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JET FUEL CONDUCTIVITY

The purpose of this bulletin is to provide guidance on Jet Fuel Conductivity variations that can occur in the distribution system, the impact of the additive Stadis 450 on Water Separation Characteristics (MSEP) in the ASTM D 3948 test and suggestions on the optimum location and method of addition of the additive.

Conductivity is probably one of the most challenging parameters in the Jet A-1 specification and the frequency of problems associated with conductivity loss, poor response to Stadis 450 addition and low MSEP test results is increasing.

The key points are set out in the summary below followed by recommendations on how best to deal with the issues.

Conductivity Requirements and Depletion in Distribution

- Typically, undoped jet fuel has a conductivity in the range 0-5 pS/m. The rationale for increasing the conductivity by the addition of SDA is to speed up the rate at which static charge can dissipate, thereby reducing the time for which a static hazard might exist. The only approved SDA is Stadis 450 produced by Innospec.

- **The presence of SDA does not prevent the generation of static charge. Bonding is essential when transferring jet fuel during activities such as sampling, loading or fuelling aircraft.**

- The requirement for conductivity (50-600 pS/m at the ambient temperature of aircraft fuelling) in the Joint Fuelling Systems Check List (see JIG Bulletin 19 for latest issue) comes from the DEF STAN 91-91 specification, but it is acknowledged that the Static Dissipator Additive (SDA) may be injected downstream of the point of manufacture for practical reasons. The ASTM D 1655 specification for Jet A-1 has no mandatory conductivity requirement.

- It is a well-known phenomenon for conductivity to decrease as fuel moves through the supply chain and this can require re-doping between the refinery and the airport fuelling operation. The DEF STAN 91-91 and ASTM D 1655 specifications acknowledge this by applying a 3 mg/L limit for Stadis 450 on initial doping and a cumulative limit of 5 mg/L. The DEF STAN 91-91 specification also recognizes that, because of losses in the distribution system, the refinery may not be the best place to inject Stadis 450.

- According to this specification (and hence also the Joint Fuelling Systems (AFQRJOS) Check List), the conductivity limits need only be met at the point of aircraft fuelling at ambient temperature. In the supply chain, it is permitted to certify that 'product meets the requirements of the specification for all properties except conductivity'.

- At the skin of the aircraft, if the conductivity doesn't meet the requirement cited above at ambient temperature, a minimum limit of 25 pS/m can be adopted as a temporary measure, subject to user notification requirements, to avoid supply disruption, provided that at the SDA injection point, the conductivity at ambient temperature was over 50 pS/m. This is known as the Low Conductivity Protocol and full details can be found in Defence Standard 91-91 (latest edition).

Impact of SDA on Water Separation (MSEP)

- In addition to (sometimes unpredictable) changes in conductivity during distribution, the other major problem is that Stadis 450 is a surfactant. As a result, it can increase the pick-up and dispersion of dirt and water in the fuel, especially if it is poorly mixed into the fuel. Although Stadis 450 is not a strong surfactant, in some fuels it can cause significant reductions in the MSEP rating. This is well known and the DEF STAN 91-91 specification has different limits for fuel with and without Stadis 450 (70 and 85 respectively). The reduction in MSEP caused by Stadis 450 does not necessarily indicate problems with the performance of filter water separators, especially since the introduction of coalescer elements meeting API 1581 5th Edition. All the evidence points to the fact that the MSEP test (D 3948) can be overly sensitive to Stadis 450 with some fuels.

- Although the DEF STAN 91-91 specification sets MSEP limits at point of manufacture only, and does not require testing in the distribution system, MSEP testing in the supply chain is quite common as a means of identifying potentially harmful surfactant contamination. In addition to the problems noted above, interpretation of MSEP test results is complicated by the poor reproducibility of the MSEP test method itself. JIG has endorsed, and encourages the use of, the MSEP protocol (JIG Bulletin 14) to help interpret measurements that are made in the distribution system and prevent unnecessary supply disruption.

- As a result of the problems noted above, suppliers often find themselves having to re-dope with Stadis 450 to make up for lost conductivity, only to find that the MSEP rating has dropped below 70 (sometimes used as an ad-hoc limit for custody transfer). This is an extremely difficult situation to manage. Not only does it waste a great deal of time and money for no obvious benefit but the frequency and severity of the problems are increasing. The following guidance for dosing is intended to help operators manage the situation and clarify JIG requirements in this area.

Recommendations for the dosing of stadis 450

1) Stadis 450 is commonly injected into Jet A-1 at refineries. The advantages of this route are that refineries are often well equipped to inject additives and for some supply chains no further dosing is required. However, this is not necessarily best practice because transport modes from the refinery (such as multi-product vessels and pipelines) can cause significant and unpredictable loss of conductivity. It is also worth noting that there is no requirement for a defined conductivity level when handling jet fuel on multi-product ships or pipelines.

2) Initial injection of Stadis 450 should be done as close as possible to the airport, preferably into storage directly upstream of a dedicated supply route to the airport. Injection at the airport itself is an option, but only where the installation has capacity to deal with problems such as over-dosing or unresponsive jet fuel. Also, the options for blending and problem mitigation are usually limited at airports. Consequently, injection of Stadis 450 at airports should be limited to fine-tuning conductivity levels where necessary to meet the specification limits.

3) The optimum point for additive injection within a storage facility depends on the specific local circumstances and the following principles are provided for guidance.

    a) Given that Stadis 450 is a surfactant and can increase dirt and water pick-up, it is best to delay injection until after major amounts of dirt and water are removed. Injection during a receipt from a multi-product tanker or pipeline into storage only makes sense if there is a high level of confidence that the incoming product is consistently free from dirt and water. Unless this is the case, it is better to wait until after the product has been settled and drained before injection. Suitable injection schemes would be inline dosing during transfer from receipt to delivery tanks or by tank recirculation.

    b) Injection of Stadis 450 during delivery of product from a storage facility by dedicated pipeline to an airport is not recommended except where the airport depot has capacity to deal with problems such as over-dosing or unresponsive jet fuel. If the airport doesn't have facilities for injection or blending, it is not the place to find out that there are conductivity problems.

4) Experience shows that the worst place to inject Stadis 450 is on multi-product tankers. Injection during loading will help disperse dirt and water from the vessels tanks with not much increase in conductivity. Even worse is the practice of manually adding the additive to ship's compartments (eg using the sampling tube). The concentrated Stadis 450 does not mix well and can lead

to major dirt and water problems, with limited conductivity improvement and/or non-homogeneous batches. Both are very inefficient methods for using the additive.

5) It should also be noted that, if SDA is added downstream of the point of manufacture, there is no specification requirement to re-check the MSEP rating after injection of Stadis 450 and it is therefore not mandatory to quote the MSEP rating on the release certificate of analysis.