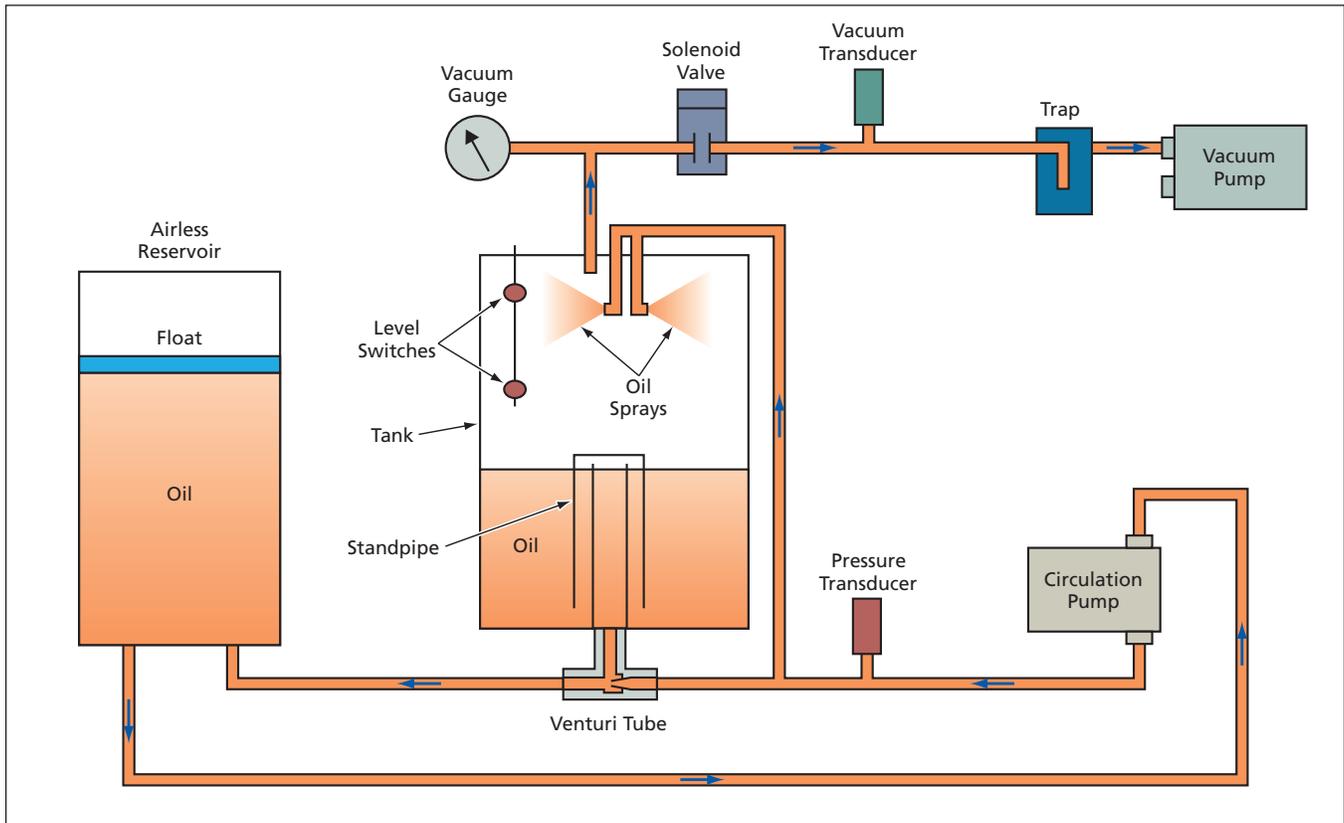




## System for Continuous Deaeration of Hydraulic Oil

The proportion of dissolved air is reliably maintained below 1 volume percent.

*John F. Kennedy Space Center, Florida*



**Oil Is Circulated** continuously between the reservoir and the tank. Oil is sprayed in the tank to maximize its exposure to vacuum for rapid removal of dissolved air and water.

A system for continuous, rapid deaeration of hydraulic oil has been built to replace a prior system that effected deaeration more slowly in a cyclic pressure/vacuum process. Such systems are needed because (1) hydraulic oil has an affinity for air, typically containing between 10 and 15 volume percent of air and (2) in the original application for which these systems were built, there is a requirement to keep the proportion of dissolved air below 1 volume percent because a greater proportion can lead to pump cavitation and excessive softness in hydraulic-actuator force-versus-displacement characteristics. In addition to overcoming several deficiencies of the prior deaeration system, the present system removes water from the oil.

The system (see figure) includes a pump that continuously circulates oil

at a rate of 10 gal/min (38 L/min) between an 80-gal (303-L) airless reservoir and a tank containing a vacuum. When the circulation pump is started, oil is pumped, at a pressure of 120 psi (827 kPa), through a venturi tube below the tank with a connection to a standpipe in the tank. This action draws oil out of the tank via the standpipe. At the same time, oil is sprayed into the tank in a fine mist, thereby exposing a large amount of oil to the vacuum. When the oil level in the tank falls below the lower of two level switches, a vacuum pump is started, drawing a hard vacuum on the tank through a trap that collects any oil and water entrained in the airflow. When the oil level rises above higher of the two level switches or when the system is shut down, a solenoid valve between

the tank and the vacuum pump is closed to prevent suction of oil into the vacuum pump.

Critical requirements that the system is designed to satisfy include the following:

- The circulation pump must have sufficient volume and pressure to operate the venturi tube and spray nozzles.
- The venturi tube must be sized to empty the tank (except for the oil retained by the standpipe) and maintain a vacuum against the vacuum pump.
- The tank must be strong enough to withstand atmospheric pressure against the vacuum inside and must have sufficient volume to enable exposure of a sufficiently large amount of sprayed oil to the vacuum.

- The spray nozzles must be sized to atomize the oil and to ensure that the rate of flow of sprayed oil does not exceed the rate at which the venturi action can empty the tank.
  - The vacuum pump must produce a hard vacuum against the venturi tube and continue to work when it ingests some oil and water.
  - Fittings must be made vacuum tight (by use of O-rings) to prevent leakage of air into the system.
- The system is fully automatic, and can be allowed to remain in operation with very little monitoring. It is capable of reducing the air content of the oil from 11 to less than 1 volume percent in about 4 hours and to keep the

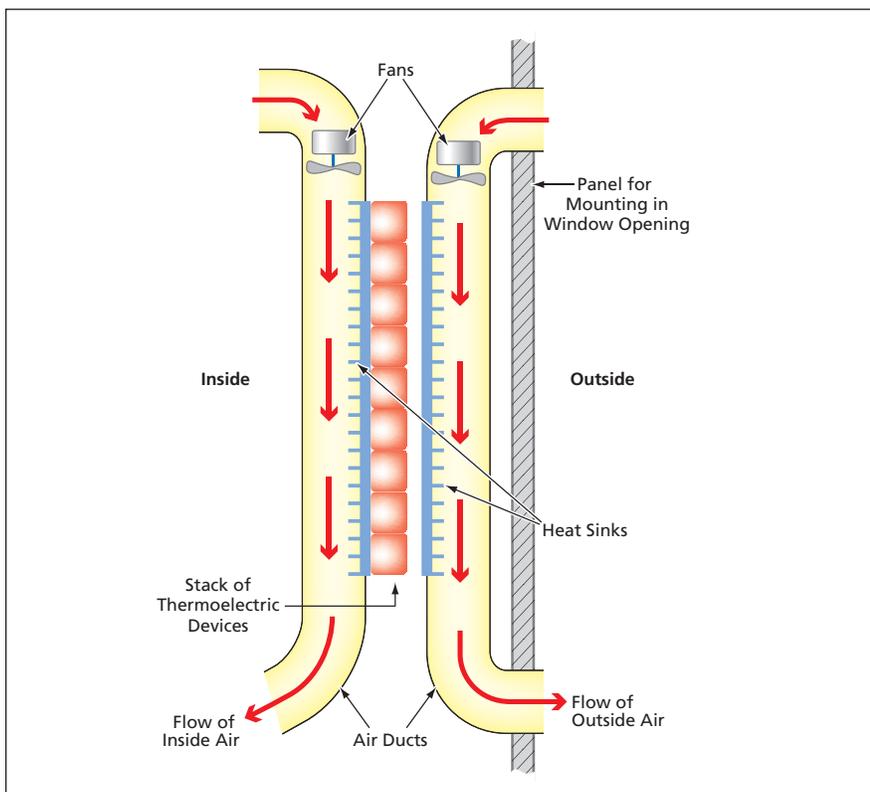
water content below 100 parts per million.

*This work was done by Christopher W. Anderson of Lockheed Martin Space Operations for Kennedy Space Center. Further information is contained in a TSP (see page 1).  
KSC-12528*

## ⚙️ Solar-Powered Cooler and Heater for an Automobile Interior

Thermoelectric devices and fans would run on solar power.

Marshall Space Flight Center, Alabama



An Assembly Mounted in a Window Opening of an automobile would include thermoelectric devices that would transfer heat between interior and exterior circulating airflows. The thermoelectric devices and the fans in the assembly would be powered by a solar photovoltaic panel mounted on the roof.

The apparatus would include a solar photovoltaic panel mounted on the roof and a panellike assembly mounted in a window opening. The

window-mounted assembly (see figure) would include a stack of thermoelectric devices sandwiched between two heat sinks. A fan would circulate

interior air over one heat sink. Another fan would circulate exterior air over the other heat sink. The fans and the thermoelectric devices would be powered by the solar photovoltaic panel. By means of a double-pole, double-throw switch, the panel voltage fed to the thermoelectric stack would be set to the desired polarity: For cooling operation, the chosen polarity would be one in which the thermoelectric devices transport heat from the inside heat sink to the outside one; for heating operation, the opposite polarity would be chosen.

Because thermoelectric devices are more efficient in heating than in cooling, this apparatus would be more effective as a heater than as a cooler. However, if the apparatus were to include means to circulate air between the outside and the inside without opening the windows, then its effectiveness as a cooler in a hot, sunny location would be increased.

*This work was done by Richard T. Howard of Marshall Space Flight Center. Further information is contained in a TSP (see page 1).*

*This invention has been patented by NASA (U.S. Patent No. 6,662,572). Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to Sammy Nabors, MSFC Commercialization Assistance Lead, at sammy.a.nabors@nasa.gov. Refer to MFS-31751-1.*