



## Biokerosene proven in flight operations

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### **DLR exhaust gas measurements during first operational Lufthansa flight using biosynthetic kerosene**

Lufthansa AG has conducted a long-term test of biokerosene on 1187 scheduled flights. This involved one of the engines of an Airbus A321 being powered by a fuel mixture containing 50 percent biosynthetic kerosene. Researchers from the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR) investigated the pollutant emissions from both engines. The results show that biokerosene can be used in normal flight operations without problems and does not produce more pollution than normal, commercially available kerosene.

#### **"Biokerosene is at least as good"**

This is the first time that an airline has conducted long-term tests of biokerosene on its scheduled flights. Joachim Buse, Vice President, Aviation Biofuel at Lufthansa draws a favourable conclusion: "No adverse effects were experienced on flight operations on scheduled flights between Hamburg and Frankfurt. Engineering inspections all gave favourable results and we were able to verify that biokerosene does not emit higher pollutant levels than normal kerosene."

During these long-term tests, researchers from the DLR Institute of Combustion Technology investigated pollutants in the engine exhaust emissions. They positioned a probe behind the engines and directed exhaust gases to the analysis equipment through a pipe. "Measurements have demonstrated that, with regard to pollutant emission levels, biokerosene is at least the equal of commercially available kerosene. Similar readings for levels of nitrogen oxide and carbon monoxide were recorded in the exhaust emissions of both engines," stated Manfred Aigner, Head of the DLR Institute of Combustion Technology in summary.

These tests were conducted during the night at Hamburg's Fuhlsbüttel Airport, and involved ground simulations of the various phases of a flight – take-off, steep ascents and final approach. The researchers conducted these probe measurements on both engines, which enabled them to compare the pollutant emissions of a 50-percent biokerosene mix with those obtained with normal kerosene.

#### **Reduced fuel consumption achieved with higher energy density**

During the long-term tests, Lufthansa Technik regularly checked all the most important engine parameters. These checks revealed that the fuel flow rate in the engine using the biokerosene mix was about one percent lower than the rate in the engine running on conventional fuel, resulting in a reduction in fuel consumption. This is because the biokerosene mixture has an average energy density about one percent higher than normal kerosene. After the experiment, Lufthansa Technik examined the main fuel system components between the tank and the engine. All components remained in very good condition after operating with biokerosene.

#### **Biokerosene made from jatropha beans and rapeseed oil**

The biokerosene employed by Lufthansa is produced entirely from biomass. The oil company Neste Oil derives most of its oil from jatropha beans, rapeseed and animal fats. Due to regulations imposed by the aviation authorities, the maximum permitted ratio of biofuel is currently restricted to 50 percent. Lufthansa is confident of improving fuel efficiency and reducing carbon dioxide emissions through the use of biokerosene and other measures. Since 1991, through the use of new technologies, Lufthansa has been able to increase its fuel

efficiency by more than 30 percent; today, the average fuel consumption is 4.3 litres of kerosene per 100 passenger kilometres.

From 15 July to 27 December 2011, as part of the burnFAIR research project, a Lufthansa Airbus A321 flew eight times per day between Hamburg and Frankfurt. During these trials, one engine on the aircraft was fuelled with a 50 percent mix of biofuel and kerosene. Lufthansa conducted this long-term test on a joint basis with other partners. DLR researchers were responsible for measuring engine emission levels and evaluated all the results jointly with experts from Lufthansa. Through its aviation research programme (Luftfahrtforschungsprogramm; LuFo), the German Ministry of Economics and Technology (Bundesministerium für Wirtschaft und Technologie; BMWi) supported the long-term testing with funding amounting to about 2.5 million Euros.

### **DLR research into alternative fuels**

The DLR Institute of Combustion Technology in Stuttgart is conducting research to find substitutes for conventional, petroleum-based kerosene and, in the longer term, to replace it altogether with better fuel to achieve environment-friendly, sustainable aviation. Among other things, the researchers are also working to improve synthetic fuels based on natural gas, known as GtL (Gas to Liquid), and are investigating the properties of this new generation of synthetic fuels.

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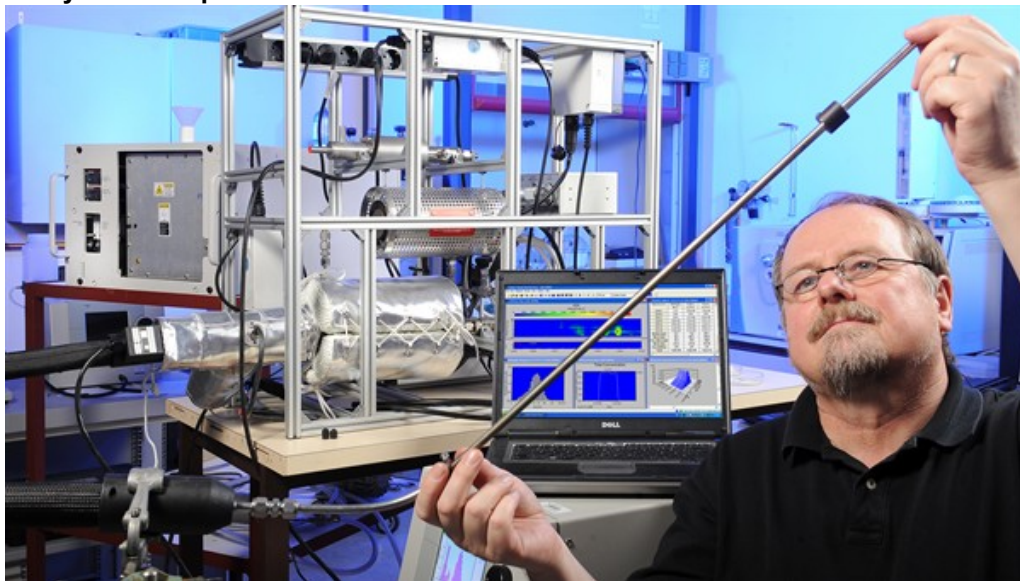
### **Contacts**

*Dorothee Bürkle*  
*German Aerospace Center (DLR)*  
*Media Relations, Energy and Transport Research*  
*Tel.: +49 2203 601-3492*  
*Fax: +49 2203 601-3249*  
*Dorothee.Buerkle@dlr.de*

*Prof. Dr. Manfred Aigner*  
*German Aerospace Center (DLR)*  
*DLR Institute of Combustion Technology*  
*Tel.: +49 711 6862-309*  
*Fax: +49 711 6862-578*  
*Manfred.Aigner@dlr.de*

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### **Analysis of the pollutant emissions of new fuels**



Claus Wahl, Head of the Analytic Chemistry Department, working on a mobile measuring device for exhaust gas analysis and particulate measurement with GtL fuel. Chemical and instrumental analyses are an indispensable part of modern combustion research, measuring the emissions from combustion processes and helping to devise measures for reducing pollutant levels.

Credit: DLR (CC-BY 3.0).

### **DLR measures exhaust emissions as part of the burnFAIR research project**



These tests were conducted during the night at Hamburg's Fuhlsbüttel Airport, and involved ground simulations of the various phases of a flight – take-off, steep ascents and final approach. The researchers conducted these probe measurements on both engines, which enabled them to compare the pollutant emissions of a 50-percent biokerosene mix with those from normal kerosene.

Credit: Deutsche Lufthansa AG.

### **Lufthansa used biosynthetic kerosene in a long-term test**



In a long-term test conducted from 15 July to 27 December 2011, Lufthansa used biosynthetic kerosene in an Airbus A321 that flew eight times per day between Hamburg and Frankfurt.

Credit: Lufthansa photo archive.

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