

I General Specifications.

1) Aviation fuel gas has to be delivered in gastight containers approved by the authorities (cylinders, tank trucks or tank cars).

2) Aviation fuel gas must meet the specifications listed.

3) Aviation fuel gas must not contain chemical anti-knock agents, corrosion inhibitors or gum inhibitors.

II Quality Specifications.

1) Aviation fuel gas must contain at least 90% butane (iso and n-butane). Besides light hydrocarbons not more than 3% inert gases must be present.

2) The lower heating value must be at least 19,650 B.t.u. per pound (3,060 B.t.u./cu.ft.).

3) Specific gravity at 32°F. and 760 mm Hg. 0.156 lbs./cu.ft.
" " of liquid at 5°F. about 4.75 lbs./gallon.

4) H_2S content less than 5.66 mg/1000 cu.ft.

5) Organic Sulphur content less than 7.1 mg/cu.ft.

6) Elementary Sulphur must be absent (Mercury test).

7) COS must be absent (Test with alcoholic plumbite solution).

8) Mercaptans must be absent.

9) Oil must be absent.

10) Actual and potential gum must be absent.

11) Vapor pressure less than 8.8 pounds per square inch at 34°F.

12) Water must be absent.

III Analytical Methods

1) Composition : Gol u. Kohle, 45, 778 (1938)
2) Heating Value: Junkers Calorimeter
3) Density : As gas (Chemiker Kalender 1938, III, p. 908)
4) H_2S Content : Holde, 7. ed., p. 218 (1933)
5) Organic S : Total S - (H_2S + elementary S)
7) COS : The gas is passed through an absorption train composed as follows:

III Analytical Methods (cont'd)

1) Wash bottle 1 and 2, Cadmium acetate solution – 10% glacial acetic acid, for H_2S
2) " " 3 , dilute lead acetate solution, control for H_2S absorption
3) " " 4 , silver nitrate solution, for mercaptans
4) gas holder bottle 15-20 liters , cadmium acetate solution (ammoniacal), for COS.

Wash bottles 1 and 2 are filled with 100 cc. of 25% acidic Cd acetate solution and placed in a water bath. The Pb acetate solution is made by diluting 10 cc. of solution with 100 cc. of water. Mercaptans are removed by a solution consisting of 10 cc. 0.1N Ag NO_3 solution, 1 cc. IN H_2SO_4 and 89 cc. water.

The gas holder bottle of known volume is evacuated and filled with 100 cc. of a 10% Cd acetate solution and 30 cc. conc. NH_4OH.

At the start of the analysis the volume of the gas holder bottle is calculated from the pressure. The gas holder is connected with the wash bottles and the analysis is started.

The wash bottles 1 and 2 are heated in a water bath to 140°F. because Cd acetate absorbs mercaptans at room temperature. All wash bottles are flushed with gas for 10 minutes; the connection to the gas holder is closed during this time. In case that H_2S and mercaptans should be determined quantitatively besides COS it is necessary to fill the wash bottles with the absorption solution after flushing.

After flushing, the connection to the gas holder is opened and gas is admitted to the absorption train and gas holder at the rate of 10 liters/hour; the velocity of the gas flow is regulated according to the manometer reading on the gas holder. After sufficient gas has been washed the gas holder is shaken violently for 10 minutes and subsequently the gas is removed by pumping. The procedure is repeated if only small amounts of COS are present in the gas; since NH_3 is lost during evacuation, it must be replaced before each run.

The CdS formed is filtered off; the CdS adhering to the bottle is washed out with iodine solution containing acetic acid (15 cc. 0.1N I_2 solution). The CdS is dissolved in a known volume of I_2 solution and titrated as usual with thiosulfate using starch as indicator.

Calculation:

$$\frac{I_2 \text{ used} \times 3.0 \times 1000.}{\text{gas vol. (liter) at normal cond.}} = \text{COS mg/m}^3(0^\circ, 760 \text{ mm Hg}).$$

III Analytical Methods (cont'd)

8. Mercaptans: Holde, 7. ed. (1933), page 218.

9. Oil.

10. Gum.

The oil and gum content is determined by weighing the residue which remains after evaporating 250 grams of fuel gas. The evaporation is carried out as follows.

A small tube with a fine tip is connected to the test bottle. The dimensions of the tip are such that 250 grams of fuel gas require a flow time of not less than 45 minutes. The liquid fuel gas is passed into a flat bottom flask of 55 cc. which is kept on the steam bath. The liquid gas evaporates, oil, gum and elementary Sulphur remain as residue and are determined by weighing. The details for the procedure are given as follows.

The gas line consists of a special glass tube of about 300 to 350 mm. length and 6 mm. diameter. One end of the glass tube has been widened to about 12 mm. for a length of 35 mm. The ends are ground flat and the tube is connected by means of a nut with the gas bottle which has been turned upside down. A small piece of cotton is placed, by means of a small wire spiral, in the widened space of the glass tube and this arrangement serves to keep impurities from the bottle and thereby prevents clogging of the fine nozzle of the glass tube. A cotton filter is placed into the gas stream leaving the small flask which retains entrained oil and elementary Sulphur in the form of fog and very fine dust and permits to determine these materials quantitatively. This might be necessary if evaporation takes place too fast due to incorrect design of the nozzle. After gas sampling has been finished, the gas line inside the flask and the cotton filter of the gas exit line is washed with pure benzol which is evaporated in the flask from the steam bath. The flask is subsequently dried for 30 minutes at 105°C. and weighed after cooling. The residue can consist of: 1) Oil or oil and gum in the case of fuel gases from the Fischer-Tropsch synthesis or, 2) oil and elementary sulphur in fuel gases from the hydrogenation of coal tar or brown coal. In case that oil and gum is present in the evaporation residue, the following treatment is applied.

The oily residue is treated with about 30 cc. naphtha and shaken with Fullers Earth or some other adsorbent clay. The solution is decanted off and the treatment with clay is repeated. The clay portions are combined and are again extracted with fresh naphtha and decanted until the naphtha remains colorless, that is, until all oil has been removed by means of clay. The combined clay portions are washed with a mixture of benzol-alcohol (50-50) which extracts the adsorbed resins and decolorizes the clay. The benzol solution is evaporated and the residue is weighed.

11. Vapor Pressure at 0°C.

The apparatus consists of a pressure bomb of 1 liter volume, equipped with two valves and dip tubes which reach to the bottom. It further is equipped with a manometer covering the measuring region of 0 to 20 kilograms per square centimeter. The operating pressure of the bomb is 35 atmospheres.

12. Determination of water.

The apparatus consists of a receiver having a volume of about 1.5 liters, the receiver is placed in a Dewar vessel. The receiver is connected on one side with a glass filter and stopcock and on the other side with a U-tube manometer. The receiver is connected with the sampling line and swept out by a slow gas stream for about 5 minutes. After flushing, the stopcock next to the glass filter is closed and the receiver is cooled to minus 30°C. The gas stream is now regulated in such a way that it corresponds to 200 mm. pressure. The temperature should be kept at minus 30°C. during the entire determination. As soon as 1 liter of liquefied gas has been collected in the receiver, the experiment is discontinued. The presence of water is detected by the cloudiness of the liquid or the separation of crystals. The receiver is emptied through the glass filter. The glass filter is washed with a known amount of methanol and the water is determined in aqueous methanol solution by the iodine-pyridine method.