Study of Specific Gravity Floats to Indicate Jet Fuel in AVGAS

In the past there have been balls of fixed specific gravity used to indicate the presence of Jet Fuel in AVGAS. This is a dangerous practice and is more misleading than helpful.

Specific gravity is essentially the density of a material as it compares to a standard value. In the case of liquids and solids the standard is water, which is given the value of one. Water is unique in that it hovers around one over a wide range of temperatures. Most other liquids whose major constituent is not water, such as petroleum distilled fuels, change more dramatically and predictably over a common range of temperatures. Solids can also be measured by their specific gravity.

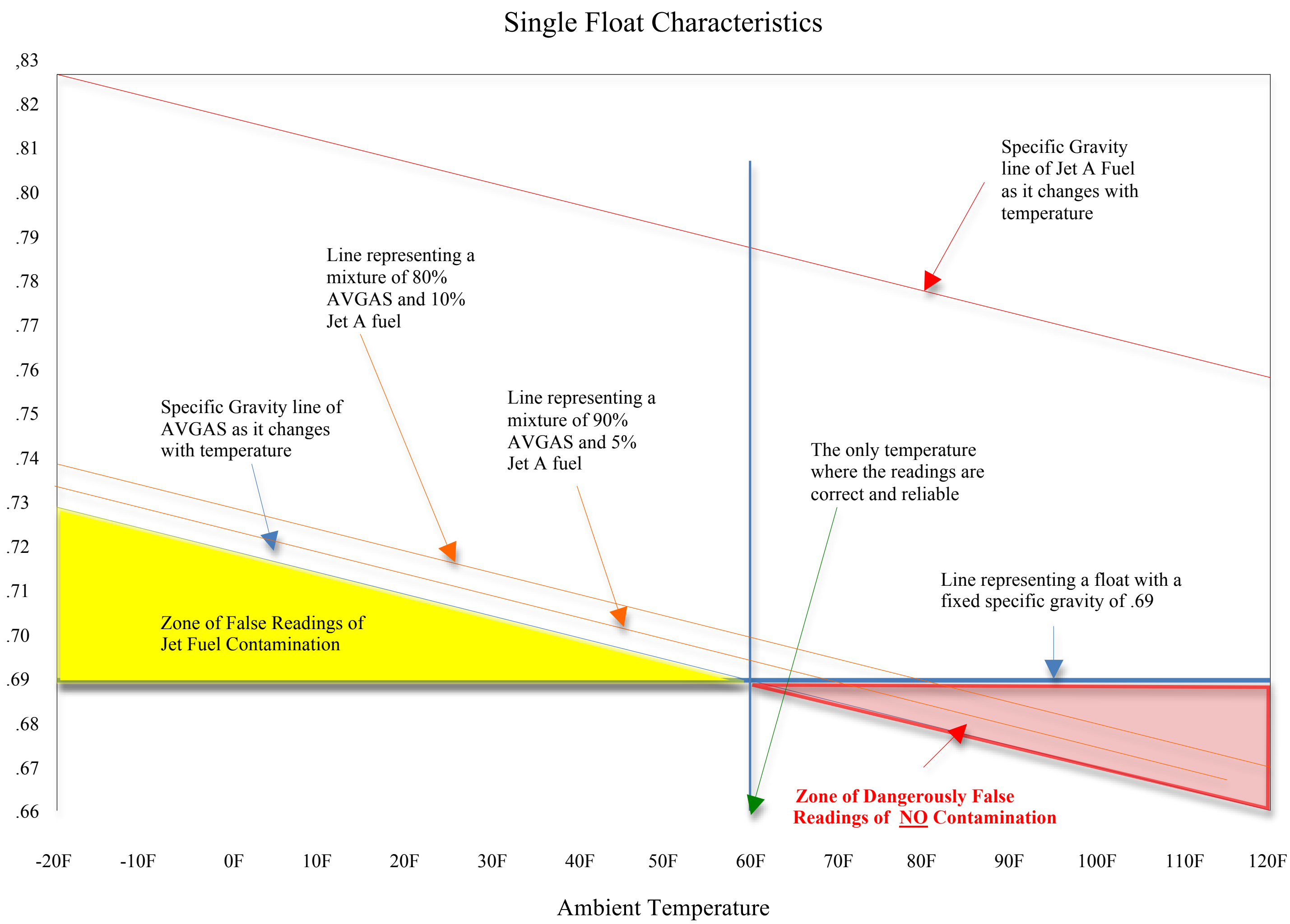
Hydrometers use the comparison of the specific gravity of float or combination of floats to indicate the specific gravity of a liquid. Hydrometers, as their name implies, are used to test water-based liquids. Because water changes density very little and the floats don't change at all, the readings are generally reliable in that the variations are so small as to be insignificant to the overall measurement. For this reason the most common hydrometers are used to evaluate battery acid and automotive antifreeze.

Many years ago a float with a density of .68 was put into a fuel tester with the idea that it would give a visible indication of the presence of Jet fuel in AVGAS. This was an attractive proposition because of the harm that is caused a gasoline engine when as little as 5% by volume of Jet fuel is mixed into its gas. At 80 degrees Fahrenheit ambient temperature it worked quite well. The float would hover just under the surface of a volume of AVGAS. With the introduction of Jet A fuel, which is most commonly put in an airplane gas tank by mistake, the float would bob to the surface of the AVGAS like a cork in water. If there was water contamination of the fuel sample also, the operation of the float was essentially unaffected. In fact, if the Jet A absorbed any of the water it only increased its density and made the indication more pronounced. Soon after the float was introduced to the general aviation market it was noticed that known uncontaminated fuel gave a false positive reading at lower temperatures. Because of these erroneous readings, the whole issue of using specific gravity floats was investigated over a broad range of temperatures with various concentrations of Jet A fuel in AVGAS. The results of this experimentation are represented in the graph within this report.

Since that time there have been other fuel tester manufacturers who have introduced floating indicators of Jet fuel contamination for a time and the possibility exists that they will be seen again. The danger of using these float indicators is that a single float is only accurate at one temperature and wrong most of the time. If the temperature is lower than the specific gravity convergence point of AVGAS and the float, the AVGAS becomes denser and the test gives a false positive because the float goes to the surface. If the temperature is higher than the convergence point the float will sink in the thinner AVGAS and if there is Jet fuel in the gas it may not be detected if the contaminated mixture results in a specific gravity that is less than that of the float. For that reason a damaging amount of Jet fuel contamination can go undetected.

A hydrometer style tester with multiple floats could be constructed to overcome the deficiencies of the single float indicator. Even though it would contain several balls or floats of different colors, it would require a fairly complicated table or graph to interpret the results. The real problem though, is the lack of measurement precision. To cover the range of temperatures encountered in all locations around the year seven balls would be required at a specific gravity interval of 0.1 and even with that complexity there would still be a window of uncertainty spanning 25 degrees F. Consequently, there is likely no simple and inexpensive hydrometer-like device to be had for Jet fuel contamination of AVGAS.

These conclusions are easily ascertained by analyzing the table constructed from the results of the tests done.



The chart above demonstrates the characteristics of AVGAS, Jet A fuel and a fixed specific gravity float at .69. The AVGAS slope runs from the left margin at the .73 point down to the lower right margin at the .66 point in a linear or straight line. The Jet A fuel slope runs from the left margin at the .83 point down to the right margin at the .76 point in a similarly linear line. These slopes occur over ambient temperatures from -20F to 120F. The depicted values are not high precision measurements, but accurate enough to demonstrate the reality of the situation under consideration.

The float is represented by the line running horizontally along the .69 line. The intersection of the float density and the AVGAS slope occurs at 60 degrees F. This is the temperature where the float will neither sink nor float on top of the liquid. As the ambient temperature drops, the specific gravity of AVGAS increases and the specific gravity of float is fixed resulting in the float riding on the surface, which would normally mean the AVGAS sample should be contaminated with Jet fuel, but it is not. This situation is at worst an annoyance. It does however desensitize the user over time. Conversely, as the ambient temperature rises the specific gravity of the AVGAS drops, so the float sinks in the liquid column. This means that there could be a significant Jet fuel contamination and as long as the resulting specific gravity of the mixture is less than the float's specific gravity it would appear that the AVGAS is free of contamination, which it would not be. This situation could result in engine damage and an emergency landing or crash landing.

There are two slopes indicating a concentration of 5% and 10% contamination with Jet A fuel. It can be seen that a temperature variation of as little as 5 degrees F can render unreliable results. Furthermore, with an increase of as little as 12.5 degrees from the ideal 60F there can be as much as an undetectable 5% Jet fuel contamination, which is generally considered destructive to AVGAS engines.

Because of the shallow angle of the slope of the fuels in relation to a fixed density small, but functionally significant variations are possible, rendering little visible deviation from acceptable results. Put simply, reliable results require a much greater precision of measurement than is easily or cheaply obtained.

Conclusion

For the reasons outlined above, specific gravity float indicators for aviation fuels are never a good idea and should never be used or relied upon to analyze AVGAS for heavy fuel contamination.