

SPECIFICATION

DEVICE FOR MAGNETICALLY AGGLOMERATING AND TREATING IMPURITIES IN LIQUIDS

Technical Field

This invention relates to a device for magnetically agglomerating and treating impurities in liquids so as to magnetically agglomerate and treat the impurities such as magnetic suspensions and non-magnetic suspensions in the liquids, thereby to magnetically adsorb them on magnets, for example, relates to a device for removing from processing liquids, impurities of magnetic suspensions such as cuttings and metal powders, and non-magnetic suspensions such as carbon and soil matters, which are contained in oily or aqueous processing liquids used for electrical discharge machining by an electrical discharge machine or for cutting work or grinding work to cast articles by machine tools.

Prior Art

Hitherto, fine impurities such as suspensions (colloidal substances) contained in liquids have been removed by a filter using a filter paper or filter cloth or by a pre-coat filter coated with a filtration auxiliary. These fine impurities such as suspensions are, however, immediately adhered to the filter and accumulated thereon to increase a flow resistance of the filter, for which reason removal of the impurities by the filters are often made impossible within a short time.

Therefore, there were disadvantages that removal process of fine impurities such as suspensions by means of a filter or a pre-coat filter has to be discontinued to exchange the filter paper or filter cloth, or to pre-coat the filter with the filter auxiliary every times.

According to circumstances, fine impurities such as suspensions may be removed by using a screen or a strainer. In this case, however, clogging with the fine impurities appears soon to increase the flow resistance, thereby making removal process of the impurities impossible in a short time, for which reason it is necessary to discontinue the removal



process of the fine impurities for cleaning the screen or strainer every times.

As mentioned above, in the conventional impurity removing process, in order to remove the fine impurities such as suspensions in the liquids, it is necessary to discontinue the removal process frequently, for which reason there are disadvantages in not only inefficiency of the process but also complicated, time-consuming and inconvenient operations such as exchange of the filter paper or cloth, pre-coating with the filtration auxiliary and cleaning the screen or punching metals. Particularly, upon disassembling the filter (apparatus), many problems are raised not only in long term discontinuation of the impurity removing process but also in increasing initial and running costs of the impurity removing system.

In addition to the above-mentioned filtration apparatuses, magnets such as ferrite have also been used to magnetically adsorb and remove fine impurities such as suspensions in liquids. Since, however, magnets such as ferrite are used, which have a magnetic force of 1200 to 4000 gauss. The removable impurities in liquids by such the magnets would be only the magnetic suspensions such as iron or nickel, but non-magnetic suspensions such as carbon or oils are almost unremovable to reside in the treated liquids.

The residual non-magnetic suspensions such as carbon and oils in the treated liquids cause problems in pollution and corruption likely to generate malodor and off-flavor, thereby deterioration of the work environments.

If the liquids containing such the non-magnetic suspensions are discharged to sewage or rivers without proper treatments, then the problem with environmental pollution are caused, for which reason it is necessary to separately provide waste-liquid treating systems, thereby increasing plant and equipment investments.

For disposal as industrial waste in open-spaces near the factory, it is necessary to keep a vast disposal space due to a large amount of the waste. Relying upon disposal trader raises another problem with increase in the cost for disposal.

If a treating object is a used electrical discharge working liquid or a coolant liquid, then the magnetic suspensions and non-magnetic



suspensions are included as impurities, for which reason effective ingredients for the machining liquid or coolant liquid are also included therein. The removal of these impurities makes the liquid available again as an electrical discharge machining liquid or the coolant liquid. Notwithstanding, no re-cycle was made as resources.

The present inventor has conducted intensive researches on magnetic adsorption of fine impurities such as suspensions by using magnets in order to solve the above-mentioned problems with the prior art, and could develop a method and an apparatus for magnetically agglomerating and treating impurities in liquids to remove the impurities from the liquids as mentioned in Japanese Laid-open Patent Publication No. 6-71195.

Namely, in accordance with this developed impurity removing method, a liquid including impurities such as magnetic suspensions or non-magnetic suspensions is flowed onto a magnet having a magnetic force of not less than 4000 gauss (preferably not less than 12000 gauss) at a flow rate of 0.01 to 0.1m/sec, so that the impurity containing liquid is made into contact with the magnet for 0.1 to 180 minutes, (preferably 0.05 to 60 minutes), thereby causing a magnetic agglomeration of the non-magnetic suspensions in cooperation with the magnetic suspensions in the liquid as core particles, resulting in magnetic adsorption on the magnets for removed thereof.

For the impurity removing system, rotary plates are fixed to opposite ends of a rotary shaft provided in a magnetically agglomerating and treating tank, and a plurality of magnets having a magnetic force of not less than 4000 gauss (preferably not less than 12000 gauss) are attached at a predetermined interval onto entire regions of confronting sides of the two rotary plates. In this case, the plural magnets are so arranged as to make magnetic pole pairs, so that the plural magnets on the one rotary plate form magnetic pole orders of N, N, S, S, N, N, S, S, whilst the plural magnets on the other rotary plate form magnetic pole orders of S, S, N, N, S, S, N, N, thereby causing the magnetic agglomeration of the non-magnetic suspensions in cooperation with the magnetic suspensions as core particles to form a magnetic field for magnetic adsorption onto the magnets, whereby the magnetic agglomerates adsorbed on the surfaces of the magnets are peeled by scrapers which are provided adjacent to the



surfaces of the magnets fixed on the two rotary plates in order to remove the impurities in the liquids.

During the continuous investigation of the impurity removal technique in the liquids mentioned in Japanese Laid-open Patent Publication No. 6-71195, the following facts were found. If the magnetic force of the magnets, the flow rate of the liquid, the time of contact of the liquids with the magnets, and the magnetic pole arrangement of the magnets were set under the same conditions as mentioned above, then during the magnetic agglomerates of the impurities in the liquids, a part of the non-magnetic suspensions is not involved into the magnetic agglomerates and thus removed, whilst other part of the non-magnetic suspensions is not magnetically agglomerated nor involved into the magnetic agglomerates, thereby residing in the treating liquids, resulting in deterioration of the quality of the treating liquid.

Accordingly, it is an object of the present invention to provide a treating apparatus capable of magnetically agglomerating all the impurities such as magnetic suspensions and non-magnetic suspensions (colloids) included in liquids to completely remove the same from the liquids without discontinuation of the removal treatment of the impurities such as the magnetic suspensions and non-magnetic suspensions in the liquids.

It is another object of the present invention to provide a treating apparatus capable of reducing initial and running costs for impurity-removal process from a liquid without discontinuation of the removal process, and with nor exchange of filter papers or filter cloths nor cleaning strainers every times.

It is a further object of the present invention to remove impurities from waste liquors such as the used electrical discharge machining liquids and coolant liquids, which are hard to be treated and discharged and also which require costly disposal, and to recycle the electrical discharge machining liquids and coolant liquid as the treating liquids for effective use as resources.

It is a still further object of the present invention to separate impurities in the liquids and eliminate the liquid from the impurities for collections of the impurities, thereby to largely reduce the amount of the wastes, save the disposal space, curtail the disposal cost, and to prevent corruption of wastes and generation of odors for improvement of the work



environments.

Disclosure of the Invention

The apparatus for magnetically agglomerating and treating impurities in liquids according to the present invention is characterized in that rotary plates are fixed to opposite ends of a rotary shaft provided in a magnetically agglomerating and treating tank which is communicated with a stock solution inlet pipe and a treated liquid outlet pipe, and the confronting sides of the two rotary plates are attached with sides of a U-shaped yoke, and a plurality of magnets having a magnetic force of not less than 4000 gauss are provided at an interval on entire regions of confronting sides of the yoke so as to form a magnetic field defined by a distance of 3 to 200mm between the confronting faces of the magnets, and a magnetic adsorption means is provided for flowing, through the magnetic field at a flow rate of 0.01 to 0.1m/sec, a liquid containing impurities such as magnetic suspensions and non-magnetic suspensions, so as to make the impurity containing liquid into contact with the magnets for 0.05 to 60 minutes in order to release one of the paired electrons of the non-magnetic suspension in the liquid to produce unpaired electrons which are magnetically agglomerated together with the magnetic suspensions and adsorbed on the magnets, and a peeling means is provided for peeling the magnetic agglomerates adhered onto the surfaces of the magnets.

In the apparatus for magnetically agglomerating and treating impurities in liquids according to the invention, magnets having a magnetic force of not less than 12000 gauss are attached to rise an efficiency of removing the impurities.

Also in the apparatus for magnetically agglomerating and treating impurities in liquids according to the invention, the plural magnets attached at the interval on the entire surface of the side of the yoke attached to the side of one of the rotary plates and the plural magnets attached at the interval on the entire surface of the side of the yoke attached to the side of another of the rotary plates are so arranged to form magnetic pole pairs for forming a magnetic field having an interactively enhanced magnetically agglomerating and treating capacity thereby to further rise the efficiency of removing the impurities.

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Also in the apparatus for magnetically agglomerating and treating impurities in liquids according to the invention, a plurality of the magnets attached at an interval onto the entire surface of one side of the yoke attached to one of the rotary plates are arranged to have a magnetic pole order of N, N, S, S, N, N, S, S, whilst a plurality of the other magnets attached at an interval onto the entire surface of the other side of the yoke attached to the other rotary plate are arranged to have a magnetic pole order of S, S, N, N, S, S, N, N, so as to form the magnetic pole pairs, thereby forming a magnetic field having an interactively enhanced magnetically agglomerating and treating capacity for further rising the efficiency of removing the impurity.

Brief Descriptions Of The Drawings

Figure 1 is a view showing operational principles of the apparatus for magnetically agglomerating and treating impurities in liquids according to the present invention.

Figure 2 is a schematic cross-sectional side view of the main part of the apparatus for magnetically agglomerating and treating impurities in liquids according to an embodiment of the present invention.

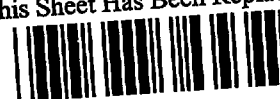
Figure 3 is a fragmentary schematic cross-sectional plain view of the apparatus for magnetically agglomerating and treating impurities in liquids shown in Figure 2.

A preferred embodiment of the present invention will be described in detail with reference to the accompanying drawings.

Best Modes For Carrying Out The Invention

As a preferred embodiment of the apparatus for magnetically agglomerating and treating impurities in liquids according to the invention, there will be described an apparatus for treating an oily waste electrical discharge machining liquor containing magnetic suspensions (steel powders) and non-magnetic suspensions (carbon powders) as impurities which are discharged from machine tools.

In Figures 2 and 3, the apparatus for magnetically agglomerating and treating impurities in liquids according to the invention has rotary plates 14a, 14b fixed to opposite ends of a rotary shaft 12 provided in a magnetically agglomerating and treating tank 10, and magnets 16 attached



on confronting sides of the two rotary plates 14a, 14b. In this case, the individual confronting sides of the two rotating plates 14a, 14b are attached to the individual sides of a U-shaped yoke 18. A plurality of disk-like magnets 16 having a magnetic force of not less than 4000 gaussses, preferably not less than 12000 gaussses are mounted at a predetermined interval on the sides of the U-shaped yoke 18. A non-magnetic adhesive plate 20 may, if necessary, be mounted on the magnets to sandwich the magnets 16 between each of the rotary plates 14a and 14b and the adhesive plate 20.

As the magnets 16 to be used in the present invention, there are useful permanent magnets such as a ferrite magnet having a magnetic force of not less than 4000 gaussses, and preferably rare earth magnets having a magnetic force of not less than 12000 gaussses. Particularly, samarium-cobalt based rare earth magnets or neodymium-iron-boron based rare earth magnets are preferable. Anisotropic neodymium-iron-boron based rare earth magnets having a magnetic force of not less than 2000 gaussses are optimum. Further, as the magnets 16, electromagnets may, in some cases, be suitable instead of use of the above-mentioned permanent magnets.

As to the shape of the magnet 16, polygonal shapes such as tetragon are available instead of the disk-shape. The proper size is in the range of 1 to 100 cm². The proper thickness is in the range of 0.5 to 3 cm. The proper number in use is 4 to 300 which are arranged at an interval of 0.1 cm to 5 cm.

A plurality of the magnets 16 are attached on the sides of the U-shaped yoke 18 so that, as illustrated in Figures 2 and 3, they are attached on the sides of the U-shaped yoke 18 provided onto the rotary plates 14a, 14b, so as to have a predetermined interval in the form of a merry-go-round fashion. Further, as illustrated in Figure 2, a distance between the confronting faces of the magnets 16 provided on the sides of the U-shaped yoke 18 is maintained in the range of 3 to 200 mm to produce a magnetic field 22 for magnetic agglomeration treatment of the impurities in the waste liquor.

For forming the magnetic field 22, the magnetic poles of the plural magnets 16 attached on the sides of the U-shaped yoke 18 may be in the form of (1) random arrangements of S pole and N pole or (2)



alternating arrangement of N pole and S pole such as in the order of N, S, N, S, however, (3) the magnetic pole order of N, N, S, S, N, N, S, S enables to increase the magnetically agglomerating and treating capability up to about two times higher than the arrangements of (1) or (2).

If the plural magnets 16 attached onto the yoke 18 provided on the one rotary plate 14a and the other magnets 16 attached onto the yoke 18 provided on the one rotary plate 14b are arranged to form such opposite magnetic poles that the magnetic pole of all the magnets 16 on one side is N pole whilst the magnetic pole of the other magnets 16 on the other side is S pole, thereby to increase the magnetically agglomerating and treating capability up to about three times higher than the arrangements of (1) or (2).

If the plural magnets 16 attached onto the yoke 18 provided on the one rotary plate 14a are arranged in the form of magnetic pole orders of N, N, S, S, N, N, S, S whilst the other magnets 16 attached onto the yoke 18 provided on the other rotary plate 14b are arranged in the form of the magnetic pole orders of S, S, N, N, S, S, N, N, so as to form alternating opposite magnetic poles, thereby to increase the magnetically agglomerating and treating capability up to about six times higher than the arrangements of (1) or (2).

In the invention, the inlet of the magnetically agglomerating and treating tank 10 is connected to an inlet pipe 24 for introducing a waste electrical discharge machining liquor which is discharged from machine tools, and contains magnetic suspensions and non-magnetic suspensions. The outlet of the magnetically agglomerating and treating tank 10 is connected to an outlet pipe 26 for discharging a coolant liquor (treated liquid) from which impurities have been removed by the magnetically agglomerating and treating processes. A scraper 28 is also provided adjacent to the rotary adhesive plate 20 to scrape magnetic agglomerates 30 adhered to the adhesive plate 20 from the plate, and a discharge tank 32 is arranged adjacent to the scraper 28 to discharge the magnetic agglomerates 30 scraped off by the scraper 28.

A sprocket 34 of the rotary shaft 12, to which the rotary plates 14a, 14b are fixed, is connected to a motor 38 via a chain 36. By rotating the two rotating plates 14a, 14b, the plural magnets 16 mounted thereon are also rotated. The two rotary plates 14a, 14b are preferably rotated at a



rate of 0.1 to 50 turns per minute.

The flow rate of the waste liquor containing impurities to be magnetically agglomerated and treated is 0.01 to 0.1m/sec. If the flow rate is less than 0.01m/sec, the efficiency is too low as practical, even no trouble with respect to the magnetic agglomeration process. If the flow rate is beyond 0.1m/sec, the flow rate of the waste liquor is too high to effect the magnetic agglomeration process.

When the magnetic agglomeration process is carried out by using the magnets 16 having a magnetic force of 4000 gaussses, a contact time between the impurity-containing waste liquor and the magnets 16 is set in the range of 0.1 to 180 minutes. If the contact time is less than 0.1 minute, then a predetermined magnetic agglomeration treatment effect cannot be expected. If the contact time is beyond 180 minutes, then there is no longer merit.

When the magnetic agglomeration process is carried out by using the magnets 16 having a magnetic force of 12000 gaussses, then a contact time between the impurity-containing waste liquor and the magnets 16 is set in the range of 0.05 to 60 minutes. If the contact time is less than 0.05 minute, then a predetermined magnetic agglomeration treatment effect cannot be expected. If the contact time beyond 60 minutes, then there is no longer merit.

The magnets 16 and 16 having magnetic forces of 4000 gaussses or 12000 gaussses respectively are disposed on the confronting sides of the U-shaped yoke 18 in the form of opposite poles as shown in FIGS. 2 and 3, and also a distance L between the confronting faces of the magnets 16 and 16 is set in the range of from 3 to 300 mm as shown in FIG. 1. The magnetic flux density H was measured at the center point P of the distance L, and the results shown in Table 1 were obtained.

Table 1

distance between magnets (L)	magnetic flux density of magnet (H)	
	magnet with 4000 gaussses	magnet with 12000 gaussses
3 mm	3750.5 gaussses	11251.4 gaussses
6 mm	3503.9 gaussses	10511.6 gaussses
12 mm	3029.8 gaussses	9089.5 gaussses
25 mm	2212.2 gaussses	6633.6 gaussses



50 mm	1171.6 gauss	3514.8 gauss
100 mm	422.0 gauss	1266.0 gauss
200 mm	119.6 gauss	358.8 gauss
300 mm	53.0 gauss	158.0 gauss

As described above, if the distance L between the confronting faces of the magnets 16 and 16 is set in the range of 3 to 200mm, then the magnetic flux density H is not less than 100 gauss. If the distance L is not less than 200mm, then the magnetic flux density H is not higher than 100 gauss. For example, if the distance L is set to 300mm, the magnetic flux density H is 53.0 gauss. It is difficult to obtain a sufficient magnetic flux for magnetically agglomerating almost all of the non-magnetic suspensions in the waste liquor to be described below. If the distance is less than 3mm, the distance between the magnets 16 and 16 is too narrow to form a space for providing the scraper 28 to remove magnetically adsorbed suspensions between the magnets 16 and 16, even no problem with regard to the magnetic flux density.

As having been well known, magnetic materials such as iron, nickel and cobalt adhere to the magnets 16. One of the reasons why is that these magnetic materials have unpaired electrons in view of atomic structure. By contrast, non-magnetic materials have no unpaired electrons in view of atomic structure and thus do not adhere to the magnets 16.

The followings have been found. The distance L between the confronting faces of the magnets 16 and 16 is set in the range of 3 to 200mm, for flowing the non-magnetic suspension containing waste liquor through a magnetic field 22 having a magnetic flux density H of not less than 100 gauss preferably not less than 3000 gauss, whereby one of the paired electrons of the non-magnetic suspensions in the waste liquor is released to produce unpaired electrons or magnetic material which could be magnetically agglomerated.

Subsequently, operations and running of the system for magnetic agglomeration process according to the present invention will be described below. The impurity containing waste liquor containing magnetic suspensions and non-magnetic suspensions having been discharged from machine tools is discharged from the electrical discharge machine to flow the same through the inlet pipe 24 into the magnetically agglomerating



and treating tank 10 at the predetermined flow rate as described above, and concurrently, a motor 38 provided on a mount 40 of the magnetically agglomerating and processing system is driven to rotate the sprocket 34 of the rotary shaft 12 via the chain so as to rotate the rotary plates 14a, 14b with the plural magnets 16 in the clockwise direction.

The electrical discharge machining waste liquor introduced into the magnetically agglomerating and processing tank 10 is then flowed through the plural confronting magnets 16 attached on the two rotary plates 14a, 14b in the anti-clockwise direction. In the magnetic field 22 having a high magnetic flux density of not less than 100 gaussses preferably not less than 3000 gaussses, the non-magnetic suspensions in the waste liquor are converted to magnetic materials having unpaired electrons, resulting in magnetic agglomeration together with the magnetic suspensions and magnetic adsorption onto the surfaces of the adhesive plates 20 on the magnets 16 as magnetic agglomerates 30.

The treated liquor from which the magnetic suspensions and the non-magnetic suspensions have been removed as the magnetic agglomerates 30 is then recycled via the outlet pipe 26 of the magnetically agglomerating and treating tank 10 as an electrical discharge machining liquid. The magnetic agglomerates 30 magnetically adsorbed onto the surfaces of the adhesive plates 20 on the magnets 16 are rotated in the clockwise direction together with the two rotary plates 14a, 14b so as to be scraped by the scraper 28 from the surfaces of the adhesive plates 20, before the scraped magnetic agglomerates 30 are then transferred along the scraper 28 and discharged into a waste storage tank 32.

Example

As illustrated in FIGS. 2 and 3, preparations were made for two sets of magnetically agglomerating and treating tanks (500cc) according to the present invention, wherein magnets (50×40×15cm) of rare earth elements having magnetic forces of 4000 gaussses and 12000 gaussses respectively were mounted at a distance between the confronting faces of 6mm and 12mm respectively on the opposite sides of the U-shaped yoke 18 fixed to the two rotary plates 14a, 14b in the form of opposite poles. Also, as a comparative example, preparation was made for a single set of a magnetically agglomerating and treating tank (500cc), wherein the



distance between the confronting surfaces of the magnets was set at 300 mm.

Into each of the magnetically agglomerating and treating tanks, there is introduced 300cc of an electrical discharge machining aqueous waste liquor containing 6667 ppm of impurities of steel powders (3.3%) as a magnetic suspension and carbon powders (96.7%) as a non-magnetic suspension, so that the magnetic agglomeration process was carried out under the following conditions (see Table 2). The results of measuring the concentration of the residual suspensions are shown in Table 2.

Table 2

<u>process conditions</u>	<u>Apparatus A</u> <u>according to</u> <u>the invention</u>	<u>Apparatus B</u> <u>according to</u> <u>the invention</u>	<u>Apparatus</u> <u>comparative</u> <u>example</u>
magnetic force of magnet(gauss)	12000	4000	120000
distance between magnet faces (mm)	6	12	300
flow rate of waste liquor (ml/sec)	0.01	0.01	0.01
contact time of waste liquor (min.)	180	60	180
magnetic flux density of magnet (gauss)	10500	3030	158
<u>amount of impurities in treated liquor</u>			
magnetic suspension (ppm)	3	28	2650
non-magnetic suspension (ppm)	130	1987	6356

As being apparent from the above-mentioned example, according to the apparatus of the present invention, it is possible to magnetically agglomerate the non-magnetic suspensions deteriorating the quality of the liquid together with the magnetic suspensions and to remove the same from the liquid without discontinuation of the removal process.

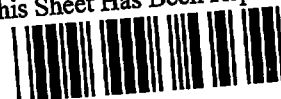
Further, in accordance with the apparatus of the present



invention, it is also possible to reduce the initial and running costs of removal process to impurities such as suspensions from the liquid since it is unnecessary to exchange filter papers or filter cloths or to wash a strainer or the like every time.

Furthermore, in accordance with the apparatus of the present invention, it is advantageous that the impurities requiring costly disposal, for example, the used electrical discharge machining waste liquors and the used coolant waste liquors are removable to allow recycling the electrical discharge machining liquors and the coolant liquors. This is just suitable for the current requirements for recycling resources.

Since, in accordance with the apparatus of the present invention, the impurities such as suspensions in liquids are separable as a scale, (1) it is possible to largely reduce the amount of the wastes, and (2) it is possible to curtail the disposal cost without taking disposal space, and (3) it is possible to keep good working environments without corruption of the wastes and generation of malodors.



Claims

1. An apparatus for magnetically agglomerating and treating impurities in liquids which is characterized in that rotary plates are fixed to opposite ends of a rotary shaft provided in a magnetically agglomerating and treating tank which is communicated with a stock solution inlet pipe and a treated liquid outlet pipe, and the confronting sides of the two rotary plates are attached with sides of a U-shaped yoke, and a plurality of magnets having a magnetic force of not less than 4000 gauss are provided at an interval on entire regions of confronting sides of the yoke so as to form a magnetic field defined by a distance of 3 to 200mm between the confronting faces of the magnets, and a magnetic adsorption means is provided for flowing, through the magnetic field at a flow rate of 0.01 to 0.1m/sec, a liquid containing impurities such as magnetic suspensions and non-magnetic suspensions, so as to make the impurity containing liquid into contact with the magnets for 0.05 to 60 minutes in order to release one of the paired electrons of the non-magnetic suspension in the liquid to produce unpaired electrons which are magnetically agglomerated together with the magnetic suspensions and adsorbed on the magnets, and a peeling means is provided for peeling the magnetic agglomerates adhered onto the surfaces of the magnets.
2. The device for magnetically agglomerating and treating impurities in liquids according to claim 1, wherein magnets having a magnetic force of not less than 12000 gauss are attached to rise an efficiency of removing the impurities.
3. The device for magnetically agglomerating and treating impurities in liquids according to claim 1 or 2, wherein the plural magnets attached at the interval on the entire surface of the side of the yoke attached to the side of one of the rotary plates and the plural magnets attached at the interval on the entire surface of the side of the yoke attached to the side of another of the rotary plates are so arranged to form magnetic pole pairs for forming a magnetic field having an interactively enhanced magnetically agglomerating and treating capacity thereby to



further rise the efficiency of removing the impurities.

4. The device for magnetically agglomerating and treating impurities in liquids according to claim 3, wherein a plurality of the magnets attached at an interval onto the entire surface of one side of the yoke attached to one of the rotary plates are arranged to have a magnetic pole order of N, N, S, S, N, N, S, S, whilst a plurality of the other magnets attached at an interval onto the entire surface of the other side of the yoke attached to the other rotary plate are arranged to have a magnetic pole order of S, S, N, N, S, S, N, N, so as to form the magnetic pole pairs, thereby forming a magnetic field having an interactively enhanced magnetically agglomerating and treating capacity for further rising the efficiency of removing the impurity.

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Page 15

