FUEL

# Handling the pressure

**The effectiveness of filtration systems within the aviation fuel supply chain is critically dependent on ensuring they are operated within prescribed limits based on differential pressure. Providing guidance on this concept is a current task being undertaken by the EI's Aviation Committee. *Martin Hunnybun* – EI Head of Good Practice Fuel & Fuel Handling and *Phil Rugen* – Shell Global Solutions, Chairman of the EI Aviation Fuel Filtration Committee, explain.**

Filter/water separators at an airport fuel storage facility

An article in the September 2014 issue of *Petroleum Review* (see **bit.ly/2shZzEl**) described how scrupulously clean aviation fuel is required to be at its point of delivery to aircraft. Maintaining fuel cleanliness can be challenging because the supply chain fuel handling systems can readily provide unwanted sources of free water and particulate matter (including rust, sand, other types of dust/dirt and microbiological growth). This is removed by the deployment of filter/water separators (for dirt and free water), microfilters (for dirt only) or filter monitors (for trace levels of dirt and free water) throughout the supply chain. Such filtration systems incorporate disposable elements or cartridges inside a vessel, through which fuel flows.

The restriction to fuel flow caused by the filters results in an increase in line pressure upstream of the vessel and a decrease downstream of it. This difference, or differential pressure (DP), is used by the filtration system operator to assess its ongoing ability to remove dirt and/or free water.

A filter vessel containing no filter elements, operating at a given flow rate, will generate differential pressure. The vessel design/configuration has an impact on this value. Ideally the filter vessel designer/manufacturer should ensure that this value is as low as possible to prevent excessive DP when elements are first installed. After installation, clean filter elements generate further restrictions to fuel flow which increases the DP. The increase in DP due to filter elements depends on the porosity of the media that they contain to effectively remove contaminants of a known size and type. The smaller the contaminants that can be removed (the lower the porosity), the greater the restriction that a filter causes to fuel flow, and hence the higher the pressure it creates. This is generally referred to as the 'start-up' DP, ie clean elements with minimal restriction.

During service, when elements are removing particulate matter/free water that is held up within their media, the restriction to fuel flow increases further, and the DP will increase (if the fuel is kept at the same flow rate). This is the DP that occurs during fuel transfer operations. Under normal operating conditions (and assuming a constant flow rate is maintained) there will be a progressive increase in the DP over time as particulate matter/free water is removed and gradually accumulates on elements.

During the filter qualification process undertaken by the manufacturer, filters are tested under controlled conditions to ensure that they provide the required level of contaminant removal performance and that this performance is not compromised when they are subjected to elevated DP (up to a specified maximum value). During its laboratory qualification, a filter model is assigned a maximum flow rate (determined from the flow rate per linear length of each element contained in the filtration system). In service, filtration systems can be operated up to their maximum qualified flow rate – their rated flow – with the expectation that their contaminant removal performance will be acceptable, but never at higher flow rates (at which contaminant removal performance may be compromised).

The monitoring of DP during a fuel transfer operation, particularly during aircraft fuelling, is therefore a critical safeguard in terms of fuel cleanliness. All aviation fuel handling operations that incorporate a filtration system should ensure that:

- The maximum flow rate of an installation (to which a filtration system may be exposed) is known and recorded. The filtration system should be sized to ensure that its rated flow is never exceeded.
- If an existing vessel's rated flow is significantly higher than the maximum achievable flow rate of the installation, consideration should be given to derating the vessel (see further guidance in EI 1550 *Handbook on equipment used for the maintenance and delivery of clean aviation fuel*, 2nd edition, 2014).
- All filtration systems used to fuel aircraft incorporate a DP measuring device with a quantitative scale.
- DP measuring devices are checked regularly to confirm that they function correctly.
- All filtration systems used to fuel aircraft are fitted with a DP switch set at, or below, the change-out DP of the filtration system to prevent fuelling when change-out DP has been reached.
- DP is regularly monitored and recorded during a fuel transfer operation.
- Mobile filtration systems that have reached change-out DP are immediately taken out of service for element replacement. Those that are approaching change-out DP should not continue in service in lower flow rate applications.
- The DP of a filtration system is recorded over time (daily or weekly) and attention paid to the trend that is observed.

An animation to highlight some of the above points is currently being prepared by the EI and will be made freely available later this year. Further information on this topic is also available in EI 1550 – visit **bit.ly/2tuo551** ●

investing time and money into research and development (R&D) for biofuels and other sustainable alternatives. Sustainable biofuels created from biomass, such as algae and jatropha, are favoured.

A third of airlines' operating costs today are spent on fuel, versus 13% in 2001, according to the Air Transport Action Group (ATAG). Revenue management in what is already a boom-and-bust industry is challenged by volatile oil markets – today's low prices will inevitably rise – coupled with IATA's forecast that passenger numbers will nearly double to 7.2bn in 2035. The use of biofuels from biomass can reduce the carbon footprint of aviation fuel by up to 80% over their full lifecycle. Even if biofuels accounted for just 6% of airlines' fuel use, the aviation industry's overall carbon footprint would be reduced by 5% by 2020, it is claimed.

'More sustainable feedstock for biofuels and R&D will be needed to accelerate the uptake of cleaner aviation fuels. This will require changes along the value chain, including refineries. It remains to seen what role biofuels will play, but there should be more clarity on rules covering the accounting of biofuels in CORSIA once ICAO goes to council in October–November,' Hemmings said.

But it is a 'chicken and egg' situation. Commercially viable alternative fuels need a robust supply chain, but investors need to have faith in the commerciality of the product to establish said infrastructure. Aviation needs to avoid repeating the sluggish early narrative of renewable energy, such as solar. Despite being a worthy R&D candidate to meet both energy consumption and low-carbon growth, it has taken four decades for solar energy to achieve commercial success. The slow-but-steady approach of R&D into sustainable fuels in aviation is driven in part by the industry's stringent safety standards, but the clock on minimising the environmental impact is ticking as passenger numbers climb.

Neste, the world's largest producer of renewable diesel from waste and residues, is a prime template for pioneering refiners eyeing greener products. Neste's refineries for renewable products in Porvoo in Finland, Rotterdam in the Netherlands and in Singapore have enabled the company's production capacity to rise from 200,000 tonnes to 2.6mn tonnes in the last decade. The company is targeting 3mn tonnes by 2020 – 15% growth in less than three years. This market is potentially gold dust for early adopters. The Gulf's new and large refining sector, characterised by some of the world's most complex and flexible operations, could leverage its position as home of some of the world's biggest airlines, for example.


The Solar Impulse 2 completed a 40,000 km journey in 2016 without using a drop of aviation fuel

*Source: SolarImpulse*

While the volume of alternative fuels in aviation is still small, they have powered 5,000 commercial flights to date and there are regular commercial operations based on alternative fuels at a number of airports around the world, according to Michael Gill, Director Aviation Environment at IATA. But alternative fuels are still far from emerging as the new status quo.

The completion of a 40,000 km journey by Solar Impulse 2 last year without a drop of fuel raised two questions in equal measure – what is possible if this embryonic technology for aviation can be so successful and why has it taken so long?

'Drop-in alternative fuels are technically ready to go and can deliver up to an 80% reduction in carbon emissions. Governments have a role in providing incentives to make sustainable alternative jet fuels (SAF) commercially viable, just as they do with supporting solar power for homes or electrically-powered cars,' de Juniac said. It should be noted, however, that biofuel 'drop-ins' can only be used up to a maximum of 50% combined with conventional petroleum-based jet fuel (and some a lot less) under current rules.

## Golden opportunity

CORSIA could mark a key juncture in the future of forest conservation if REDD+ is used for carbon offsets in the global market-based mechanism. REDD+ is a UN initiative to reduce emissions from deforestation and forest degradation in developing countries, as well as to increase conservation, sustainable management of forests and the betterment of forest carbon stocks.

First established in 2007, REDD+ was recognised as a valuable mitigation strategy in the 2015 Paris Agreement, the world's most comprehensive climate deal. Using REDD+ as part of an offsetting market-based mechanism both avoids $CO_2$ being emitted into the atmosphere and ticks many socio-economic boxes. This includes sustainable development, biodiversity conservation and the general well-being of the human population; tropical forests provide food, water, fuel and medicine to 1.6bn people, according to the United Nations Framework Convention on Climate Change (UNFCCC).

'REDD+ was enshrined in the Paris Agreement and has long been one of the most advanced offsetting mechanisms in terms of longevity and safeguards. REDD+ credits are immediately available and in the volume required, with widespread benefits to the environment and local communities. Why wouldn't we use it?' Andrew Mitchell, Founder Director of Global Canopy, an environmental think tank based in Oxford and a Special Adviser to Ecosphere Plus, told *Petroleum Review*.

'Using REDD+ as an integral part of the market-based mechanism could be the deal of the century to save rainforests. The next 18 months of ICAO's talks are crucial – this is when the details must be pinned down.' ●

**12%**

*The percentage of $CO_2$ emissions from global transport that aviation is responsible for – road transport accounts for 74%*

**$1.3tn**

*Achieving the target of 1.5% average fleet fuel efficiency improvement per annum from 2010 until 2020 means the world's airlines will have to purchase 12,000 new aircraft at a cost of $1.3tn*

**1960s**

*Jet aircraft today are more than 80% more fuel efficient per seat kilometre than the first jets in the 1960s, while the average occupancy of aircraft is around 80% greater than other forms of transport*

**173**

*The number of air navigation service providers that help coordinate the world's 1,397 airlines and their combined fleet of 25,000 aircraft serving 3,864 airports through a route network of several million kilometres*

**1.7**

*It took 130 weeks for a person earning the average Australian wage to earn enough for the lowest Sydney to London return airfare in 1945 – it took just 1.7 weeks in 2009*

**2026**

*The aviation industry is likely to contribute $1tn to the world's GDP by 2026*

*Sources: ATAG bit.ly/1PSU5rz*