APPLICATION NOTE

JET FUEL MONITORING AIR TRANSPORT

Jet Fuels

Jet turbine fuel used for commercial aircraft is considered a heart-cut kerosene produced at an oil refinery. The source of the crude oil supplying the refinery will affect the composition. The International Air Transport Association (IATA) has published specifications for two commonly used jet fuels, Jet A and Jet A-1. The primary difference is the freeze point (the temperature when wax crystals disappear in laboratory test). Jet A, which is mainly used in the United States, must have a freeze point below -40°C and Jet A-1 must have a freeze point below -47°C.

Measurement of Density and Viscosity

The measurement of density and viscosity is important to the operation of a jet engine and flight safety. Fuel is loaded on the plane and it is traditionally metered using a volumetric meter. The pilot is concerned with the mass of fuel loaded on the plane, the energy available to power the flight. The density of the fuel is used to convert the measured volume into mass by simple multiplication of the density times volume. Fuel density meters are commonly included on aircraft in the fuel system as a secondary in-flight check of the mass of fuel available to the pilot. These density sensors can be mounted in the fuel tanks or in the fuel delivery systems on the aircraft.

Flight Safety and Reduce Costs

Density and viscosity of jet fuel can vary based on the source of the crude used to refine the fuel, on temperature and the operation of the refinery. The IATA specification for jet fuel density can vary from 775-840 $kg.m^{-3}$ at 15°C. The kinematic viscosity of jet fuel, which is the dynamic viscosity divided by its density, must be lower than 8 cSt at -20°C according to ASTM.

Typically, at the airport, jet fuel density is manually measured using a glass hydrometer 3 times per day. This density measurement used as the correction factor to convert the volumetric measurement to total weight of fuel delivered to the aircraft. The goal is to supply the safe amount of fuel per flight while reducing the cost of carrying extra fuel weight.

Viscosity of jet fuel is commonly determined from samples analyzed in a laboratory. It is a key parameter to safe engine operation in many areas. Viscosity affects the fluidity of jet fuel, which must be low enough to be correctly delivered to the engine by the fuel pump. The spray pattern, the droplet size and the fuel line pressure drop are also influenced by viscosity. An engine could be difficult to relight in flight and the fuel pump would work harder if viscosity is too high.

DEVIL® uses MESOSCALE® technology

The AVENISENSE DEVIL® liquid density and viscosity sensor is ideal for monitoring jet fuel. Robust, compact and ATEX certified, DEVIL® is perfectly suited for installations from the fuel farm to on-board the aircraft. This real-time solution provides accurate monitoring.
The patent pending innovative technology - MESOSCALE® - is an elegant solution for density and viscosity measurements. A small metallic precision-machined paddle is vibrating in contact with the jet fuel and an integral sensor measures fuel temperature. DEVIL® can be installed in a pipe, in a tank or in a bypass for flexible installation options.

DEVIL® makes real-time embedded jet fuel density and viscosity measurements

DEVIL® Low Temperature Jet Fuel Density-Viscosity Performance

To demonstrate the performance of DEVIL® measuring A-1 Jet Fuel, a sample of fuel filled a sensor. It was placed in a temperature controlled chamber and cycled 5 times over a temperature range of -40 to 20°C. This test confirmed the repeatability of the viscosity measurement. The results are summarized in Figures 1 and 2.

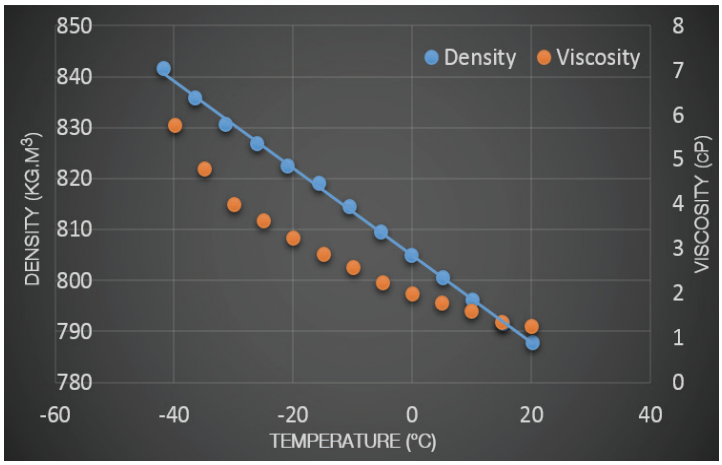

Figure 1: Viscosity and Density measurements of Jet-A1 by DEVIL®

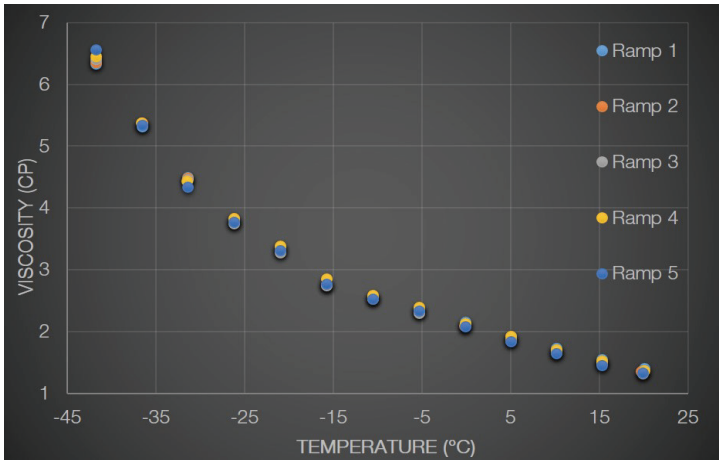

Figure 2 shows 5 successive temperature ramps performed with jet A-1 from ambient down to -40°C. Results show excellent DEVIL® repeatability (typically 0.05 - 0.1cP) of the viscosity output

SUMMARY

Electronic density and viscosity sensors used in jet fuel systems enhance operational efficiency and safety. DEVIL® is the ideal technology for jet fuel density and viscosity measurements due to its accuracy, small size, rugged construction, safe operation and digital communication capability.

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