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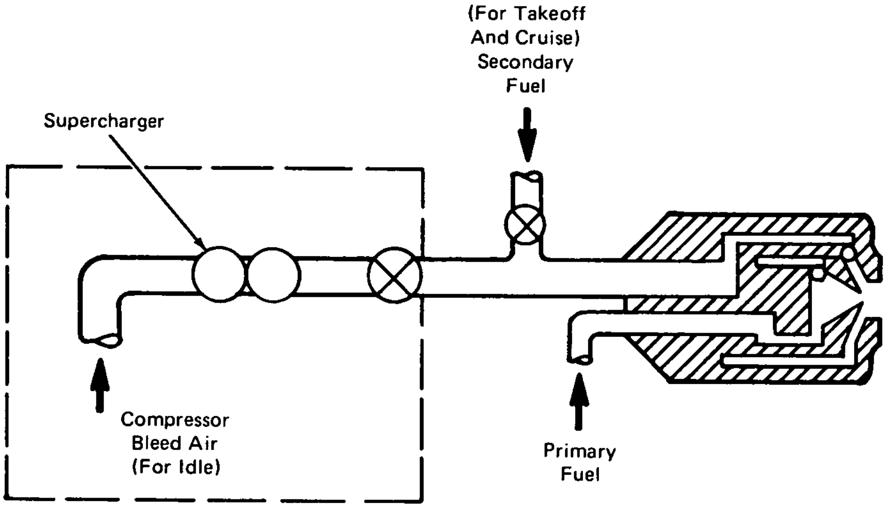
NASA TECH BRIEF

Lewis Research Center

Air Assist Fuel Nozzle Reduces Aircraft Gas Turbine Engine Emissions at Idle Operation



The use of an air assist fuel nozzle has been shown to reduce the relatively large concentrations of carbon monoxide and unburned hydrocarbons from the combustor of a conventional jet engine during idle operation. During idle and taxi of jet aircraft, the combustion efficiency is much lower than that at takeoff, landing, and cruise. Exhaust emissions of unburned hydrocarbons and carbon monoxide are therefore much higher during idle and taxi operation. The off-design conditions encountered at idle and taxi operations cause the combustion efficiency to be at times well below 90 percent, while at take-off, landing, and cruise, the combustion efficiency is 98-100 percent.

The conventional pressure atomizing fuel nozzles that are used in gas turbine combustors are unable to fully atomize the fuel spray at the low nozzle pressure differentials that occur during idle fuel flow. The combustion efficiency may be improved by improving fuel atomization. One way of doing this is by means of an air-assist fuel nozzle.

An air assist fuel nozzle has been evaluated (see the figure) that consisted of a system whereby a source of high pressure air was connected to the secondary chambers of conventional dual-orifice fuel nozzles. Fuel flow was introduced into the combustor through the primary chambers of the fuel nozzles. Using this system, idle efficiency increased from 90.3 percent to 96.5 percent. The total unburned hydrocarbon and carbon monoxide emissions were decreased from 26 to 3.3 and from 51 to 40 grams per kilogram of fuel burned, respectively.

In the application of air-assist fuel nozzles to a gas turbine engine, compressor bleed air, supercharged by a small compressor, could be supplied to the secondary side of the fuel nozzle during idle operation. During off-idle operation the air assist flow would be valved off and fuel introduced into the combustor through the primary and secondary chambers of the fuel nozzles as required by the engine operating schedule.

(continued overleaf)

Notes:

1. Substantial increases in combustion efficiencies and reductions of total unburned hydrocarbon and carbon monoxide emissions were accomplished at air assist pressure differential as low as 70 N/cm^2 (102 psi). At this pressure differential, less than 0.5 percent of the combustor airflow is passed through the secondary side of the fuel nozzle.
2. Application of this system to turbojet engines could also reduce fuel consumption at idle and taxi operation.
3. The following documentation may be obtained from:
   National Technical Information Service
   Springfield, Virginia 22151
   Single document price $3.00
   (or microfiche $0.95)
   Reference: NASA TN-D-6404 (N71-31456), Use of an Air Assist Fuel Nozzle to Reduce Exhaust Emission from a Gas Turbine Combustor at Simulated Idle Conditions
4. Technical questions may be directed to:
   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio 44135
   Reference: B72-10434

Patent status:

No patent action is contemplated by NASA.

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