John F. Kennedy Space Center
Kennedy Space Center, Florida 32899

Technical Support Package

System for Continuous Deaeration of Hydraulic Oil

NASA Tech Briefs
KSC-12528

National Aeronautics and
Space Administration

Technical Support Package

for

SYSTEM FOR CONTINUOUS DEAERATION OF HYDRAULIC OIL

KSC-12528

NASA Tech Briefs

The information in this Technical Support Package comprises the documentation referenced in **KSC-12528** of *NASA Tech Briefs*. It is provided under the Commercial Technology Program of the National Aeronautics and Space Administration to make available the results of aerospace-related developments considered having wider technological, scientific, or commercial applications. Further assistance is available from sources listed in *NASA Tech Briefs* on the page entitled "NASA Innovative Partnerships Program."

Additional information regarding research and technology in this general area may be found in a variety of publications available from the NASA Scientific and Technical Information (STI) Program Office. You can access the STI Program Office via **http://www.sti.nasa.gov** or as follows:

NASA STI Help Desk
NASA Center for AeroSpace Information
7121 Standard Drive
Hanover, MD 21076-1320

Telephone: (301) 621-0390, Fax: (301) 621-0134, E-mail: help@sti.nasa.gov

---

System for Continuous Deaeration of Hydraulic Oil

Brief Abstract

To remove air from liquid in continuous flow, a vacuum is created over a maximum surface area of the fluid and the fluid is continuously returned to the reservoir. The removed air or gas is expelled through the vacuum pump.

Section I — Description of the Problem

The hydraulic oil in the Space Shuttle Orbiters' hydraulic systems by design and calculations must be less than 1% by volume to prevent aero-surface catastrophic flutter and failure. Hydraulic oil has an affinity to absorbing air and normally holds 10 to 15% entrained air. The original system was slow and unreliable having numerous failures at critical times during Orbiter processing. This system had internal components that included springs and floats that required the system to be opened for repair and replacement of these internal components. Maintaining the sealing surfaces under vacuum was a major problem. Tank problems included pinhole leaks from reinforcing structure and imploding of tanks due to cyclic pressure vacuum cycles.

Section II — Technical Description

Purpose

A new system was developed to continuously remove air from the system with the added benefit of also removing moisture from the oil. The new system uses a constant vacuum on a tank into which the oil is sprayed. The deaerated oil is then returned to the reservoir. Problems to overcome were as follows: to fit in an existing system, have the system continuously work on an 80-gallon reservoir, and how to expose the maximum amount of oil to a vacuum in a minimum amount of time.

Operation

When the circulation pump is started, oil is pumped through the Venturi at 120 psi, which draws the oil out of the vacuum tank. At the same time, oil is sprayed into the tank in a fine mist against the tank walls, producing the maximum amount of fluid to be exposed to the vacuum. When the level drops to below the level switch, the vacuum pump is started, drawing a hard vacuum on the tank through the trap, which collects any oil and moisture. The standpipe keeps some oil on the bottom of the tank routing oil to the Venturi.

Critical Components

Circulation pump must have sufficient volume and pressure to operate the Venturi and spray nozzles. Venturi must be sized to empty the tank and maintain a vacuum against the vacuum pump. Tank must be strong enough to withstand a vacuum and have sufficient volume to allow maximum fluid be exposed to the vacuum. Spray nozzles must be sized so as not to exceed the Venturi ability to empty the tank and be able to atomize the fluid. The vacuum pump must produce a hard vacuum against the Venturi and work with an oil/moisture being sucked into the pump. Fittings must be vacuum-tight (O-ring) not to allow any air leakage into the system.

Section III — Unique or Novel Features

Novel features

1. Use of a fluid Venturi to remove the deaerated fluid from the tank back into the reservoir.
2. The system is fully automatic requiring very little monitoring.
3. Consistent air from 11% to less than 1% in about 4 hrs.

Advantages of innovation

1. Can be run independently of the rest of the system, using the oil from the common reservoir.
2. All mechanical components are external to the tank (Vacuum Pump Circulation pump).
3. Tank internal components can be removed through their individual ports; no disassembly of the tank is required.
4. Water removal system, which was a source of contamination, was removed from the system.
5. System removes water from oil to less than 100 ppm.

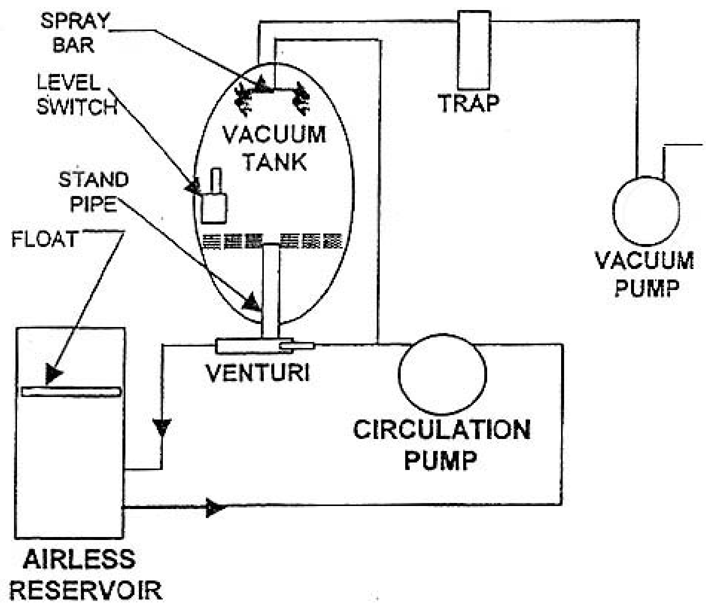
Test Data

Prototype Hydraulic Deaeration System

RUN NO.	PRIMARY			BACK UP		
	START	4HR	8HR	START	4HR	8HR
1	10.9%	1.2%	0.6%	11.3%	0.8%	0.6%
2	10.5%	1.7%	0.3%	10.5%	0.7%	0.22%
3	10.0%	0.6%	0.56%	10.0%	0.6%	0.48%
4	11.3%	0.86%	0.6%	10.0%	2.1%	0.53%
5	11.0%	1.5%	0.6%	10.5%	1.4%	0.66%
6	10.0%	0.6%	0.43%	10.0%	0.6%	0.5%
AVERAGE	10.5%	1.02%	0.5%	10.5%	1.0%	0.4%

Data taken, using Seaton Wilson Aire-Ometer Model AD-4000 Series

SCHEMATIC DRAWING



Section IV — Potential Commercial Applications

Any commercial or government agency requiring gas to be removed from a fluid in a closed loop system. An example is removing air and water vapor from aircraft hydraulic fluid to less than 1.0%.