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AVIATION FUEL CONSULTANCY

Assuring aviation fuel is fit for purpose

Clearly, everyone involved in the supply and use of aviation fuel wants it to be 'fit for purpose' but exactly what is 'fit for purpose' and how do we assure it? Fit for purpose must be more than just 'meeting spec parameters' because there are examples of fuels that have met the specification values but have subsequently caused operational problems. So, if the numbers are not enough, what is? This article describes the system that has evolved for assuring aviation fuels are fit for purpose wherever they are picked up. It is based on the triumvirate of meeting specification, traceability and quality assurance.

Fit for purpose is a term that is often used in the world of retail. We all know when we have bought something that is not 'fit for purpose'. There is nothing as frustrating as trying to open a bottle of wine with corkscrew that doesn't work or, even worse, breaks mid-task. Annoying but at least you can take it back to the shop and get your money back.

In aviation, assuring fit for purpose for all fuel wherever it is delivered is absolutely essential; it is hard to return jet fuel to the airport when you are flying at 35,000 feet, half way across the Atlantic.

Fuel specifications

Specifications are the fundamental tool for defining the characteristics that a fuel must have to be fit for purpose. Specification groups like ASTM and the UK Aviation Fuels Committee bring together representatives from all the main stakeholder groups: the equipment manufacturers (like Boeing or Rolls-Royce, fuel suppliers (such as Shell or BP) and users (such as British Airways, Lufthansa and militaries). Today's specifications represent the accumulated wisdom of the industry over many years, often a direct result of learning from incidents. Moreover, with most engineering solutions, the resulting specifications are a compromise between often conflicting requirements such as performance, availability, cost, reliability, ease of manufacture.

It is really important to stress that the specification is much more than just the main table of test requirements like flash point, freeze point, distillation, existent gum etc. Within the specification there are many implicit and explicit assumptions and constraints. Until recently (2009), international jet fuel specifications only allowed jet fuel to be manufactured from crude oil using traditional refinery processes. Effectively, the specification is saying that provided we make jet fuel from the same materials that we have always used, using the same processes that we have always used and it passes our list of test requirements, our accumulated experience says that it will work satisfactorily in aircraft and engines.

One of the main reasons why the approval of jet fuel made from new sources using new processes (eg hydrogenated vegetable oils) has taken a relatively long time is that the industry had to test whether the same specification limits would be still able to guarantee the same level of performance in engines and aircraft.

Some of the implicit assumptions in the fuel specifications are quite subtle. Trace materials are a good example. In the jet fuel specification, there are no limits on all sorts of trace materials such as silicon and salt. In theory, they are prohibited by the catch-all requirement that 'jet fuel shall consist solely of hydrocarbons or approved additives'. 'Solely' implies zero but what is zero? With today's sophisticated analytical techniques, labs can detect parts per billion and the question how much is zero becomes an interesting question. Effectively the specification, which has been built up over many years, is saying that the typical day-to-day levels are ok because they are what we have got used to. But that immediately asks the question what about new feedstocks and processes? Are they going to introduce new trace materials that we need to worry about?

So, as long as we manufacture the jet fuel correctly, following the specification requirements and not doing anything significantly different to what we have done for the past 50 years, we know that aircraft and engines can cope with variations in composition and the typical levels and variations in trace materials. Exxon have a nice phrase that captures this idea - 'make it right'.

Quality Assurance

However, quality assurance is also critically important because, although it would be nice and simple, very few airports are supplied directly from refineries. Often supply chains are long and complex. In the supply and distribution system between refinery and aircraft we have also got to 'keep it right'. Quality assurance is setting up a combination of facilities and procedures that prevent contamination with other products or trace materials. At the airport, it is not practical to test the fuel for every known contaminant or trace material. We need to have confidence that the application of the QA procedures will be sufficient to assure no unexpected contamination. As noted above, even for fuels that fully meet the specification requirements, trace levels of unexpected materials can cause dramatic performance problems in engines and aircraft.

Just as in the specification world, there is an accumulated wisdom on how to look after aviation fuels in the supply chain. This has been developed and added to over the years as a result of experience and incidents. If we follow this best practice, we can have confidence that all will be well. One important piece of good news is that recently (October 2013) the new EI/JIG 1530 document ‘Quality Assurance Requirements for the Manufacture, Storage and Distribution of Aviation Fuel to Airports’ was published. For the first time, we now have a document, endorsed as best practice by the global fuel supply industry that covers all aviation fuel quality assurance upstream of airports. There was always good coverage of QA standards for airports but the supply chain was not so well documented. Now there is no excuse for not doing the right thing upstream of airports.

Also, as with fuel specifications, it is good to appreciate that we don’t live in a perfect world. Jet fuel is not a pure chemical and it is transported at an industrial scale as a bulk liquid. The rules and guidance set out in EI/JIG 1530 represent what has worked over the years to prevent bulk contamination with other fuels and pick up of trace contaminants. However, even when we are comparing test results from contamination sensitive properties like freeze point or flash point (for example, in the Recertification Test defined in 1530), there could be up to 0.5-1.0% of gas oil mixed with the jet fuel and we would not be able to detect its presence. This level of discrimination has been perfectly adequate for over 40 years and aircraft have operated perfectly well. Interestingly, it was the introduction of FAME (Fatty Acid Methyl Ester - the bio-component in biodiesel) that suddenly required that the crossover of biodiesel into jet fuel had to be less than 0.01%. This has proved to be a tremendous challenge for the industry and explains why there has been so much interest in achieving approval for 100 ppm of FAME in jet fuel compared with the current 5 ppm.

Traceability

The final piece of the jigsaw that complements the ‘make it right’ and ‘keep it right’ mantras is traceability. Traceability is one of the underlying principles that has contributed to commercial aviation’s fantastic record for safety and reliability. Every important component on an aircraft must have been manufactured as an aircraft component and must be traceable back to its point of manufacture. Traceability provides two key benefits: it ensures that only genuine products, produced to the right specification and using the correct materials and techniques are used in aircraft; traceability also enables long-term performance to be related back to original design and manufacture so that the aviation industry is able to learn from incidents and instigate changes to prevent them from recurring.

When applied to aviation fuel, traceability ensures that a batch of aviation fuel was manufactured specifically as aviation fuel and was originally certified by a refinery as meeting an aviation fuel specification. Crucially, it means that it is not any old mixture of molecules that happens to meet the minimum or maximum limits of the tests in the main table of the fuel specification. The reason that meeting the numbers is not good enough goes back to the piece on fuel specifications. They work because we use the same traditional crude oils and traditional processing, and refineries adhere to the rules in the specification. If we take any batch of hydrocarbons and just test against the specification parameters in the main table of requirements, we have no idea what trace or unusual materials are present. Experience tells us that the standard laboratory test methods may not detect them, we cannot take the risk that aircraft engines might be more sensitive than the routine laboratory test methods!

Essentially, assuring fit for purpose is based on accumulated experience and wisdom built up over many years and incorporated into ways of working. Implicit in all of it is the need to be particularly vigilant for any change that might undermine the effectiveness of the triumvirate. Consequently, management of change is an absolutely essential process and is embedded into the way the industry develops and moves forward. Everyone working in the industry needs to have a mindset based on the old adage 'when in doubt, don't assume, ask the question'.

Commercial aviation has a fantastic track record for flight safety and aviation fuels have been a very important contributor to that achievement. It is all about assuring that aviation fuels are fit for purpose wherever in the world they are loaded into aircraft. That fitness for purpose is achieved via a combination of specification, traceability and quality assurance. Just like a three-legged stool, you need all three.