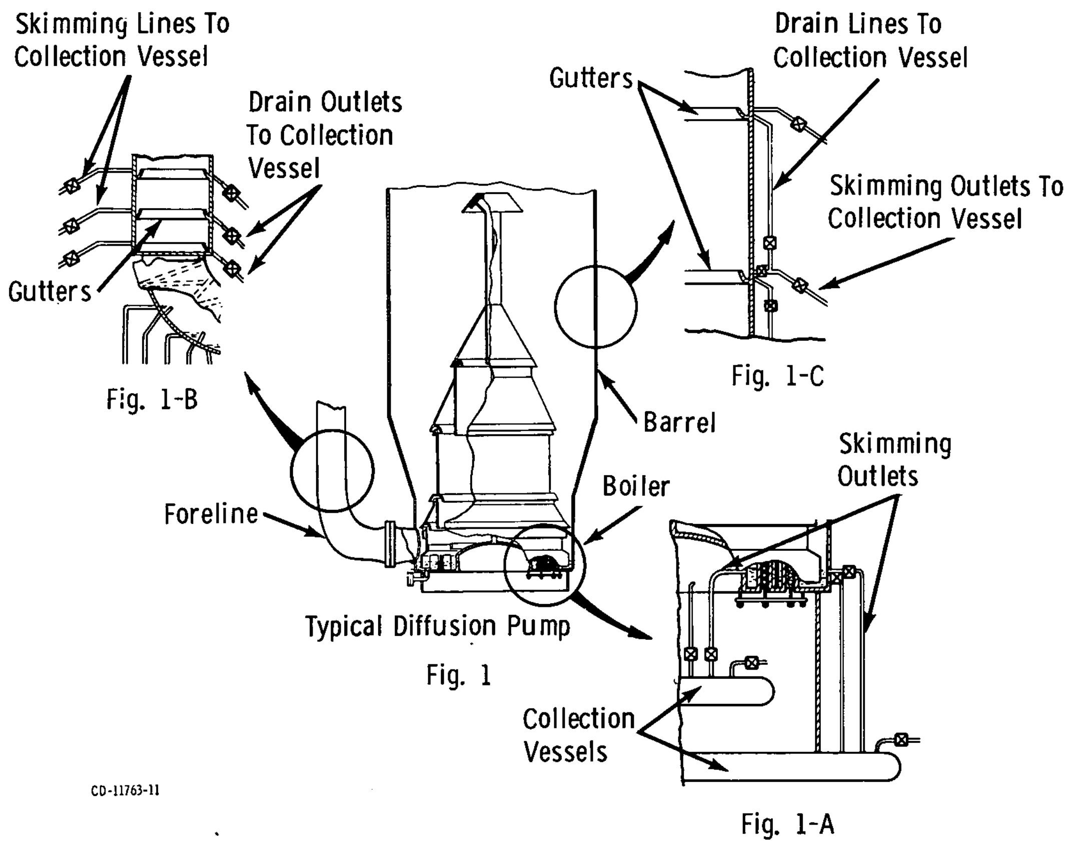
NASA TECH BRIEF

Lewis Research Center

Diffusion Pump Modification Promotes Self-Cleansing and High Efficiency



The Problem:

Typical large diffusion pump vacuum systems (Figure 1) have no effective means for removing some contaminants absorbed by the vaporizing fluid. These contaminants tend to collect on the evaporative surface, thus drastically limiting evaporation rates, lowering the pump gaseous molecular throughput, and significantly reducing efficiency and attainable vacuum by 1½ to 2 decades (efficiency varies with the type of pump fluid used).

Other related problems are:

(1) Low evaporative rates evident from the quiescent (torpid) evaporative surface of the pump fluid. This torpidity phenomenon is caused almost entirely by "heavy end" contaminant substances of higher molecular weight than the pump fluid. These "heavy ends" include, to a large extent, polymerized molecules of lighter substances. These contaminants tend to collect into nonevaporating "islands" on the evaporative surface, thus restraining the release of fluid molecules in these areas. Only the working "holes" in the evaporative surface release fluid molecules at an appreciable rate.

(2) Some lighter contaminant molecules migrate from the pump jets back into the vacuum chamber. As pressure in the chamber being evacuated decreases, the rate of backstreaming increases. When it equals the throughput of gas, no further decrease in chamber pressure can occur.

(3) Although cryogenically cooled baffles between the vacuum chamber and the diffusion pump have been

(continued overleaf)

helpful in trapping chamber gases and reducing backstreaming, they have not been able to trap all passing gases. Once they are filled with condensate, they lose their effectiveness. Baffle warmup causes these impurities either to revaporize or to drip into the pump boiler where they cannot be removed.

The Solution:

Modify all vapor-operated vacuum diffusion pumps into self-cleansing devices by:

(1) Adding skimming outlets (Figure 1A) in the boiler for periodically skimming the evaporative surface of the working fluid.

(2) Adding a series of peripheral gutters in the foreline (Figure 1B) for trapping, separating and draining off condensates.

(3) Providing gutters in the pump barrel (Figure 1C) for further removal of trace quantities of residual volatile impurities.

How It's Done:

These modifications eliminate contaminant substances from the pump fluid during operation, which are the principal causes of torpidity on the evaporative surface. Thus, the diffusion pump is also acting as a still. The resulting 100% vigorous working surface provides a much greater molecular throughput and greatly improved efficiency (15 to 200 times).

Most heavy ends are eliminated by the periodic skimming of the evaporative surface of the pump fluid in the boiler during operation. Skimming outlets are located around the periphery of the boiler and also toward the center of the boiler in large pumps having concentric annular boiler channels. The skimming openings are provided at various levels in the boiler and are connected by valved lines to a collection vessel of lower internal pressure than the boiler.

Nearly all light ends are eliminated by withdrawing condensed distillate from the pump foreline. Gutters installed in the foreline for condensing and enriching the condensates flowing down the internal walls are connected by valved lines to a collection vessel of lower internal pressure than the foreline. The periodic removal of these condensates that contain high concentrations of light-end substances prevents their return to the boiler by revaporization and possible polymerization into heavy-end molecules. In this way, backstreaming is nearly eliminated, and the overall quantities of impurities are significantly lessened.

Trace quantities of heavy and light ends present in the diffusion pump barrel are removed by gutters, drain lines, and collection vessels similar to those installed in the foreline.

Thus, the entire process permits the self-cleansing of diffusion pump liquid, provides for a more efficient pump, and permits the reuse of costly diffusion pump oils without removal to a separate source for cleansing.

The research leading to the preceding findings was conducted with a series of experimental scale-model glass diffusion pump vacuum systems. Investigations to incorporate these findings in full size systems appear desirable.

Notes:

1. This innovation may also be of value to those technical disciplines relating to: (a) chemical processing or reprocessing; (b) the removal of contaminants in materials used in biomedical applications; and (c) separation of impurities from metals.
2. Further information is available in the following report:

   NASA TM-X-2932 (N75-18278), Better Vacuum by Removal of Diffusion Pump Oil Contaminants

   Copies may be obtained at cost from:

   Aerospace Research Applications Center
   Indiana University
   400 East Seventh Street
   Bloomington, Indiana 47401
   Telephone: 812-337-7833
   Reference: B75-10065
3. Specific technical questions may be directed to:

   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio 44135
   Reference: B75-10065
4. A film, "Better Vacuum by Removal of Diffusion Pump Oil Contaminants," describes in more detail this vacuum technology and is available for a no-charge two-week loan from the Technology Utilization Officer, Lewis Research Center (address above).

Patent Status:

This is the invention of a NASA employee, and a patent application has been filed. Inquiries concerning license for its commercial development may be addressed to the inventor: Mr. Alvin E. Buggele, Mail Stop 301-1, NASA Lewis Research Center, 21000 Brookpark Road, Cleveland, Ohio 44135.

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