7 · Aviation Gasoline Introduction

Since the engines first used to power flight were based on the automotive engines of the day, they were fueled with automotive gasoline. The following decades saw large improvements in aviation engines and fuels. Much of the development was driven by the military’s interest in aviation, both in the United States and in Europe. The primary goals were always better reliability and more power but without a proportional increase in engine size or weight.

Because engine and fuel are interdependent components of a single system, the path of progress resembled a game of leapfrog. “Engine development made it obvious that better fuels were needed, and when the improved fuel was used it immediately became evident that further engine development was necessary to make suitable use of the available fuel. As the engines caught up with the available fuel it became evident that still better engine performance would result from even better fuel. As a result, the engine builder and user have, over a period of years, consistently demanded better and better fuel.”

For fuels, the primary challenge was to improve antiknock properties so that the engines’ power output would not be knock-limited. The major developments were the use of lead antiknock additive (tetraethyl lead), the identification of petroleum crudes with the best lead response, and the identification and production of specific hydrocarbons with good antiknock properties.

In 1930, the U. S. Army Air Corps specified a Fighting Grade gasoline with a minimum octane number requirement of 87. This is believed to be the first instance in which the antiknock properties of an aviation gasoline (avgas) were defined in terms of octane number. By the start of World War II, fuels very similar to today’s Grade 100 were in use.

Avgas reached its development peak during World War II. In 1944, the U. S. military issued a specification for Grade 115/145. This fuel, which had the highest antiknock rating of any avgas in large scale production, was used to obtain maximum output from high-performance engines.

GRADES OF FUEL

Grades of avgas are identified by their nominal minimum lean-mixture antiknock rating(s). Previously, both the lean- and rich-mixture ratings (see page 56) were used; now, only the lean-mixture rating is used.

In the decade following the war, six grades were in military and commercial use (see Figure 7.1). In the same decade, turbine engines became the engine of choice for the military. As turbine engines also began to dominate commercial fleets, both ends of the avgas grade lineup were eliminated. Demand for the fuels with the higher antiknock ratings disappeared. And, at many commercial airports, an avgas tank was converted to jet fuel storage. But

1 R. Schlaifer and S. Heron, Development of Aircraft Engines and Fuels, Graduate School of Business Administration, Harvard University, Boston, 1950, p. 552.

2 Ibid., p. 596.
when some of the older 80-octane-rated engines were fueled with Grade 100/130, they encountered spark plug fouling and exhaust valve deterioration because of its higher lead content. A lower lead content version of Grade 100/130 (Grade 100LL) was developed in an effort to create a single universal grade of avgas.

Today avgas is used mainly by small airplanes and light helicopters, but there is also a significant number of military and civilian transports powered by large piston engines that use avgas. The D 910 avgas specification recognizes three grades, all of which contain lead (see Figure 7.1). As planned, Grade 100LL is the most popular, by far. Grade 100 and Grade 80 are used sparingly. A new specification for low-octane unleaded aviation gasoline, Grade 82UL, has recently been approved by ASTM (see page 54).

**FUEL CONSUMPTION**

Air power was critical to the outcome of World War II, and toward its end, the Allies’ production of avgas peaked at more than 25 million gallons per day. Two years after the war, it had decreased sharply to about 5 million gallons per day. The growth of commercial aviation together with military use resulted in a gradual increase to about 14 million gallons per day in 1957. Then production began to decrease again as turbine engines replaced piston engines, first in military and later in commercial applications, returning to about 5 million gallons per day in 1970.

In 1999, total avgas production in the United States was 0.8 million gallons per day, \(^4\) a very small amount compared to the production of turbine fuel (70 million gallons per day) or motor gasoline (346 million gallons per day). Worldwide use of avgas in 1996, the most recent data available, is estimated to be about 2.2 million gallons per day.\(^5\)

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