THE GAMGRAM

No. 78 WATER DETECTION IN AIRPORT FUEL SYSTEMS - A HISTORY MAR. 2025

Note: This history is simplified. There were more steps to this, and several different approaches. For example, monitor media started out as plain paper, not SAP; and early filter separators, before we had Teflon, used separators made of silicone-treated paper or even wool - yes, really! They were called “shrouds.”

We are not addressing water detector instruments (at ASTM D3240) or spot checks. This GamGram is dedicated to sensors (electronic, electric, hydraulic, and mechanical) in the flowing stream of fuel or mounted on filter separator sumps.

There have long been hydrant carts and refueler trucks. Hydrant carts have no pump or tank, getting fuel from a pressurized underground hydrant system. Refuelers have tanks and pumps. Both need to stop water and dirt, although little of such contamination should be present as the fuel has already been filtered many times.

The industry was using filter separators (the design of which evolved over the years) exclusively on both fixed locations and into-plane vehicles since the 1950s. This changed when advanced “monitor” elements came along, made with water-absorbing media taken from the disposable baby diaper industry (SAP - Super Absorbent Polymer). The monitor vessels were cheaper, lighter, and positively stopped water. Most people stopped using filter separators. This saved a lot of money (smaller vessels and elements, no water sensor needed).

SAP monitors were only used on into-plane applications, as they held very little water before they plugged up. Filter separators are used for fuel receipt and for pumping fuel to a hydrant system.

But due to quality issues and operating errors, some SAP media got into aircraft. Testing showed that every monitor brand shed some media and since the engine manufacturers could not say how much was too much, monitors were determined to be unsafe. They are (presently) used only in the USA, under strict DP limits.

Operators either put in differential limit alarms to stop flow if the monitors collect water (to limit media getting downstream, our Gammon Gauge Control System is the most common), went to filter separators, or went to Faudi’s solution of a plain dirt element (DDF) in the older monitor vessel and an Avguard sensor downstream. The DDF does not remove the water and the Avguard only alarms if excess water is present. So if you are refueling and water shows up, you stop the fueling, switch vehicles, and continue refueling. The first vehicle is then flushed.

This approach didn’t remove the water, but it is true that significant amounts of water are rarely found at this point in a fuel system.

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We have learned that filter separators are highly resistant to surfactants and contamination. At a major airport, they ran with both filter separators and monitors for over 30 years and never had a filter separator pass enough water to cause a monitor to see an increase in DP. So the filter separators never failed, pumping over a billion gallons a year. This was considered a worst-case test, as all their fuel comes through a pipeline over 1,000 miles long, owned by three separate companies - and it is a multi-product pipeline so cross-contamination is common.

But on the other hand, some people pointed out that in very dry/clean systems, trace surfactants can build up on the coalescer elements in a filter separator and when water does show up, the filter separator does not remove all the water immediately, at least until the surfactant is washed off. So some water could get to the aircraft. How much, we do not know. We are not aware of a case where excess water got to an aircraft this way.

The simple solution to surfactant build-up would be to inject a small volume of water when the vehicle is periodically tested on a test stand or in recirculation, to flush any surfactant out. But most everyone worries about the idea of injecting water into the fuel, for any reason.

The alternative is to put a water sensor downstream of the filter separator, like an Avguard, and logically this would seem to make the system about as good as is possible. But it is expensive.

Otherwise, water sensors in use today are limited to detecting water that has collected in filter separator sumps, which is where the water is supposed to collect when a filter separator separates water from fuel.

Detecting water in a filter separator sump is done to EI-1596. This specification defines filter separator and accessory designs. These water sensors may be separated into two groups: ones that can be tested without stopping the system flow and ones that are tested only with the system shut down.

1. Test Under Flow Designs

   The most common of these is the counterweight float design. These are hydraulic, electric, or pneumatic float operated sensors with a clever test. They are able to remove some weight from the float so it will float in fuel, as if the fuel was water.

   The second type is our own “1cc Water Probe.” It has a built-in tiny water pump that is manually operated and injects just 1 cc (mL) of water directly onto the fuel wetted surfaces inside the system. With its built-in backup contact surface, this probe detects water, even when under test.

2. Testing Off-Stream

   These sensors can be either float switches (the float weighted to flow in water but not fuel) or electronic. In either case the system must be shut down and water is used to determine if the sensor is working.