THE GAMGRAM

No. 67 **"DIRT" IN AVIATION FUELS** **JUN. 2016**

In several previous GamGrams, we have addressed several aspects of fuel contamination. This GamGram specifically addresses dirt (particulate or solid) contamination.

In all things, dirt can be a problem. In food it may cause illness, and in working parts it can cause wear. In water, it can cause problems, but in a jet engine, there are many bad things that can happen.

Dirt can clog filters, it can damage pumps, valves and fuel controls or clog/damage anything in the fuel system. If it builds up in injection nozzles, it can also affect the burning of the fuel. It can also build up in low-flow areas, such as sumps and damage drain valves.

Dirt can enter anywhere. It comes in as dust through vents, with mixed fuels and dirty equipment. Rust is generated by steel pipe, tanks and components in the system. Dirt can be created by micro-organisms. It may be solid or gummy, large or small particles, flakes or fibers. We even found a small fish in a nozzle strainer once. What we call "dirt" (particulate or solid contamination) can be almost anything.

Certainly we all acknowledge that we need to keep any fuel as pure as possible, but in an aircraft engine, this is critically important.

We monitor every aspect of fuel quality and look for any contamination also as a warning that something else has gone wrong in the handling of the fuel. Not only do we worry about the nature of the specific contamination we discover, but we must also be concerned that other characteristics of the fuel may be affected. Particulate contamination may be the tip of the iceberg.

A good example is when diesel fuel becomes mixed with jet fuel. The gravity/density of the fuel may not change a lot, the visual appearance may not change a lot but it burns differently. When we find darker membranes (or particles on the membrane), we need to make sure other chemical characteristics of the fuel have not changed.

Most commonly, particulate contamination is either rust, dust or inherent contamination found in the crude oil itself (for example, sulfur compounds). We usually detect particles visually, either by seeing large particles with the human eye, or by straining very small particles from the fuel with filter membranes to ASTM D2276 and D5452. We can also detect it as an increase in pressure drop across filters. See also GamGrams 2, 3, 13, 25, 42, 46, and others on differential pressure.

But what is particulate contamination, and where does it come from?

First, we need to understand how small this "dirt" can be. A red blood cell is about 8 microns wide. The human eye cannot see a dark particle smaller than about 40 microns against a white background. A hair is about 100 microns thick.

The refueling filters used on avgas are typically rated about 5-10 microns, and on jet fuel the filters are rated about 1-2 microns. If a particle is visible to the naked eye, it did not pass through your filter.

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An interesting fact is that we have had aircraft engine filters rated at 10-50 microns become plugged with “dirt”. How can that happen when the refueling filters are much finer?

One way is for the dirt to enter the aircraft not through the fuel system, but through the aircraft fuel tank vents. This dirt is usually silica dust. Do you think the strainers on the aircraft vents protect you? A 100 mesh strainer is only going to remove particles over 130 microns, so dust can be a problem. Another way we can plug engine filters is with tiny particles of rust that gather together into larger “clumps” on tiny condensed water drops. If below freezing, these can be little, dirty snowballs .

It is also possible for tiny particles (or fibers) of water absorbing filter media to grow larger (swell) and contribute to filter plugging, but changes in filter manufacturing and testing have greatly reduced this sort of contamination.

Underwing Nozzle Strainers – Larger particles will tend to fall from the strainer back into the hose when flow stops. If you see unusual debris in the strainer, place the nozzle in a container on the ground with the poppet open. You may need to have someone hold it stable. Go to the other end of the hose and lift the hose over your shoulder and walk to the nozzle, sliding the hose over your shoulder. This directs debris in the hose to the nozzle. Then remove the strainer. The fuel in the hose will have washed debris from the hose into the strainer.

When you find that membrane color or weight has suddenly and significantly increased, or differential pressure has increased suddenly and significantly on a filter or filter separator:

1. It is CRITICAL that you stop dispensing that fuel and prevent damage or risk to any aircraft that have been fueled.

2. Determine when and where this increase (change) took place. For example, if the fuel at the terminal is clean and the fuel in the transport trailer is dirty, the source is likely to be the trailer.

3. Get someone to take responsibility for the safety of the fuel. In 99% of cases, you (the testing person) cannot determine if the fuel is safe to use. We suggest you go through the chain of command, ownership of the fuel, contracts and/or contact the fuel supplier.

Interesting examples:

A. We had a customer with dirty fuel leaving a storage tank, but clean fuel coming in. The cause? The tank had a floating roof (or “pan”), and on the edge of the tank wall there was a rubber “skirt seal” that helped seal the edge of the floating roof as it moved up and down with the fuel level. The walls of the tank were only epoxy coated 3' (1 m) above the tank floor, so this rubber “seal” rubbed fine rust off the tank walls as the fuel level changed.

B. We had fine grain sand in the hydrant system filters, but not in the incoming fuel. The cause was a concrete plant near the airport. Dust from this plant was entering the storage tank vents.

C. We had fine dirt in the dispensing system at a small heliport. The cause was dusty air entering the tank of the storage trailer when it delivered a previous load of jet fuel near a construction site.

D. We were plugging filters at the airport, but the membranes were not discolored. The cause was cross contamination with low-sulfur diesel fuel with calcium salt contamination. The calcium reacted with water and corrosion inhibitor in the fuel and created a white, gel-like contaminant called calcium carboxylate. (This can also happen on barge shipments due to calcium in salt spray.)

The point of this GamGram is not to cover all of the possible forms of dirt or ways the dirt can get in. It is meant to open your eyes to the fact THAT it can get in. Be diligent. As Shell Oil has said for 60 years, if you only find a problem the 10,000th time you check, you can save lives.