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PROPOSAL FOR INCREASING THE LIFETIME OF  
A SPUTTER-ION PUMP WHEN PUMPING HYDROGEN

Under normal conditions of pumping on an air system, water vapor and nitrogen are the main constituents of pumped gases. Hydrogen is rarely a problem. However, when hydrogen is the main gas pumped various deleterious effects occur.

When a brand new sputter-ion pump is used on a pure hydrogen gas, such as in the ion sources, no problem exists for a period of time. The hydrogen pumping speed is usually 200 to 300% of the rated air speed and good ultimate pressures are attained. Within a few hundred hours, continuous decrease in pumping speeds are encountered with a rise in gas evolution and a rise in the ultimate pressure.

These effects occur because hydrogen does not of itself sputter but the pumping mechanism is a diffusion process into the crystal lattice of the cathode and formation of a spongy material, titanium hydride. This cathode coating resists the penetration of further hydrogen into the cathode and decreases the pumping speed and if the decomposition temperature rises past 250°C at the cathode surface, which can easily happen, then hydrogen is released which causes the pump to stall.

Attempts have been made by the manufacturers to overcome some of these difficulties. They have made the cathode extra thick to allow more titanium volume. They have strengthened the supports of the cathode because the titanium hydride sponge is very fragile and under high temperature conditions, cracks and distorts. These improvements are not sufficient though to permit a continuous high pumping speed for hydrogen because while the total volume of titanium is important, the available volume for hydride formation is the critical parameter.

At this time, only two recommendations from the pump people can cure this. One is to remove the pump and treat it with argon at sputtering pressures to reactivate the surface. If the sponge formation has gone too far the only other alternative is to re-electrode the pump, a time consuming and expensive procedure.

I propose therefore to admit a mixture of hydrogen and argon to the pump. The hydrogen to come from the ion source and the argon to be admitted right at the pump mouth through a controlled leak. I don't know what percentage argon to hydrogen mixture will cause sufficient sputtering to allow completely free diffusion of the hydrogen into the titanium. I don't know what effect this will have on the total pressure at the ion source but it would probably be only 1/10 of a decade in whatever pressure range we are in. This argon flow might be continuous or it might be periodic but I believe it might increase the effective life of the pump by a factor of 10 or 100.

I would like to set up a test using one ion pump with argon and one without as a control. This could be done on either a test ion source or just a controlled leak of pure hydrogen at a rate consistent with the hydrogen rate of a source. After a hundred hours or so, speeds and ultimates recorded, the cathodes could be microscopically examined to determine gross physical effects.

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