AASF Safety Spot – September 2022

Contaminated Fuel
by Rocky Capozzi

It's been one wet summer here in Alaska and that's motivated me to learn what I could about accidents caused by water in the fuel. I read quite a few accident reports from around the country and found two Special Airworthiness Information Bulletins (CE-12-06.doc (faa.gov) , CE-10-40R1.pdf (faa.gov) and one Advisory Circular (AC20-125.pdf (faa.gov) that address this topic. If you are only inclined to read only one of the documents, I recommend AC 20-125. It's by far the most in-depth treatment of all the ways water can get into your system and defines some terms and concepts worth understanding.

I had a couple of takeaways from AC 20-125. All aviation fuels dissolve water to varying degrees. "*Dissolved water* in fuel is like humidity in the air." Like humidity, decreased temperature can cause the dissolved water to come out of solution like the way fog can appear. Dissolved water generally doesn't cause engine operation problems. Problems are caused by *free water*.

Free water can occur if dissolved water precipitates out of the fuel. If the fuel supply or fuel container is contaminated, free water is pumped in along with the fuel. Free water can occur as *slugs* (think of a blob of water or layer of water) or *entrained water* – suspended droplets. Fuel with enough suspended droplets will appear hazy. If a water slug and fuel are violently shaken, as they will be passing through a pump, entrained water is likely to result. Entrained water will precipitate out – but where will it be when it does?

SAIB CE-12-06 tells us what we should do as pilots, and I quote paragraph 2 of the recommendations in its entirety.

2. With the airplane in the normal ground attitude and starting at the highest drain location, check all drain locations for contaminants before every flight, whether or not refueling has occurred. Have fuel sample disposal provisions and proper lighting at your disposal to properly check for fuel tank system contamination.

• Drain at least one cup of fuel (using a clear sampler cup) from each drain location.

• Drain the fuel strainer as required to completely flush its contents in each of the fuel selector positions.

• Check for water, clarity, cloudiness, haze, proper fuel type/grade (i.e.; 100LL is light blue in tint, jet fuel is clear or yellowish), odor, or other contaminants.

• Allow time between fueling and draining. It takes time for any contaminates to settle to sump area prior to draining tanks.

• If any contamination is detected in the fuel tank system, thoroughly drain all drain locations again.

• If contamination is observed, take further samples until the fuel appears clear, and gently rock the airplane in both the roll and pitch axis to move any additional contaminants to the drain points.

• Take repeated samples from all drain locations until all contamination has been removed.

• If contaminants are still present, do not fly the airplane. Have qualified maintenance personnel drain and purge the fuel tank system. Remove all evidence of contamination prior to further flight.

The narratives of many fuel contamination accidents reveal the pilots found water in the fuel before they took off but thought they had removed it. The three accidents below are typical examples.

Piper PA-18 N40832 Taylorcraft N39226 Cessna 152 N757PY

Here are some final thoughts on the subject. I've always refueled to full tanks after every flight to minimize the possibility of condensation occurring within the tanks. Refueling after every flight is also recommended by SAIB CE-12-06. If your airplane parking spot isn't level, your fuel drains (and water) may no longer be at the low point as they would be if you were on level ground. Do what you need to do to get any water to the low points. Depending on your fuel system plumbing and where your drains are located, leaving the fuel selector in the "Both position" may not get the job done properly. The fuel will drain along the path of least resistance. Remember, it takes some time for water to migrate to the low points after fueling or changing the airplanes' attitude. Based on the accident reports above, it seems likely that water may be present throughout the fuel system if it's encountered at drain ports during the pre-flight.

Data Dump from NTSB General Aviation 2018 data spreadsheet.

Total accidents = 1292

Purpose of Flight – Top 2: Personal 892 (65.9%), Instructional 202 (15.6%),

Defining Event – Top 3: Loss of Control-Ground 234 (18.1%), Loss of Control-Air 218 (16.9%), System Malfunction-Powerplant 210 (16.3%)

Phase of Flight – Top 3: Landing 438 (33.9%), *Takeoff + Initial Climb (to pattern altitude) 272 (21%), En_Route 225 (17.4%)

*NTSB uses ICAO definitions for defining events and phase of flight. I combined their phase of flight data for Takeoff and Initial Climb since the ICAO definition of initial climb terminates at 1000 feet or pattern altitude. Considering how little time is spent from brake release to 1000 feet, this shows that the takeoff phase is more "dangerous" than the landing phase. If you follow the link to the spreadsheet, you will see the number of fatal accidents in the takeoff phase is higher than the landing phase. There were 8 fatal accidents in the landing phase and 55 in the takeoff-initial climb phase.