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IMPROVEMENTS OF UHV COPPER GASKETS

by

T. Wikberg

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INTRODUCTION

This note is concerned with improvements on existing types of flat copper gaskets, as used in most commercial UHV flange seals. First; oxidation of the copper has been overcome by silver plating the gaskets. Second; the need for special clips to hold the (flat) gaskets in place during assembly of flanges has been eliminated by making a small alteration in the normal gasket design.

SILVER PLATING

During bakeout of UHV systems hard oxide layers will form on the surface of the copper gaskets which is exposed to air, unless the gaskets are provided with some surface protection. These oxide layers can be quite heavy even after a "mild" bakeout and will then peel off when the gaskets are removed. The hard copper oxide flakes may contaminate the vacuum system or even destroy sealing surfaces during reassembly. At CERN several surface protections have been tried on the copper gaskets; namely silver-, gold-, indium- and nickel-plating. Only silver- and gold-plated gaskets gave good UHV performance, while the other treatments failed, probably due to gas diffusion through the applied coatings. The preliminary tests, however, also confirmed that the gold layer itself diffuses fairly rapidly into the copper gasket at bakeout temperature. Furthermore, for cost considerations, the remaining tests were limited to silver plating. Since the bakeout temperature (which prompted these investigations) was fixed at 300°C, the diffusion of oxygen through the silver layer is negligible.

From extensive tests it has been concluded that a carefully controlled silver plating of the copper gaskets completely eliminates the problem of oxidation. The overall

thickness of the silver layer on normal (commercial) flat copper gaskets must be minimum 5 μm (or 200 μin). The silver plated coating will withstand a minimum of 10 bakeout cycles, each of 8 h at 300°C, without tarnishing or peel-off of the silver. Numerous gaskets have shown excellent performance (and appearance) even after 800 h at 350°C (200 cycles each of 4 h). Contaminations of the gaskets by traces of sulphur, however, can cause heavy discolouration of the silver layer during bakeout. Such contamination must be avoided during processing in the electrolytic baths and when the gaskets are used by selecting lubricants for the bolts etc. not containing sulphur. The cost of this type of silver plating is estimated to be about 25 o/o of the price of untreated gaskets.

GASKET "EARS"

During assembly of UHV flanges special clips to hold the gaskets often are recommended. These clips have to be inserted in the radial leak-check grooves of the flanges and removed again before the final tightening of the bolts. In practice, however, this technique has not been entirely satisfactory. It requires clips to be always at hand, access to the leak-check grooves may be difficult and the clips themselves do not always provide a satisfactory grip.

For the investigations at CERN, the clips were abandoned completely and the effort put on improving the gasket design. The outcome is shown in Figure 1. As can be seen the gasket is provided with two light, diametrically opposed indentations. The dimensional tolerance of these "ears" are made such that they fit the leak-check grooves when the gaskets is gently pressed into the recess of the flange. Because of this slight "press fit" the gasket, once located in the recess, will then be retained in the flange irrespective of the position of the latter.

CONCLUSION

To conclude, first, normal UHV copper gaskets plated with 5 μm (200 μin) silver are He mass spectrometer leak tight at a bakeout temperature of 300°C whilst heavy oxidation and subsequent peel off is suppressed. Second, "gasket clips" are unnecessary if the normal flat copper gaskets are provided with small "ears", and the gaskets are given a slight local "press fit" at the leak check grooves in the flange recess.

The indentations might, of course, be provided on both surfaces of the gasket (instead of on one face only). This will give the tracer gas (He) better access to the sealing area and consequently requires less severe tolerances on the depth of the leak check groove. However, in this case it is imperative that the leak check grooves on the mating flanges be located against each other during assembly.

Figure 1

 