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Jerry Kagan
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RECENT DEVELOPMENTS IN MAGNETICALLY COUPLED VANE PUMPS FOR TRITIUM SERVICE

F. C. Capuder, L. T. Quigley, and C. K. Baker
Monsanto Research Corporation
Mound*
Miamisburg, Ohio 45342
(513)865-3354

ABSTRACT

Despite advances in shaft sealing, a totally reliable shaft seal for two-stage vane pumps has never been developed. Therefore, the magnetically coupled vane pump drive was developed to solve the critical problem of tritium leakage at the shaft seals of vane pumps. As a result, radioactive contamination of the work area and loss of valuable material can now be prevented.

INTRODUCTION

The first magnet coupled vane pump built at Mound was described at the first ANS Tritium Meeting in 1980.¹ Since then, that pump, which we designated the M-1, has undergone many changes. Two new pumps have been fabricated and tested: we built the M-2 with increased pumping capacity for rapid transfer, and we developed the M-3, a miniature version of the M-1, for laboratory-scale experimental work and as a replacement for Toppier pumps. The M-4, now in the design stage, is intended to double the pumping rate of the M-1 vane pump in either forward or reverse while being only slightly longer than the M-1.

Because various processing methods require faster pumping, pump design has been tailored to provide optimum pumping capacity. All the present models have right angle drive, speed reducers, and motors that minimize the space required in enclosures.

These Mound-built vane pumps are leak-tight because their shaft seals have been replaced with magnetic couplings. Completed pumps are pressurized to 50 psig of helium, bagged, and leak tested to 10^{-10} cm³/s helium leak rate. On all future M-1, M-2, and M-4 pumps, casing design pressure will be increased from 200 psig to 1000 psig. The magnetic couplings will also be upgraded to this level, and vented metal O-rings will be used between segments.

M-1 VANE PUMP

The first magnetic coupled pump built in 1980 (see Figures 1 and 2) operated at a maximum speed of 250 rpm with a flow rate of 0.22 cfm (free air). Since then, its speed has been increased to 750 rpm with a flow rate of 0.70 cfm.

The M-1 has been upgraded to 200 psig casing pressure; the number of vane springs has been increased; and the oil baffles have been redesigned to be more effective. This pump has also been used as a compressor. At an inlet pressure of 5 psig of helium, a discharge pressure of 200 psig was achieved in less than three minutes. Table 1 gives the capacity of the M-1 pump at various pumping speeds.

Table 1 - PUMPING SPEED OF THE
M-1 VANE PUMP

rpm	cfm	l/min
250	0.22	6.23
402	0.37	10.48
556	0.52	14.73
750	0.70	19.82

M-2 VANE PUMP (RAPID TRANSFER PUMP)

We foresaw the need for a vane pump with much larger cfm pumping capacity for use as a rapid tritium gas transfer pump and also for use in the commercial nuclear power installations. A vane pump, designated M-2, was built and equipped with a higher torque magnetic coupler. Many improvements were made. End plates and plate retaining cap screw size was increased to permit a safe discharge working pressure of 200 psig with evacuation capabilities to 10 micron. Twenty ml. of either 5-ring or 4-ring polyphenol ether oil is used to lubricate the

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Fig. 1 - M-1 vane pump and components: pumping plates, shaft, and outer and inner magnetic couplers.

Fig. 2 - The fully assembled M-1 pump as it appears today.

vane pump. Forward, reverse, and variable speed features were retained. However, the rapid transfer rate (see Table 2) is achieved in the forward position; reverse pumping is much slower.

Table 2 - PUMPING SPEED OF THE
M-2 VANE PUMP

<u>rpm</u>	<u>cfs</u>	<u>L/min</u>
205	1.50	42.50
402	2.58	73.06
556	3.07	86.94
750	4.80	135.94

This pump has been designed to provide the equivalent flow of a Sargent-Welch 1402 vacuum pump. In fact, it would be a superior pump for mass spectrometer applications. An experiment was done with a cold trap installed on the suction side of the pump. No detectable backstreaming residue was found. This vane pump can also be used as a gas compressor.

We have received numerous inquiries for a pump of this capability, and believe such a vane pump should have wide application. Many users are disenchanted with the scroll pumps, because the compression is low, and they cannot pump into the low vacuum range.

M-3 VANE PUMP (LOW PUMPING MINIATURE)

We have also developed a miniature version of the M-1 vane pump which we have designated the M-3. The M-3 was designed as a low-pumping capacity pump to be used either in laboratory experiments or to replace the Toepler pump and its associated mercury problems. The casing

size is the same size as the M-1 casing; however, the internal vanes and rotors have been miniaturized. Its capabilities are given in Table 3.

Table 3 - PUMPING SPEED OF THE
M-3 VANE PUMP

<u>rpm</u>	<u>L/min</u>
246	1.90
556	4.27
750	5.79

M-4 VANE PUMP

This pump is still being designed. It will embody all of the previous upgrading mentioned, including the 1,000 psig casing. It should pump at least twice as fast as the M-1 pump.

SUMMARY

The original M-1 magnetically coupled vane pump was designed for leak-proof containment of tritium. This type of vane pump has been operating for several years with extremely low maintenance and reliability. Three new vane pumps have been added, M-2, M-3, and M-4, to accommodate the varying needs of operating personnel. These pumps have ushered in an era of reliable tritium containment while pumping a hazardous gas.

REFERENCE

1. F. C. CAPUDER, J. REED, AND L. T. QUIGLEY, "Magnetic Drive Vane Pump," U. S. DOE CONF-800427, Proceedings: Tritium Technology in Fission, Fusion, and Isotopic Applications, p. 264.