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MASS SPECTROMETER VACUUM-LOCK CARRIAGES
COATED WITH TEFLON-S

O. H. Howard
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UNION
CARBIDE

OAK RIDGE GASEOUS DIFFUSION PLANT
OAK RIDGE, TENNESSEE

*prepared for the U.S. ATOMIC ENERGY COMMISSION
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Oak Ridge Gaseous Diffusion Plant
Union Carbide Corporation
Oak Ridge, Tennessee

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ABSTRACT

Seizing of the metal-to-metal, piston-like carriages of a thermal ionization mass spectrometer vacuum lock was eliminated by replacing 0.0015 in. of the carriage surface with Teflon-S. The vacuum lock has been operated 1600 times in the 3.5 years since the carriages were coated. Both the plastic surface and the mass spectrometer vacuum remain satisfactory.

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MASS SPECTROMETER VACUUM-LOCK CARRIAGES
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INTRODUCTION

A thermal ionization mass spectrometer is used at the Oak Ridge Gaseous Diffusion Plant for the isotopic analysis of uranium as well as other elements. It is a 12-in. radius, 60° magnetic instrument supplied by Nuclide Corporation as SU-1.¹

A sliding-bar type vacuum lock² enables changing samples without breaking vacuum. The original chromium plated stainless-steel, piston-like carriages of the vacuum lock were designed to slide inside a close-fitting stainless-steel cylinder without lubrication. The vacuum lock performed satisfactorily for 10 years before the sliding surfaces seized.

Return of the vacuum lock to the manufacturer for repair was considered. However, anticipated high cost, long downtime, and uncertainty of a permanent solution to the problem prompted coating of the carriages with Teflon-S.³

SUMMARY

A metal-to-metal sliding-carriage vacuum lock, used to introduce samples into a thermal ionization mass spectrometer, became inoperable due to seizing of the contacting surfaces. The problem was solved by removing 0.0015 in. of metal from the surfaces of the carriages and replacing it with Teflon-S. No deterioration of the plastic coating or of the mass spectrometer vacuum has been observed after 3.5 years and 1600 operations of the vacuum lock.

DESCRIPTION OF VACUUM LOCK

The vacuum lock (figure 1), fabricated of stainless steel, includes the ion-source chamber, two cylinders of nominal 3-in. ID extending from opposite sides of the chamber, and a source carriage and a blank carriage which slide inside the cylinders with less than 0.0003-in. clearance. The source and blank carriages are 7 and 16 in. long, respectively.

Three circumferential recesses at intervals in the cylinders connect with pumps and provide differential pumping stages. The outer and middle stages are pumped by 350- and 100-l/min mechanical pumps, and the inner

SOURCE IN

SOURCE OUT

Figure 1
MASS SPECTROMETER VACUUM LOCK

stages are pumped by a 15-l/sec, water-cooled electronic pump. Teflon chevron gaskets at the outer ends of the cylinders retard atmospheric inleakage. (The actuator and rotational positioner, shown in figure 1, were designed and fabricated at this plant.)⁴

During analysis of a sample, the carriages are in the positions shown in the top portion of figure 1. When the source carriage is removed to change the sample, the electrically driven blank carriage displaces it (bottom portion of figure 1), preventing loss of vacuum in the mass spectrometer. For reinsertion, the source carriage is manually forced past a Teflon chevron gasket into the first pumping stage as the blank carriage is withdrawn. Thereafter, the source carriage is driven by atmospheric pressure, as the blank carriage is withdrawn, until the source carriage is fully inserted.

COATING OF CARRIAGES

Mandrels were machined for mounting the carriages in a grinder. The carriages were ground until their diameters had been reduced 0.003 in. They were then vapor blasted, cleaned in acetone, and baked 15 min at 650°F to degas them. Next, the carriages were given three coats of Teflon-S, according to the manufacturer's instructions³, for a total film thickness of about 0.003 in. The Teflon-S liquid, consisting of "a special fluorocarbon resin and suitable modifiers dispersed in organic solvents"³, was applied with a manual spray gun. The first and second coats were baked 15 min at 300°F, and the final coat was baked 15 min at 650°F.

Finally, the coated carriages were reduced to the required carriage diameter by surface grinding. The thickness of the resulting Teflon-S film was 0.0015 in. as determined from the finished carriage diameter minus the precoating diameter.

PERFORMANCE

Using the vacuum lock with the coated carriages, the mass spectrometer source and analyzer pressures are 4×10^{-7} and 2×10^{-8} torr, respectively, during an analysis, one hour after a sample change. These pressures compare with 1×10^{-7} and 1×10^{-8} torr for the previous metal carriages during an analysis, one hour after a sample change. (All stated analysis pressures are with a liquid nitrogen coldfinger, not shown in figure 1, in the source chamber.) The slightly higher pressures with the coated carriages are probably due to imperfect carriage diameter, which could be improved with additional sizing care.

The vacuum lock has been operated 1600 times during the 3.5 years since the carriages were coated, with no deterioration of spectrometer vacuum. The coating remains adherent and sound. Mishandling has caused a few minor blemishes on the source-carriage coating; however, these have not affected performance.

ACKNOWLEDGMENTS

Grinding and coating of the vacuum lock carriages were under the directions of C. L. Eller and C. R. Barlow, respectively, of the Fabrication and Maintenance Division, Oak Ridge Gaseous Diffusion Plant.

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