A More Reliable Way of Recording and Archiving Jet Fuel Oxidation Test Results

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The jet fuel thermal oxidation test is a procedure used to evaluate the thermal stability of a fuel to ensure it can withstand the maximum temperatures that jet fuel experiences during operation and does no damage to the critical metal parts it contacts. This is accomplished by assessing the fuel's resistance to undergoing any chemical changes with increased thermal oxidative stress, until a thermal breakpoint temperature is reached. In practice, the fuel is pumped isocratically past a precision machined aluminum heater tube, located in the heater tube section on a jet fuel thermal oxidation instrument, at a fixed temperature and duration (See Image 1). Deposits may adhere to the heater tube; the operator then visually compares these deposits to a reference colour scale to decide if the sample passed or failed.

Standards Compliance

Due to the sensitive nature of this test, jet fuel thermal oxidation testing has always been strictly regulated. Originally, ASTM D1660 (Method of Test for Thermal Stability of Aviation Turbine Fuels) was the standard written for this test. It required a large amount of sample (5 gallons) and took around 7 hours to run including set up and tear down. This test standard was formally withdrawn in 1992.

The current jet fuel thermal oxidation test consumes less than a litre of sample and takes 150 minutes (2.5 hours) in length to complete. It is described in jet fuel reference standards DEFSTAN 91-91, ASTM D1655, and ASTM D7566. These references list the acceptable limits for temperature, visual rating, and pressure differential across the test filter. These references also list the approved standards used to determine the quality of aviation turbine fuels, which are ASTM D3241 and IP323. In these tests, the specification and use of the instruments and heater tubes are clearly defined.

Record and Archive Concerns

The jet fuel thermal oxidation standards describe how the test should be run in terms of fuel flow and duration. However, they impart little information about the best practice to record or archive the heater tube deposit results. The general laboratory practice is to keep a paper copy of the test results, with some labs using LIMS to record final deposit data. In some cases, the heater tube is retained with a printed copy. On average, labs run 10 tests per week so this can lead to storage problems. It is also not efficient to store heater tubes taped to full size or even folded print outs. Labs that retain their used heater tubes need a simpler process.

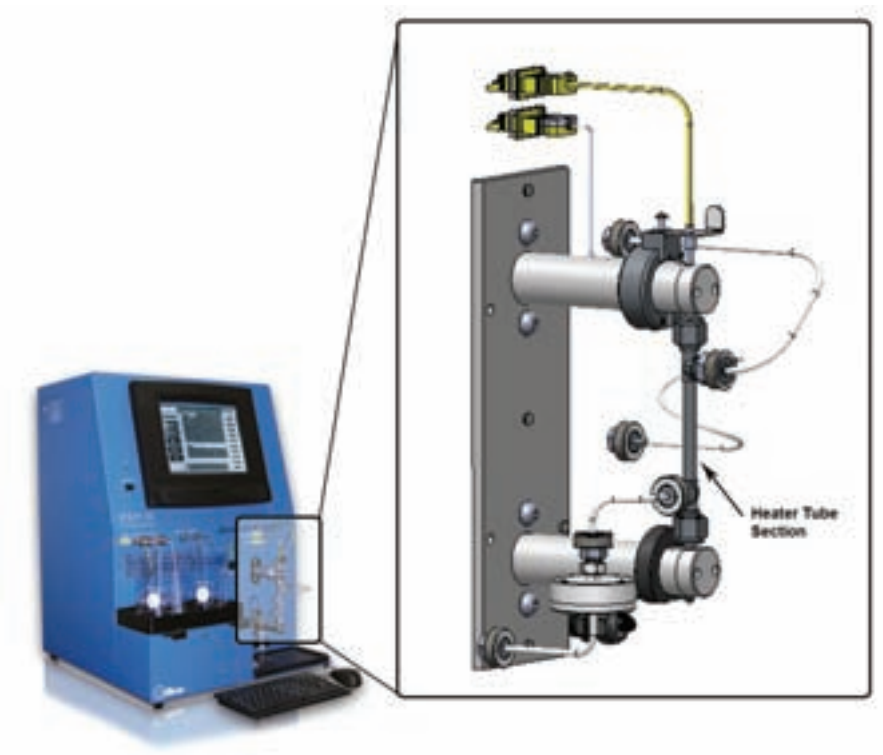

Image 1: Typical Assembly of Heater Tube Section on Jet Fuel Thermal Oxidation Instrument

The standards have long mentioned that the heater tube may be physically identified with a unique serial number for traceability. Recently, digitally recording data directly on the heater tube was approved for use. Radio-frequency identification (RFID) equipment has been shown to be an efficient way to digitally record test and deposit data. The standards do not require that the heater tubes be kept or discarded, only that they be used once. Therefore, laboratories have developed their own procedures for keeping or discarding heater tubes. When audited by quality standard accreditation organisations, which can be based on regularly scheduled events, spot audits, or associated with specific projects or events, companies may be required to match reported data along with the heater tube. It is standard for laboratories to keep heater tubes and data separate, which can be a real issue for laboratories that are subjected to frequent audits. Audits can turn up mismatched data due to poor record keeping or simple transcription errors, which can result in audit findings or perhaps more severe consequences.

Reducing Data Matching Errors

To reduce data matching errors, companies must be able to store the results data and the heater tube together. The ideal solution for this would be to include a recording device on the heater tube that would electronically store results so that the heater tube and test data are inseparable (See Image 2). One such recording device is the radio frequency identification device (RFID). It is a relatively simple technology to use and is commonly used across all industries. Its data is secure while being easy to program and read. Since the jet fuel thermal oxidation standards have recently included the use of electronic data storage onto heater tubes, the RFID could be used for this solution and would still be in compliance.

With the RFID, although time may degrade the deposit on the heater tube, the data on the IHT will always stay with the heater tube for quick and easy access which is advantageous for audits. This saves laboratories time and money due to fewer errors and less time finding and correcting those errors. It also provides several other significant benefits:

- Improves traceability
- Increases analysis integrity by minimising risk of data transcription errors
- Ensures smoother audits of jet thermal oxidation test results
- Promotes laboratory process and procedure discipline
- Aids in preventing the reuse of heater tubes which is a requirement of the standard methods
- Helps ensure the correct heater tube is used based on individual company requirements
- Saves storage space since only the heater tube needs to be kept

To address these issues faced by end users, PAC developed the Alcor Intelligent Heater Tube™

Image 2: Heater Tube with RFID Assembly

Image 3: RFID device (left), Intelligent Heater Tube (center), and Traditional Heater Tube (right)

(IHT), which uses an industry standard ISO 15693 compatible RFID (radio-frequency identification) equipment on the heater tube that can be accessed wirelessly or be read via a USB connection to the instrument. The IHT is manufactured to the same high precision and tight dimensional tolerances as the regular heater tube and the only difference is that an RFID is inserted at the bottom of the heater tube where a plastic rivet was once placed (See Image 3). The IHT provides detailed traceability of tests and easy access to stored data.

Laboratory Case Studies

Laboratory procedures can vary significantly from company to company and from location to location based on their objectives and the market needs they seek to fulfill. In several major oil companies, we found that the benefits of the IHT helped to address multiple issues: traceability, data integrity, audit accuracy, and testing specifications.

Refineries

A large refinery in India with several laboratory analysts found that not all of their jet thermal oxidation test data was being properly entered to the instrument and it varied from technician to technician. Sometimes, even the heater tube serial numbers were left off reports because this information was not entered at the start of the test. This was leading to mismatching the report data and heater tube. The IHT helped correct these issues since, in order to save the data onto the IHT, the serial number of the heater tube had to be entered on the instrument and matched to the IHT.

Outsourcing to Independent Labs

Being able to match data printouts with the actual heater tube can be challenging, particularly when testing is contracted to an independent laboratory. One US Midwest terminal outsources their jet thermal oxidation testing to an independent laboratory and when a particular test result was questioned, the terminal lab asked for the heater tube used to produce the certificate of analysis. Some of the original data was lost so it was difficult to match the heater tube with the report and the certificate of analysis. The terminal now requires their supplier to use IHTs and return the IHT along with the final report. The terminal has its own RFID reader and will review the test data directly from the IHT.

Since there are several manufacturers of heater tubes, independent labs may have more than one brand of heater tube in house. A refinery in the Northeast US was required to use Alcor heater tubes for a customer's product. Although the refinery screens their product internally, the final product certification is performed by an independent laboratory as required by the final customer. During a spot audit, it was thought that an Alcor heater tube may not have been used since the test data could not be matched with the corresponding heater tube serial number. Using an IHT would have prevented this since the original jet thermal oxidation test data and the heater tube serial number is stored permanently on the IHT's RFID.

Even with quality processes in place, these scenarios still happen since laboratories are under more pressure to do more with less, particularly with regard to labour resources. As seen in the examples above, mounting a memory device, such as an RFID, on to a heater tube greatly increases the traceability of jet thermal oxidation results. Laboratories are no longer spending valuable time and resources searching for the heater tube that is associated with a certain result, whether it was recorded on paper or in a LIMS. Audits, whether conducted by external quality standard accreditation organisations, customers, or internal groups, are now able to be performed quickly and accurately.