**Title:** MAGNETIC WATER CONDITIONER APPARATUS

**Abstract**

Much feed water for boilers and hot water heaters contains minerals which result in boiler scale and deposits in heaters and water pipes. Treatment of such water by causing it to flow through a magnetic field has been effective to greater or lesser degree in preventing boiler scale and deposits in heaters and water pipes. An effective magnetic field for such water treatment has been determined as one wherein the lines of flux are parallel to the water flow. This is provided by apparatus with an axial hole (21) utilizing a permanent magnet or an electromagnet (20). The apparatus has a non-magnetic water conduit (13) fitting tightly within axial hole (21) of the magnet (20). The magnet (20) is axially magnetized and the magnetic structure is arranged to maximize the magnetic flux (22-25) in axial hole (21). A principal use of the apparatus is the magnetic treatment of feed water for boilers and hot water heaters. This is in reducing scale and deposits from minerals in such water.
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Description

Magnetic Water Conditioner Apparatus

Technical Field

My invention relates to the magnetic treatment of mineralized water and has particular reference to an improved geometry of magnets that more effectively treats or conditions water to increase its apparent softness.

Feed water for boilers and hot water heaters has been magnetically treated for decades to reduce boiler scale, heater deposits and water pipe deposits. Feed water has been subjected to various configurations of magnetic fields, both steady fields and alternating fields. This magnetic treatment has been effective to greater or lesser degrees in preventing boiler scale and heater deposits and deposits in water pipes. While the chemistry and electronics of magnetic field effects on dissolved and suspended minerals has not been precisely determined, the magnetic treatment causes the mineral content to remain in suspension rather than deposit out as scale. In the case of boilers the accumulated suspended minerals are continuously or periodically flushed out by flushing the boiler water. This magnetic treatment is generally less expensive than ion-exchange treatment of feed water or additive chemical treatment of feed water.

Background Art

Municipal water systems are generally the source of water for boilers. No boiler can operate efficiently or dependably if its heat transfer surfaces are allowed to foul with scale. Yet, most municipal water systems provide water that contains scale-producing minerals. The major dissolved
materials in water are silica, iron, calcium, magnesium, and sodium compounds. Metallic constituents occur in various combinations with bicarbonate, carbonate, sulphate, and chloride radicals. Scaling occurs when calcium or magnesium compounds in the water precipitate and adhere to the internal surfaces of the boiler. These scaling compounds become less soluble as temperatures increase, causing them to separate from solution. The result is overheating of boiler tubes, followed by failure and equipment damage.

This same scaling occurs in the heater and pipes of hot water heater systems. Unless these scaling deposits can be reduced, they result in heater failure and reduced carrying capacity of scaled-up pipes.

Many different types of water treatments are used to reduce the scaling, including sodium zeolite softening, hot lime zeolite softening, split stream softening, demineralizing, and distillation. All of these treatments require extensive capital outlays for various treatment tanks and controls, as well as a continuous supply of chemicals, or in the case of evaporation, a continuous use of fuel.

While the magnetic treatment of water to reduce its apparent hardness has been known for decades, it has not been commercially used for boilers and heaters, because it has been ineffective. I have determined that a properly designed magnetic treatment conditioner or apparatus can be made that is effective for water-softening. The tremendous capital outlays for the usual softening processes may be avoided, as well as the continuous expenditures for chemicals and fuels.

Disclosure of Invention
I have ascertained that the most effective magnetic treatment occurs when the lines of flux are parallel to the
water flow.

I have determined that the most effective magnetic field for water treatment is a steady or permanent field as contrasted to a fluctuating field or as contrasted to an alternating magnetic field. I have further determined that the most concentrated field is the most effective. I have devised a magnetic field that is extremely concentrated for the available magnetic material. I have devised a hollow cylindrical permanent magnet that is axially polarized and has a water pipe of non-magnetic material passing axially through the cylinder. Alternatively, I have constructed a direct-current coil of hollow cylinder shape which has a non-magnetic conduit passing axially through it. I have determined further that the conduit must fit these magnetic structures as tightly as possible and that the conduit wall should have minimum thickness for the water pressures being used.

I have discovered that if the water exits from the south pole of the magnetic field it gives the maximum "softening" effect to the water; that is, the maximum suspension of mineral in the water and the minimum of deposits. Conversely, if the water exits from the north pole of the magnetic field the water is "hardened" and tends to deposit out more readily and to react with soap. This may be useful as a defoaming treatment for water. I suspect that this south pole exiting to soften is not universally true and may be limited to a particular geographical area. Perhaps in the southern hemisphere the polarity to soften water will be reversed. Orientation of my magnetic field with the earth's magnetic field does not appear to be important.

I have found that my magnetic treatment improves potability of "softened" drinking water as compared to water
treated with chemicals or ion-exchange to render it softer.

Brief Description of Drawings

Various objects, advantages, and features of the invention will be apparent in the following description and claims, considered together with the accompanying drawings forming an integral part of this specification and in which:

Fig. 1 is a three-dimensional view of piping passing through a permanent magnet in vertical section.

Fig. 2 is a three-dimensional view of the magnet and pipe of Fig. 1.

Fig. 3 is a schematic diagram of a direct-current coil passing around a pipe to create a magnetic field in the pipe.

Fig. 4 is a three-dimensional view of the commercial embodiment of the direct-current coil of Fig. 3.

Fig. 5 is a schematic sectional view through the magnets of Figs. 1 and 4 showing the concentration of lines of flux in the center of the conduit through the magnets.

Fig. 6 is a schematic end view of the magnet of Fig. 5 showing the manner in which the lines of flux concentrate in the conduit portion of the magnet.

Best Mode for Carrying Out the Invention

Referring to Figs. 1 and 2, pipes 11 and 12 are connected by a pipe 13 provided particularly in accordance with the invention. The pipe 13 may be secured to the pipe sections 11 and 12 by any suitable means such as couplings 14.

Pipes 11, 12, and 13 form part of a continuous conduit for raw water leading to a boiler or to a water-heating system. Disposed about the pipe 13 prior to its coupling to pipe lengths 11 and 12 are a plurality of ring-shaped permanent magnets 16, 17, 18, and 19, which are all axially magnetized, that is, along an axis parallel to the pipe 13. While any
suitable permanent magnet material may be used, I presently prefer, for purposes of manufacturing economy, ceramic magnets.

The pipe 13 is made of non-magnetic material and may be metal or plastic or glass or other nonferrous materials, and I presently prefer glass or plastic to eliminate any electrical effects on the water due to dissimilar metals being present. The interior of the conduit 13 should be as smooth as commercially feasible to avoid any turbulence in the flow, and in this connection the couplings 14 should be of such construction as to minimize any turbulence in the flow. Each ring magnet 16, 17, 18, and 19 is oriented with the adjoining magnet or magnets so that there is a continuous magnetic field from north on the left to south on the right as viewed in Fig. 1. This stack of ring magnets develops a magnetic field, which is shown in schematic form in Figs. 5 and 6, wherein a schematic magnet 20 of hollow-cylinder construction has an axial hole 21 through it, and lines of flux 22, 23, 24, and 25 emanate from the ends of the magnet 20 to pass through the hole 21. There it will be noted that the lines of flux 22 emanating from the farthest radial area pass toward the center of the bore 21 and that the next lines 23 emanating from the ends closer to the bore take a path to one side of the center of the bore 21; that the lines 24 that are closer to the bore take a path fairly close to the bore edge and that the lines 25 emanating close to the bore follow the interior of the bore 21.

This distribution of lines of flux is shown schematically in Fig. 6 wherein the outermost lines 22 pass toward the center of the bore 21 and the other lines 23, 24, and 25 that are closest to the bore 21 have their lines of flux away from the center of the bore. The result of this
inwardly projecting series of flux lines 22 through 25 is to give a very intense field in the bore 21 so that a maximum intensity of magnetic field will be exerted upon water flowing through a conduit placed in the bore 21 of the magnet 20 of Figs. 5 and 6.

Referring now to Fig. 2, this illustrates in full outline the magnet of Fig. 1 shown in section. Shown in Fig. 2 is a dimension L for the length of the magnet which is designated by the numeral 15. There is also shown a dimension D for the diameter of the magnet 15, and there is shown a dimension C for the outside diameter of the conduit 13 passing through the magnet 15. Depending upon the material from which the magnet is made, the geometry is so chosen as to maximize the lines of flux thru the axial hole compared to the flux lines thru the air on the outside of the magnet. Also the environment of the magnet must be selected not to interfere with this maximization of axial flux.

I have found that for ferrite magnets the magnet length L must be greater than one-fourth of the diameter D for the best water-conditioning. I have also found that if the length of the ferrite magnet is more than about two times the diameter, then there is very little added flux strength because of this added length. The diameter C of the pipe conduit passing through the magnet, which is the same as the inside diameter of the hole through the magnet, of course, has a bearing on these length and diameter dimensions, and these length and diameter ratios apply generally when the conduit dimension C is one-half of D or smaller.

I have also used direct-current coils of hollow-cylinder shape and find that these function effectively to create the desired magnetic field in a pipe passing through
the hollow of the cylinder.

Referring to Figs. 3 and 4, a conduit 30 has a coil of wire 31 wrapped tightly about the conduit 30, and this is energized by a battery 32 passing direct current through the coil. The coil generates a steady magnetic field which is identical in all respects to the magnetic field of the permanent magnets and generates lines of flux as illustrated in Figs. 5 and 6. Shown in Fig. 4 is the commercial version of the schematic Fig. 3, wherein the conduit 30 has a multilayer coil 33 wrapped around it and this coil 33 will generate a north pole at the left end as indicated by the letter N and a south pole at the right end as indicated by the letter S. The coil is energized by any suitable source of direct current, and there is shown schematically a direct-current generator 34 driven by a AC-motor 36 or any other suitable motor, which in turn delivers current to the coil 33 through conductors 37 and 38.

I find that it is important that the conduit through the magnets be straight and even in cross section so that there is no turbulence as the water passes through the magnet. The flow of water, therefore, is aligned with the lines of flux as shown most graphically in Fig. 5 as the water passes through the magnet 20. If the raw water carries in it floating particles, these should, of course, be screened out, and the conduit 13 of Fig. 1 could, for example, be made of transparent glass or other transparent nonmetallic material so that any iron or iron oxide particles that collect on the interior of the conduit 13 in the region of the magnet will be clearly visible and can thereupon be cleaned.

For creating apparent softening of the raw water, the water should flow through the magnets from north to south. If it is desired to increase the apparent hardness of the
water, then the water should flow through the magnets from south to north. When the flow is from north to south, then the apparent softening also seems to loosen some boiler scale already formed.

The term "apparent softening" is used to denote the effect on the dissolved material. My apparatus does not remove any dissolved material, and a chemical analysis on a dry basis of water treated by my apparatus would be the same as the untreated input water. However, there is a chemical or electronic change in these scale-producing materials so that they do not deposit out as readily as the materials in raw water. The same analysis applies to my water treatment to increase the "apparent hardness", except in this case scaling is increased and the usefulness is for defoaming and other uses of hard water.

I have found that the beneficial effects conferred by magnetic water treatment with my apparatus occur independently of the rate of water flow through the magnet. I have described my permanent magnet with respect to ferrite materials, but it will be apparent to those skilled in the art that any other material may be used and any other configuration other than rings of permanent magnets may be used. For example, ceramic magnets are made in cylindrical shells or two semicylindrical shells that are cemented together for completion of the cylinder. These shells or cylinders are magnetized in an axial direction. If a long solenoid is used, then almost all of the lines of flux will be contained within the axial bore.

I have experimented with ceramic magnets, primarily because they are cheaper by several times than those of alnico, and rare earth cobalts and mixtures with other metals. These ferrite magnets have a smaller flux density than other more expensive magnet materials, but suitable
geometrics of ferrite result in very satisfactory flux densities. I have found that the ring-shaped loudspeaker magnets, which are axially magnetized, are readily and inexpensively available and, by stacking, any desired length of cylindrical magnet may be quickly formed that is also axially magnetized. If alnico magnets are used the length must be greater compared to diameter than with ceramic magnets.

I have described my invention with respect to presently preferred embodiments thereof as required by patent statutes. I do not limit myself to these embodiments, however, as they are illustrative only of my invention. I include within the scope of the following claims all variations, modifications, and improvements that fall within the true spirit and scope of my invention.
Claims

1. Apparatus for the magnetic treatment of mineralized flowing water, comprising:
   a) a magnet of cylindrical shape that is axially magnetized and which has an axial hole of uniform cross section;
   b) and a water conduit disposed in the axial hole of the magnet and in a close fit with the magnet hole and formed of non-magnetic material, said magnet having a geometry and environment to maximize the magnetic flux in the axial hole.

2. Apparatus as set forth in claim 1 wherein the magnet is a permanent magnet.

3. Apparatus as set forth in claim 1 wherein the magnet is a direct-current coil.

4. Apparatus as set forth in claim 1 wherein the conduit within the confines of the magnet is straight and smooth to minimize water turbulence.

5. Apparatus as set forth in claim 1 wherein the conduit is formed of nonmetallic material.

6. Apparatus for the magnetic treatment of mineralized flowing water comprising:
   a) a magnet of hollow cylinder shape that is axially magnetized with a continuous magnetic field having a north pole at one end and a south pole at the other end;
b) a water conduit axially disposed in the magnet with a close fit and formed of non-magnetic material;
c) and means for flowing mineralized water through the conduit in a selected direction.

7. Apparatus as set forth in claim 6 wherein the means for flowing causes water in the conduit to exit the magnet at the south pole of the magnet to reduce the apparent hardness of the water.

8. Apparatus as set forth in claim 6 wherein the means for flowing causes water in the conduit to exit the magnet at the north pole of the magnet to increase the apparent hardness of the water.

9. Apparatus as set forth in claim 6 wherein the magnet is a permanent magnet of ceramic ferrite material and has a length more than one-fourth of the diameter and less than twice the diameter.
INTERNATIONAL SEARCH REPORT

International Application No PCT/US81/00304

I. CLASSIFICATION OF SUBJECT MATTER (If several classification symbols apply, indicate all)”

According to International Patent Classification (IPC) or to both National Classification and IPC

Int. Cl 3B01D 35/06
U.S. Cl. 210/222

II. FIELDS SEARCHED

Minimum Documentation Searched *

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Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched *

III. DOCUMENTS CONSIDERED TO BE RELEVANT **

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<td>A</td>
<td>N The Magnetic Effect, Published 1975, by Davis &amp; Rawls, Jr. Exposition Press. Hicksville, N.Y. See p. 115-p.120.</td>
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“X” document of particular relevance

IV. CERTIFICATION

Date of the Actual Completion of the International Search **

15 April 1981

Date of Mailing of this International Search Report **

05 MAY 1981

International Searching Authority **

ISA/US

Signature of Authorized Officer **

Theodore A. Cranger

Form PCT/ISA/210 (second sheet) (October 1977)