

5 The present invention relates to a method for removing residual water from a container which contains ion exchanger resin, which container is provided with supply and discharge pipes for ion-containing water and de-ionized water respectively. The present invention furthermore relates to a device for carrying out said method.

The regeneration of the saturated ion exchanger resin is a relatively costly process, which is difficult to carry out. The containers, in which residual water is still present, are heavy and must be detached from the ion exchanging plant in order to be transported to the regeneration plant. Such a treatment is laborious and the present Occupational Health and Safety Act does not allow personnel to lift and move containers having a weight of more than 50 kg. In practice crane installations are used for moving containers which are filled with residual water, but such an installation requires a great investment, whilst in addition to that not every facility can accommodate such an installation. Another possibility is to drain the water when disconnecting the containers containing the ion exchanger resin, resulting in undesirable spillage of substantial amounts of residual water, which is often contaminated with heavy metals. In addition to that the spillage of residual water means a loss of water in the de-ionization plant, so that the amount of water needs to be replenished after some time.

The above drawbacks are eliminated by the present invention as referred to in the introduction, and the method according to the invention is characterized in that said container is subjected to a pressure difference in order to remove said residual water therefrom.
5 This makes it easier to move a container which contains ion exchanger resin and from which the residual water has been removed, because the weight of such a container is considerably lower. In addition to that there will be no spillage of residual water, which means a considerable improvement from an environmental and economical point of view.

10 Preferably a pressure higher than the atmospheric pressure is generated in the container. The residual water is removed from the container as a result of the presence of an excess pressure generated by means of a pressurized gas, for example air or nitrogen, or another gas which is inert in comparison with the contents of the container. The
15 advantage of this is that by generating the excess pressure it becomes readily possible to control the rate of outflow from the container. Another advantage is that the residual water, which is corrosive in many cases, only comes into contact with existing pipes, as a result of which it is not necessary to use special alloys for the excess pressure pipes. In
20 addition to that existing containers can be readily adapted for carrying out such a method. Furthermore it is not necessary to adapt an existing installation because the available piping equipment can be used.

In another embodiment a pressure lower than the atmospheric pressure is generated in the container which contains ion
25 exchanger resin, in order to remove the residual water from said container. The sub-atmospheric pressure is for example generated by a pump or by a similar means capable of generating a sub-atmospheric pressure, for example a water jet pump. The advantage of this is that it is not necessary to adapt an existing container, because the pump may be connected to the
30 supply and discharge pipes for ion-containing water and de-ionized water respectively. In addition to that it is possible to remove practically all residual water from the container.

In a preferred embodiment of the present invention the ion exchanger resin present in the container is subjected to a mixing
35 treatment before removing said residual water from said container. After the mixing treatment the ion exchanger resin is once more ready for

deionization purposes. The advantage of this is that by mixing the resin particles the dirt or contamination deposited thereon will be removed from the ion exchanger resin particles, resulting in a liberation of an active surface area. Therefore, the mixing treatment can be seen as a cleaning treatment for the resin particles. Furthermore, the mixing treatment results in a physical rearrangement of the resin particles present in said container, which in turn has a positive effect on the overall activity of the resin particles.

Preferably, the mixing treatment is carried out by supplying a medium, i.e. a gas, a liquid or a mixture thereof, to said container at a position located at the bottom of said container. The preferred medium is air because the air bubbles rising through the bed of resin particles will cause a good mixing action within said bed. The advantage of this is that all the resin particles become well mixed, resulting in the removing of the material deposited thereon. After the mixing treatment the supply and discharge pipes can be connected into the original mode in order to deionize the process water.

Preferably, the mixing treatment is carried out in a pulsating mode. Due to the pulsating mode the resin particles will be mixed more effectively. Furthermore the formation of so-called channels in the bed of resin particles is prevented. The formation of channels is considered to be disadvantageous for deionization purposes.

The present invention furthermore relates to a device for carrying out the method according to the present invention. Such a device is for example known from German Auslegeschrift 27 52 581. The main components of the container disclosed in said Auslegeschrift are a supply pipe and a discharge pipe for saltwater and desalinated water respectively, a gauge for measuring conductivity and a casing in which an exchangeable ion exchanger resin cartridge is placed. After such an ion exchanger resin cartridge has become saturated, the casing is removed and the cartridge is taken out and exchanged for a new cartridge. While such cartridges are being removed, the residual water still present therein will leak out. In addition to that only cartridges having a small capacity are commercially available, as a result of which these cartridges have to be exchanged at short intervals. It should be noted that said Auslegeschrift

makes no mention of removing the residual water from the container by subjecting the container to a pressure difference.

5 The device according to the present invention is characterized in that said container is provided with a connecting means other than said supply pipes and discharge pipes, which connecting means can be coupled to a pressure means for generating an excess pressure in the container.

10 Preferably the pressure means is connected to said connecting means by one or more rapid-action couplings. The advantage of this is that the connection between said connecting means and said pressure means can be effected in a simple manner and that any loss of residual water is minimized by using one or more rapid-action couplings. The pressure means used is for example compressed air which is generally available with an excess pressure of about 2 bar. However, the present
15 invention is not restricted to the use of compressed air with an excess pressure of 2 bar. Also other compressed gases may be used, insofar as such gases do not affect the contents of the container.

In another embodiment the pressure means is connected to the connecting means via a valve means, preferably the supply pipe for ion-containing water is provided with a valve means, which valve means
20 is connected to a pressure means for generating an excess pressure in the container. The advantage of this is that it is not necessary to disconnect pipes in order to generate an excess pressure in the container, as a result of which the loss of residual water is minimized.

25 In another embodiment of the present invention the discharge pipe of de-ionized water is provided with a pump for generating a sub-atmospheric pressure in the container. The advantage of using a pump for generating a sub-atmospheric pressure in the container is that rate of outflow of the residual water from the container can be precisely
30 controlled. It should be noted that the pump must be resistant against the corrosive action of the residual water.

The present invention relates in particular to a device for carrying out the mixing treatment as already discussed, characterized in that said container is provided with a pipe, wherein said pipe extends
35 downwardly into said container. Preferably said pipe is perforated at the end thereof in order to create several openings for distributing the

medium, i.e. a gas, a liquid or a mixture thereof. Furthermore, the pipe extending downwardly into said container is provided with connecting means via rapid-action couplings outside said container. The advantage of this is that the connection between said connecting means and said pipe
5 extending downwardly into said container can be effected in a single manner and that loss of any residual water is minimized by using one or more rapid couplings.

In another preferred embodiment said pipe is connected via a valve means outside said container. The advantage of this is that
10 it is not necessary to disconnect the pipe in order to supply the medium into the container, as a result of which the loss of residual water is minimized.

The method according to the present invention and the device for carrying out said method are suitable for various applications
15 where water must be de-ionized, for example in laboratories, hospitals, industrial plants, water treatment plants and the like. The present invention is particularly suitable for use as a de-ionizing plant in an electro discharge machining which is as known as "spark erosion" or more common as Electric Discharge Machining (EDM). The machines for this process
20 are called EDM-machines or EDM-installations. The present invention will be explained in more detail with reference to the following Figures.

Description of the Figures.

Figure 1 shows a prior art de-ionization plant, such as for example used in an EDM-installation.

25 Figure 2 shows a de-ionization plant according to the present invention, such as for example used in an EDM-installation.

Figure 3 schematically shows the device according to the present invention, wherein an excess pressure is generated in the container, whereby the pressure means is connected to the connecting means
30 on the container by means of rapid-action couplings.

Figure 4 shows a device according to Figure 3, wherein the pressure means is connected to the connecting means via a valve means, however.

35 Figure 5 schematically shows the device according to the present invention, wherein a valve means is fitted in the supply pipe

for ion-containing water, which valve means is connected to the pressure means for generating an excess pressure in the container.

Figure 6 schematically shows the device according to the present invention, wherein a sub-atmospheric pressure is generated in the container by means of a pump in the discharge pipe for de-ionized water.

Figure 7 schematically shows the device according to the present invention, wherein a water jet pump is provided for generating a sub-atmospheric pressure in the container, after which the residual water is led from the container to a buffer vessel for de-ionized water.

Figure 8 shows the same device as is shown in Figure 7, with this difference that the residual water removed from the container is led to a buffer vessel for ion-containing water.

Figure 9 shows the same device as is shown in Figure 3, with this difference that the mixing treatment is carried out before removing said residual water from said container.

Figure 10 shows a device according to the present invention, for remixing the resin.

Figure 11 schematically shows the device according to the present invention wherein the exhaust takes places via a purge into drain or EDM machine.

Figure 12 schematically shows the device according to the present invention, wherein the pipe extending downwardly into said container is provided with connecting means via rapid-action couplings or a valve means, respectively.

Figure 13 schematically shows the device according to the present invention, wherein the mixing treatment is carried out by supplying a mixture of a gas and a liquid at a position located at the bottom of the container.

Figure 1 shows a prior art de-ionization plant, whereby ion-containing water from EDM-installation 6 is led to a buffer vessel 1 for ion-containing water. The ion-containing water is led to an ion exchanger resin-containing container 3 via a filter 2. The de-ionized water from container 3 is then transferred to a buffer vessel 4 for de-ionized water, and then carried back to EDM-installation 6 via pipe 5.

Figure 2 shows the device according to the present invention. The ion-containing water from EDM-installation 6 is supplied after eventually being subjected to a filter treatment to ion exchanger resin-containing container 8 via pipe 7. Said ion-containing water is de-ionized in container 8 and carried back to EDM-installation 6 via pipe 5. After some time the ion exchanger resin present in container 8 is saturated with ions, after which container 8 must be exchanged for a new identical container 8'. The residual water present in container 8 is removed therefrom, for example by generating an excess pressure in the container with the aid of pressure means 9, in this case a hose provided with a connection for compressed air. It is also possible, however, to remove the residual water from container 8 by generating a sub-atmospheric pressure in container 8 by means of a pump.

Figure 3 illustrates in more detail the method and the device according to the present invention, wherein an excess pressure is generated in the container. Picture A shows the situation in which water is supplied to ion exchanger resin-containing container 8 via supply pipe 7. The de-ionized water exits container 8 via discharge pipe 5 for de-ionized water. After some time the ion exchanger resin is saturated, after which the resin must be exchanged. To that end the residual water present in container 8 must be removed. Supply pipe 7 is removed from container 8 via rapid-action coupling 25, compressed air is connected to connecting means 10 via pipe 9 and rapid-action coupling 27 (Picture B). By generating an excess pressure in container 8, in this case by supplying compressed air 28 to said container, the residual water is removed from container 8 via discharge pipe 5, which is connected to container 8 via rapid-action coupling 26 (Pictures C and D). In picture E shown in Figure 3 all residual water is removed from ion exchanger resin-containing container 8, after which the container 8 is exchanged for an ion exchanger resin-containing container 8', which is connected to supply pipe 5 and discharge pipe 7 via rapid-action couplings 25 and 26 respectively (picture F). It should be noted that situation F corresponds with situation A, after which situations B - E are passed through anew.

Figure 4 corresponds with Figure 3, with the difference, however, that pressure means 9 and supply pipe 7 are connected to ion exchanger resin-containing container 8 via valve means 11 and 12

respectively. In picture A supply pipe 7 for ion-containing water is connected to container 8 via valve means 11, said container 8 being provided with discharge pipe 5 for de-ionized water. Connecting means 10 is connected to pressure means 9, in this case compressed air, via valve means 12. After the ion exchanger resin present in container 8 is saturated, picture B, the residual water present in container 8 must be removed. The valve means 11 in supply pipe 7 is closed, container 8 is pressurized by supplying compressed air 28 via pressure means 9, valve means 12 and connecting means 10, after which the residual water is removed from container 8 via discharge pipe 5. In picture E all residual water is removed from container 8 and, as shown in picture F, said container is exchanged for a new ion exchanger resin-containing container 8', which container 8' is connected to supply and discharge pipes 7, 5 and pressure means 9. Picture F corresponds with picture A, after which situations B - E are passed through anew.

Figure 5 shows the embodiment wherein container 8 is pressurized via a valve means 13 fitted in supply pipe 7, which valve means is connected to pressure means 9. After the ion exchanger resin present in container 8 is saturated, the residual water must be removed from container 8 before said container can be exchanged. In picture B valve means 13 is adjusted such that no ion-containing water is supplied to container 8 via supply pipe 7, but that compressed air 28 is supplied to container 8 via pressure means 9, which is connected to valve means 13. A pressure higher than the atmospheric pressure is generated in container 8 and the residual water that is present, exits container 8 via discharge pipe 5. In situation E all residual water is removed from container 8. This container 8 is then exchanged for a new ion exchanger resin-containing container 8' as shown in picture F, which situation corresponds with situation A. Then situations B - E are passed through anew.

Figure 6 shows an embodiment according to the present invention, wherein a pressure lower than the atmospheric pressure is generated in container 8. In picture A ion-containing water is supplied to container 8 via supply pipe 7, which is connected to container 8 via valve means 14, from which container 8 the de-ionized water is removed via discharge pipe 5, which is connected to container 8 via valve means 15. After some time the ion exchanger resin present in container 8 is

saturated and the residual water must be removed from container 8. Valve means 15 is adjusted such that the residual water is removed from the container via pipe 5 by generating a sub-atmospheric pressure in container 8. In picture E all residual water has been removed from container 8, after which container 8 is exchanged for a new ion exchanger resin-containing container 8', shown in picture F. Situation F corresponds with situation A, in which situation valve means 15 is adjusted such that the de-ionized water exits container 8 via discharge pipe 5.

Figure 7 shows a special embodiment of the present invention, wherein the residual water is removed from the ion exchanger resin-containing container 8 by generating a sub-atmospheric pressure in the container, which takes place by means of a water jet pump 18. In picture A the water jet pump 18 is connected to valve means 20 in discharge pipe 5. Valve means 19 is in supply pipe 7. After some time the ion exchanger resin present in container 8 is saturated and the residual water must be removed from container 8. Valve means 19 is adjusted such that water jet pump 18 generates a sub-atmospheric pressure in container 8, after which the residual water exits container 8 via discharge pipe 5 by correctly adjusting valve means 20. In picture E all residual water has been removed from container 8, and container 8 is exchanged for a new container 8', as shown in picture F, which corresponds with situation A. The residual water removed from container 8 is led to a buffer vessel for de-ionized water (not shown) via discharge pipe 5.

Figure 8 corresponds with Figure 7, with the difference, however, that water jet pump 23 is provided in supply pipe 7 via valve means 21, and that valve means 22, which is provided in discharge pipe 5, is connected to container 8. After some time the ion exchanger resin present in container 8 is saturated and the residual water must be removed from container 8. A sub-atmospheric pressure is generated in container 8 by correctly adjusting valve means 21, after which the residual water exits container 8 via discharge pipe 5 once valve means 22 has been adjusted. In picture E all residual water has been removed from container 8, and container 8 is exchanged for container 8', as shown in picture F. The residual water removed from container 8 is led to a buffer vessel for ion-containing water (not shown). Situation F corresponds with situation A, after which situations B - E are passed through anew.

Figure 9 corresponds to the device according to Figure 3, wherein in the third picture the mixing treatment according to the invention takes place. As can be seen from this third picture the mixing treatment takes place before removing the residual water from container 8 via pipe 5. In the second picture pipe 30 is perforated at the end for distributing the fluidum gas and/or liquid. By supplying the fluidum through line 30 the resin will be remixed so that new active parts of the resin are available for the water to be cleaned. The removal of said residual water takes place in pictures 4 and 5, corresponding to pictures D and E as disclosed in Figure 3 respectively. After the mixing treatment it will be possible to use the resin again so that it is unnecessary to replace container 8 by a new container 8'.

Figure 10 shows the embodiment wherein a mixture of liquid and air is injected through the water jet pump 34 via pipe 31 into the container 8 for a remixing operation. Pipe 31 extends downwardly into said container 8 and the discharge of liquid and air takes place via pipe 32 and pipe 7.

Figure 11 shows three embodiments a), b) and c) of the present invention for carrying out the remixing treatment. According to the situation a) the gas is injected into pipe 31 and the exhaust takes place via outlet 35 to drain or EDM machine. In picture b) of Figure 11 gas is injected via pipe 31 into container 8 and the discharge takes place via pipe 32 into drain or EDM machine and installing the fastcouplings 5 and 7. In picture c) gas injected via pipe 31 into container 8 and the discharge thereof takes place into drain or EDM machine via outlet 35. It also is possible to inject fluidum through fastcoupling 7 and to discharge fluidum through fastcoupling 5.

Figure 12 shows the embodiment wherein in a) the medium, i.e. a gas, a liquid or a mixture thereof is injected via pipe 30 into container 8. The discharge thereof takes place via pipe 32 located at the top of said container 8. In picture a) there is an adequate fastcoupling system by crossing the tubes. Picture b) of Figure 12 is the same embodiment as disclosed in a) with either manual or controlled valves 33. Picture c) shows the embodiment wherein the medium, i.e. a gas, a liquid or a mixture thereof is injected via pipe 30 into said container 8. The discharge thereof takes place via pipe 32 located at the top of said

container 8. There also is a possibility for the inlet of external liquid e.g. refill-water for EDM machines via fastcoupling. Picture d) shows the embodiment wherein the medium, i.e. a gas, a liquid or a mixture thereof is directly injected via pipe 30 into said container 8 wherein the discharge thereof takes place via pipe 31 and valves 33. This installation is based on picture a) of Figure 12 for hydraulic remixing with either manual or controlled valves 33, inlet of external liquid e.g. refill-water for EDM machines.

In figure 13 picture A) is based on picture a) of figure 12. In figure 13A) a mixture of a gas and a liquid is directly injected by using water jet pump 34 via pipe 30 into said container 8. The discharge thereof takes place via pipe 32 located at the top of said container 8. Picture B) shows the embodiment wherein a gas/liquid-mixture is injected via an either manual or controlled valve means 33 and pipe 30 into said container 8. The discharge thereof takes place via a pipe 31. Picture C) shows the embodiment wherein a liquid/gas-mixture is injected via pipe 30 into said container using external liquid e.g. refill-water for EDM machines supported with aspirated gas by installing an injector 34, and installing adequate fastcouplings. The discharge thereof takes place via a pipe 32 located at the top of said container 8. Furthermore picture D) shows the embodiment wherein the gas/liquid-mixture is injected via a pipe 30 into said container 8. Picture D) is based on picture C) of Figure 13, but is installed now with manual or controlled valves. The discharge takes place via pipe 31.

The container 8 is provided according to the invention with connecting means via rapid-action couplings or via a valve means outside said container. However, the present invention is not restricted to a special combination of those connecting means.

CLAIMS

1. A method for removing residual water from a container which contains ion exchanger resin, which container is provided with supply and discharge pipes for ion-containing water and de-ionized water respectively, characterized in that said container is subjected to a pressure difference, as a result of which said residual water is removed from said container.
2. A method according to claim 1, characterized in that a pressure higher than the atmospheric pressure is generated in said container.
3. A method according to claim 1, characterized in that a pressure lower than the atmospheric pressure is generated in said container.
4. A method according to claims 1 - 3, characterized in that, said residual water, removed from said container, is recycled to the system in which the water is to be used.
5. A method according to claims 1 - 4, characterized in that, the ion exchanger resin present in said container is subjected to a mixing treatment before removing said residual water from said container.
6. A method according to claim 5, characterized in that, said mixing treatment comprises supplying a gas, a liquid or a mixture thereof to said container at a position located at the bottom thereof.
7. A method according to claim 6, characterized in that, said mixing treatment is carried out in a pulsating mode.
8. A method according to claims 6 - 7, characterized in that, air is used.
9. A device for carrying out the method according to claim 2, characterized in that said container is provided with a connecting means other than said supply and discharge pipes, which connecting means can be coupled to a pressure means for generating an excess pressure in the container.
10. A device according to claim 9, characterized in that said pressure means is connected to said connecting means via rapid-action couplings.



11. A device according to claim 9, characterized in that said pressure means is connected to said connecting means via a valve means.
- 5 12. A device according to claim 2, characterized in that the supply pipe for ion-containing water is provided with a valve means, which valve means is connected to a pressure means for generating an excess pressure in said container.
- 10 13. A device for carrying out the method according to claim 3, characterized in that the discharge pipe for de-ionized water is provided with a pump for generating a sub-atmospheric pressure in said container.
14. A device according to claim 13, characterized in that said pump is a water jet pump.
- 15 15. A device according to claim 13, characterized in that the discharge pipe of said pump is connected to a buffer vessel for ion-containing water.
16. A device according to claim 13, characterized in that the discharge pipe of said pump is connected to a buffer vessel for de-ionized water.
- 20 17. A device for carrying out the method according to claim 5, characterized in that, said container is provided with a pipe, wherein said pipe extends downwardly into said container.
18. A device according to claim 17, characterized in that, said pipe is perforated at the end of said pipe.
- 25 19. A device according to claims 17 - 18, characterized in that, said pipe is provided with connecting means via rapid-action couplings outside said container.
20. A device according to claims 17 - 19, characterized in that, said pipe is connected via a valve means outside said container.

