PROCESS FOR THE PRODUCTION OF AN ULTRA-HIGH VACUUM

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The present invention is concerned with a process for the production of an ultra-high vacuum in a vessel by means of a diffusion pump and a forepump connected to it where the working fluid is in communication with a storage container arranged outside of its working fluid boiler. It is well known to have a diffusion pump with a working-fluid-storage-container situated outside of its boiler-chamber having a charging conduit through which the working fluid is led by a drainage gutter arranged at the lower end of the condensation wall of the diffusion pump and a connecting conduit between the storage container and the boiler for returning the working fluid into the diffusion pump and an arrangement for the control of the flow of the working fluid. The object of the above known device is to quickly pressureize the evacuated system and afterwards to quickly evacuate it again, since it is important to hold the working fluid at a temperature close to its boiling temperature during the time the vessel is open in order to avoid the unnecessary lost time arising through cooling and subsequent heating again of the working fluid.

Another known vacuum pump with a boiler has one or more jets for the delivery of the vapor produced in the boiler, a main vapor pipe which connects the boiler with the pump jets and supplies them with vapor, a valve for shutting off the boiler from the main pipe and for interrupting the vapor to supply to the pump jets, and a condenser which, during the shutting off of the boiler from the main pipe, condenses away the vapor produced at such a rate that the resulting temperature drop of the working fluid as well as the pressure in the boiler may be held at predetermined values. This known device also only serves to avoid the difficulty which would occur if the working fluid were exposed to air at atmospheric pressure at the operating temperature. It has already been proposed when working with diffusion pumps, before letting in higher pressures, particularly the atmosphere, to reduce the temperature of the hot working fluid by the introduction of working fluid of lower temperature to a value which precludes damage.

These known processes become possible only if the evacuated vessel and, if desirable, the diffusion pump connected directly thereto can be pressurized during the operation. In contrast to this, as mentioned above, the present invention is concerned with a process for the production of an ultra-high vacuum. It is usual to bake out the vessel which is to be evacuated to ultra-high vacuum, at a temperature of 450° C., in order to remove the gases absorbed on the inner walls. For this purpose it is customary to surround the part of the equipment to be heated with heat radiation.

In order to be able to bake out a diffusion pump, the working fluid must first be removed from it. The process for the production of an ultra-high vacuum in a vessel according to the invention by means of a diffusion pump and the forepump connected to it in which the diffusion pump is arranged with a storage container outside its working fluid boiler and being in connection with it is characterized in that after the evacuation of the connected vessel to a predetermined initial high vacuum and before the evacuation to ultra-high vacuum, the working fluid will be distilled into the storage container from the boiler of the diffusion pump under the simultaneous pumping by the after connected forepump, later returned to the connected boiler of the diffusion pump and the further evacuation of the vessel to ultra-high vacuum is then carried out.

The invention will be described in more detail with the use of an example as follows. The apparatus for carrying out the process according to the invention cited as an example is represented in the accompanying schematic drawing which shows two diffusion pumps connected in series and a heatable storage container for the working fluid of the diffusion pump, connected directly to the vessel to be evacuated are provided where the storage container is connected to the connecting pipe between the two diffusion pumps.

Numerical 1 designates a vessel to be evacuated to ultra-high vacuum to which an apparatus 2 for the prevention of oil backstreaming (a so-called bakeoff) and a diffusion pump 3 are connected. The discharge pipe 4 of this diffusion pump leads to a second diffusion pump 5 which is connected in series with the first diffusion pump 3. The discharge pipe of the second diffusion pump in turn is in communication with the rotating forepump 7 through the pipe 6.

The connecting pipe 4 between the two diffusion pumps is constructed in a special manner for the carrying out of the invention. As the drawing shows, it is inclined upwards and shows a laterally attached condensation pipe with stub 11 for the working fluid on whose bottom an electrical heater 12 is fitted. The portion 13 of the connecting pipe 4 between the stub 11 and the pump 5 is provided with a cooling wall, for example, in the form of a surrounding cooling coil 14.

If the ultra-high vacuum pump directly connected to the vessel is heated as a whole through putting it into oven, then the working fluid vapor is led off through the pipe 4 and is condensed on the wall of its upper part 13. The backflowing condensate will be collected in the stub 11.

As soon as the complete working fluid charge of the first pump 3 is distilled over into the stub 11, the actual baking out at a temperature above the boiling point of the working fluid can begin. According to the bake out temperature used, the gas load of the gases to be released from the inner walls of the pump and the degree of evacuation to be subsequently attained in the vessel, the baking out will require between a half hour to several hours. Afterwards, the working fluid in the stub 11 can be distilled back into the first diffusion pump 3 by putting the heater 12 into operation. Thus, the working fluid vapor flows out of 11, part going directly into the first diffusion pump 3 and will there be condensed on its again cooled inner walls, and part going to the cooled portion 13 of the connecting pipe 4 where it is likewise condensed and flows back into the stub 11 and is again vaporized until finally all of the working fluid is brought back again into the first diffusion pump 3 with the exception of the easily escaping components ("light ends") which will be removed during the process by the running forepump 5. Following this, the evacuation of the vessel 1 to ultra-high vacuum can be carried out with the first diffusion pump 3.

If a valve is provided between the vessel 1 and the diffusion pump 3 to be baked out, so that both spaces can be separated from each other, it is recommended to first outgas the vessel alone in the usual manner by baking out and pumping off the liberated gases through a diffusion pump and immediately following this also carry out the baking out of the diffusion pump as was described above, during which the vessel and the diffusion pump being baked out are separated from one another by the valve. In this way, one can prevent the entrance of large
amounts of the working fluid into the vessel and there to possibly cause detrimental reactions, for example, with the filament of the ionization gauge.

In place of the back distillation of the working fluid from the storage container 11 in to the pump, a special pipe can be provided for its return in liquid form.

The invention yields the advantages of a better ultimate vacuum, shorter evacuation time and simultaneously, a basic operating purification of the working fluid of the pump from all easily escaping components (light ends) which arise in the course of the operation (or on occasion existing from the beginning) and could very well impair the excellence of the vacuum. For example, it was found that with an ultra-high vacuum pumping system, which without the processing according to the invention, could be evacuated, after previously baking out the vessel in the previous usual manner, to a vacuum of 10⁻¹⁰ torr in the vessel within about 72 hours, a pumping time reduction of 50 hours, that is to say 54, was achieved by the use of this invention. The distillation of the working fluid over into the stub 11, the baking out of the diffusion pump and the return distillation required approximately one hour. It is to be observed that this time is not in addition to the normal pump time that must be used since the processing steps referred to can be carried out during the same time in which the vessel is being outgassed by baking out.

I claim:

1. A process for producing an ultra-high vacuum in a vessel employing a diffusion pump, a forepump, and working fluid storage container external to and communicating with the diffusion pump comprising the steps of:

   reducing the pressure in the vessel to a predetermined initial high vacuum;

   removing the working fluid to a storage container by the forepump;

   heating the vessel to a temperature exceeding the boiling point of the working fluid;

   returning the working fluid to the diffusion pump; and

   reducing the pressure in the vessel to an ultra-high vacuum.

2. The process as claimed in claim 1 wherein the step of removing the working fluid to the storage container comprises:

   pumping the working fluid by the forepump; and

   distilling the working fluid.

3. The process as claimed in claim 1 wherein the step of returning the working fluid from the storage container to the diffusion pump comprises:

   distilling the working fluid in the storage container.

4. A process for producing an ultra-high vacuum in a vessel employing a diffusion pump, a forepump means, and a working fluid storage container external to and communicating with the diffusion pump comprising the steps of:

   reducing the pressure in the vessel to a predetermined initial high vacuum;

   pumping and distilling substantially simultaneously the working fluid into the storage container;

   heating the vessel to degas the said vessel;

   returning the working fluid to the diffusion pump; and

   reducing the pressure in the vessel to an ultra-high vacuum.

5. An apparatus for producing an ultra-high vacuum in a vessel comprising:

   a first diffusion pump having a connection to said vessel;

   a second diffusion pump in series with said first diffusion pump;

   a mechanical pump member in series with said second diffusion pump;

   a first pipe means interconnecting said first and second diffusion pumps;

   a condenser member cooling a portion of said first pipe means; and

   a trap means comprising a stub pipe member, and a heating element disposed adjacent the bottom of said stub pipe member; said trap means adapted to catch the condensate produced in said first pipe means.

6. The vacuum apparatus as claimed in claim 5 wherein said first pipe means interconnects the discharge of the first diffusion pump and the intake of the second diffusion pump; and said first pipe means is obliquely inclined.

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