Fuel Injection Vs. Carburetor

Advantages and disadvantages of the two fuel supply systems are analyzed. Carburetor-icing bugaboo may have been overemphasized

In general aviation circles there is considerable discussion currently on the subject of the merits of fuel injection. The general aviation public has evidently seized on fuel injection as a very desirable improvement over the carburetor. The public, along with some members of industry, often has a tendency towards overemphasizing the value of a departure from the standard, without due knowledge or consideration of the facts. Frequently, after the various factors become apparent, the advantages of the previous standard bring it back into public favor. This may well be the case in the present controversy of fuel injection versus the carburetor.

My own preference, after having carefully investigated both types of fuel metering systems, is for the carburetor, at least on aircraft up to and including those of the complexity of the *Aztec*, and on the types of engines that are used in these models. The reasons for this preference are given below.

The automobile industry has in recent years experimented with production applications of fuel injectors, found them inferior for their purposes and retained the carburetor. A statement in the New York Times of Oct. 16, 1960, sums up the situation: "Up to now, all efforts to replace the carburetor with more expensive fuel injection have failed. While some lower cost fuel distribution system may come along in the next 10 years, the carburetor appears to be far ahead of its competitors at the moment."

What is true for the automobile industry is for the most part true in the less-sophisticated general aviation aircraft. The fuel injector does not offer enough advantage to compensate for its increased complexity and cost.

Where a fuel injector can replace a "pressure" carburetor instead of a "float-type" carburetor, as in the Beech *Bonanza*, the complexity and cost are not necessarily increased, and may even be less. Where the injector must replace an automotive-type float carburetor, as in all of our models, and particularly in installations where gravity fuel flow can be used, the increases are substantial.

Fuel injection is simply a means of introducing fuel to the cylinders directly at each cylinder head, by pumping it through small tubes similar to primer lines. Air is taken in through an intake system not unlike a carburetor intake arrangement, except that there is only a butterfly valve instead of a carburetor incorporating the butterfly. The amount of fuel pumped to the cylinders must be in approximate proportion to the volume of air being taken in.

To match the fuel flow to the air flow and maintain a proper mixture, it is necessary to vary the flow of fuel with r.p.m. and with butterfly opening. This means a linkage of the fuel injector pump with an engine gear, as well as a connection with the butterfly through the throttle. All of this gets a little complicated, requires extra mechanism and fairly high pressure.

The carburetor, in which fuel is mixed with air simply by the suction of air flowing through the venturi, requires only a minimum of fuel pressure, and is about as simple and trouble-free an arrangement as could be devised.

The advantages of the fuel injector are:

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The fuel injector-carburetor argument reaches the desk of Piper's Vice President Howard Piper, shown in the photograph. On the left is a conventional aircraft-engine carburetor while on the right is the integral part of a fuel injection system

Fuel Injection

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1. No carburetor icing due to refrigeration in the venturi.

2. Better distribution of fuel in some cases, providing for more consistent cooling, less accumulation of deposits in the engine, more smoothness, better economy.

3. With more consistent cooling, the flow of cooling air can be less critical.

4. No carburetor heat system is required in some cases.

5. No primer system is required.

6. A gauge for leaning is provided, making effective leaning easier.

7. A lower profile in some cases, permitting smaller nacelles, particularly in wing-mounted installations.

8. A small increase in power is usually available with the same size engine due to less air restriction in the intake system or more efficient "breathing".

Disadvantages of fuel injection:

1. Much more complicated, with resulting increase in possibility of service trouble.

2. Numerous small fuel lines running through the engine compartment are a source of potential fuel line failure, with resultant fire hazard.

3. More expensive by far; the fuel injector costs almost three times as much as a float carburetor and increases the cost to the retail purchaser considerably.

4. Higher pressures are required (15-25 lbs. per sq. in.). This gives more possibility of trouble from fuel leaks and requires a higher-priced emergency fuel pump.

5. Almost all currently used fuel injectors require return lines back to a fuel tank. This complicates the fuel system, increasing cost and weight, and makes fuel management more difficult, because the pilot has to keep in mind that a large flow of fuel is returning to one tank. The measurement of fuel consumption can be harder, and fuel can be pumped overboard.

6. Icing in the intake manifold is not eliminated, and some source of hot air is needed.

7. Idling frequently is not as smooth as with a well-carbureted engine.

8. Starting can be very critical, because overloading is easily done.

9. Use of the mixture control with changes in altitudes can be quite critical. If the mixture is not properly adjusted with altitude variations, erratic engine operation results more than with the carburetor.

Advantages of the float type carburetor:

- Much less expensive, simpler, lighter.
- Much more trouble-free because of simplicity and service experience. Very little to go wrong. Safer from fire hazard.
- No high pressures required; can be used even with gravity flow, no fuel pumps at all then required.
- Less fuel leakage hazard.
- No return lines required.
- Better idling.
- Better starting.
- In a well designed carburetor-intake system, distribution is about equal to that provided by fuel injection. Fuel economy is just as good, smoothness, cooling and engine service life are equivalent.

Disadvantages of the carburetor:

- More susceptible to icing.
- Requires a priming system.
- No gauge is presently available to assist in precise leaning.
- In some cases, distribution of fuel is not as good; cooling, fuel consumption, service life and smoothness may be inferior.

From the above it may be concluded that in some engine installations, fuel injection could be quite an improvement, if the engines did not run very well with a float carburetor. If the carburetion system functions properly, however, so that distribution is good, and the system is not readily susceptible to icing, not much gain can be realized and numerous new problems are introduced.

In our development program at Piper Aircraft, we are planning to use fuel injection on certain more advanced fu-

ture models where its advantages make it the logical choice. We are not planning to use it where we would be doing the customer a disservice by changing to fuel injection.

For the most part, the distribution on our engines is already very good, and smoothness, fuel consumption, etc., is equivalent to what it would be with fuel injection. The icing problem is taken care of very adequately with high capacity carburetor heaters, and the engines are not particularly susceptible to icing. This is partly because on our Lycoming engines the carburetor is mounted on the bottom of the oil sump and all mixture flows to the cylinders through passages surrounded by hot oil. The carburetor and the mixture are warmed enough to prevent certain icing and provide for improved acceleration. It is usually possible to glide one of our airplanes from 5,000 feet to sea level on a cold day with the engine idling and no carburetor heat on, and just before landing slam the throttle forward and have the engine accelerate perfectly.

The carburetor icing bugaboo, which is obviously the main reason for the interest in fuel injection, has in my opinion been greatly overemphasized. Carburetor icing, over the past two decades, has been given as the cause for most any kind of accident whose real cause wasn't apparent. Being a rather mysterious phenomenon and one which frequently can't be traced because of melting of the ice, carburetor icing gets blamed for everything. Certainly, carburetor icing is something that pilots must understand and guard against, but it is not the serious menace that many people consider it to be. With the use of a good carburetor heat system and a little judgment, the problem of carburetor icing becomes insignificant.

Fuel injection does have some decided advantages over the carburetor. It also has some serious disadvantages. When all of the factors are weighed, it becomes clear that there is a place for fuel injection in certain aircraft models, but that the float type carburetor will most probably continue to be furnished in the majority of general aviation airplanes for many years to come.

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'Pusher' Twin Nears Certification

Certification of a new "pusher-type" light twin, the *Brigadier* B-290, is expected by the end of July, according to Dr. George S. Stayner, president of the Phoenix Aircraft Manufacturing Corporation, Nanuet, N.Y., which is developing the new airplane. Production is expected to start by the end of the year, he said.

An all-metal, five-place aircraft, the *Brigadier* prototype is powered by two 145 h.p. Continental engines and is now going through the final phase of certification, Phoenix's president stated. It has been under development since 1952. The twin will sell for about $37,000, The PILOT was told. The company expects to supply it with the choice of one of two power packages: either 180 h.p. or 260 h.p. Continental engines.

The following specifications and performance data on the *Brigadier* were supplied by Dr. Stayner:

Gross weight	4,000 lbs.
Empty weight	2,250 lbs.
Cruising speed (70% of power)	155 m.p.h.
Range	850 miles
Climb	1,000 f.p.m.
Stalling speed (flaps down)	56 m.p.h.
Takeoff (over 50 ft. obstacle)	1,300 feet

END

Phoenix Aircraft Manufacturing Corporation's Brigadier B-290 undergoes tests near Nanuet, N.Y.