

Diffusion pumps

Over the past ten or fifteen years, modifications of the diffusion pump have doubled its pumping speed and reduced backstreaming of pump fluids by four or five orders of magnitude. These improvements result from re-design of some basic pump features and from development of new pump fluids with lower vapor pressures.

The accompanying figure illustrates a diffusion pump with some recent modifications. The basic components are

- ▶ a heater (a) that vaporizes the pump fluid (b)
- ▶ one or several nozzles (c) that deflect the vapor stream down and out toward the cold pump walls
- ▶ the high-speed, low-pressure jet stream (d) that sweeps gas molecules from the inlet toward the fore-pump

- ▶ a cold cap (e) that intercepts backstreaming pump fluid at its primary source, the top nozzle
- ▶ water-cooled baffles (f)
- ▶ a cold trap (g)

The combination of cold cap, baffles and cold trap are needlessly redundant.¹ When he replaced the full ("op- pedes the pumping speed. Marsbed Hablanian has shown that, especially with the new pump fluids, the baffles and cold trap are needlessly redundant.¹ When he replaced the full ("optical") baffles with partial baffles (see the figure), he found little or no increase in backstreaming but a substantial increase in speed. Other experiments have indicated that the standard cold cap does not prevent all backstreaming. One remaining source of backstreaming is evapora-

tion from pump fluid that drips off the cold cap. Thus a disk was attached to the cap, as shown in the figure, to reduce backstreaming by 99%.

With these modifications and with liquid nitrogen in the trap, the pumping speed is 50% of the available speed, or twice the speed attained ten years ago. The backstreaming rate corresponds to formation of a monolayer of hydrocarbon molecules on the surface of a bell-jar system over a period of one year. Contamination at this low rate is just as likely to come from rubber gaskets or inadequate cleaning.² The ultimate vacuum obtained with a trapless diffusion pump has been lowered to 10^{-9} torr, trapless, and still lower pressures can be reached with properly trapped systems.

Another new diffusion-pump design is based on an enlargement of the section directly under the inlet flange.³ This innovation increases the space available for pumping action and makes room for more gas molecules to flow into the pump. Of course this modification had to be accompanied by other changes in order to improve the performance of the pump as a whole. For example, the baffle was enlarged and the lower stage nozzles were designed for higher pumping speeds, to keep pace with the increased pumping speed created by the enlarged inlet. At the same time, the overall pump dimensions were unchanged so that the pump would be compatible with standard vacuum flanges.

Diffusion pumps play a different role from sputter-ion and sublimation pumps. The latter are preferred for isolated systems, such as accelerators, that must be maintained at high vacuum over a long period of time. They are also best for systems where cleanliness is so important that one cannot tolerate the risk of an accident. Diffusion pumps can more easily handle large quantities of gas. They can pump continuously, in a steady-state situation even at inlet pressures as high as 10^{-3} torr, whereas sputter-ion and sublimation pumps cannot go above 10^{-6} torr. Diffusion pumps may thus be preferred for systems that must be pumped often.

Barbara G. Levi

References

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