

APPARATUS FOR RECYCLING SULFURIC ACID- HYDROGEN PEROXIDE SOLUTION

CROSS-REFERENCE TO RELATED APPLICATION

[0001] The present application is based on, and claims priority from, Taiwan Patent Application No. 103203460, filed February 27, 2014, the disclosure of which is hereby incorporated by reference herein in its entirety.

TECHNICAL FIELD

[0002] The present invention generally relates to a recycling apparatus, and more specifically to an apparatus for recycling sulfuric acid- hydrogen peroxide solution by removing hydrogen peroxide.

BACKGROUND

[0003] Traditionally, hydrogen peroxide (H_2O_2) is used as an oxidizer in the semiconductor process, and often works with sulfuric acid (H_2SO_4) to form a removing agent or an etching agent for a photo resist agent. Thus, more than 30% to 40% of waste liquid generated by the semiconductor process is sulfuric acid waste liquid, which is mostly the sulfuric acid- hydrogen peroxide solution.

[0004] As shown in FIG. 1, the structure for treating the sulfuric acid- hydrogen peroxide solution in the prior arts comprises a container 11, a heating unit 12, a reaction tank 13 and a cooling water heat exchanger 14. The container 11 is substantially made of quartz or glass for accommodating the sulfuric acid- hydrogen peroxide solution to be treated. The heating unit 12 is provided below the container 11 to preheat the sulfuric acid- hydrogen peroxide solution by use of electrical heating or hot coal oil. The container 11 is connected to the reaction tank 13 through a tube 111,

and a reacting agent supply unit 15 transfer the reacting agent to the reaction tank 13 through a tube 151. When the sulfuric acid- hydrogen peroxide solution and the reacting agent react in the reaction tank 13, oxygen gas, water or other reaction gas is generated depending on the reacting agent. At the same time, a great deal of heat is generated. The reaction gas or oxygen gas is discharged or collected through a tube 131, and the remaining reaction product is accumulated and discharged to the outside through a tube 132. The cooling water heat exchanger 14 comprises heat exchange tubes provided inside the reaction tank 13. The above-mentioned huge heat is cooled down by using the cooling water in the heat exchange tubes due to thermal conduction and convection. Thus, it is possible to prevent the reaction tank 13 from too much internal pressure. However, the above operation in the prior arts has some problems as below.

[0005] 1. The heating unit 12 implemented by electrical heating or hot coal oil is always an external heat source, which is energy consuming and increases heating cost.

[0006] 2. If the heating unit 12 is implemented by hot coal oil, leakage is potentially and possibly risky. Once the reaction of the sulfuric acid- hydrogen peroxide solution and the heat medium like hot coal oil becomes strong, more extreme secondary damage is caused.

[0007] 3. The cooling water heat exchanger 14 takes water as the cooling medium. If leakage happens in the heat exchange tube of the reaction tank and the sulfuric acid- hydrogen peroxide solution contained in the reaction tank is mixed with the cooling water, additional heat.

[0008] 4. The traditional reaction tank is a chemical storage tank, and the heat, gas and liquid generated by the reaction will potentially cause the risk of leakage and pressure overloading.

SUMMARY

[0009] The primary object of the present invention is to provide an apparatus for recycling sulfuric acid- hydrogen peroxide solution. Since the decomposition of hydrogen peroxide contained in the sulfuric acid- hydrogen peroxide solution by adding some reacting agent to remove hydrogen peroxide and form oxygen gas and water is strongly exothermic, the resultant solution is heated. The apparatus of the present invention employs the heated solution as the heating medium for preheating the sulfuric acid- hydrogen peroxide solution prior to treatment. Thus, valuable heat is effectively utilized and the risk of operation due to a great deal of heat generated is prevented.

[0010] To this end, the apparatus of the present invention generally comprises a recycle heater, a reaction tank, a heat storage tank and a liquid storage tank. Specifically, the recycle heater has a closed tank body and at least one set of heat exchange tubes provided inside the tank body. The first transfer tube and the second transfer tube are connected to the internal of the tank body, wherein the first transfer tube is used for transferring the sulfuric acid- hydrogen peroxide solution to the tank body, and the second transfer tube outputs the preheated solution to be treated. The reaction tank is further connected to the second transfer tube, at least one reacting agent supply tube, at least one gas discharge tube and the third transfer tube. The sulfuric acid- hydrogen peroxide solution flows into the second transfer tube and reacts with the reacting agent supplied by the reacting agent supply tube. After the reaction, the resultant reaction production is transferred through the third transfer tube. The storage tank is connected to the third transfer tube, the fourth transfer tube and the hydraulic pump. The reaction product flows into the heat storage tank through the

third transfer tube, and is further pumped and transferred to the heat exchange tubes of the recycle heater by the hydraulic pump. The liquid storage tank is connected to the fifth transfer tube and the discharge tube. The fifth transfer tube is further connected to the outlet of the heat exchange tubes such that the cooled reaction product flows into the liquid storage tank and is then discharged through the discharge tube after being cooled down and collected.

[0011] Furthermore, the reaction tank of the present invention further comprises a heat exchange tube, and the liquid storage tank is connected to the sixth and seventh transfer tubes. The sixth transfer tube is connected to the inlet of the heat exchange tube of the reaction tank, and the seventh transfer tube is connected to the outlet of this heat exchange tube such that the reaction product cooled down in the liquid storage tank can be used as the heat medium for reducing the internal temperature of the reaction tank.

[0012] The apparatus for recycling sulfuric acid- hydrogen peroxide solution according to the present invention employs the reaction product after being heated as the heat medium for the recycle heater, and the reaction product after being cooled down is collected in the liquid storage tank and used as the cooling medium for the reaction tank. It is thus obvious that valuable energy is effectively utilized to reduce the heating cost. In particular, when leakage occurs in the piping, the problem is not harmful because each tank contains similar and composition. As a result, the apparatus of the present invention can operate more safely.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] The present invention will be apparent to those skilled in the art by reading the following detailed description of a preferred embodiment thereof, with reference to the attached drawings, in which:

[0014] FIG. 1 is a view showing the structure for treating the sulfuric acid-hydrogen peroxide solution in the prior arts;

[0015] FIG. 2 is a view showing the apparatus for recycling sulfuric acid-hydrogen peroxide solution according to one embodiment of the present invention; and

[0016] FIG. 3 is a view showing the operation of the apparatus of the present invention.

DETAILED DESCRIPTION OF THE DISCLOSED EMBODIMENTS

[0017] The accompanying drawings are included to provide a further understanding of the invention, and are incorporated in and constitute a part of this specification. The drawings illustrate embodiments of the invention and, together with the description, serve to explain the principles of the invention.

[0018] As shown in FIG. 2, the apparatus for recycling sulfuric acid- hydrogen peroxide solution according to one embodiment of the present invention comprises a recycle heater 2, a reaction tank 3, a heat storage tank 4 and a liquid storage tank 5.

[0019] Specifically, the recycle heater 2 is generally configured to preheat the sulfuric acid- hydrogen peroxide solution to be recycled. For example, the solution is preheated up to 40-60°C so as to facilitate the latter chemical reaction. A heat medium used here refers to the reaction products formed and heated after removing hydrogen peroxide from the solution. The reaction product is basically a solution containing sulfuric acid, remaining reactant and other products generated by the reaction. The recycle heater 2 has a closed tank body 21 and at least one set of heat exchange tubes 22. The tank body of the recycle heater comprises a plurality of partition plates internally configured for forming a plurality of separate regions, which are intercommunicated and form an extended heating channel 212 to prolong a

flowing path. The heat exchange tubes 22 are provided inside the extended heating channel 212. The heat medium in the heat exchange tubes 22 is the preheated reaction product. Additionally, the first transfer tube 61 and the second transfer tube 62 are connected to the internal of the tank body 21. The first transfer tube 61 is used for transferring the sulfuric acid- hydrogen peroxide solution to the tank body 21, and the second transfer tube 62 outputs the preheated solution to be treated. The inlet of the heat exchange tube 22 is connected to the fourth transfer tube 64 and the outlet of the heat exchange tube 22 is connected to the fifth transfer tube 65.

[0020] The reaction tank 3 is a closed container serving as a reaction chamber for removing hydrogen peroxide from the sulfuric acid- hydrogen peroxide solution. Since the decomposition of hydrogen peroxide generates a great deal of oxygen gas to cause a problem of bubble overflowing, a specific space region reserved in the reaction tank 3 is needed to accommodate the gas generated so as to guarantee safety during the whole reaction. Therefore, the reaction tank 3 has a shape of long column such that a ratio of gas to liquid in the reaction tank 3 is larger than 1.5 after the solution is fed. Furthermore, at least one set of heat exchange tubes 31 is provided inside the reaction tank 3. The heat exchange tubes 31 are primarily configured to cool down the solution so as to prevent the solution from risky overheat.

[0021] In addition, the piping intercommunicated inside the reaction tank 3 comprises the second transfer tube 62, at least one reacting agent supply tube 71, at least one gas discharge tube 81 and the third transfer tube 63. The reacting agent supply tube 71 is connected to a reacting agent supply unit 72 and a hydraulic pump 73 for suitably supplying the reacting agent to the reaction tank 3. The sulfuric acid- hydrogen peroxide solution flows into the reaction tank 3 through the second transfer tube 62, and reacts with the reacting agent supplied by the reacting agent supply tube

71. Since the decomposition of hydrogen peroxide is an exothermic reaction, a great deal of heat is generated to cause the temperature of the solution to increase. An excess of oxygen gas is discharged through the gas discharge tube 81 and the reaction product after being heated up is discharged through the third transfer tube 63. The gas discharge tube 81 is further connected to a gas supply tube 82, and provided with adjustable air door 83 and 84, which are controlled to allow the concentrated oxygen gas in the gas discharge tube 81 to mix with the air in the gas supply tube 82 so as to reduce the concentration of oxygen gas and assure safety during discharging operation.

[0022] The heat storage tank 4 is mainly configured to collect the heated reaction product. Preferably, the heat storage tank 4 is implemented by a closed container with the excellent thermal insulation effect. The third transfer tube 63 and the fourth transfer tube 64 are internally connected to the heat storage tank 4. The fourth transfer tube 64 is further connected to a hydraulic pump 641. The third transfer tube 63 is used to allow the heated reaction product in the reaction tank 3 to flow into the heat storage tank 4. The product solution in the heat storage tank 4 is further pressured and pumped by the hydraulic pump 641 to the heat exchange tubes 22 of the recycle heater 2 through the fourth transfer tube 64.

[0023] The liquid storage tank 5 is configured for collecting the solution treated by removing hydrogen peroxide and cooled down, which is the cooled product solution. The liquid storage tank 5 has an accommodating volume larger than the reaction tank 3 by 3 times, and a ratio of the apparent volume of the liquid storage tank 5 to the apparent volume of the reaction tank 3 is up to tens. The liquid storage tank 5 performs naturally cooling effect by using its surface area to contact the environment. Also, the design of larger volume may slow down the heating rate.

Moreover, the liquid storage tank 5 is connected to the fifth transfer tube 65, the liquid discharge tube 66, the six transfer tube 67 and the seventh transfer tube 78. The fifth transfer tube 65 is used to transfer the cooled solution in the heat exchange tube 22 to the liquid storage tank 5, and the liquid in the fifth transfer tube 65 is further cooled down by natural cooling. After a certain amount of liquid is collected, the collected liquid is discharged and recycled through the liquid discharge tube 66.

[0024] In addition, the product solution in the liquid storage tank 5 can serve as the heat medium for circulating in the heat exchange tubes 31 of the reaction tank 3. The sixth transfer tube 67 is connected to the inlet of the heat exchange tube 31, and the seventh transfer tube 68 is connected to the outlet of the heat exchange tubes 31. The sixth transfer tube 67 is provided with a hydraulic pump 671, which suitably supplies the product solution to the heat exchange tubes 31. Since heat exchange tubes 31 is primarily configured for temperate cooling, instead of strong cooling, it is allowed to maintain the temperature of the product solution in the reaction tank 3 around 70-90°C. Therefore, the product solution is not continuously circulated. The volume of the storage tank 5 is considerably large such that natural cooling is enough to prevent the solution in storage tank 5 from overheating and adversely affecting the cooling effect.

[0025] Next, the actual operation of the present invention will be described in detail. As shown in FIG. 3, the sulfuric acid- hydrogen peroxide solution to be treated is fed in the recycle heater 2 through the first transfer tube 61. At this time, the temperature of solution in the first transfer tube 61 is around 25 °C. Some thermal reaction product previously treated exists in the heat exchange tubes 22 of the tank body 21. The sulfuric acid- hydrogen peroxide solution flowing through the heating channel 212 continuously performs heat transfer and thermal convection. When the

solution flows into the reaction tank 3 through the second transfer tube 62, its temperature can be up to 60 °C. When the sulfuric acid- hydrogen peroxide solution in the reaction tank 3 is reacted with the reacting agent supplied from the reacting agent supply tube 71, the temperature of the solution in the reaction tank 3 is possibly heated up to 70-90°C because the decomposition of hydrogen peroxide is a strong exothermic reaction. The gas discharge tube 81 is used to exhaust oxygen gas generated. The primary remaining in the product solution is sulfuric acid solution, and its temperature is possibly up to 90 °C. The product solution is transferred to the heat storage tank 4 through the third transfer tube 63, and further transferred to the heat exchange tubes 22 through the fourth transfer tube 64. Then, the product solution continuously performs heat exchange as flowing in the heat exchange tubes 22 provided in the tank body 21. Thus, the solution output from the fifth transfer tube 65 is lowered to 30 °C, and further collected by the liquid storage tank 5 with natural cooling by contacting the environment. Moreover, the collected solution in the liquid storage tank 5 can serve as the cooling medium transferred to the heat exchange tubes 31 of the reaction tank 3 so as to prevent the temperature of the reaction tank 3 from overheating. The solution is further transferred back to the liquid storage tank 5, wherein the temperature is about 40 °C. In principle, through the specific design of controlling the reaction rate and the liquid storage tank 5 with a larger volume, the solution in the liquid storage tank 5 can be maintained at normal temperature of about 20-30 °C. Assume the recycling treatment is continuously performed and the liquid storage tank 5 is not cooled down as fast as desired, a set of electrical fans are possibly provided outside the liquid storage tank 5 to enhance the cooling effect.

[0026] From the above mention, one primary feature of the present invention is described a below.

[0027] 1. The heat source used to supply the recycle heater for the recycling sulfuric acid- hydrogen peroxide solution apparatus is the reaction heat generated due to the decomposition of hydrogen peroxide in the reaction tank so as to effectively utilize valuable energy.

[0028] 2. The reaction product is used to serve as the heat medium, and if the heat exchange tubes provided in the recycle heater happen to overflow, the damage is greatly reduced because the primary component of the reaction product is sulfuric acid and is mixed with the sulfuric acid- hydrogen peroxide solution in the recycle heater.

[0029] 3. The reaction product after cooling down through the heat exchange tubes is effectively stored so as to increase safety of the operation.

[0030] 4. The reaction product is collected by the liquid storage tank and further serves as the cooling medium such that energy saving is improved and the risk of leakage from the piping is prevented.

[0031] 5. The adjustable air door works with the gas discharge tube and the gas supply tube to discharge concentrated oxygen gas and reduce its concentration, thereby improving safety of discharging operation.

[0032] Although the present invention has been described with reference to the preferred embodiments, it will be understood that the invention is not limited to the details described thereof. Various substitutions and modifications have been suggested in the foregoing description, and others will occur to those of ordinary skill in the art. Therefore, all such substitutions and modifications are intended to be embraced within the scope of the invention as defined in the appended claims.

WHAT IS CLAIMED IS:

1. An apparatus for recycling sulfuric acid- hydrogen peroxide solution, comprising:

a recycle heater having a closed tank body and at least one set of heat exchange tubes provided inside of the recycle heater, the closed tank body connected to a first transfer tube for receiving the sulfuric acid- hydrogen peroxide solution, the solution in the first transfer tube preheated through the heat exchange tube and further flowing into a second transfer tube for discharging;

a reaction tank connected to the second transfer tube, at least one reacting agent supply tube, a gas discharge tube and a third transfer tube, the solution flowing into the reaction tank through the second transfer tube and reacting with an reacting agent from the reacting agent supply tube, a reaction product generated and heated after reaction in the reaction tank configured to be discharged through the third transfer tube;

a heat storage tank connected to the third transfer tube, a fourth transfer tube and a hydraulic pump, the reaction product flowing into the heat storage tank from the third transfer tube, the reaction product in the heat storage tank being pumped by the hydraulic pump to the heat exchange tube of the recycle heater; and

a liquid storage tank connected to a fifth transfer tube and a discharge tube, the fifth transfer tube connected to an outlet of the heat exchange tube for performing heat exchange to cool down the reaction product flowing into the storage tank, the cooled down reaction product being collected and then discharged through the discharge tube, wherein the reaction product in the liquid storage tank is not continuously but intermittently supplied to the storage tank.
2. The apparatus as claimed in claim 1, wherein the reaction tank comprises at least one set of heat exchange tubes internally configured, the storage tank is connected to a sixth transfer tube and a seventh transfer tube, the sixth transfer

tube is connected to an inlet of the heat exchange tube of the reaction tank, and the seventh transfer tube is connected to an outlet of the heat exchange tube of the reaction tank.

3. The apparatus as claimed in claim 1 or 2, wherein the tank body of the recycle heater comprises a plurality of partition plates internally configured for forming a plurality of separate regions, the separate regions are intercommunicated and form an extended heating channel to prolong a flowing path, and the heat exchange tube is provided in the extended heating channel.
4. The apparatus as claimed in claim 1 or 2, wherein the reaction tank has a shape of long closed column, and a ratio of gas to liquid in the reaction tank is larger than 1.5.