ANTIMISTING KEROSENE

Harold W. Schmidt
National Aeronautics and Space Administration
Lewis Research Center

Antimisting kerosene (AMK) is a kerosene-fraction jet fuel containing an additive that reduces the flammability of the fuel in an aircraft crash circumstance. AMK additives, when dissolved in Jet A fuel in concentrations in the range of 0.3 percent, have been demonstrated to inhibit ignition and flame propagation of the released fuel in simulated crash tests. The AMK fuel resists misting and atomization from wind shear and impact forces and instead tends to agglomerate into globules. This agglomeration significantly reduces ignitibility and flame propagation.

Several AMK additives have been developed and evaluated for their potential to reduce post-crash fires. The antimisting additive (FM-9), selected for more comprehensive testing in this program, was developed by the Imperial Chemical Industries and the Royal Aircraft Establishment of the United Kingdom and is being evaluated for crash-fire resistance by the U.S. FAA in an agreement with the United Kingdom.

The NASA has agreed to conduct propulsion system tests for the FAA. The purposes of the tests are to evaluate the effects of the additive on engine operation, to identify operating problems, to assess the adaptability of existing engines to AMK, and to determine the potential viability of this fuel for use in present and future fan-jet engines. The Pratt & Whitney Aircraft Group has been contracted to perform the experimental test program on the JT8-D engine and fuel system components.

This additive, FM-9, which creates the high shear resistance desirable in the crash circumstance, results in non-Newtonian flow characteristics that cause some undesirable behavior in the engine fuel system. For example, figure 1(a) shows the typical atomization of Jet A fuel in a standard JT8-D nozzle at ignition flow rates. Figure 1(b) shows the behavior of undegraded AMK in the same nozzle. However, in actual conditions, the AMK would be partially degraded from being pumped through the fuel control system. Similarly, figure 2 shows the effect of the nozzle design on undegraded AMK. Figure 2(a) is for the standard nozzle, and figures 2(b) and (c) are for nozzles with successively increased atomization capabilities built into their designs. Figure 3(a) shows the change of viscosity of AMK fuel as a function of shear exposure time in a blender. Changes in viscosity of this magnitude are significantly higher than changes due to temperature (fig. 3(b)) and are in addition to the temperature influence on viscosity.

The very high-molecular-weight polymeric additive tends to clog small flow passages, screens, filters, and close-tolerance clearances in the fuel controller. AMK fuel exhibits the greatest shear resistance and crash-fire resistance right after mixing and before any exposure to shear, such as pumping and flow through pipes, fittings, filters, or other components. Successive exposure to any of these shear forces tends to break the polymeric molecules and thereby reduce the average molecular weight and the subsequent shear resistance. Continuation of such degradation causes the AMK to revert back toward the original properties of the base fuel.

This characteristic provides the possibility of using AMK in existing engines by assuring a level of degradation required for acceptable performance for each critical component. In anticipation of this possible requirement, the United Kingdom is developing a fuel degrader that could be incorporated into the fuel system. The practicality of the various ways to accommodate AMK fuel in existing engines will be evaluated in this program. If it is determined that retrofit modification of the fuel feed system would be required to accommodate AMK fuel in existing engines, the extent of such modification requirements will be identified and evaluated. This will determine the course of follow-on experimental work on AMK fuel.

Antimisting kerosene is being considered as a jet fuel because 15 percent of the total facilities in aircraft accidents result from postcrash fire. Significant postcrash fires do not occur in accidents caused by fuel depletion. Simulated crash tests with AMK fuels have demonstrated the potential reduction in postcrash fire. Further development effort would be warranted if the fuel can be used in turbofan jet engines without extensive modification. Of several additives tested, FM-9, developed by ICI and the RAE of Great Britain, was selected for further evaluation.

AMK PROGRAM ORGANIZATION

- ORGANIZATIONAL COMPOSITION - BY MEMORANDUM OF UNDERSTANDING BETWEEN THE MINISTRY OF DEFENSE, U.S. AND DOT/FAA, U.S.
- MANAGEMENT TEAM - MINISTRY OF DEFENSE (MOD) AND DOT/FAA
- PROJECT RESPONSIBILITY -

MANAGEMENT TEAM

MOD/U.K.

FUEL DEVELOPMENT AND PRODUCTION;
LABORATORY STUDIES;
FUEL HANDLING AND PROCESSING
LOGISTICS SYSTEMS DEVELOPMENT

DOT/FAA

CRASH FIRE TESTS AND SIMULATION;

BY LETTER OF AGREEMENT

NASA/LeRC

PROPULSION SYSTEM/AMK COMPATIBILITY EVALUATION

CS-80-1618

TYPICAL ATOMIZATION OF JET A FUEL USING JT8-D STANDARD NOZZLE AT IGNITION FLOW RATES

$T_F = 17^0$ C

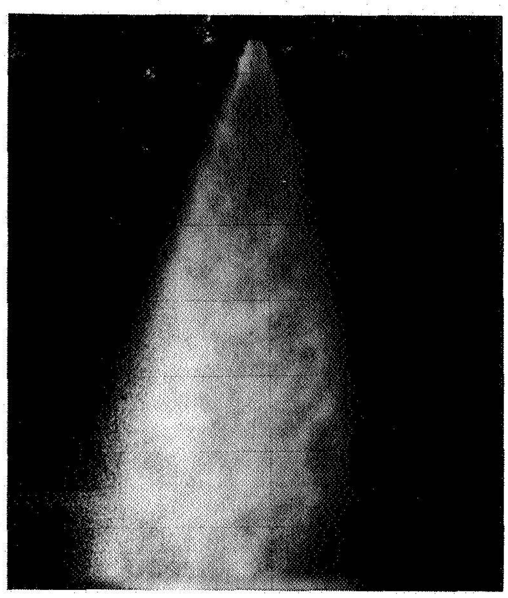

Figure 1(a)

TYPICAL ATOMIZATION OF UNDEGRADED AMK IN
JT8-D STANDARD NOZZLE AT IGNITION FLOW RATES

$T_F = 13^0$ C

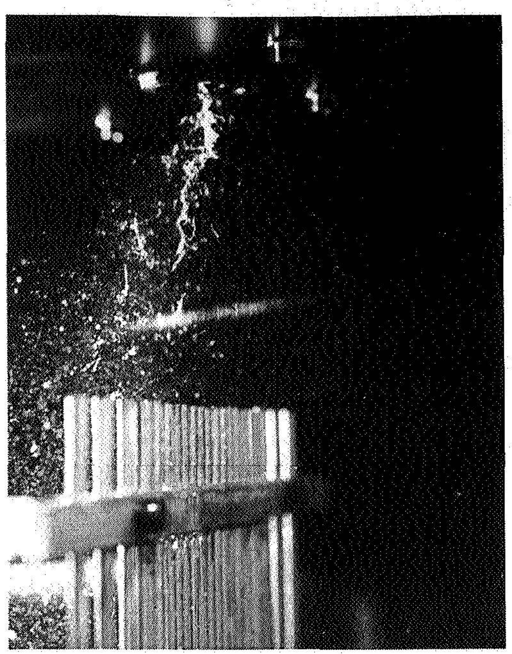

Figure 1(b)

TYPICAL ATOMIZATION OF UNDEGRADED AMK IN
JT8-D STANDARD NOZZLE AT CRUISE FLOW RATES

$T_F = 14^0$ C

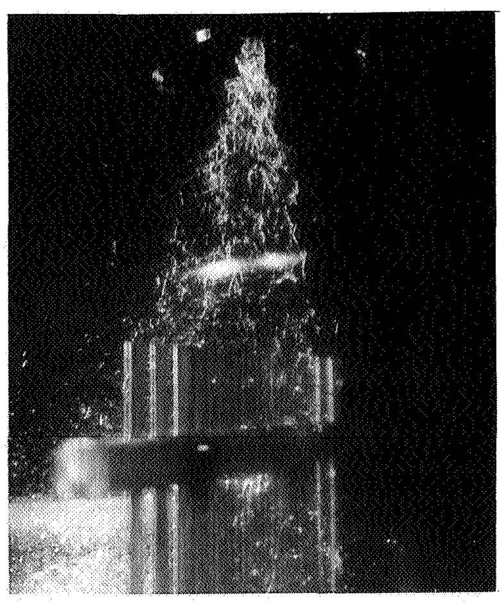

Figure 2(a)

TYPICAL ATOMIZATION OF UNDEGRADED AMK IN
JT8-D LOW EMISSION NOZZLE AT CRUISE FLOW RATES

$T_F = 16^o$ C

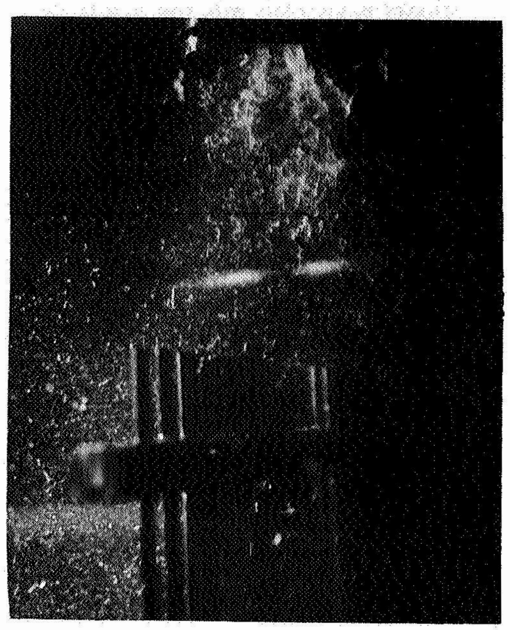

Figure 2(b)

TYPICAL ATOMIZATION OF UNDEGRADED AMK IN
AIR BOOST NOZZLE AT CRUISE FLOW RATES

$T_F = 7^o$ C

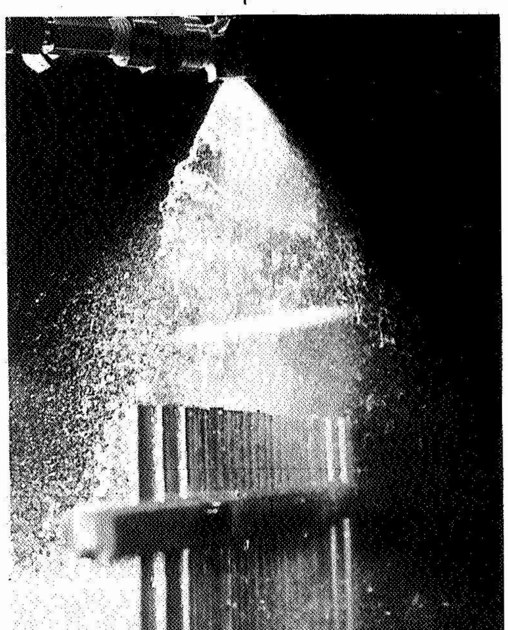

Figure 2(c)

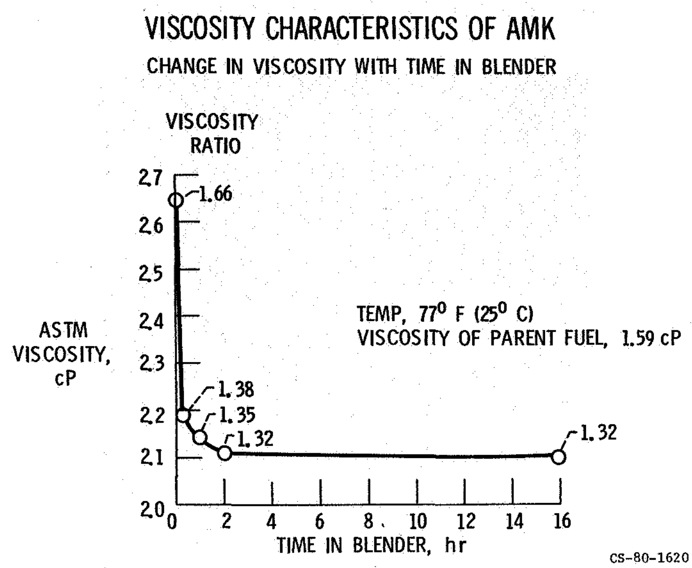

Figure 3(a)

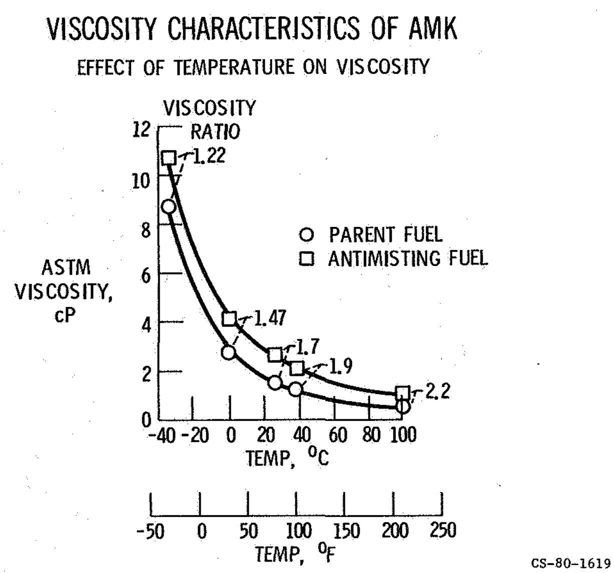

Figure 3(b)