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MAGNETIC TREATMENT DOES WORK

Roland K. Carpenter

251 W. Canal Drive
Palm Harbor, Florida 33563

Physische

ABSTRACT

The procedures for making a magnetic analysis of fluid ingredients is discussed. In addition; applications to installation factors, such as velocity, turbulence and interference factors are also discussed. Some factors that cause magnetic treatment to have a low success rate is discussed.

INTRODUCTION

The problems caused by fluids flowing through pipes and other thermodynamic vessels has been the subject of study by the chemical or reagent methods. Today however, there are both chemical and non-chemical methods available to provide solutions to the problems created when fluids flow through pipes and other heat transfer vessels. The use of magnetic fields to cause piping and vessels to operate at higher efficiencies as compared to no treatment has been the subject of much critisism during the last thirty years, primarily in the United States. The use of magnetic fields to treat fluids in other countries has also been subjected to scientific evaluation and analysis leading to one of the methods of treatment. The reason for evaluating magnetic treatment of fluids is that when it is a viable method; the economic benefits as compared to chemicals is superior in many instances.

MAGNETIC PROPERTIES OF FLUIDS

All substances know to man have magnetic properties. One of the best known properties of substances is the factor "Magnetic Susceptibility". This property can be found in the Handbook of Chemistry and Physics under the table of magnetic susceptibility. Some substances are paramagnetics, ferromagnetic, and some are diamagnetic. Many of the common scaling substances are diamagnetic. The following definitions from the Handbook of Chemistry and Physics are appropriate at this time.

Susceptibility (magnetic) is measured by the ratio of the intensity of magnetization produced in a substance to the magnetizing force or intensity of field to which it is sujected. The susceptibility of a substance will be unity when unit intensity of magnetization is produced by a field of one gauss. Dimension, $-(e^{-1}l^{-2}l^{2}),(u)$.

Diamagnetic materials.-Are those within which an externally applied magnetic field is slightly reduced because of an alteration of the atomic electron orbits produced by the field. Diamagnetism is an atomic-scale consequence of the Lentz law of induction. The permeability of diamagnetic materials is slightly less than that of empty space.

Paramagnetic Materials: Those within which the magnetic induction is slighly greater than the applied magnetic field. Paramagnetism arises from the partial alignment of the permanent magnetic dipole moments of atoms or ions. The permeability is slightly greater than that of empty space, and the magnetic susceptibility is positive and small.

Ferromagnetic Materials: Those in which the magnetic moments of atoms or ions in a magnetic domain tend to be aligned parallel to one another in zero applied field, below a characteristic temperature called the Curie Point. Complete ordering is achieved only at the absolute zero of temperature. Within a magnetic domain, at absolute zero, the magnetization is equal to the sum of the magnetic moments of the atoms or ions per unit volume. Bulk matter, consisting of many small magnetic domains, has a net magnetization which depends upon the magnetic history of the specimen (hysteresis effect). The permeability depends on the magnetic field, and can reach values of the order of 10 times that of free space. Above the Curie Point, These materials become paramagnetic.

When one uses the table of magnetic susceptibility, we find that various scaling substances are diamagnetic. The first step is a chemical analysis of the fluid ingredients. Given the chemical names and the milligrams per liter (mg/L) or parts per million (ppm) of each of the each substance, they are located in the magnetic susceptibility table to determine the sign and susceptibility of the fluid ingredients.

WATER ANALYSIS

In analyzing the fluid to determine magnetic susceptibility as described above, a chemical anaylsis of the fluid is needed. If this is not available use the State Water Analysis Tables for the average mineral content of the local water supply.

Check each element or compound. For example, Calcium Carbonate ($CaCO3$) has a -.382 susceptibility. This can be controlled and deposits removed. Calcium Chloride ($CaCl2$). Calcium Sulfacte($CaCO4$), Lime ($Na2O$) and Sodium Chloride ($NaCl$) are all a greater negative number than the required minimum of a -.25. Free Silicon (Si) is a -.13. This is low and could be effectively controlled only when it's bonding agent falls above a -.25.

The total molecule is the determining factor in magnetic susceptibility. For example, Magnesium (Mg) in a pure form is a +.55, thus a pure Mg deposition could not be removed. Magnesium Chloride (the total molecule) is a -.58 and can be removed.

On the troublesome side would be such elements as Manganese (+9.9) and Ferrous Oxide (+20.6). The analysis should be checked for Iron (Fe) and Manganese (Mn). Generally, any combination formed with these two elements would present a problem. Only by removing their bonding agents could these two elements be moved.

Where Fe or Mn (or both) are present, the following formula has been used to determine control and removal. Maximum of one part per million (PPM) of Fe and Mn, to each 200 PPM of total dissolved solids (TDS).

Example:

T.D.S.	Fe	Mn
465 ppm	1.6 PPM	0.4 PPM

Fe + Mn = X (200)
1.6 + 0.4 = 2.0 PPM
2.0 X 200 = 400 PPM

400 PPM of TDS are required to offset

the 2.0 PPM of Fe and Mn. 400 PPM of TDS, thus a margin of protection and removal is possible.

OTHER FACTORS FOR INSTALLATION

Time Factor for Scale Removal. Under most circumstances results of the action of the Power Units will be noticeable within four weeks, and the entire system will be noticeable within several months. However, the time required will vary not only with rate of fluid flow, operating conditions and schedule of equipment, and type of equipment, but also the scale causing substances themselves. Some variation can be expected.

Rate of Fluid Flow. Velocity of the fluid flow should be a minimum of 15 ft. (½) per second, regardless of the inside diameter (ID) of the pipe. The greater the velocity of the fluid flow, the faster deposited scale will be removed. Marginal control of scale deposition has been experienced where velocity was less. An increased magnetic energy level (more Power Units) may be needed where velocity is low. Refer to Table I for required flow per pipe size.

For pipe velocities in variance, additional information concerning the integration of magnetic devices, installation options, and piping/vessel factors would be necessary.

Marginal control may be experienced where internal circulation of fluid is low or restricted, such as in low pressure firetube boilers. This may also occur on the upper tubes of a water tube hot water heater since the fluid circulation is somewhat restricted in this area.

Minimum velocities for boilers (firetube or water-tube) may be higher. Higher velocity are circulated into the boiler to achieve the necessary internal fluid agitation, and to assure an adequate energy level of polarization.

FACTORS AFFECTING PROPER INSTALLATION

1. External Magnetic Field. The magnetic field of an electric motor will knock down the energy level of the Power Units. This motor field is at right angles to the drive shaft and usually does not extend for beyond the ends of the motor case. Power Units should not be placed within 3 ft. of the motor case, and preferrably to one side of the end of the drive shaft. A minimum of 10 ft. clearance should be used on a large electric motor.

2. Temperature Ranges. Maximum temperature of the fluid should not exceed 300 degrees F.

3. Vibrations. A high speed impeller pump tends to mechanically depolarize the fluid and it's mineral content. The polarization created by the power units is not neutral in condition and an increase of molecular movement, due to the action of the impeller pump, tends to break down polarization. A pump turning 1750 RPM will cancel our some of the total induced polarization. This percentage of loss will increase as the RPM is increased. Therefore, an installation should be made on the output side of an impeller pump.

4. Masses of Metal. Large globe valves, pipe junctions and equipment walls will tend to rob the magnetic field created by the Power Units. These factors are usually critical inside 3 ft. Achieve at least 5 ft. clearance whenever possible.

5. Effects of BRASS Materials. A mass of brass material tends to depolarize the fluid. Such things as a large brass bodied globe valve or check valve can cause loss of polarization. Should there be succession of brass bodied valves (any type) within a relatively short linear distance; the loss of polarization could be excessive. Wherever possible, replace these valves with iron bodied valves. Equipment with brass seats or small fittings are not troublesome.

6. Fluid Saturation. The units will cause deposited scale to be resuspended into the fluid, assing to the solids already being held in suspension. Let it be known that these solids are not removed from the fluid by the action of the Units. Therefore, the solids must be removed from a system through the use of bleedoff or blow-down. Otherwise saturation will occur and efficiency is reduced.

7. Time Factor. Induced polarization has a limited life expectancy. This is based upon the diamagnetism of the fluid, the belocity of the fluid and time. The higher the total diamagnetic count the velocity, the longer polarization will continue at a maximum level. Under normal fluid and operating conditions, the life expectancy is far in excess of the time required to re-circulate the fluid through the Unit installation. At this point, the energy level would be reestablished. Polarized fluid will lose efficiency if allowed to remain static over a period of several hours. This occurs due to the lack of a continuous energy source being provided throuhg circulation of polarized fluid.

This explanation of the application of magnetic fields to diamagnetic substances for scale control and removal is, of necessity, an over simplification of a very complex subject. Since we are dealing with energy of the atom, the molecule, and crystalline forms, and with the action, counter-action and inter-action of these energies, many factors must be considered.

MAGNETIC DEVICE INSTALLATION FACTORS

Magnetic devices can be permanent magnet or elector-magnetic. They can also be in-line or fastened to the outside of the pipe.

Elector magnets can produce magnetic fields of greater intensity than permanent magnetic fields, however the permanent magnetic materials available today produce sufficiently intense fields to perform in industry. Also permanent magnetic devices require no external power and produce no stray magnetic fields because they employ a zero frequency field with no ripple.

The life of permanent magnet material is such today that, it will outlast even a superior design of an electro amgnetic device with little or no maintenance.

STABILITY AND STABILIZATION

Permanent magnets do not "run down". In this respect, they fundamentally differ the like. The magnetic field surrounding a magnet does not require energy to maintain it, therefore there is no theoratical reason for permanent magnet to continually lose strength. In actual practice, however, flux changes may occur as a result of several factors. Proper stabilization will eliminate or reduce these.

1. Metallurgical Changes. In the older permanent magnet materials, such as Cobalt-steel, some metallurgical changes take place as a function of time. If such a magnet is magnetized before these changes have stabilized, flux changes superimposed on those to be described in the next section will occur. (This effect can be reduced to a negligible factor by artificial aging.) In the newer materials, such as Alnico or Ceramic, metallurgical changes do not take place to any measurable degree at room temperature.

2. Time. A freshly magnetized permagnent magnet will lose a minor percentage of its flux, as a function of time. It has been shown that, if one plots flux loss linearly against time logarithmically, an essentially straight line results. Laboratory measurements on some materials are shown in Table II. All losses are based on measurements made starting at 0.1 hours after magnetizing.

This loss in flux can be essentially eliminated by a partial demagnetization of the freshly charged magnet in an amount of 7% to 15%. This is most conveniently accomplished by an ac coil The ac field should be in the same direction as was the magnetizing field. It should be reduced to zero gradually, either by withdrawing the magnet with power on or by reducing the ac voltage to zero with a variable auto transformer.

3. Temperature. Temperature effects fall into three catagories:

A. Metallurgical Changes may be caused by exposure to too high a temperature. Such flux changes are not recoverable by remagnetization. The approximate maximum temperatures which can be used without experiencing metallurgical changes range from 5500 for Alnico 5 to 1080C for the Ceramics. The effect of metallurgical changes, if present, can be avoided only by long-time exposure of the magnet to the temperature involved, prior to magnetizing.

B. Irreversible losses are defined as a partial demagnetization of the magnet, caused by exposure to high or low temperatures. Such losses are recoverable by remagnetization. Merely as examples, table III shows values measured on laboratory specimens, with percent flux losses measured at room temperature after exposure to indicated temperatures. Percentages shown in Table III are not additive for consecutive cycles above and below room temperatures. The ideal method of stablizing magnets against temperature induced irreversible losses, is installing them in the magnetic circuit for which they are intended, magnetize, then subject the assemblies to several temperature cycles which they are expected to experience in service. However, this is a time consuming procedure which is normally impractical in production. Alternatively, the magnetized assembly may be partially demagnetized by means of an ac field, following the procedure described in the last paragraph of "Time". A "rule of thumb" to follow is determining by experiment that temperature cycling will cause X% flux loss, then the ac field should be such as to cause a 2% loss, to properly stabilize against temperature.

C. Reversible losses are changes in flux which are reversible with temperature. For example, if any of the Ceramic grades are heated 1C above room temperature, they will lose 0.19% of room temperature flux. However, this will be spontaneously regained upon the magnet's cooling back to room temperature. The Alnico and E.S.D. materials have reversible variation by stablization treatments. However, use of proper temperature compensation material in parallel with the magnet will reduce the effect to a negligible factor. Amoung others, household watt-hour meter magnets and speedometer magnets are temperature compensated in this matter.

4. Reluctance Changes. If a magnet is magnetized in a magnetic circuit and subsequently subjected to permeance change (such as changes in air gap dimensions or open-circuiting of the magnet) it may be found that a partial demagnetization of the magnet has occurred. Whether or not such a loss is experienced depends upon material properties and upon the extent of permeance change. Stablization against such change is accomplished either by several times subjecting the magnet to such reluctance changes after magnetizing, or by use of the previously described ac field. Contacting the magnet with ferro-magnetic material (screw drivers, pliers, and the like), at points other than the poles, can cause an appreciable drop influx at the poles. It is difficult to stablize against this type of abuse. The remedy is to avoid such practices.

5. Adverse Fields. If a magnet or magnet assembly is subjected to an adverse magnetic field, a partial demagnetization may result, depending upon material properties and upon the intensity and irection of the adverse field. Proper stablization consists of subjecting the magnet or assembly to a dc or ac demagnetizing field of the same magnetitude as it is expected to encouter in service. The direction should be the same as that of the anticipated demagnetizing field.

6. Shock, Strees, and Vibration. The effects of shock, stess, and vibration below destructive limits on most permanent magnet materials are so minor (a few tenths of a percent) that little consideration need be given to them. Proper stablization as described in any of the preceeding sections will also stablize against shock and vibration.

As one can see from the previous data supplied by the magnetic manufacturers in their permanent magnetic guidelines the use of Ceramic magnetic material has revolutionized the magnetic design process. The magnetic circuits that were taught in my college days are not applicable for Ceramics as their characteristics at open circuit and closed circuit are similar. Estimates of life expectancy of a ceramic unit in a normal operating state have been made. Only estimates are available because no one has outlined a Ceramic unit as of this date. Some engineers in this country and other countries estimate the loss of magnetic strength at one hundreth of one percent per year (1/1000 of 1% lyr.) or in 100 years the loss could be one percent (1%).

Now that we have discussed the merits of permanent vs electro magnetic de-prior to magnetizing.

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TABLE I - FLOW CHART

Pipe Size In Inches ID	Cubic Inches per .5 ft. (Volume)	GPS	GPM	GPH
½"	1.18	.005	0.3	18.0
3/4"	2.64	.01	0.6	36.0
1"	4.21	.02	1.2	72.0
1¼"	7.38	.03	1.8	108.0
1½"	10.62	.05	3.0	180.0
2"	18.85	.08	4.8	288.0
2½"	29.58	.13	7.8	468.0
3"	42.42	.20	12.0	720.0
3½"	57.66	.25	15.0	900.0
4"	75.42	.33	20.0	1200.0
5"	117.84	.50	30.0	1800.0
6"	169.62	.83	50.0	3000.0
8"	302.22	1.30	78.0	4680.0
10"	471.24	2.50	150.0	9000.0
12"	678.60	2.95	177.0	10620.0

TABLE II

Magnetic Material Loss vs Time

Material	Loss per Log Cycle	Loss at 100,000 Hrs (11.4 Years)
Ceramic	Essentially Zero	Essentially Zero
Alnico 3 (near Max. Energy)	0.4%	2.4%
Alnico 3 (near Coercive)	0.6%	3.6%
Alnico 5 (near residual)	0.01%	0.06%
Alnico 5 (near Max. Energy)	0.15%	0.9%
Alnico 5 (near coercive)	0.4%	2.4%
Alnico 8 -- no data (expected to be less than Alnico 5)		

TABLE III

Magnetic Material Loss vs Temperature

Material	350 C	200 C	-20 C	-60 C
Ceramic 5 B_d/H_d 2 (above max. energy)	0	0	0	0
Ceramic 6 B_d/H_d 1.1 (near max. energy)	0	0	0	0
Alnico 5 (near max. energy)	1.3%	0.8%	1%	2.5%
Alnico 6 (near max. energy)	0.6%	0.4%	0.5%	1.3%
Alnico 8 (near max. energy)	0.3%	0.2%	0.1%	0.1%
Alnico 8 (near coercive)	3.5%	2.0%	0.5%	0.8%

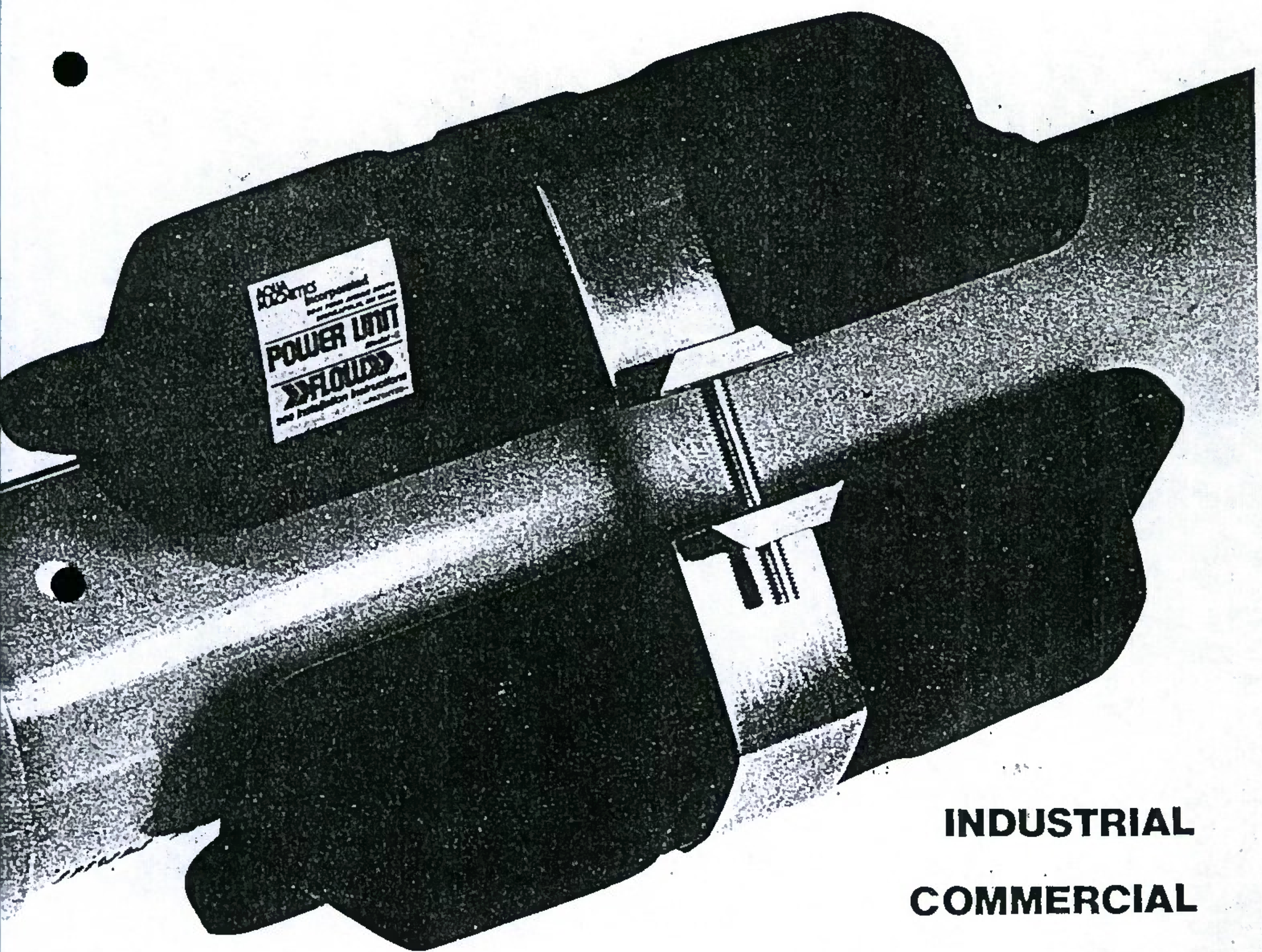
TABLE IV

Comparison of In-Line vs Outside Pipe Installation

In-line	Outside Pipe
Fluid actually touches the product and comes in intimate contact with magnetic material.	Fluid does not touch product as product fastens to the outside of pipe.
Paramagnetic substances adhere to the interior surfaces requiring cleaning on a periodic basis.	Paramagnetic material does not adhere for proper installations because magnetic material on outside of pipe- little or no maintenance required.
Installation of product always requires splicing into pipe.	Installation does not always require splicing into pipe. Installation can be made in most cases without disturbing fluid flow.
Installation is more costly.	Installation relatively simple
Requires operating within specified maximum velocities for good results.	Requires operating above a minimum only velocity for good results.
Achieves a more intense magnetic field in the fluid.	Using a lower intensity field in the fluid to prevent acculmulation of paramagnetic scale.

TREATING FLUIDS MAGNETICALLY™

Scale · Paraffin · Salt · Carbon Control



INDUSTRIAL

COMMERCIAL

RESIDENTIAL

AQUA MAGNETICS Incorporated

REFINERIES

PETRO-CHEMICAL PLANTS

The Aqua Magnetics Power Unit

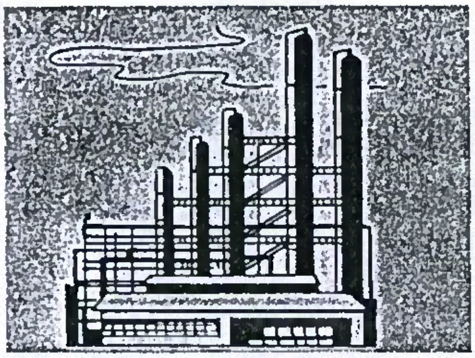
The development of the Aqua Magnetics Power Units for control of scale and paraffin in fluid systems is the result of many years of research and field testing.

The operation of the Aqua Magnetics Power Unit is based on the fact that most of the scale causing solids in fluid systems are diamagnetic. Being diamagnetic their nature is such that they will be repelled by a strong magnetic field. Typical of such substances are Calcium Carbonate, Calcium Sulphate, Barium Sulphate, Sodium Chloride, Magnesium Sulphate, Paraffin, Oil, Waxes and Greases.

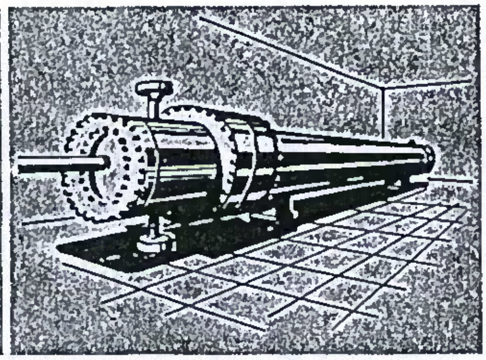
When subjected to a strong magnetic field these substances become polarized, they take on the polarity of the magnetic field itself. This is called "induced polarization". This polarization is such that the magnetic field of the magnet induces a similar polarity in the diamagnetic substances. Thus, since likes repel, the diamagnetic molecule is repelled by the magnetic field and by other polarized diamagnetic molecules. This is characteristic of all diamagnetic substances, and is due to the fact that the diamagnetic molecule has no permanent magnetic moment of its own.

Since most scale causing particles are diamagnetic, in order to cause these substances to move away from the inner surface of pipes and fluid systems, it is necessary to provide the proper source and quantity of magnetic energy. This has been accomplished with the Aqua Magnetics Power Unit in such a manner that the resulting low cost energy output of these units make them unique in their field.

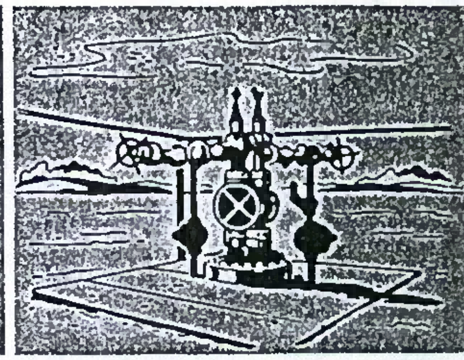
PROCESS SYSTEMS

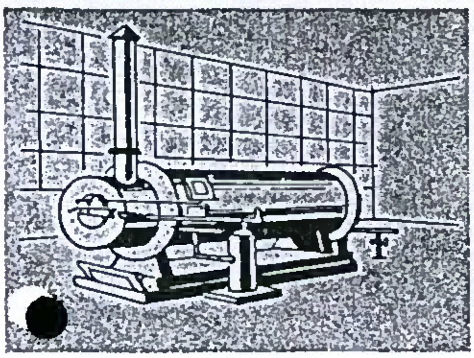


HEAT EXCHANGERS

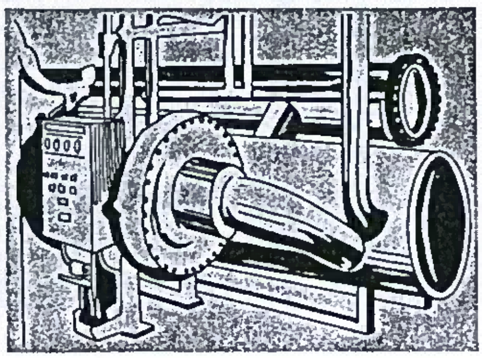


FLOWLINES

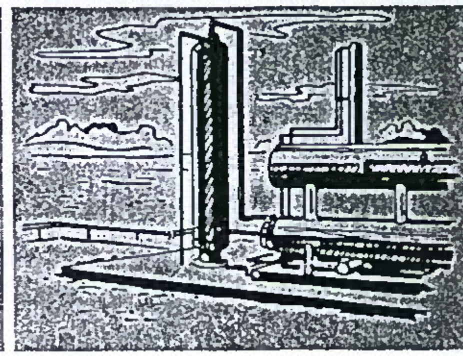




HEATERS



AIR CONDITIONERS



TREATERS

The Use Of Aqua Magnetics Power Units

Aqua Magnetics Power Units, when properly installed, will move existing diamagnetic scale in fluid systems and will prevent the build up of such scale.

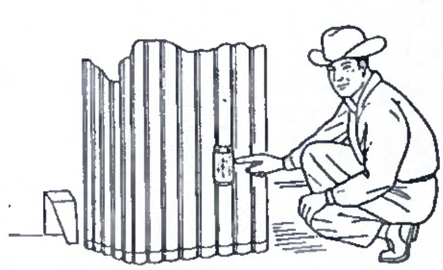
When installed in accordance with installation instructions these Power Units will normally take care of 500 to 1500 feet of fluid systems. This is true not only for steel pipe, but also copper, aluminum, plastic, etc. The actual length of system which can be protected will depend to a great extent on the rate of fluid flow, since the greater the rate of flow the more efficient the unit.

Under most circumstances results of the action of the Aqua Magnetics Power Units will be noticeable within two weeks, and the entire system will clean up within several months. However, the time required will vary not only with the rate of fluid flow, but also with the compostion of the scale causing substances themselves. Some variation can be expected.

The information shown herein applies not only to scale itself, but also to paraffin and salt in oil field flow lines, and to salt problems in salt water disposal wells.

The Aqua Magnetics Power Unit requires no electrical connection or costly installation.

(Oil Flow Line)



(Oil Down Hole)

Applications

- Paper processing
- Injection molding
- Chemical plants
- Concrete plants
- Iron ore plants
- Solar collectors
- Humidifiers
- Coffee makers
- LP vehicles
- Buses
- Water wells and water supply systems
- Air conditioning and evaporative coolers
- Dishwashers
- Laundry
- Water heaters
- Refineries
- Faucets and shower heads
- Swimming pools.
- Irrigation and sprinkler systems
- Oil fired boilers
- Trucks
- Boilers
- Heat exchangers and condensers
- Cooling towers
- Steam Jennys
- Distillers
- Car washes
- Salt water lines
- Oil lines (paraffin-salt)
- Automobiles
- Oil wells
- Petro-Chemical plants
- Etc.

Aqua Magnetics Power Unit Family

Model A Plus Residential unit fits plastic, copper and galvanized iron pipe sizes up to 1-1/8" O.D. Recommended for 14 grains per gallon or less of hardness.

Model C-1 Small commercial unit fits plastic, copper, and stainless steel pipe sizes up to 1-1/8" O.D. Recommended for most applications.

Model C/R-1 Commercial/Residential unit fits plastic, copper, and stainless steel pipe sizes up to 1-1/8" O.D. Recommended for most applications.

Model C-2 Commercial/industrial unit fits plastic, copper and stainless steel pipe sizes up to 2-1/4" O.D. Applications: swimming pools, small industrial.

Model C-8 Industrial unit fits plastic, copper, galvanized iron, and stainless steel pipe sizes over 2" O.D. These units are clustered around the pipe using the following formula: Use one unit for each inch of pipe diameter, plus one. Example: 3" pipe, 4 units; 4" pipe, 5 units. Application: control of paraffin, hard water minerals (calcium and magnesium salts), and salt water (NaC1).

Model H/I Residential/commercial unit fits on the small copper or plastic pipe up to 3/8" O.D. leading to the humidifier, toilet tank, ice machine, coffee makers, distillers, swamp coolers, and drinking fountains.

Model H/I Plus Residential/commercial unit fits on small copper or plastic pipe up to 3/4" O.D. leading to the humidifier, toilet tank, ice machine, coffee makers, distillers, swamp coolers, and drinking fountains.

Model E Economy unit for small pipes such as several on the 1/2" pipes in an apartment or as a booster.

Petro Mag Auto/truck/internal combustion engines fits fuel lines on most all vehicles. Recommended for non-magnetic fuel lines.

MC-1 A paraffin, salt (NaC1), and hard water scale treating system for "in well" oil treatment. (Recommended for installation on stainless steel or fiberglass non-magnetic pipe for best results)

Custom Made Units For specific installations that cannot be handled by our standard units (upon request).

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