Japan Food Research Laboratories
Authorized by the Japanese Government
52-1 Motoyoyogi-cho, Shibuya-ku, Tokyo 151-0062

No.107080279 - 003 1/1
August 8, 2007

CERTIFICATE OF ANALYSIS

Requested by: CATALINA, INC.
23-11 Nishibori 3-chome, Sakura-ku, Saitama-shi, Saitama 338-0832, Japan

Sample: Water treated with Vulcan (using flat cable)

Received: August 1, 2007

This is to certify that the following result(s) have been obtained according to our analysis on the above-mentioned sample(s) submitted by the client.

RESULT(S)

Lab.No.	Description	Oxidation-reduction potential (25 ℃ vs. NHE)	Oxidation-reduction potential (25 ℃ vs. Ag/AgCl)	pH
1	Storage test: 0 day (Start)	770 mV[1), 2)]	560 mV[2), 3)]	7.0 (18 ℃)[2)]
2	Storage test: After 1 day	750 mV[1), 4)]	540 mV[3), 4)]	6.9 (23 ℃)[4)]

Storage conditions: at room temperature.
Sampling time and date: 10:00, July 31, 2007
Sampling place: Catalina Urawa Center, 23-11 Nishibori 3-chome, Sakura-ku, Saitama-shi, Saitama, Japan
Sampling person: a staff member of CATALINA, INC.

1) Conversion value obtained by using the standard hydrogen electrode as comparison electrode. Calculated from oxidation-reduction potential (25 ℃ vs. Ag/AgCl).
2) Measurement date: August 1, 2007.
3) Oxidation-reduction potential obtained by using 3.33mol/L KCl-Ag/AgCl as comparison electrode. Apparatus: F-24 (HORIBA, Ltd.)
4) Measurement date: August 2, 2007.

Method: Oxidation-reduction potential (25 ℃ vs. NHE): Platinum electrode method
Oxidation-reduction potential (25 ℃ vs. Ag/AgCl): Platinum electrode method
pH: Glass electrode method

JAPAN FOOD RESEARCH LABORATORIES

T. Arai

Takeko Arai
Principal Investigator
Japan Food Research Laboratories

Japan Food Research Laboratories
Authorized by the Japanese Government
52-1 Motoyoyogi-cho, Shibuya-ku, Tokyo 151-0062

No.107073554 - 003 1/1
July 27, 2007

CERTIFICATE OF ANALYSIS

Requested by: CATALINA, INC.
23-11 Nishibori 3-chome, Sakura-ku, Saitama-shi, Saitama 338-0832, Japan

Sample: Water treated with Vulcan

Received: July 20, 2007

This is to certify that the following result(s) have been obtained according to our analysis on the above-mentioned sample(s) submitted by the client.

RESULT(S)

Lab.No.	Description	Oxidation-reduction potential (25 ℃ vs. NHE)	Oxidation-reduction potential (25 ℃ vs. Ag/AgCl)	pH
1	Storage test: 0 day (Start)	820 mV[1), 2)]	610 mV[2), 3)]	7.1 (17 ℃)[2)]
2	Storage test: After 3 days	830 mV[1), 4)]	620 mV[3), 4)]	7.0 (24 ℃)[4)]

Storage conditions: at room temperature.
Sampling time and date: 10:00, July 19, 2007
Sampling place: Catalina Urawa Center, 23-11 Nishibori 3-chome, Sakura-ku, Saitama-shi, Saitama, Japan
Sampling person: a staff member of CATALINA, INC.

1) Conversion value obtained by using the standard hydrogen electrode as comparison electrode. Calculated from oxidation-reduction potential (25 ℃ vs. Ag/AgCl).
2) Measurement date: July 20, 2007.
3) Oxidation-reduction potential obtained by using 3.33mol/L KCl-Ag/AgCl as comparison electrode. Apparatus: F-24 (HORIBA, Ltd.)
4) Measurement date: July 23, 2007.

Method: Oxidation-reduction potential (25 ℃ vs. NHE): Platinum electrode method
Oxidation-reduction potential (25 ℃ vs. Ag/AgCl): Platinum electrode method
pH: Glass electrode method

JAPAN FOOD RESEARCH LABORATORIES

T. Arai
Takeko Arai
Principal Investigator
Japan Food Research Laboratories

No.107080279 - 004 1/1
August 8, 2007

CERTIFICATE OF ANALYSIS

Requested by: CATALINA, INC.
23-11 Nishibori 3-chome, Sakura-ku, Saitama-shi, Saitama 338-0832, Japan

Sample: Water treated with out Vulcan

Received: August 1, 2007

This is to certify that the following result(s) have been obtained according to our analysis on the above-mentioned sample(s) submitted by the client.

RESULT(S)

Lab.No.	Description	Oxidation-reduction potential (25 ℃ vs. NHE)	Oxidation-reduction potential (25 ℃ vs. Ag/AgCl)	pH
1	Storage test: 0 day (Start)	870 mV 1), 2)	660 mV 2), 3)	7.0 (18 ℃) 2)
2	Storage test: After 1 day	890 mV 1), 4)	690 mV 3), 4)	6.9 (23 ℃) 4)

Storage conditions: at room temperature.
Sampling time and date: 10:00, July 31, 2007
Sampling place: Catalina Urawa Center, 23-11 Nishibori 3-chome, Sakura-ku, Saitama-shi, Saitama, Japan
Sampling person: a staff member of CATALINA, INC.

1) Conversion value obtained by using the standard hydrogen electrode as comparison electrode. Calculated from oxidation-reduction potential (25 ℃ vs. Ag/AgCl).
2) Measurement date: August 1, 2007.
3) Oxidation-reduction potential obtained by using 3.33mol/L KCl-Ag/AgCl as comparison electrode. Apparatus: F-24 (HORIBA, Ltd.)
4) Measurement date: August 2, 2007.

Method: Oxidation-reduction potential (25 ℃ vs. NHE): Platinum electrode method
Oxidation-reduction potential (25 ℃ vs. Ag/AgCl): Platinum electrode method
pH: Glass electrode method

JAPAN FOOD RESEARCH LABORATORIES

T. Arai

Takeko Arai
Principal Investigator
Japan Food Research Laboratories

No.107073554 - 004 1/1
July 27, 2007

CERTIFICATE OF ANALYSIS

Requested by: CATALINA, INC.
23-11 Nishibori 3-chome, Sakura-ku, Saitama-shi, Saitama 338-0832, Japan

Sample: Water treated with out Vulcan

Received: July 20, 2007

This is to certify that the following result(s) have been obtained according to our analysis on the above-mentioned sample(s) submitted by the client.

RESULT(S)

Lab.No.	Description	Oxidation-reduction potential (25 ℃ vs. NHE)	Oxidation-reduction potential (25 ℃ vs. Ag/AgCl)	pH
1	Storage test: 0 day (Start)	890 mV[1), 2)]	680 mV[2), 3)]	7.1 (17 ℃)[2)]
2	Storage test: After 3 days	850 mV[1), 4)]	650 mV[3), 4)]	7.1 (24 ℃)[4)]

Storage conditions: at room temperature.
Sampling time and date: 10:00, July 19, 2007
Sampling place: Catalina Urawa Center, 23-11 Nishibori 3-chome, Sakura-ku, Saitama-shi, Saitama, Japan
Sampling person: a staff member of CATALINA, INC.

1) Conversion value obtained by using the standard hydrogen electrode as comparison electrode. Calculated from oxidation-reduction potential (25 ℃ vs. Ag/AgCl).
2) Measurement date: July 20, 2007.
3) Oxidation-reduction potential obtained by using 3.33mol/L KCl-Ag/AgCl as comparison electrode. Apparatus: F-24 (HORIBA, Ltd.)
4) Measurement date: July 23, 2007.

Method: Oxidation-reduction potential (25 ℃ vs. NHE): Platinum electrode method
Oxidation-reduction potential (25 ℃ vs. Ag/AgCl): Platinum electrode method
pH: Glass electrode method

JAPAN FOOD RESEARCH LABORATORIES

T. Arai

Takeko Arai
Principal Investigator
Japan Food Research Laboratories

Japan Food Research Laboratories
Authorized by the Japanese Government
52-1 Motoyoyogi-cho, Shibuya-ku, Tokyo 151-0062

No.109014130 - 004 1/1
February 03, 2009

CERTIFICATE OF ANALYSIS

Requested by: CATALINA, INC.
23-11 Nishibori 3-chome, Sakura-ku, Saitama-shi, Saitama 338-0832, Japan

Sample: see the below description.

Received: January 28, 2009

This is to certify that the following result(s) have been obtained according to our analysis on the above-mentioned sample(s) submitted by the client.

RESULT(S)

Lab.No.	Description	Oxidation-reduction potential (25 ℃ vs. NHE)[3]	Oxidation-reduction potential (25 ℃ vs. Ag/AgCl)[4]	pH
1	Water treated without Vulcan Storage test: 0 hour (Start)[1]	930 mV	720 mV	7.1 (19 ℃)
2	Water treated without Vulcan Storage test: after 24 hours[2]	920 mV	720 mV	7.2 (21 ℃)
3	Water treated with Vulcan /36V (using flat cable) Storage test: 0 hour (Start)[1]	550 mV	350 mV	7.5 (19 ℃)
4	Water treated with Vulcan /36V (using flat cable) Storage test: after 24 hours[2]	570 mV	370 mV	7.6 (21 ℃)

Storage condition: room temperature

Sampling time and date of the sample: 10:30, January 28, 2009
Sampling place of the sample: URAWA CENTRAL OFFICE, CATALINA, INC.
Sampling person of the sample: a staff member of CATALINA, INC.

1) Measurement date: January 28, 2009
2) Measurement date: January 29, 2009
3) Conversion value obtained by using the standard hydrogen electrode as comparison electrode. Calculated from oxidation-reduction potential (25 ℃ vs. Ag/AgCl).
4) Oxidation-reduction potential obtained by using 3.33mol/L KCl-Ag/AgCl as comparison electrode. Apparatus: F-24 [HORIBA, Ltd.].

JAPAN FOOD RESEARCH LABORATORIES

Noriko Imaizumi
Principal Investigator
Japan Food Research Laboratories

Japan Food Research Laboratories
Authorized by the Japanese Government
52-1 Motoyoyogi-cho, Shibuya-ku, Tokyo 151-0062

No.109014130 - 003 1/1
February 03, 2009

CERTIFICATE OF ANALYSIS

Requested by: CATALINA, INC.
23-11 Nishibori 3-chome, Sakura-ku, Saitama-shi, Saitama 338-0832, Japan

Sample: see the below description.

Received: January 28, 2009

This is to certify that the following result(s) have been obtained according to our analysis on the above-mentioned sample(s) submitted by the client.

RESULT(S)

Lab.No.	Description	Electric conductivity (25 ℃)
1	Water treated without Vulcan Storage test: 0 hour (Start)[1]	25 mS/m
2	Water treated without Vulcan Storage test: after 24 hours[2]	25 mS/m
3	Water treated with Vulcan /36V (using flat cable) Storage test: 0 hour (Start)[1]	27 mS/m
4	Water treated with Vulcan /36V (using flat cable) Storage test: after 24 hours[2]	27 mS/m

Storage condition: room temperature

Sampling time and date of the sample: 10:30, January 28, 2009
Sampling place of the sample: URAWA CENTRAL OFFICE, CATALINA, INC.
Sampling person of the sample: a staff member of CATALINA, INC.

1) Measurement date: January 28, 2009
2) Measurement date: January 29, 2009

JAPAN FOOD RESEARCH LABORATORIES

Noriko Imaizumi
Principal Investigator
Japan Food Research Laboratories

Japan Food Research Laboratories
Authorized by the Japanese Government
52-1 Motoyoyogi-cho, Shibuya-ku, Tokyo 151-0062

No.109021159 - 004 1/1
February 05, 2009

CERTIFICATE OF ANALYSIS

Requested by: CATALINA, INC.
23-11 Nishibori 3-chome, Sakura-ku, Saitama-shi, Saitama 338-0832, Japan

Sample: see the below description.

Received: January 29, 2009

This is to certify that the following result(s) have been obtained according to our analysis on the above-mentioned sample(s) submitted by the client.

RESULT(S)

Lab.No.	Description	Oxidation-reduction potential (25 ℃ vs. NHE)[3]	Oxidation-reduction potential (25 ℃ vs. Ag/AgCl)[4]	pH
1	Water treated without Vulcan Storage test: 0 hour (Start)[1]	960 mV	750 mV	7.1 (18 ℃)
2	Water treated without Vulcan Storage test: after 24 hours[2]	940 mV	730 mV	7.1 (21 ℃)
3	Water treated with Vulcan /48V (using flat cable) Storage test: 0 hour (Start)[1]	570 mV	360 mV	7.5 (17 ℃)
4	Water treated with Vulcan /48V (using flat cable) Storage test: after 24 hours[2]	560 mV	350 mV	7.4 (21 ℃)

Storage condition: room temperature

Sampling time and date of the sample: 10:30, January 29, 2009
Sampling place of the sample: URAWA CENTRAL OFFICE, CATALINA, INC.
Sampling person of the sample: a staff member of CATALINA, INC.

1) Measurement date: January 29, 2009
2) Measurement date: January 30, 2009
3) Conversion value obtained by using the standard hydrogen electrode as comparison electrode. Calculated from oxidation-reduction potential (25 ℃ vs. Ag/AgCl)
4) Oxidation-reduction potential obtained by using 3.33mol/L KCl-Ag/AgCl as comparison electrode. Apparatus: F-24 [HORIBA, Ltd.].

JAPAN FOOD RESEARCH LABORATORIES

Noriko Imaizumi
Principal Investigator
Japan Food Research Laboratories

Japan Food Research Laboratories
Authorized by the Japanese Government
52-1 Motoyoyogi-cho, Shibuya-ku, Tokyo 151-0062

No.109021159 - 003 1/1
February 05, 2009

CERTIFICATE OF ANALYSIS

Requested by: CATALINA, INC.
23-11 Nishibori 3-chome, Sakura-ku, Saitama-shi, Saitama 338-0832, Japan

Sample: see the below description.

Received: January 29, 2009

This is to certify that the following result(s) have been obtained according to our analysis on the above-mentioned sample(s) submitted by the client.

RESULT(S)

Lab.No.	Description	Electric conductivity (25 ℃)
1	Water treated without Vulcan Storage test: 0 hour (Start)[1)]	25 mS/m
2	Water treated without Vulcan Storage test: after 24 hours[2)]	25 mS/m
3	Water treated with Vulcan /48V (using flat cable) Storage test: 0 hour (Start)[1)]	27 mS/m
4	Water treated with Vulcan /48V (using flat cable) Storage test: after 24 hours[2)]	27 mS/m

Storage condition: room temperature

Sampling time and date of the sample: 10:30, January 29, 2009
Sampling place of the sample: URAWA CENTRAL OFFICE, CATALINA, INC.
Sampling person of the sample: a staff member of CATALINA, INC.

1) Measurement date: January 29, 2009
2) Measurement date: January 30, 2009

JAPAN FOOD RESEARCH LABORATORIES

Noriko Imaizumi
Principal Investigator
Japan Food Research Laboratories

Physical water treatment – this is how it works!

Dr.-Ing. Hartmut Jünke

1. Introduction

Physical water treatment has been used and discussed for the last two decades. During this time, it has proven its effectiveness that on the other hand is still questioned and denied. Why is that? If we follow the discussions, we can find various reasons that however are not going to be discussed here. It rather seems necessary to examine the physical foundations that can explain how this process works in order to protect it against the accusation of fraud and to recognize the black sheep that caused these accusations. The following is attempt to answer these questions.

Apart from my own positive experience that clearly demonstrates the effectiveness, at least of the device installed on my pipes (1), there is information coming from renowned institutions such as e.g. the Physiological Institute of the Ludwig-Maximilian-University in Munich confirming the same. In this institution, the replacement of laser tubes because of furring caused by the coolant that had been necessary before, could be avoided by the installation of a physical water treatment device. Hotels and construction companies as well as a lot of conversations with private users confirm that the device works, although the non-functioning is also often lamented. As in most cases the private users do not know the manufacturer of the device (a lot of times it was said that the product was a cheap one bought in a superstore), we can only draw the conclusion that there are some devices that do not meet the physical conditions necessary to be effective. But we cannot draw the conclusion that the treatment principle itself is useless and does not work. Unfortunately, this impression is often given in serious publications, a lot of times without giving any scientific proof and without explaining how the process works or why it does not work.

Before explaining how physical water treatment works, first we have to clarify why water pipes fur up. Let us therefore look at lime as the target of physical water treatment.

2. The lime

Chemically speaking, lime is calcium carbonate ($CaCO_3$). This compound is not soluble in water. Question: How can it be dissolved in water then? Answer: When water that contains carbon dioxide passes through chalky soil, lime is released and is present in the water as calcium hydrogen carbonate $Ca(HCO_3)_2$. This is possible as carbon dioxide CO_2 together with water H_2O forms carbon acid H_2CO_3. As everybody knows from everyday household life, acidic cleaning agents are needed to remove lime deposits. It seems like splitting hairs to underline the difference between dissolved and undissolved lime, but this is exactly where the flaw in the argumentation concerning the action of these devices lies.

Thereupon the following question is raised: why does lime separate anyway? The dissolved amount of calcium hydrogen carbonate in the drinking water never reaches the saturation limit that if exceeded leads to the separation of the dissolved substance as a crystal.

If we look at the spots in pipes where lime deposits, the answer is already given. Primary spots for lime deposits are pipe bends, branches, ending points (faucets) and especially the warm water areas. In the latter case we have to differentiate: warm water containers are generally speaking free from deposits; heating bars, heater spirals or heat exchangers, surfaces that transmit the heat to the water, are always affected.

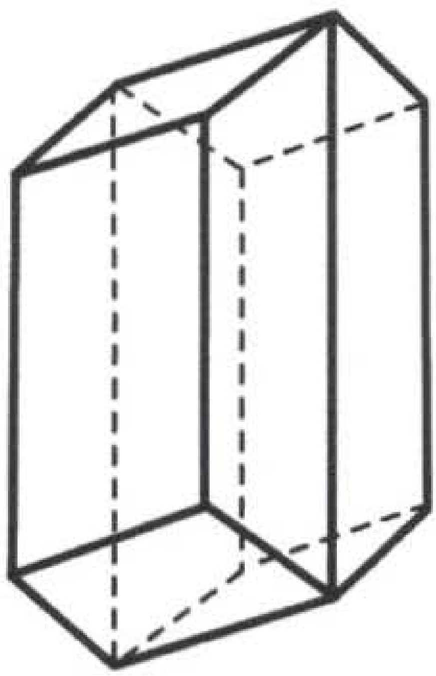
Why these spots? The answer is pretty easy: there has to be an energy gradient that leads to the opening of the water cages (see below) around the dissolved ions so that they can react with each other. At the same time the so called lime -carbonic acid- balance has to be disturbed, this means that it has to come to a local lack of CO_2. Then the elements look for a crystallization point (nucleus) where crystallization starts. These spots are always located on the walls of the pipes, which represent the solid base on which the crystals can grow. More and more elements deposit, the lime deposits grow and incrustations, also known as scale, develop. They consist of calcium carbonate mixed with magnesium compounds, gypsum, silicates and iron compounds (therefore the yellow-brownish colour). These sedimentations favour corrosion and worsen the heat transmission of heating bars and heat exchangers.

How is it possible that there are local energy differences in the water? In the case of heating bars it is easy, heat is transmitted to the water. In pipe bends the water is accelerated, the energy for

this process comes from the internal energy of the water, pressure and temperature changes are the consequences. The same goes for branches and ending points. Here, turbulences are caused, also by the internal energy of the water and with the same consequences.
If we take a look at pipes that have been used over years, we can see that incrustations always start in pipe bends or branches and from there grow into the straight areas. When a pipe clogs up, the affected areas are normally these areas, while the predominant part of the pipe system is still completely in working order and able to let the water flow through.

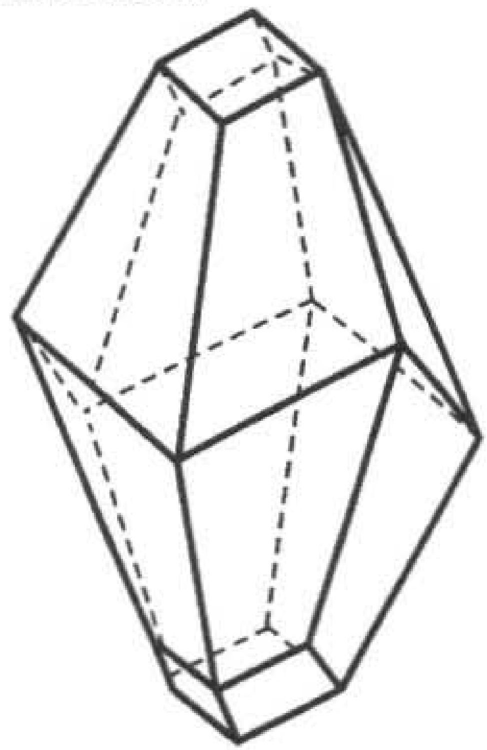
What happens chemically speaking during the crystallization? The following formula explains it:

$Ca(HCO_3)$ •'3f $CaCO_3 + H_2O + CO_2$



Picture 1: Unit cell of an aragonite
(Rhombic system)

In the first place it is remarkable that the described reactions towards a lime formation can also take place the other way round, i.e. the lime can also dissolve again (see above). Which of the two reactions takes place depends on the lime- carbonic acid- balance. If there is a surplus of CO_2, lime is dissolved, if not, lime is separated. These processes are also dependent on pressure and temperature changes, therefore on physical parameters.
At this point, it is appropriate to say something about the lime crystal. It is known that almost all substances defined as solid are crystalline. Crystals are divided in 7 crystal systems and 32 crystal classes, which differ from each other in their lattice structure.



Picture 2: Unit cell of a calcite
(Trigonal system)

Lime can crystallize in two different structures which are chemically completely identical. The lattice structures are different, but similar. Afterwards, the lattice type Aragonite (picture 1) or Calcite (picture 2) is formed. As the chemical structure is identical, it depends on thermodynamic circumstances (pressure, temperature) which type is produced. As the pictures show, in both unit cells one axis is longer than the others. This means that a crystal grows faster in this direction than in the others. The grow velocity is anisotropic, i.e. dependent on the direction. That means that crystals that grow undisturbed develop a needle-shaped form. If the grow velocity was the same in all axis directions, globular crystals would develop. In the lattice type Calcite, there is also a crystallization of magnesium carbonate $MgCO_3$ and $FeCO_3$, and that is why these substances are also incorporated in the scale formation. On the other side, Anhydrite (dried gypsum or gypsum [CaSo4 2H2O]) corresponds to the lattice type Calcite. In similar lattice types phosphates and sulphates such as silicates of calcium and magnesium also crystallize. This favours their incorporation in the deposits. Also for them present crystallization nuclei serve as a starting point for a segregation in the water and not for a deposit on the walls of the pipes or on heating bars, especially in warm water – in which these water companions often dissolve first.

So what do devices do when they show the promised effects?

1. They do not convert lime. Into what should they? The devices cause that Calcium hydrogen carbonate Ca(HCO3)2 turns out as Calcium carbonate CaCO3, which is electrically and chemically neutral in water. And it is a solid with the special concomitant that the crystal does not crystallize on an already existing solid but is formed in the flowing water. Such a crystal grows according to the laws of nature with typical parameters valid for every substance and it takes on a shape according to the law of nature.

2. The result is that these crystals do not have special characteristics but special shapes that do not adhere to each other any more and therefore prevent calcification. At this point the described mechanism has its effect.

3. Water

To understand the following processes, now some information about water is given. It is way more than what the formula H2O says. The two hydrogen atoms and the oxygen atom form a equilateral triangle and incircle a ~110° angle, as shown in picture 3.

Picture 3: Angle structure of a water molecule

This is the reason for a lot of characteristics that distinguish water from other, similar molecules. Two gases that react with each other form a liquid and not a gas, as it is e.g. with carbon dioxide CO2 (solid substance and gas!), a molecule that is a lot heavier. Because of this angle position water molecules form chains and clusters that cause the fluid state.

This is possibly the reason why water may have a "memory" in which it adopts structures in the chains and clusters that do not change even when the water moves. These chains and clusters are held together by Van de Waals powers or dispersion powers or hydrogen bridges. The bond is based on the attraction of electric dipoles present in molecules with polarized bonds or angled structure.

At the University of Stuttgart, scientific research is conducted concerning this problem and first results show that the behaviour of water is influenced by electric and magnetic fields. Such phenomena have been known for a long time but have never been investigated scientifically.

This molecule form leads to a further special characteristic. Water shows a dipolar character. Through the bond, both elements strive for an inert gas configuration in their outer electron shells. In the case of hydrogen there are two electrons, in the case of oxygen eight. Oxygen is missing two and each hydrogen one electron. In the molecule the total of two bonding electrons is available for all three atoms, so that an inert gas configuration can be reached by all molecules. In all homeopolar bonds of diverse atoms, the bond is polarized, i.e. the bonding electrons pair is moved towards the direction of the bonding partner with the higher electron affinity, in this case the oxygen atom. If the water molecule is exposed to an electric field, it lines up so that the oxygen points towards the positive electric side and the hydrogen molecules towards the negative electric side. So the water molecule is charged a little bit more negatively on the side of the oxygen and a little bit more positively on the side of the hydrogen. This fact, together with the molecule form, plays an important role for the dissolving ability of water and for physical water treatment. At this point further anomalies are only briefly mentioned: when water passes to a solid state (ice) its density decreases. If the ice is put under pressure, it liquefies again. Normally, liquids under pressure pass to a solid, crystalline state. These few indication already show that there is probably a lot more about water than today's modern research has discovered so far and that it surely contains up to now incomprehensible effects like the so-called Plocher and Grander water. We should not rashly blame the water if we do not know anything about it.

4. Physics and chemistry

What happens physically and chemically speaking when a physical water treatment device is used? As there are a lot of different application principles, from magnets introduced in the water pipes to the injection of seed crystals into the water, around which lime particles attach, in the following only one principle that is often mentioned and often controversially discussed is going to be examined.

The processes are described on the basis of a device of a typical appearance the effectivity of which is often doubted. The test here is based on the functioning and mode of action of this device. It is a blackbox from which two cables exit and are wound around the pipe. These cables transmit oscillations to the water that are supposed to "convert" the dissolved lime and render it harmless.

This formulation has been chosen intentionally because it is essentially identical to the description of the function of devices and therefore already puts in doubt the repute and seriousness. What kind of oscillations are transmitted? Some descriptions do not even talk about calcium being converted, the producers seem to come from the times of the alchemist. Some say that the pipe material does not matter and that the device can even remove already existing lime incrustations. How can oscillations achieve all this? Seriously, who thinks he understands just a little bit about physics and chemistry already finds enough apparently scientific arguments to doubt the functioning.

What does a device do that really prevents lime deposits in pipes? At this point the first question has to be: What it has to do to fulfil this demand? The answer is easy: It has to create the conditions under which the calcium hydrogen carbonate $Ca(HCO_3)_2$ is washed away with the water as a crystal and does not attach to the pipe walls as calcium carbonate crystal $CaCO_3$.

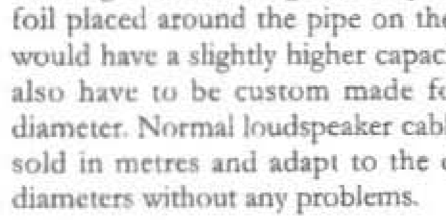
In the following, the physical and electrical possibilities that an effective physical water treatment system has to offer are examined. This simply means that it has to cause the effect that the dissolved lime does not attach in crystalline form to the walls or contact points with the pipes, to devices and fittings in contact with water. This is only possible if the dissolved lime crystallizes in the water before the contact with these areas. Therefore two conditions have to be fulfilled:

1. Crystallization nuclei have to be present or created.

2. The lime- carbonic acid- balance has to be changed so that dissolved lime becomes solid.

Experience has shown that the introduction of magnetic or electric fields in the water can have such effects, even if with different degrees of success. In the following, only the effects of electric fields are examined, but from these the conditions under which magnetic fields can also be effective can be derived.

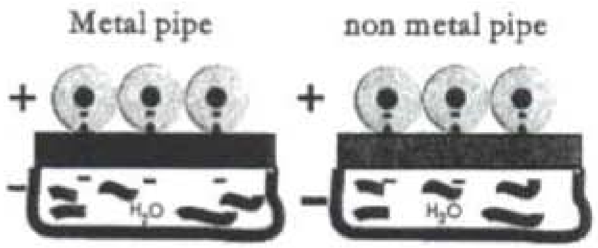
If we take a look at picture 4, we can see the two windings through which impulses are transmitted. A lot of producers call these windings "coils" because they look like coils, but electrically speaking they are not. Thus, an "inductive" coupling is not possible and if it was inductance, the device would fail in the case of iron pipes, but it does not. The winding represents a part of a capacity, it is one capacitor surface, the other one is the water. This winding is a technological compromise, a metal foil placed around the pipe on the same length would have a slightly higher capacity, but would also have to be custom made for every pipe diameter. Normal loudspeaker cables instead are sold in metres and adapt to the different pipe diameters without any problems.



Picture 5: Charge separation through influence

How can, with this arrangement, an electric field be created in the water in pipes made of all kinds of material? This is the point where most doubts begin. With this arrangement, it comes to a physical effect widely spread in the electric everyday life but not well known: the influence. In picture 5 the principle of the process is shown on the basis of a capacitor.

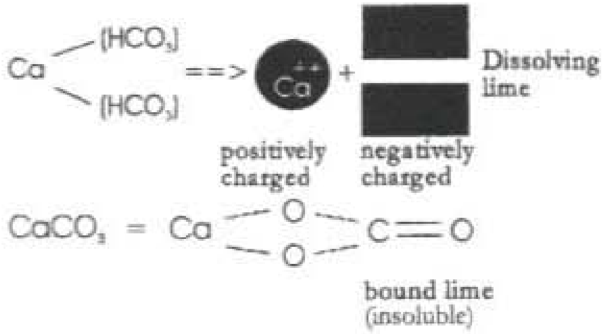
When voltage is transmitted to the two capacitor plates, a charge displacement in the dielectric (insulator) is caused, which is the opposite of the charge of the plates. When the plates are discharged, the polarisation of the insulator also disappears as in the insulator electrons cannot move but only bound electrons are displaced. But if on the other hand e.g. two metal sheets are laid on top of each other (electric conductor) and are then put into the electric field between the capacitor plates, the charge separation is the following: the surface of one metal sheet gets a negative charge (opposite of the positive capacitor plate) and the other one gets an equivalent negative charge. This phenomenon is called influence. If the two plates in the electrical field are separated, one of the plates shows a negative charge (surplus of electrons) and the other one a positive charge (shortage of electrons). A capacitor is impermeable for direct voltage but not for alternating voltage. This fact is used when it comes to creating electric alternating fields in the pipes. Picture 6 is an instant photograph of this process. You can see that the pipe material does not have any influence on the capacitor effect in the arrangement.



If the winding wire is charged by a pole of a power source, the same electric charge of the opposite sign is bound in the water pipe through influence (as the water comes from the earth).

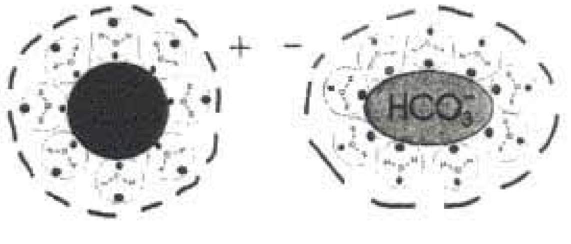
If it is a temporal periodic charge transfer, or, respectively, a charge and discharge, a so called displacement current is produced - like in a capacitor (apparently) influenced by alternating current - between the insulated winding wire and the pipe wall (this can be calculated with the Maxwell equation).This is the continuation of an alternating (+-+-+-...) or pulsating (0+0+0+0...or 0-0-0-...) conduction current which develops between the pipe (including the water) and the ground. This results on the one hand from an alternating or pulsating electric field orientated in the longitudinal direction of the pipe and on the other hand from a magnetic eddy field centrically wound around the pipe. Measurements have shown that an effective voltage of •'3f1 volts is produced between the winding and the water and that there is a displacement current of -'3f 5•A.

$$Ca(CHO_3)_2 <==> CaCo_3 + H_2O + CO_2$$



Picture 7: Schematic representation of dissolved and bound lime

At this point, some more attention has to be paid to the lime dissolved in the water. Picture 7 shows the connections. The dissolved lime – calcium hydrogen carbonate – dissociates in one double positively charged calcium ion and two negatively charged hydrogen carbonate ions. These ions are surrounded by a water cage. The water molecules settle around the calcium so that the oxygen points towards the calcium and the hydrogen towards the outside. Electrostatic powers hold these clusters together. The carbonate remnants are surrounded in the same way only that the oxygen atoms of the water molecules point to the outside. These clusters as a whole show a positive or respectively negative charge. A schematic representation is given in picture 8, the clusters just have to be imagined as minute spheres. They have a diameter of 1 to 2 nanometers (nm), assuming that about 100 to 200 water molecules are involved. If the mass of these clusters is calculated, it results that the mass of the Ca- clusters as well as the mass of the bicarbonate remnants is of 30x10^-22g up to 60x10^-22g. These results are interesting for the water treatment.



Picture 8: State of lime dissolved in water (schematic)

Coming back to the inducted electric alternating field, it is to say that that the periodically alternating field in the inside of the pipe influences the ions or dipolar molecules closed in water cages in the water in a way that they move from one direction of the pipe to the other to the beat of the alternating field. The electric oscillation has lead to an oscillation of matter which spreads axially. Physically, this is a mechanical (acoustic) longitudinal wave or shock wave. Areas with overpressure and negative pressure alternate. In atomic and molecular fields, this locally causes an adhering of the CO2. If the oscillation frequency is suitable, the water cages disintegrate and this also leads to a local decrease of the CO2 concentration. The lime-carbonic acid- balance is locally disturbed and at the same time the dissolved lime ions that are freed from the water cage can meet and react with each other: a lime molecule has been produced which now serves as crystallization nucleus.*) Other molecules are taken up by this nucleus and form a lime crystal in the water. This lime crystal is electronically neutral and does not react in tap water any more. Therefore, this lime crystal is not taken up by existing lime deposits on the pipe walls anymore.

To cause these processes, the electric alternating field has to contain frequencies that if possible lead to resonance oscillations of the water cages. Since all tap waters that correspond to the German drinking water decree are different regarding the quantity of dissolved minerals, the pH-value and the conductivity, the formation of the electric alternating field is also influenced. Besides, there is the changing flow velocity. Devices that work with only one frequency can also successfully set off this cycle by chance, but most of the times they do not show any success.

Some of technical data about the device examined here is known, and experience has confirmed its effectivness. Therefore, it makes sense to theoretically and (as far as possible) practically assess the effectiveness of the device by means of this information.

The device is provided with two windings. Each winding receives impulses with a clock frequency of 10 Hz, 50 ms pulse duration, 50 ms rest and de-energize. When one is in rest and de-energize, the other one receives the impulses. Each impulse has a frequency response of ca. 3 to 15 kHz, spread on 50 ms. As there was no suitable measuring method, the frequency response could not be measured. If 10 oscillations are counted per kHz, the pulse duration is approximately reached. At this point it has to be particularly emphasized one more time that this is only an attempt to generally explain the effectiveness. The complexity of the excited oscillations including the overlapping of different waveforms (overtones) cannot be taken into consideration.

The device is supposed to safely treat 5000 litres of water per hour. In the case of a half inch pipe this means the flow of a water column of 11,3mm/ms, in the case of a one inch pipe it would be 2,8mm/ms and in the case of a two inch pipe 0,7mm/ms. As the length of the effect of an electric alternating field is of •'98500 mm (the producer indicates •'981000 mm), this means that this distance is just covered. Every ion water cage has enough time to fall apart.

What about the reaction velocity of the chemical components? The Max-Born-Institute for nonlinear optics and transient spectroscopy in Berlin has examined the velocity of the formation of molecules on the basis of water molecules with a special laser array. The result was a time between 10 and 20 femto seconds (1 fs = 10^-15 second). This time is as inconceivably short as the universe is inconceivably big. The distance light travels in 1 fs gives us an approximate idea of how short this time is: •'3f0,3 •m. In the time light travels 6 mm, 1000 molecules can be formed. Therefore, it is very probable that the molecule formation and the formation of nucleus crystals take place in the section treated.

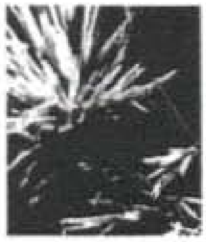
5. Protective layers and incrustations

At this point the formation of incrustations is only briefly mentioned for the processes in pipe bends. The flowing water accelerates in the pipe bends. The water flowing in the outer radius is faster than the water in the inner radius. According to the simplified Bernoulli's equation (2), the sum of the static and the dynamic pressure is constant:

Pdyn + Pstat = const.

In the water that flows faster, the dynamic pressure increases and the static pressure decreases. This means that CO_2 escapes from the inner radius towards the outer radius and the lime- carbonic acid- balance is disturbed. Lime is set free, looks for a crystallization point and finds this point on the walls of the inner radius. Little by little, a layer of lime grows epitaxially, on which other minerals also deposit. On this irregular surface turbulences develop, the same happens in pipe branches because of pressure fluctuations, so that in both cases lime deposits develop. As water, and therefore also the CO_2, evaporates in faucets and shower heads, also here lime deposits develop. On heated surfaces the CO_2 is also removed from the closer surrounding area, so that theses surfaces are also favourite crystallization points for the lime. For two reasons, the presence of lime in drinking water is important and therefore a minimal amount that corresponds to a water hardness of 8,4°d is stipulated by the German drinking water decree. Firstly, the drinking water provides a big part of calcium the body needs and secondly, the bicarbonate remnants of the dissolved lime reacts with the metal of the pipe and so forms a metal carbonate protective layer. This is especially important in the case of copper pipes (see below). Picture 9 shows a detail of such a protection layer. You can see how the crystals grow on the metal surface. Such bundles of crystals cover the surface and protect the pipe against corrosion.

Picture 10 shows this even better. It is an electron microscopic picture of an artificially produced phosphate protective layer against corrosion. Phosphates crystallize in a similar crystal system as carbonates. In time, this desirable quality of lime becomes a disadvantage as more and more lime deposits grow in these protective layers since they are ideal crystallization points. Slowly, a pipe



Picture 9: Lime protective layer

Picture 10: phosphate protective layer

Picture 11: Lime dust deposits

As indicated above, from here theincrustations grow into the straight sections of the pipe. This process takes place as long as there is dissolved lime in the water. But most of the lime transported in the water is washed out of the pipe without depositing. After all, with a water consumption of 100 m^3 per year and a water hardness of 28°d, about 45 kg of lime are transported through the pipes. If the lime has been transformed into crystals in the water as described above, the lime is washed out of the pipe with the water in the form of a fine submicroscopic crystal, a crystallization on the walls of the pipes is not possible anymore. The lime crystals deposit irregularly, as shown in picture 11. This condition stays the same also in warm water. Applications have shown that further dissolved minerals deposit on the nuclei buildt of the lime crystals and sink to the bottom of e.g. water boilers in form of dust without growing on the heating bars. This way, 2 kg of lime dust deposits could be removed from a 150 litre water boiler after a year of operation, the heating bars were absolutely scale free. Users report that the heat exchangers for the dictrict heating hot-water supply also stay lime-free on the secondary side. Since the installation of the examined device four years ago, no cleaning has been necessary. The lime has been made harmless but has not been removed and is still physiologically present. Another consequence of this is that water drops that dry on surfaces leave lime dust which can be removed with a humid cloth. But if it is left in a humid surrounding for a while, it can locally dissolve under the influence of the CO_2 in the air and if it dries again, a crystallization on the surface is possible: This incrustation can only be removed with a decalcifier.
But these devices are also supposed to remove existing deposits and to prevent rust or corrosion. Is this possible? And if it is possible, how does it work?

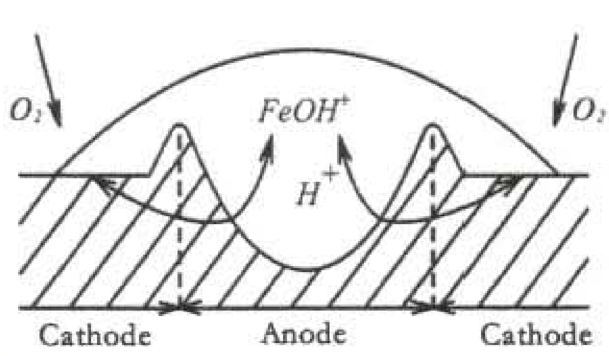
6. Removal of deposits and protection against corrosion

First of all, some information about the removal of lime deposits: If we take a closer look at the equation (1) we can see that the chemical reaction can not only take place from the left to the right side (lime segregation) but also from the right to the left (lime dissolution). Here again, the lime-carbonic acid- balance plays a crucial role. If there is a surplus of carbonic acid, lime is dissolved. For each dissolved lime molecule crystallized in the water one carbonic acid molecule is produced. This carbonic acid gradually attacks and dissolves the lime deposits on the pipe walls and this way removes the lime. Depending on the level of the incrustations in the pipe (water hardness, working life), this process can take between half a year and two years. During this time, light lime deposits outside the water develop again. When this process is finished, no more incrustations develop. The lime is removed, but the carbonate protective layer is maintained.

Of course the lime crystal in the water is also exposed to this influence. But the crystal produced in the water has been able develop in an almost weightless state and therefore a crystal structure forms that shows only a few lattice defects such as vacancies, interstitial atoms, substitution atoms and molecules, displacement and stacking faults. Therefore, this crystal offers less targets than the incrustations presenting these errors and therefore also a bigger surface and with that a higher internal energy. This is why this incrustation is attacked more, often with a selective dissolution, which leads to the eruption of coarser lime particles which can accumulate in the aerators.

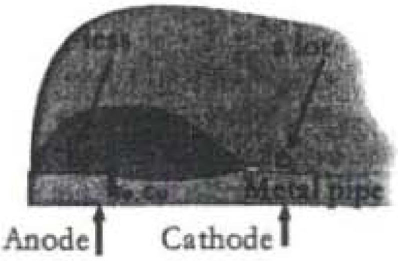
Now the equation (1) represents a balanced stationary state. In nature, however, fixed equilibria do not exist, only flowing equilibria. At the melting point of water e.g. ice and water exist at the same time, therefore balanced. This means that statistically in one time unit the same amount of water molecules changes from the liquid to the solid state as water molecules melt from the ice. The equilibrium is flowing. The lime segregation as well as the lime dissolution described in the equation (1) are also subject to this static process, if there is no intervention from the outside. The processes in the section treated will not catch all present molecules. Though if in smaller amounts, there will still be dissolved lime in the pipe which can also segregate but then dissolve again. But since the physical water treatment intervenes in favour of the dissolution of the lime and the removal of the deposits, new incrustations do not form. Statistically, it is possible that during these processes surfaces that are not yet covered with metal carbonate crystals (see pictures 9 and 10) now form such crystals and so make the corrosion protection layer thicker.

The described mechanism of the formation of a protective layer is not the only effect preventing corrosion. Since there is already a protective layer, normally no corrosion should occur, but as experiences show corrosion does occur, in galvanized iron pipes as well as in copper pipes. What is the reason?



Picture 12: Ventilation element

In technology there is a corrosion process called ventilation element. Picture 12 describes this process. Iron is an electric conductor, water is an electrolyte. When a water drop lies on iron, an electrolytic element has been formed, the only thing missing is the electric voltage. At the edge of the water drop the oxygen contact towards the metal surface is stronger, the centre of the drop is less ventilated. Thus a potential difference between these two areas develops, the edge of the water drop becomes a cathode (surplus of electrons) and the centre of the drop an anode (shortage of electrons). Being an electrolyte, the water now enables the closed electrical circuit between anode and cathode. At the anode, positively charged ions of the respective metal dissolve, react with the water and deposit as rust, while the electrons take the way through the metal to the cathode. In principle, the process is the same in the case of copper.



Picture 12a: Corrosion through lime deposits with different thickness

In principle, the same process takes places in our pipes, the only difference lies in the reasons for the different oxygen contacts to metallic surfaces. Picture 12a schematically represents this constellation. As long as the water is not physically treated, lime favours to deposit, as described above. Between the areas with strong lime deposits and the lime free areas, this causes the more or less strong oxygen contact in the water to affect the surfaces with a different concentration. This way, they same process as in the ventilation element is caused. As it is generally known, most of the times corrosion occurs in pipe bends, branches and T-pieces which show thick deposits. If these deposits are removed leaving only the protective layer, the oxygen contact is the same everywhere and an electric potential cannot develop anymore. This process is especially important for copper pipes, as with a high oxygen content and pH values lower than 6,5, copper is especially corrosion endangered and specially tends to pitting corrosion. In these cases a thick protective layer is especially important, also because the impurity of copper (cheap material) favours the formation of local elements. Thus, more and more copper gets into the water and this is unfavourable for the health. According to the recommendations of the Federal Ministry of health, babies should not drink tap water in these cases. Water suppliers call copper the "lead of the 20th century".

Pictures:

- Pictures 1 and 2: W. Kleber, Einführung in die Kristallographie, Verlag Technik Berlin, 1956
- Picture 4: Information script from Christiani Wassertechnik GmbH
- Picture 9 and 11: Information script from Christiani Wassertechnik GmbH
- Picture 10: Information script from the BMW-motorcycle factory Berlin
- Picture 12: W. Schatt (editor), Einführung in die Werkstoffwissenschaft, VEB Deutsche Verlag für Grundstoffindustrie, Leipzig, 1981

*) Coral animals build their coral sticks on the same basis. In their feet area, they have plant cells that contain chlorophyll. This produces organic material (carbohydrates) from water and CO2 by the means of sunlight. Thus, the lime- carbonic acid- balance is also disturbed (reduction of the Co2) and this leads to a secretion of lime forming the coral sticks. This is a reason why corals only exist in sun flooded shallow water, as only here there is enough sun energy for the photosynthesis process.

Functions and effects of the impulse-technology water treatment system [Vulcan]

Purpose

To protect cold and warmed water supply pipes and water heating equipment (boilers, etc.) from scale and rust, so as to prolong the life of piping system and to save energy with the equipment while extending its life.

Introduction

Iron becomes iron oxide without fail if water and oxygen exist, which can cause red water and deteriorates the strength of the piping system.

Calcium is hard to be dissolved differing from sugar and salt and it becomes to scale that will induce heating efficiency deterioration and piping obstructions. Calcium is also a cause of urinary lime at the toilets and of cold and hot water scale at the bathroom.

Functions and effects of Vulcan

- When the oxidation-reduction potential (ORP) comes down to 100-150 mV, water becomes strong in reduction, which suppresses the corrosion and enables to prolong the life of the pipes with membrane formation of the stabilized Iron oxide.
- Colloids in water repel each other because of a change in the interface potential, with which calcium and silica colloids are separated, and then they are removed becoming brittle. A form of crystallization changes and it lessens adhesion.
- Surface tension becomes weak, with which penetration of detergents becomes better and the detergent cost can be saved. One of reasons of easy removal of rust and scale is due to the better penetration of water.

  These effects have been realized by the technology of voltage signal, Pulse, which shifts phase at 3,000-32,000 Hz. The truth that can prove it is our 60-year history and our sales records of more than 80,000 units in the world 30 countries.

Way of installation

It can be applied to any pipe material and there is no need to cut the pipeline. Simply wind the cable around the pipe and just connect power supply of AC 100 V or AC 200 V. (In the case of outdoor applications, it needs a waterproof box.)

Install the device away from such equipment as a motor that generates electromagnetic wave.

Range of effects

Effective range covers up to 2 Km downstream from the device, 48 hours in the case of water, and 95°C in the case of warm water.

Selecting device type

Select a bigger standard comparing a pipe diameter with a flow volume of water.

Catalina Co., Ltd
Vulcan Project

Water supply pipe, deterioration countermeasures comparison

1. **Pipeline renewal method**

   Pipeline replacement, in the general term

   <Demerits>

   Construction cost is extremely high (0.5-1 million JPY/house, in the case of condominium). Construction takes a long time. Water outage, during construction. Open piping can lose exterior view. Cost sharing for exclusive compartments.

2. **Pipeline rectification method**

   Lining method, in the general term

   Grinding rust and pasting resin

   <Demerits>

   Construction cost is high (300,000-500,000 JPY/house. Construction takes a long time. Re-construction is difficult.

   Effective period will be 5-15 years; doubtful in environmental hormone. Cost sharing of exclusive compartments.

3. **Pipeline life extension method**

   Method that extends the life of the existing pipeline system by suppressing its rusting progress Deaeration, electric anti-corrosion, anti-corrosion agent, and water quality improvement system contain magnet method, ceramic method, pulse method, electrolysis method, minus electrification method, electron method, electron field method, ion method, and static-electricity method.

Comparison in major life extension methods

- **Deaeration:** It eliminates in-water dissolved oxygen and delays rusting progress, to extend the life. In the case of membrane type, expenditure in filter replacement, pre-filter replacement, and electric cost for a vacuum pump are required. Unable to use in the direct pressure type. Water containing small oxygen is taste bad. Noise-prevention measures on a vacuum pump are required.
- **Electric anti-corrosion:** It flows electric current on the piping system putting the electrodes inside and suppresses iron ionization. Secondary effects include sterilization effects. Effects are distinctive in the main pipe but poor in the branch piping system. The period of construction is long and it requires both running and maintenance costs.
- **Calcium injection method:** Slaked lime and sodium carbonate are injected into the pipe, with which the calcium membrane is formed at the wall of the pipe then it protects the internal pipe.

  Water quality management in such as pH is required. Scale tends to be easily produced in a boiler.
- **Anti-corrosion agent method:** It adds the anti-corrosive agent (phosphoric acid, silicic acid) to water and prevents corrosion.

  Density management and running cost are required. The Japanese Ministry of Health, Labor and Welfare recognizes this method as the first-aid treatment before the piping system renewal but not the permanent measure.
- **Magnetic method:** Magnetic field is generated inside the pipe, and by cutting the magnetic field with the rapid water flow, minute electric energy is applied with which corrosion progress is suppressed.

  Many sorts of working devices exist and the real effect is unclear with some devices.

- **Ceramic method:** Ceramic and water are touched, with which water is activated then it suppresses corrosion. Porous materials on the ceramic surface adhere foreign substances, which deteriorates effects. Thus, some of such materials can require replacement and washing. Pressure loss exists.

  Many sorts of ceramics exist and the real effect is unclear with some materials.

- **Pulse method:** By changing oxidization reduction potential (ORP), surface tension, and surface potential through the use of modulated and phase-shifted impulse (volt signal), scale and rust are removed and suppressed.

  Amazingly best price and low running cost of 120-300 JPY/year (depending on a size) comparing with the conventional water quality improvement device. 10-year warranty, based on our self-confident and reliability (safe and economy).

- **Electrolysis method:** In the electrolysis reaction, calcium is forcefully detected and separated on the electrodes. There is a type that suppresses corrosion by letting down the oxidization reduction potential.

- **Minus electrification method:** It is said that rust, scale, and oil-dirt are prevented and removed by the minus electrification water in the AC modulation magnetic field.

  Merits and demerits are unclear.

- **Electron method, electron field method, ion method, and static-electricity method:** Applying high voltage to water, supplying water with electron, flowing minute electric current to water, and other such magnetic waveform treatments exist. Those are diversified methods aiming at the water quality improvement.

4. Pipeline washing

As the pretreatment processing for the piping system life-extension measures, though not as the practical life-extension method for the piping system, there are water taste improvement measures by the slime-washing and some other piping washing methods as piping system maintenance measures in grime-prevention.

- Ozone water washing
- JAB washing, IPC washing
- Carbon dioxide gas washing (Jet bubble method)
- Citric acid electrolyte acid water washing (ROKI fresh method)
- Drug washing

Catalina Co., Ltd.
Vulcan Project

Photos of the Vulcan installed

Installed on February 16, 2007

Vulcan (pulsed water treatment system)

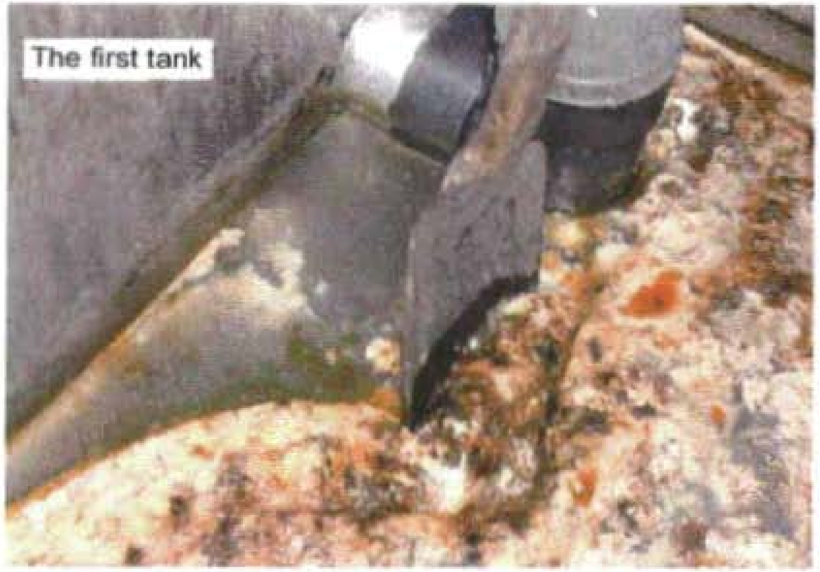
Fault-unlikely design and easy to install
Continuously blinking LED gives an assuring feeling.

Before cleaning of the grease trap in the kitchen in the Kiyokawa Factory

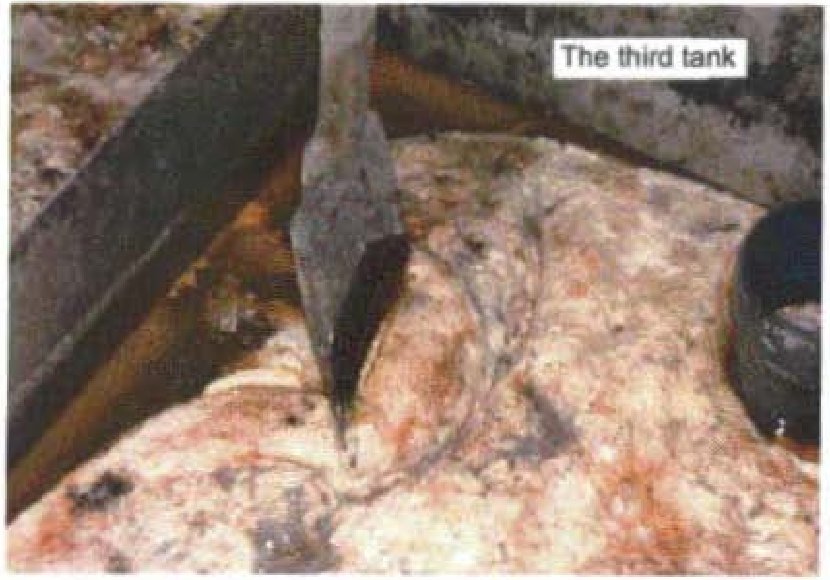
Last cleaning was made on January 4, 2007. The grease trap cleanings are scheduled seven times a year (January, March, May, July, August, September and November) **(February 16, 2007)**

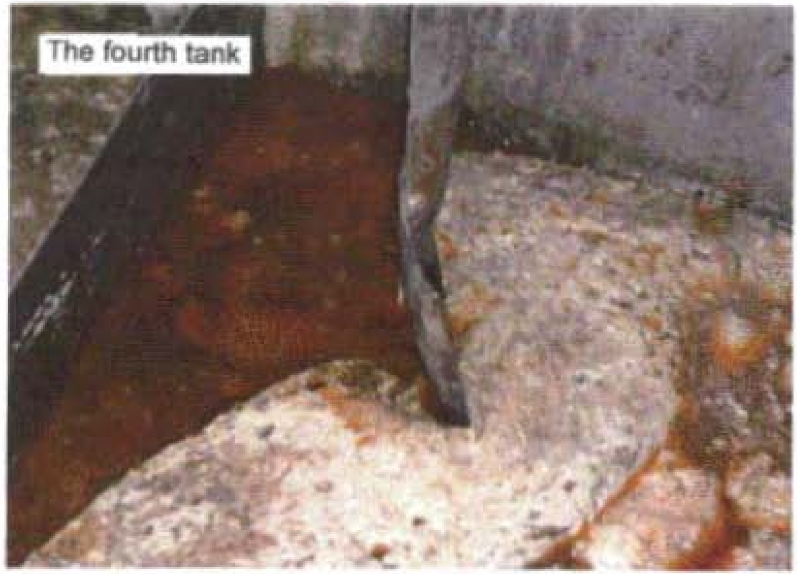
The thickness of the layer of oil content in the first tank through the fourth tank exceeds 50 mm as a whole.
The grease layer of the third tank is seemed to be the thickest.

Measurement of the thickness of the oil film was attempted but failed.


The first tank


The second tank


The third tank


The fourth tank

Upon cleaning of the grease trap in the kitchen in the Kiyokawa Factory (on February 19, 2007)

The first tank: Upon high pressure cleaning
(grease is adhered on the inside walls)

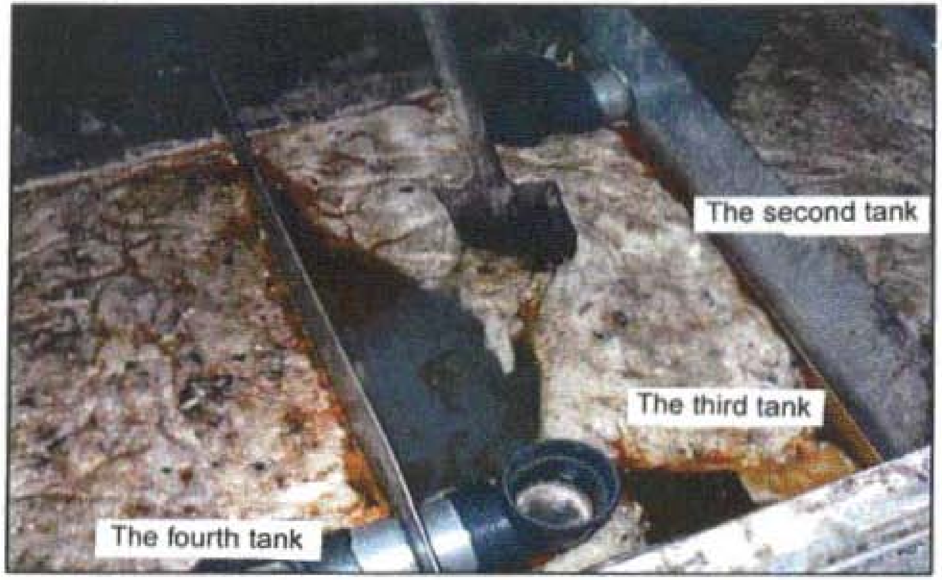
The first and the second tanks: Upon cleaning by rubbing using detergent

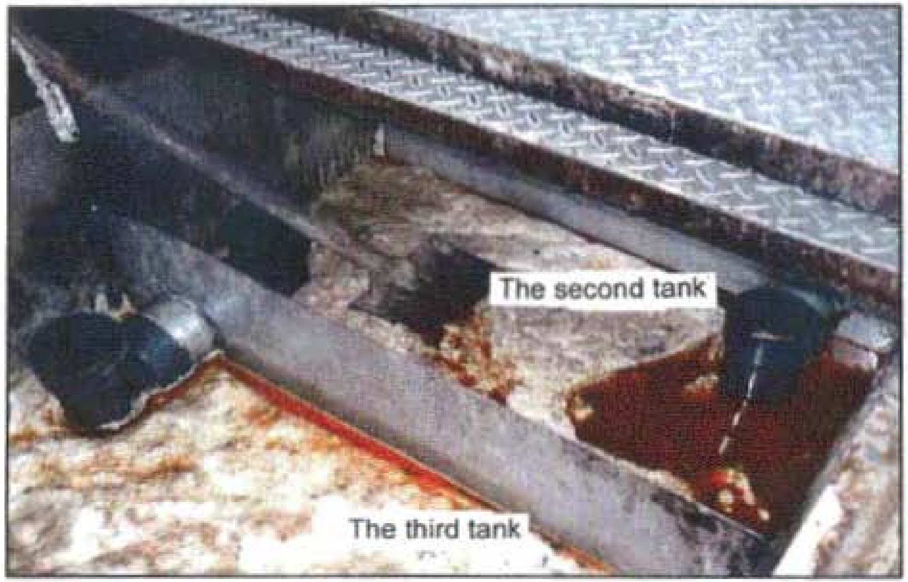
The third tank and The fourth tank: Upon cleaning by rubbing using detergent

Drainage tank: : Upon cleaning by rubbing using detergent

Grease trap in the kitchen in the Kiyokawa Factory (on March 22, 2007)

The photos show the statuses 35 days after the installation of the Vulcan.
Thickness of the layer of oil content: Around 30 mm - 40 mm, thinner compared with the previous inspection.





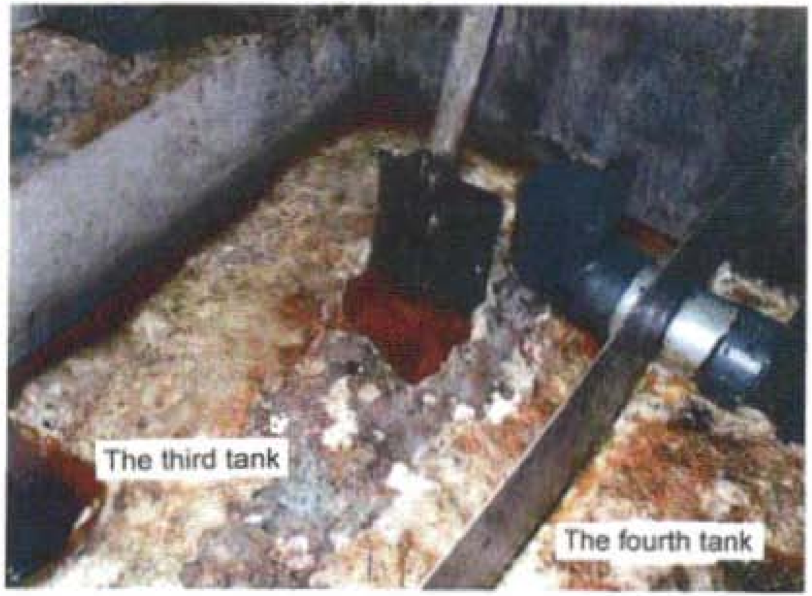
Grease trap in the kitchen in the Kiyokawa Factory (on April 19, 2007)

The photos show the statuses two months after the installation of the Vulcan.

Thickness of the layer of oil content: The seasonal changes are not known as a year-round observation was not performed, but in the inspection of this time, there are many potions having no oil balls. This might be partly due to a series of cool days in April. Naturally, the layer of oil content is thin.


①
②
③
④

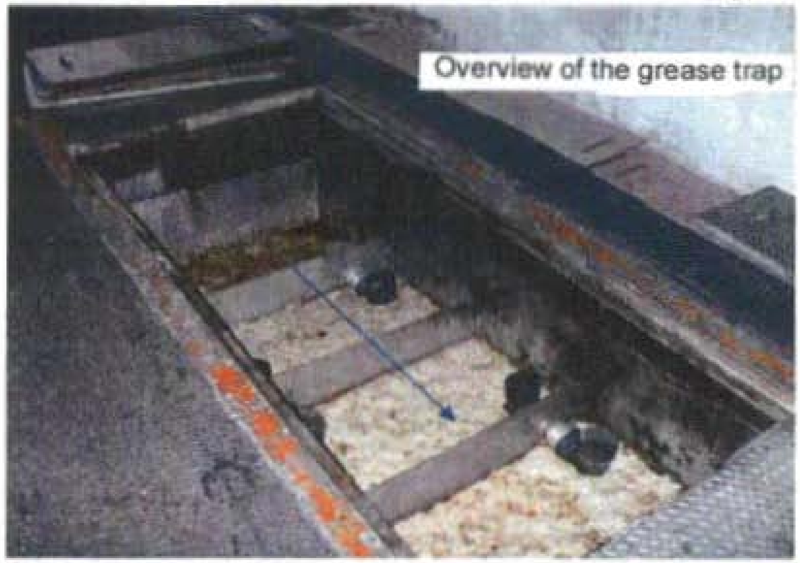
③
④

The first tank
The second tank

The third tank
The fourth tank

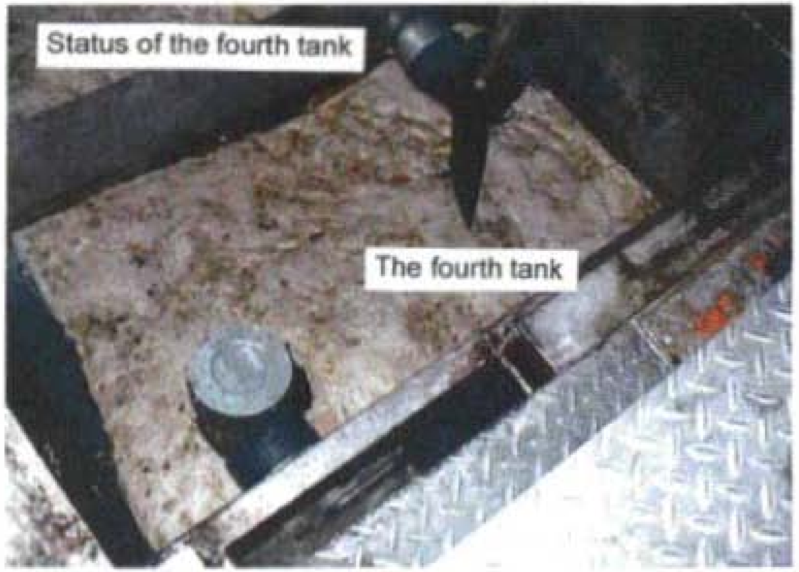
Grease trap in the kitchen in the Kiyokawa Factory (on May 18, 2007)

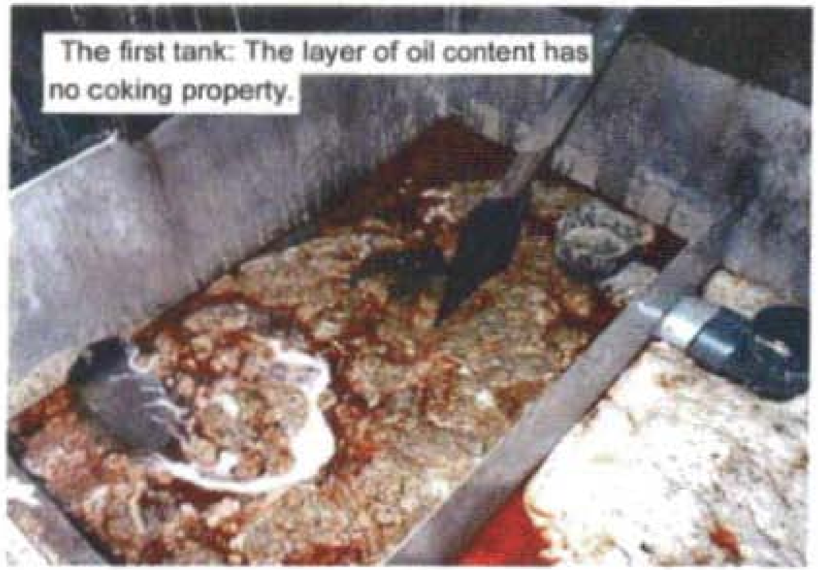
The photos show the statuses three months after the installation of the Vulcan.

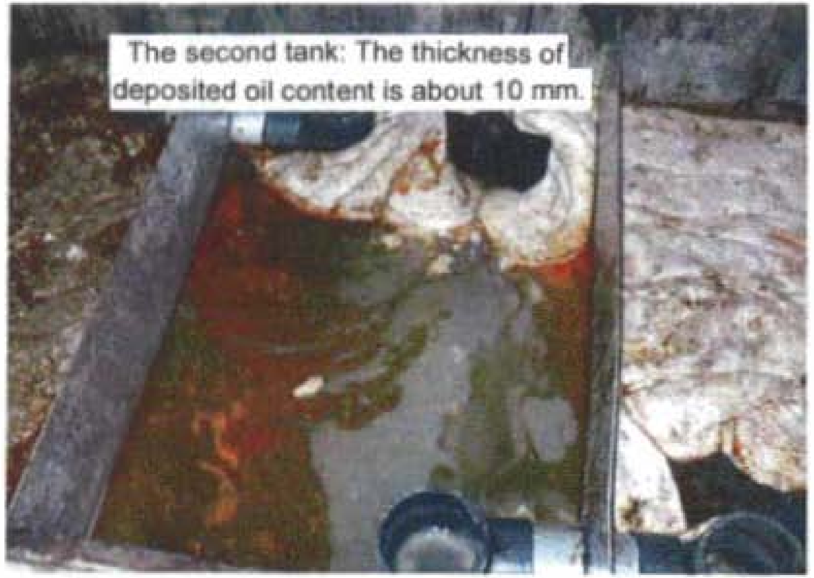
Thickness of the layer of oil content: The layer is the thinnest in the progress of observation. The first tank seems to show that oil content is floating rather than making a layer.
Stench: There was a slight stench when the manhole cover was opened but it was thinned gradually. There was no sharp stench even when the inside of the grease trap was stirred.




Status of the third tank
The third tank


Status of the fourth tank
The fourth tank


The first tank: The layer of oil content has no coking property.


The second tank: The thickness of deposited oil content is about 10 mm.

The third tank: The thickness of deposited oil content is about 10 mm. The floating oil content is less than the second tank.

The fourth tank: The thickness of deposited oil content is about 10 mm. The floating oil content is less than the third tank.

Conclusion

Although there is no data of the previous year to be compared with, the results of the three-month tests seem to show the effectiveness of the water treatment system. When the manhole cover was opened in February, there was a sharp stench despite of a low ambient temperature. When it was opened in May, however, the stench was not bothering. According to the factory, the cleanings of the tanks are scheduled every month during summer season. Judging from the current situation, this seems to be unnecessary. For determining the effectiveness of the Vulcan and the cleaning cycle, year-round observations will be necessary, but with the Vulcan installed, the cleaning frequency will be reduced substantially. The Vulcan is the system I am very interested in.

May 21, 2007

Test report on the pulsed water treatment system provided with preventive measures against clogging in the drainpipe under the sink in the cookery on the fifth floor.

December 22, 2007

Outline:

The pulsed water treatment system, Vulcan, changes the crystal structure of the scales contained in hot water passing through the piping by emitting phase-changing pulses generated by the cable wound over the existing water supply line to let the scales flow out together with water without adhering within the piping.
The treatment water is effective against rusts and scales on the primary side of the water supply pipe. When service water is used and drained on the secondary side, sliminess or clogging in the drain is reduced, preventing the buildup of metallic soaps in the grease trap. This results in the reduction of the problems of molds or stenches likely to accompany drainage. This effect also appears within the drainpipes and wastewater treatment tanks.
The effect of the treatment water lasts for about 48 hours or approximately 2 km in distance.

Vulcan has the following features: (For details, refer to the brochure attached.)
This water treatment system can change the crystal structure of scales without changing the quality of water. Therefore, nothing is added or reduced to or from the ingredients of water. The water through Vulcan is soft and has an increased permeability. Vulcan makes city water to drinking water and can be used as better cooling water.
Other features include:

- Prevents buildups of rusts and scales
- Makes cleaning of kitchen and bathroom much easier (toilets, showers, tiles, joints, etc.)
- Eliminates the necessity of strong chemicals for removing scales.
- Drastically reduces the clogging due to oil balls
- Eliminates the necessity of salts.
- Eliminates the necessity of additives.
- Does not change the water quality.
- Has no side effect.

Objectives:

To alleviate the overflow of drainage out of the basket due to oil balls in the grease trap under the sink of the counter in the cookery on the fifth floor of the building. Also, to save the administrative and maintenance expenses by reducing the periodical cleanings used to be conducted several times a year.

Installation (on June 17):

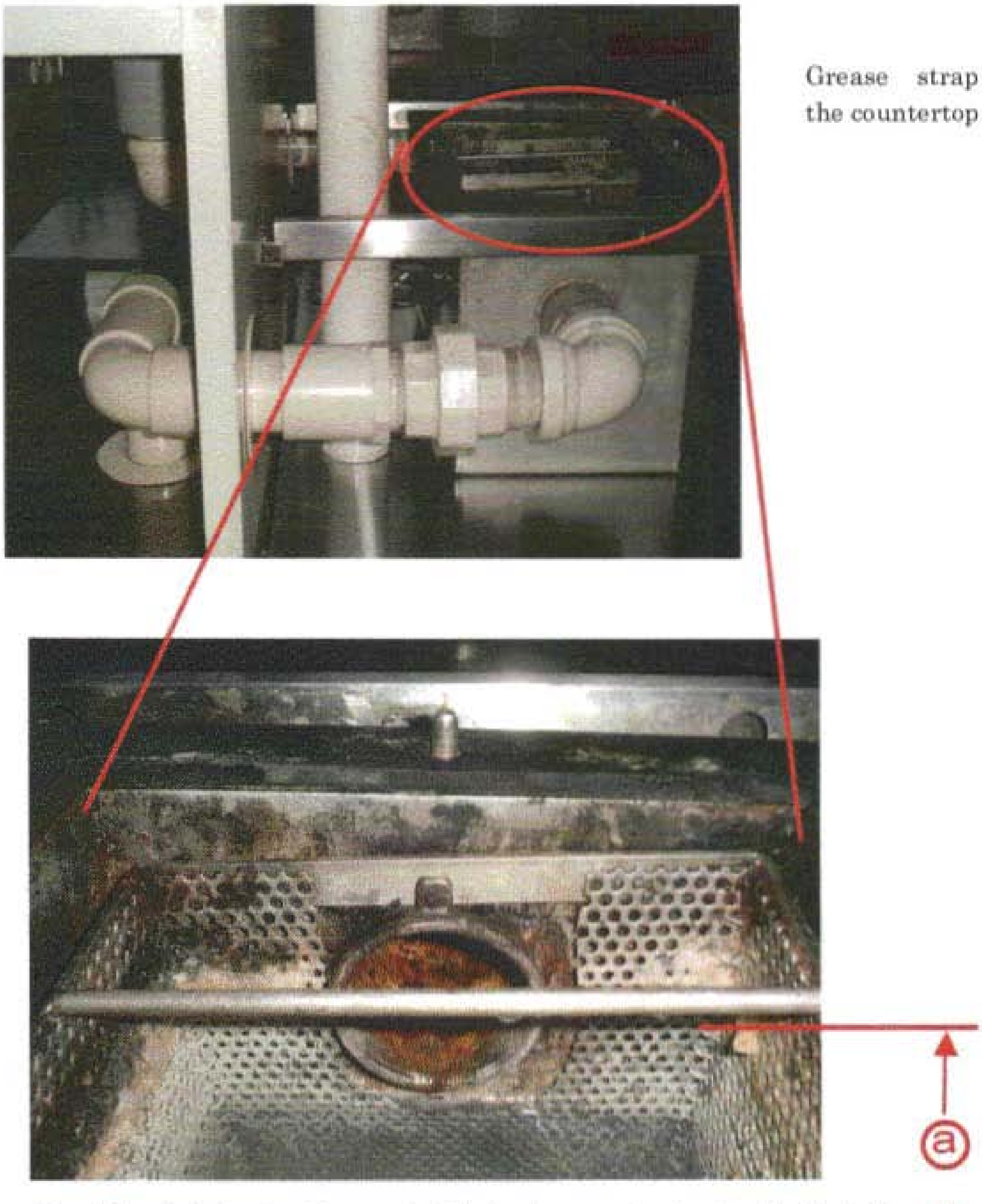
For treating water in the cookery on the fifth floor, Vulcan is installed on the vertical piping in the warehouse where the nearest main water pipe is exposed. The effectiveness of the Vulcan appears in all the service water on the fifth floor that is supplied through this piping.
Piping size: 50A. (The photo on the right shows the Vulcan installed)
Model installed: Vulcan 5000 (water treatment capacity: 5 m3/hour)

Verification of the effectiveness:

The status of the grease trap upon installation of the Vulcan was confirmed, and the changes of the statuses were observed for approximately five months from the start of the operation. In almost all cases, the effectiveness can be confirmed through the observation for about three months.

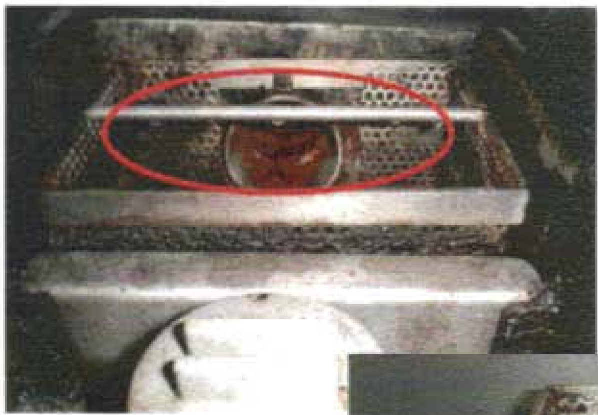
On June 13 (before installation of the Vulcan)
(*) The Vulcan was installed on June 17.

Grease strap under the countertop

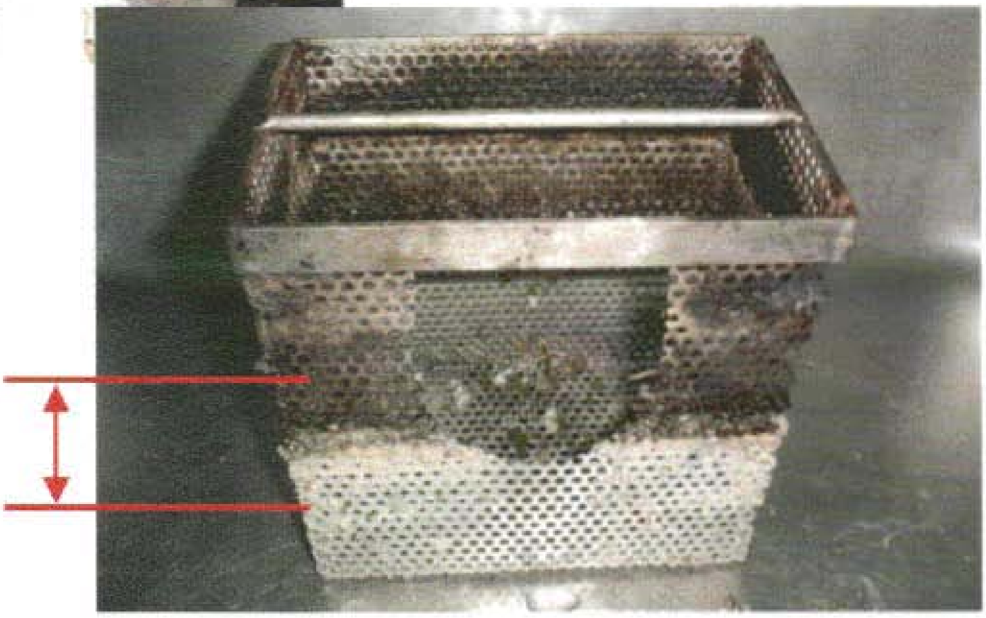


Usual level of the standing water: Water flows up to the level indicated by ⓐ.

On September 12 (three months after the installation of the Vulcan)



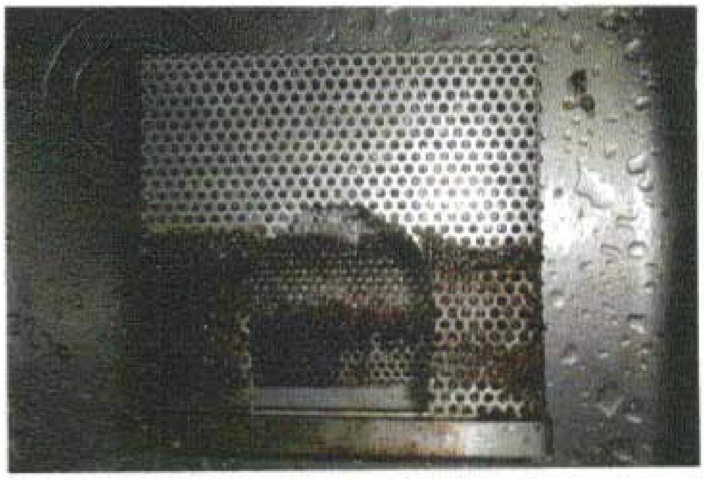
The status of the grease trap three months after the installation:
Compared with the time of installation, the peripheries of the basket drain have gotten dry.



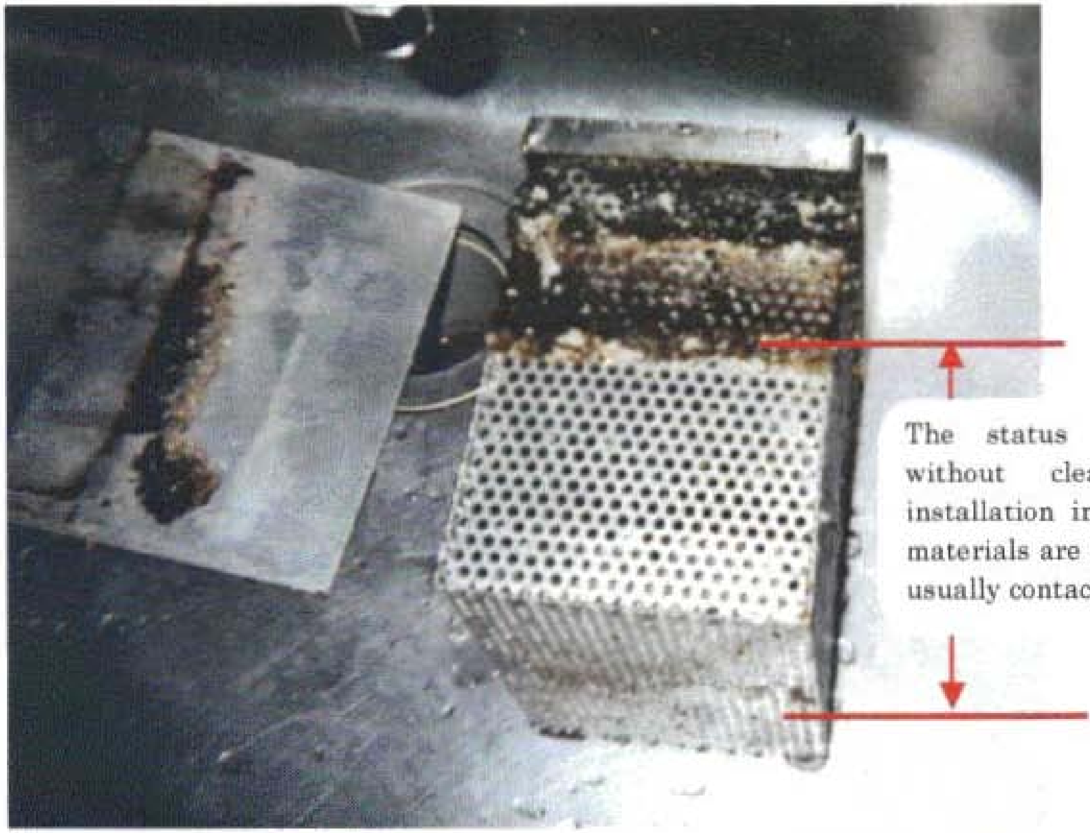
Usual water level upon installation

Standing water level has been lowered due to better drainage achieved by removal of the objects adhered on the basket.

The photo below shows the status of the basket after being washed by hosing.
The portions usually being contacted with the treatment water are cleaned easily with a water flow from the tap. Native dark color of stainless steel can be recognized after cleaning.

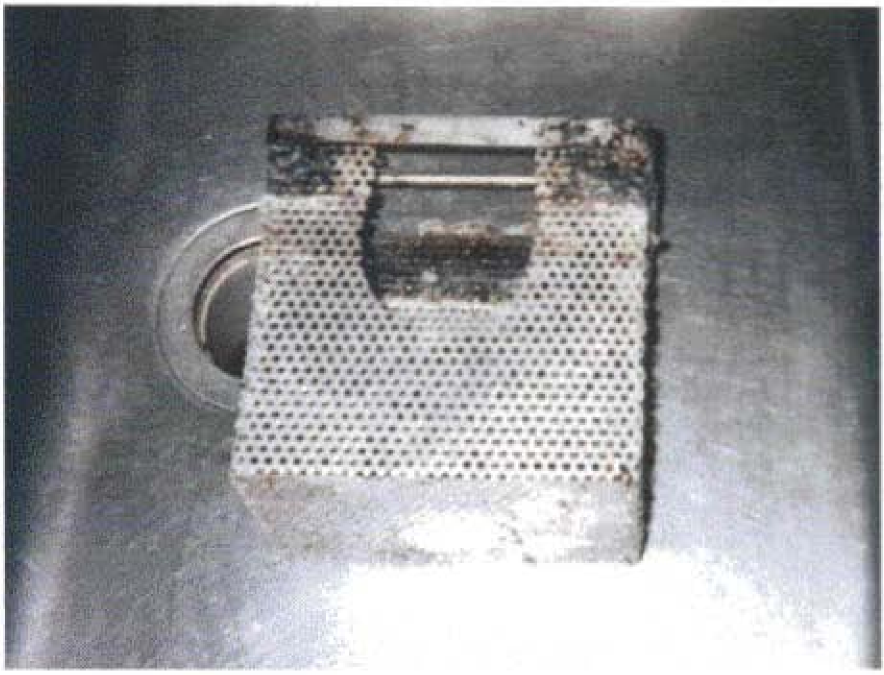


The basket taken out when cleaning the grease trap under the sink on September 20



When the grease trap under the sink was cleaned on September 20, 2006

The status after the cleaning on September 20 was inspected on November 11, 2006.
Almost no adhesion of dirt is seen, thus the effect of this treatment water is recognized.



For proper use of the Vulcan:

The similar effects have been reported in the cases of drainages in the food factories, restaurants and kitchens.
Many installation cases of the Vulcan proved that the treatment water had substantial cleaning effect even with extremely reduced volume of the conventionally used detergent. There were even some cases where the use of detergent (such as cationic detergent) causes a buildup of a thin film of dirt. Cationic detergents should not be used.
With the portions that do not contact with the treatment water, this effect cannot be expected. Vulcan has no effect of breaking or resolving solids in drainage. Although the Vulcan has no disinfection effect, its prevention of dirt from adhering to the basket and the net contributes to the reduction of mold's food source.

Example of installation of Vulcan (pulsed water treatment system)

[Overall view of the apartment building]

- Installation site: In the pit in the ground of an apartment building in Tokyo
- Model: Vulcan S-100 (external box type) Specification combining pulses and electromagnetic technology
- Water treatment capacity: 100 m3/hour

[Inside of the pit in the ground]

[Water supply line]

[Cable winding]

[Under installation]

[Cable winding completed]
The main body of the Vulcan (external box type) has been installed

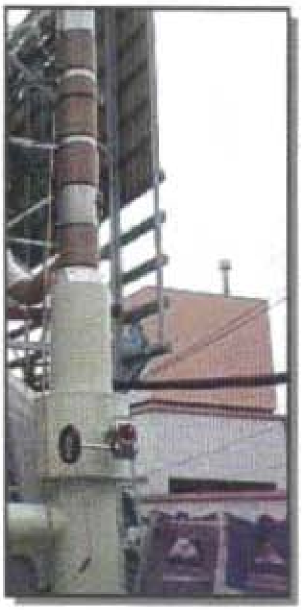
[Installation of the Vulcan completed]

Installation has been completed with the winding of the protection tape over the cable.

Example of installation of Vulcan (pulsed water treatment system)

- Installation site: The elevated water tank on the roof of an apartment building in Kanagawa Prefecture
- Model: Vulcan S-100 (external box type)
  Specification combining pulses and electromagnetic technology
- Water treatment capacity: 100 m3/hour

[Before installation of the Vulcan]



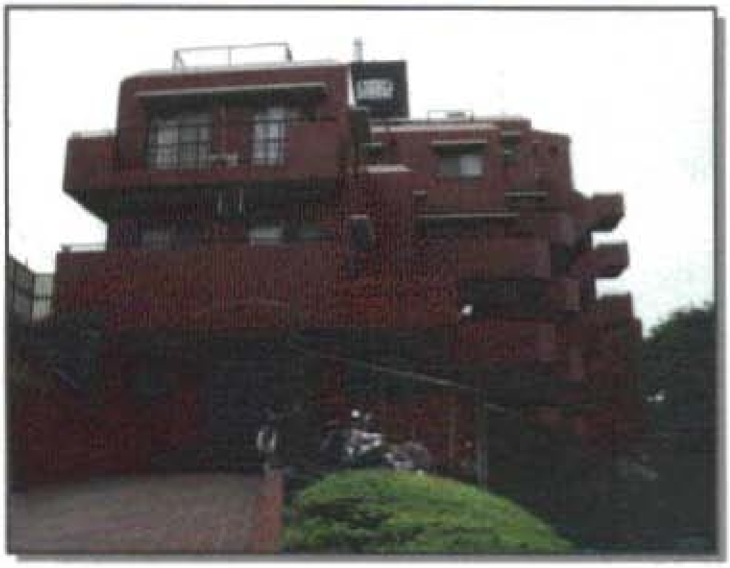
[Under installation]

The cover and the lagging material on the piping are removed and the cable is wound on the piping body.

[Installation of the Vulcan completed]

The main body of the Vulcan (external box type) has been installed, and the piping with cable wound has been covered with the lagging material and the cover.

Example of installation of Vulcan (on the water pipe of elevated water tank)



- Model: Vulcan S-100 (external box type)
  With flat cable and specification combining pulses and electromagnetic technology
- Water treatment capacity: 100 m3/hour

Piping diameter: 125 mm, Five-story building built 23 years ago (with 54 houses)

[Overall view of the apartment building]

[Under installation]

[Installation of the Vulcan completed]

The lagging material and the cover have been temporarily restored.

Example of installation of Vulcan (pulsed water treatment system)

[Overall view of the apartment building]

Installation site: In the pump house at the side of the external water receptacle of an apartment building (built 19 years ago, with 50 houses), in Kanagawa Prefecture.
The piping size is 65A.

Water supply: Pumping from the water receptacle

Model: Vulcan S-25 with flat cable and electromagnetic functions

Water treatment capacity: 25m3/hour

[Before installation of the Vulcan]

[Under installation]

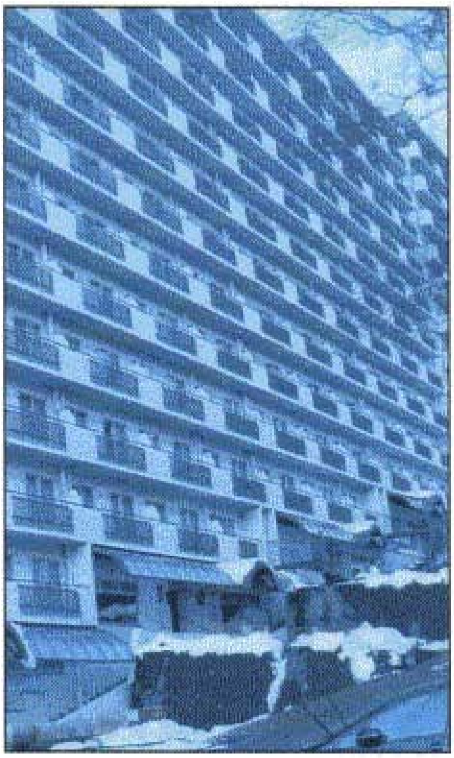
The lagging material is temporarily restored upon installation of the Vulcan.

Example of installation of Vulcan (pulsed water treatment system) within an apartment building

Installation site: Piping space in a house of a resort condominium in Niigata Prefecture
(Built 30 years ago having 420 houses, with piping size of 20A)

Model : Vulcan 1000

Water treatment capacity : 1 m3/hour



[Overall view of the apartment building]

[Under installation]

The cover and the lagging material on the piping are removed and the cable is wound on the piping body.

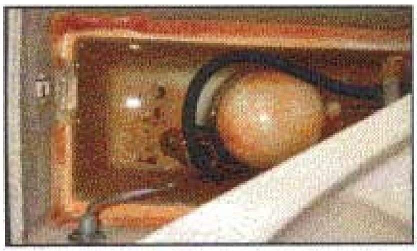
[Installation of the Vulcan completed]

[Sink in the kitchen]

[Before installation of the Vulcan]

[Cleaned with sponge ten minutes after the installation of the Vulcan]

[Inside of the low tank of toilet]



[Before installation of the Vulcan]

[Cleaned with sponge thirty minutes after the installation of the Vulcan]

Comparison Table for Anti-Degradation Measures on Water Supply Pipes

November 28, 2008
Catalina Co., Ltd.???

Method	Vulcan (Impulse system)	Pipeline renewal	Pipeline rectification	Membrane deaeration	Electric anti-corrosion	Magnetic treatment	Ceramic treatment
Principle	Scale and rust are removed and suppressed, by changing oxidization reduction potential (ORP), surface tension, and surface potential, through the use of modulated and phase-shifted impulse (volt signal).	Pipeline replacement, in the general term	Grinds rust and pasts resin. Way of resin painting causes unevenness.	Dissolved oxygen in water is removed, which postpones corrosion and extends the life. Membrane deaeration needs filter replacement cost and mechanical deaeration needs electricity cost for the vacuum pump.	Putting electrodes into the water supply pipe, and suppresses the iron ionization	Magnetic field is generated inside the pipe, and by cutting the magnetic field with the rapid water flow, minute electric energy is applied with which corrosion progress is suppressed.	Ceramic and water are touched, with which water is activated then it suppresses corrosion.
Construction period (If brings water outage)	1 to 3-hour installation work No water outage, by setting outside of the piping system	More than 1 month Water outage, during construction	1-2 weeks Water outage, during construction	2-3 days Water outage, during construction	5-10 days Water outage, during construction	1-2 hours (when setting outside of pipes) 1-3 days (when cutting pipes) Water outage, during construction	1-3 days Water outage, during construction
Effectiveness	2-6 months	Same day	Same day	1-3 months	Same day to 1 month	6 months to several years or no effects	6 months to several years or no effects
Cost (device+install) (100 houses in condominium)	180,000~360,000 JPY (4 to 6-inch pipe size: changes depending on conditions such as outdoor installation)	50-100M JPY	30-50M JPY (Partially includes piping system refit work.)	10-15M JPY	16-20M JPY	5-12M JPY	5-12M JPY
Running cost (maintenance inclusive)	Electric utility expense 150-500 JPY/Year (Depending on size)	Not necessary	Not necessary	In membrane deaeration 6M JPY for membrane replacement in every 10-year, several-time pre-filter replacement a year, 500-700K JPY electricity cost for pumps	Electricity utility expense 30-50 JPY/house Maintenance 100-150K JPY/Year	In circulation type Electricity utility expense for pumps	In circulation type Electricity utility expense for pumps
Remarks (merits/demerits)	No effects or takes time, in empty room or small water consumption (Encounters with automatic drain device having a timer), 10-year product guarantee	Pipe material can resume corrosion after renewal. Personal cost sharing. Open piping degrades assets.	Reconstruction is difficult. Personal cost sharing. Resin may have problems in environmental hormone, 5 to 10-year guarantee	Running cost is high. Useless under direct pressure type. Poor water taste. Requires soundproof measures.	Aimed at main piping; thus, insufficient effects to branch pipes. Secondary sterilization effects. 10-year guarantee.	· No effects or takes time, in empty room or small water consumption · Variety works and devices Partially unclear effects	· No effects or takes time, in empty room or small water consumption · Requires replacement or washing by ceramic sorts. Low water pressure.
Safeness	◎	◎	○	△	○	○	○
Construction cost	◎	△	△	△	△	○	○
Maintenance cost	◎	◎	◎	△	○	○	○
Service life	○	◎	△	△	◎	△	△

Test report on Vulcans (pulsed water treatment systems) installed as a preventive measure against scale buildups causing faulty of the cooling towers

February 24, 2007

Tested field: Factory of a pharmaceutical company

Installation sites: Cooling towers on the rooftop of the second building

2-1 cooling tower **A**: Makeup water piping size is 50A.

2-2 cooling tower **B**: Makeup water piping size is 50A.

1 cooling tower **C**: Makeup water piping size is 50A and circulating piping size is 80A.

Model installed:

Vulcan S25

(water treatment capacity: 25 m3/hour)

Date installed:

For the cooling towers **A, B**, and **C**: July 22, 2006

For the cooling tower **C**: October 6, 2006

Objectives:

1 To prevent scale buildups on the cooling towers.

2 To reduce chemicals used for water treatment

(measure for complying with ISO 14001)

3 To save the energy cost by preventing the deterioration of the heat exchange effectiveness

Vulcan installed on the makeup water piping (50A)

Used for the cooling towers **A, B**, and **C**

Vulcan installed on the circulating piping (80A)

Used for the cooling towers **C**

Verification of the effectiveness:

After installation of the Vulcans, the statuses of the cooling towers A, B, and C were inspected without using any water treatment chemicals. Even after elapse of approximately six months, almost no scale buildups were observed inside the refrigerators and the heat exchanger tubes, and no water pollution warning was displayed. (Usually, without water treatment chemicals, the water quality is deteriorated and water pollution warning is displayed.) Silica adhered on the cooling towers was easily removed with a finger touch. With these results, the effectiveness of the installation of the Vulcans could be confirmed.

Remarks (Summary)

The water treatment system, Vulcan, has the following features: (For details, refer to the brochure attached.)

Vulcan changes only the crystal structure of scales without changing the quality of water. Therefore, nothing is added or reduced to or from the ingredients of water. The water through Vulcan is soft and has an increased permeability. Vulcan makes city water to drinking water and can be used as better cooling water.

(*) The effectiveness of the water treatment in the water supply line will last for 48 hours and for approximately 2 km in distance.

Major features include:

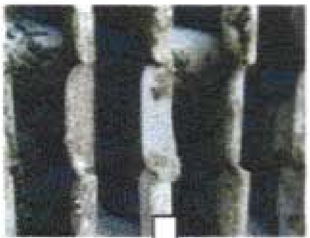
- Prevents buildups of rusts and scales
- Makes cleaning in the kitchen and bathroom much easier (toilets, showers, tiles, joints, etc.)
- Drastically reduces the clogging due to oil balls
- Eliminates the necessity of strong chemicals for removing scales.
- Eliminates the necessity of additives.
- Does not change the water quality.
- Prevents the clogging at the time of drainage

2.1 Cooling tower A
2.2 Cooling tower B

1 Cooling tower C

Developments after installation of the Vulcan

(Zoomed)



Adhesion of silica six month after the installation of the Vulcan

Water is hosed.

After the hosing

Silica is not removed by hosing, but can be pealed off with a nail.

Silica is removed by simply hosing the water. (The remaining silica is pealed off with a touch of a finger.)

(*) The installation of the Vulcan in the circulation line seems to create the status equivalent to the cooling tower C.

Water quality tests on the cooling tower C	
Quality tests of three types of water approximately six months after the installation of the Vulcan:	(1) Makeup water (2) Circulating water (3) Makeup water (raw water)

(*) Refer to the attached test report.

Cost vs. effect in cooling water system, by introducing impulse water treatment system, Vulcan

January 6, 2009

1. Non-treatments
2. Chemical-injection treatments
3. Impulse water treatment system, Vulcan-treatments

Conditions

- Cooling tower for 100RT turbo chiller (circulation water volume: 78 m3/hr), pipe diameter 125A, 24-hour yearly operation
- Quality of replenishment-water: total hardness 80-100 mg/l, ion-shaped silica 20-25 mg/l
  In the case of non-treatments, density upper limit becomes N=2 or less.
- Presumed unit price of water and sewer services: 400 JPY/m^3
  (In such metropolis as Tokyo, Chiba, and Kanagawa, presumed unit price of business purpose water supply only: 300-400 JPY/m3)
- Vulcan capability upper limit: total hardness 400 mg/l, based on experimental values, ion-shaped silica 100 mg/l

Annual replenishment-water volume calculation example

Circulation water volume (R=78 m3/hr), temperature conditions (Δt=5°C)

Vapor loss volume E: Δt=5°C, 0.9% of circulation water volume R is evaporated.
E=Rx0.9/100=78x0.9/100=0.70 m3/hr

Replenishment-water volume M=ExN÷(N-1)

<u>In the case of non-treatments, density N=2</u>

Replenishment-water volume M=0.70x2÷(2-1)=1.4 m3/hr
In one year, (service time 24x365=8,760 hr)
Annual replenishment-water volume: 1.4 m3/hx8,760 h=12,264 m3/year

<u>In the case of chemical-injection and Vulcan treatments, density N=4</u>

Replenishment-water volume M=0.70x4/÷(4-1)=0.933 m3/hr
Annual replenishment-water volume: 0.938 m3/hrx8,760 h=8,176 m3/year

Chemical-injection dosage

Dosage density 200 mg/l
Annual chemical-injection chemical dosage volume
= annual replenishment-water volume x chemical maintenance density ÷ density multiple
= 8,176 m3/yearx200 mg/l÷4
= 408.8 kg/year

Cost comparison, trial balance sheet

1. Non-treatments running cost

Conditions: Density N=2

Replenishment-water quality: total hardness 80-100 mg/l, ion-shaped silica 20-25 mg/l, unit price of water-service 400 JPY/m^3

Annual water consumption m^3	Annual water-service cost JPY	Chemical cost JPY	Maintenance cost JPY	Total cost JPY/year
12,264	4,905,600	0	150,000	5,055,600

2. Chemical-injection treatment running cost

Conditions: Density N=4, density control with the automatic blow device

Replenishment-water quality: same as the water-service unit price (1.)

Chemical density 200 mg/l, chemical unit price 2,500 JPY/kg

Annual water consumption m^3	Annual water-service cost JPY	Chemical cost JPY	Maintenance cost JPY	Total cost JPY/year
8,176	3,270,400	1,022,000	50,000	4,342,400

* Cost in the chemical-injection devices is not included.

3.1 Vulcan-treatment running cost

Conditions: density N=4, density control with the automatic blow device

Replenishment-water quality: same as the water-service unit price (1.)

Sterilization and anti-algae chemical products:

New motokurinn W (pack-type)

1 piece per 50RT, 2-month effective, unit price 10,000 JPY

Power consumption: not inclusive, because smaller than that for the chemical-injection pump (150-500 JPY/year)

Annual water consumption m^3	Annual water-service cost JPY	Chemical cost JPY	Maintenance cost JPY	Total cost JPY/year
8,176	3,270,400	120,000	0	3,390,400

3.2 Impulse water treatment system, Vulcan, system price (Initial cost)

VULCAN Model	Price JPY	Installation cost JPY	Total JPY
S100 Maximum flow volume 100 m^3/hr	360,000	40,000	400,000

*A waterproof box is required separately in the case of outdoor installation.

—

According to the above trial balance sheet,

Vulcan-treatment vs. non-treatment indicates:

Annual water saving volume: 12,264-8,176=4,088 m3
Water saving ratio=33%

Vulcan-treatment vs. chemical-treatment indicates:

The time when the Vulcan initial cost becomes less expensive than the difference in the running cost between the chemical-injection treatment and Vulcan-treatment is about five months.
400,000÷(4,342,400-3,390,400)=0.42 year
Cost reduction by Vulcan 10-year function guarantee:

	Chemical-infection treatment Running cost JPY	Vulcan-treatment Initial cost + running cost JPY	Cost reduction in JPY JPY
1st year	4,342,400	3,790,400	5520,000
2nd year	8,684,800	7,180,800	1,504,000
3rd year	13,027,200	10,571,200	2,456,000
5th year	21,712,000	17,352,000	4,360,000
10th year	43,424,000	34,304,000	9,120,000

In addition to such effects as water saving, chemical saving, and maintenance-cost saving, Other merits include:

- electric saving (about 5-15%) by the scale prevention on the turbo chiller,
- gas-saving (about 5-25%) by the scale prevention on the absorption chiller, and
- life extension (about 30-60%) of the equipment.

Practical examples

1. F-company Chiba plant, in the health food market, have installed Vulcan, type S25, on the replenishment water pipe in the cooling tower (180RT) for their absorption chiller, in reply to a request from a customer. Then, 1.65 million JPY have been saved in the cost of annual scale dispersion elements. Required were anti-algae chemical products only.

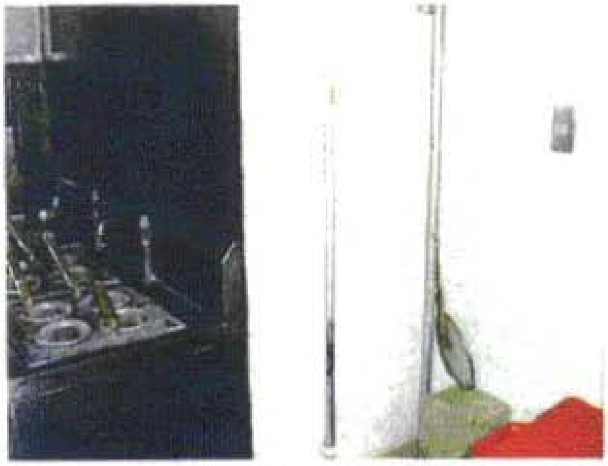
   Where after, they placed additional orders of 7 units of Vulcan, type S25, for their cooling water systems.

2. M-printing company, Funabashi city, installed Vulcan, type S25, for their 20RT compressor cooling water circulation system as ISO14001 measures, and they have saved the cost of general water treatment agent's equivalent to 200,000 JPY. Moreover, rigid scale unable to remove with the general water treatment agents came out becoming brittle.

   Where after, they placed an additional order of Vulcan, type S100, for their chiller.

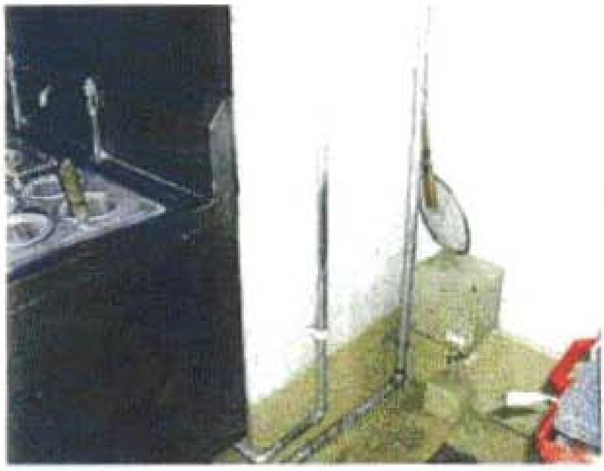
March __, 2006

Noodle boiler in the kitchen

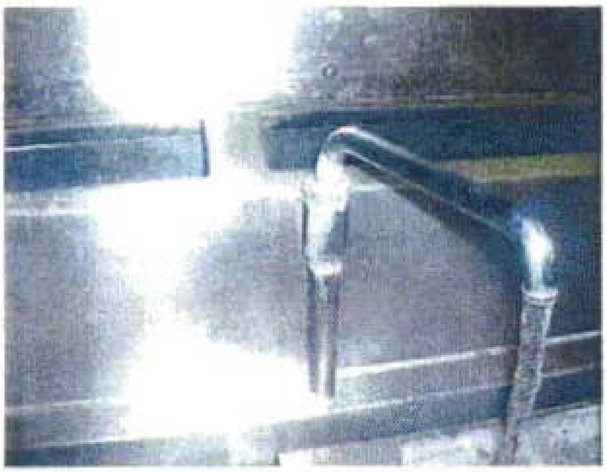


Noodle boiler in the kitchen

Noodle boiler in the kitchen



Noodle boiler and hot water supply line



Hot water tap

Water treatment system installed

Main body of the water treatment system installed

Main body of the noodle boiler

Water tank of the noodle boiler
(White portions show silica adhered)

Heating section in the water tank of the noodle boiler
(hot water is supplied)

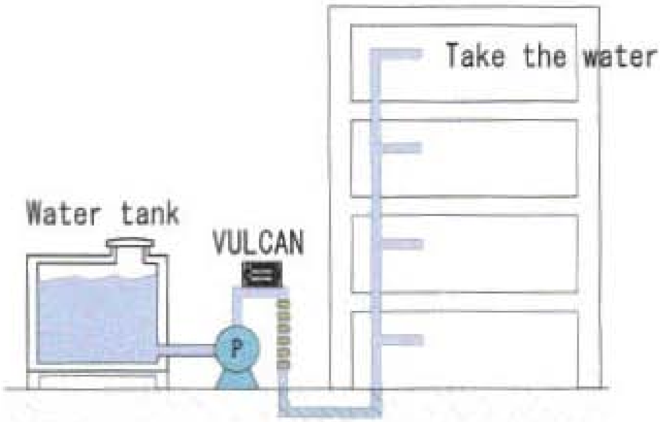
Example of installation of VULCAN

The rust water from inside coved pipe by coating

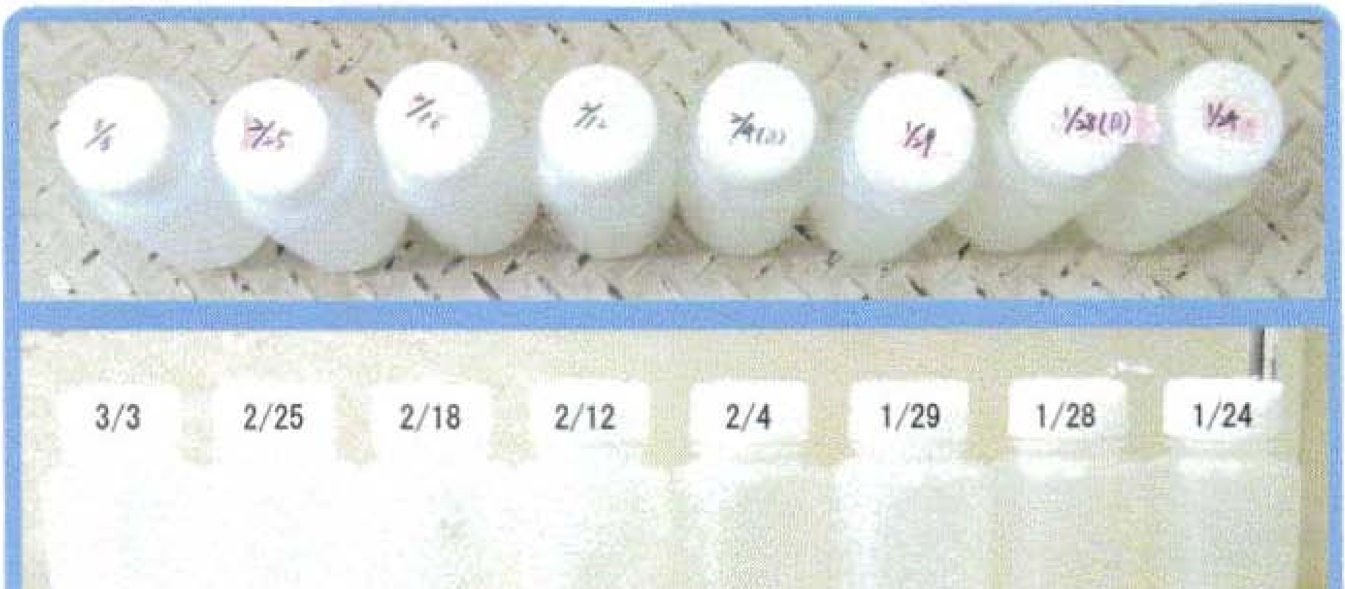
The picture of the installation

- Installation day : 23/Jan-2008
- Installation place : Sizuoka pref(JPN) office BLD. of pharmaceutical company outside pipe room
- Installation type : VULCAN S25
- Installation pipe size : 100A inside covered by coating
- Problem : Rust water flew every day in the morning

Especial, the rust water flew from tap at 4 floor.
every morning these rust water gathered up
into the plastic holder and water color comparison
to day by day.
After the 40 days later, from the VULCAN installation.
This problem improved in almost colorless water,
by teh VULCAN system.



Water system



A gatherepuper the rust and thickness
water color decreased day by day

CATALINA

Process about check on effect for the water quality [Rust]

Running test by Vulcan S-100 (with flat cable)

Date of picking	Jewl shop (1F) Sink				7F Toilet for men				8F Toilet for Women				8F Toilet for men			
	Regard by eyes	Iron(Fe)	Color point	Cloud point (thickness)	Regard by eyes	Iron(Fe)	Color point	Cloud point (thickness)	Regard by eyes	Iron(Fe)	Color point	Cloud point (thickness)	Regard by eyes	Iron(Fe)	Color point	Cloud point (thickness)
		mg/ℓ	point	point		mg/ℓ	point	point		mg/ℓ	point	point		mg/ℓ	point	point
19/Jul-'07	Rust	0.71	15	2.2	Normal	1.6			Rust	2.8	31	8.4				
27/Jul-'07	Rust	0.84														
10/Nov-'07	Line up for get rightness flush, set up to automatic flush system.															
25/Dec-'07	Rust	0.23	5.6	0.2	Normal	0.12	1.8	0.3	Nothing	0.13	1.6	0.3				
21/Jan-'08	Little Rust	0.26	5.7	0.3												
23/Jan-'08	Nothing	0.14	3.2	0.1												
4/Mar-'08	Nothing	0.09	2.2	0.1												
5/Mar-'08	Normal													0.05	0.9	0.1
17/Mar-'08	Normal	0.02	0.6	0.2												
27/Mar-'08	Bad smell from flush pipe. By defctive installation of flush system.															
31/Mar-'08	Cloud	0.58	12	1.6												

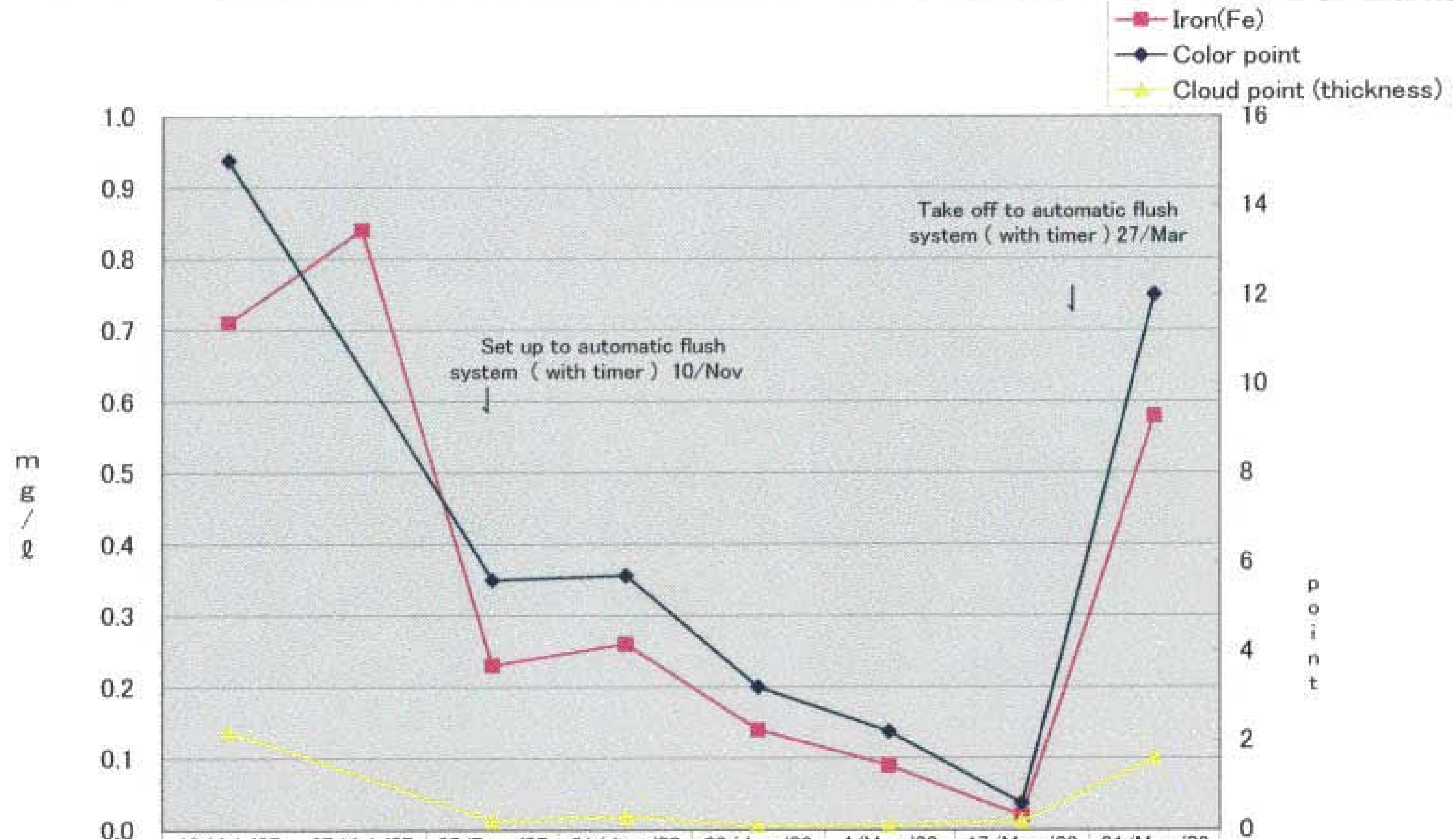
Japanese standard

Iron (Fe)	:	under the 0.3 mg/ℓ
Color	:	under the 5 point
Cloud (thickness)	:	under the 2 point

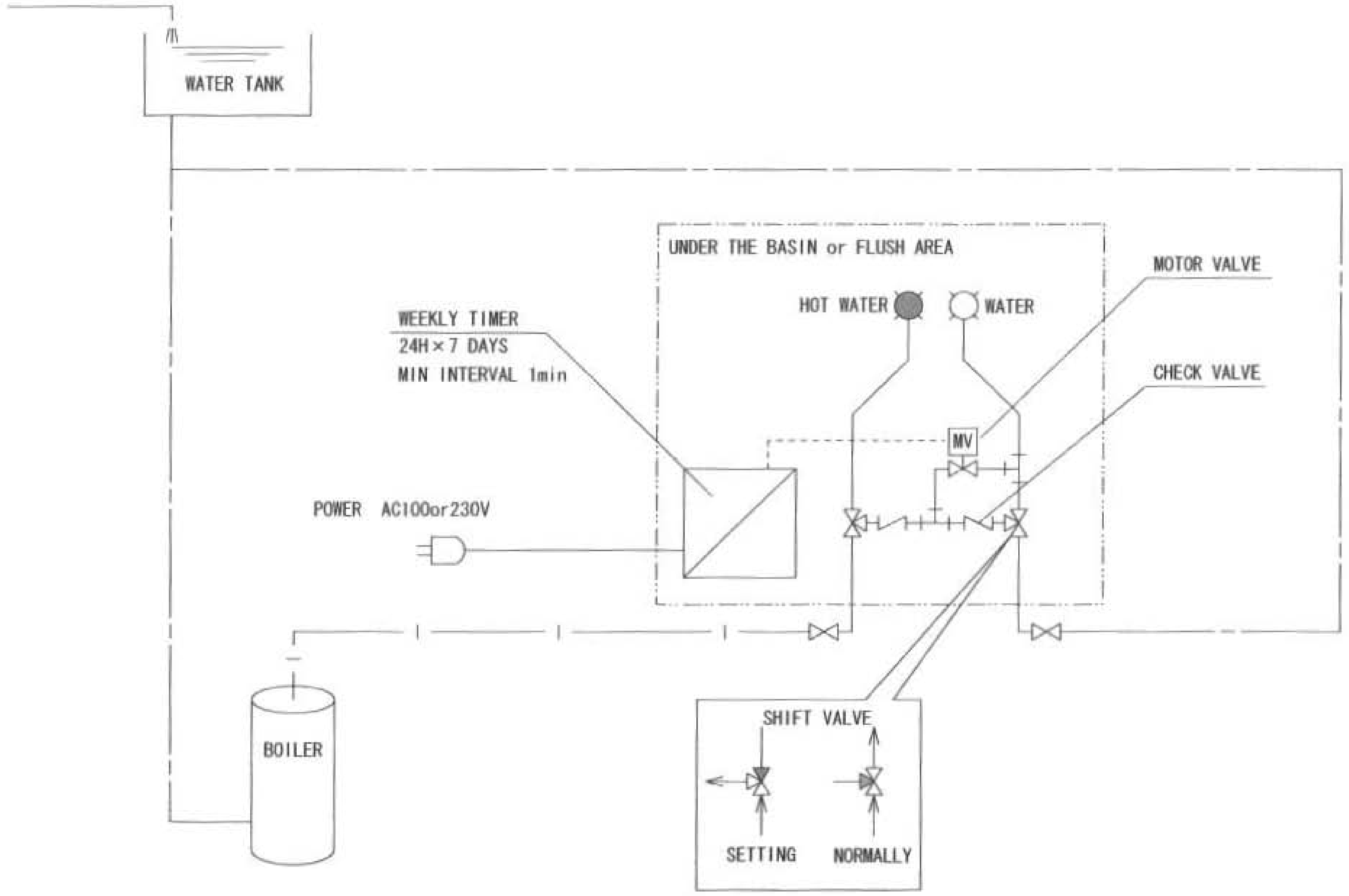
Process about check on effect for the water quality [**Rust**]

Running test by Vulcan S–100 (with flat cable)

Place : Jewl shop (1F) of Inofisu Building



	19/Jul-'07	27/Jul-'07	25/Dec-'07	21/Jan-'08	23/Jan-'08	4/Mar-'08	17/Mar-'08	31/Mar-'08	
Iron(Fe)	0.71	0.84	0.23	0.26	0.14	0.09	0.02	0.58	mg/ℓ
Color point	15		5.6	5.7	3.2	2.2	0.6	12	point
Cloud point (thickness)	2.2		0.2	0.3	0.1	0.1	0.2	1.6	point



CUSTOMER	Q.TY	APPROVE	CHECK	DESIGN		SCALE	DWG. No.	TITEL
******************			2008-09-26		CATALINA	No	NO. *********	AUTOMATIC FLASH SYSTEM FLOWSHEET

The Vulcan 5000 use be the effect upon remove and smell the stone of urine at lavatory. (Test Report by the pictuires at cleiant building)

Before the installation Vulcan 5000 5/Mar,2008

After 20 days later the effect upon remove 24/Mar,2008

The stone of urine removed
gradually soft and like clary.
The smell is not any more.

The Vulcan 5000 instration at outlet of
the water tank.

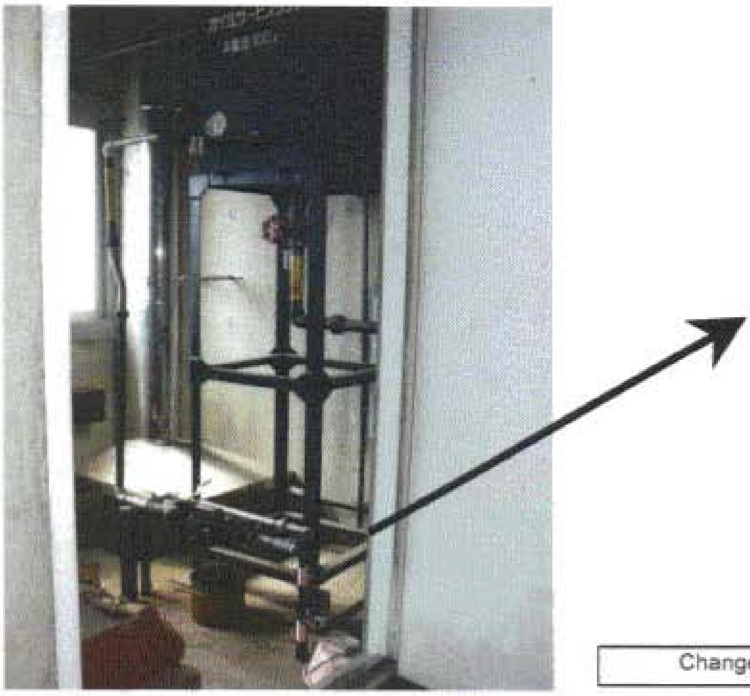
Fuel-efficiency improving measures with the pulse system [Vulcan]

Place installed: Place installed: Nishiki Onsen (Spa), Akita Prefecture
Machine room in a certain facility
Heavy-oil-A piping to a boiler 20A

Machine type: Vulcan 1000, originally (Then, replaced with Vulcan 5000)
Flat cable type

Maximum processing capacity: 5,000 L/H

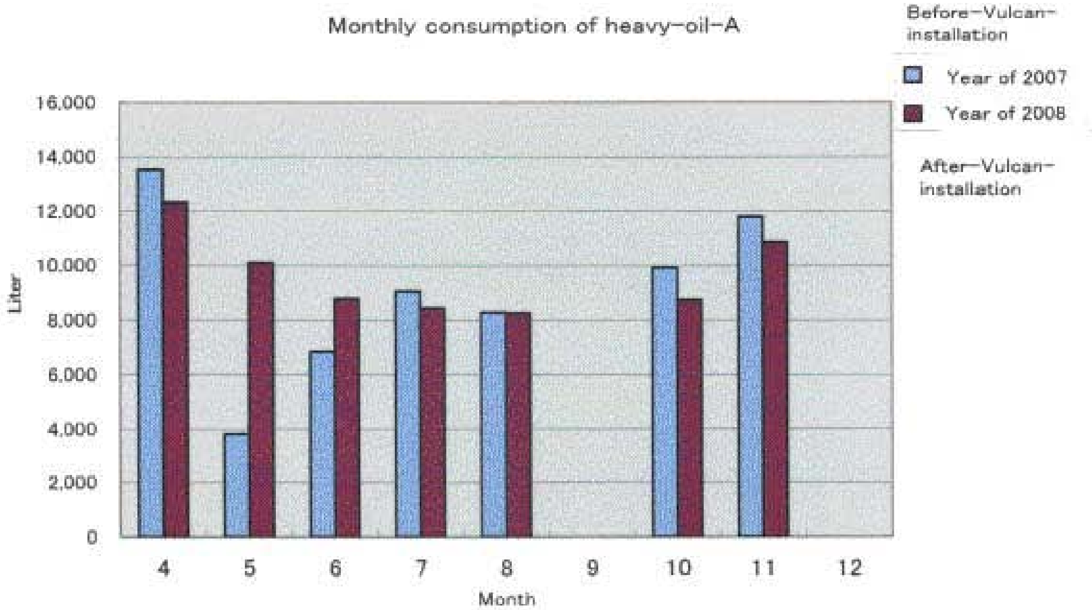
March 10, 2008
Installed Vulcan to the heavy oil supply pipe.



Changed to the flat cable on October 28, 2008.

Purpose
Decreasing the consumption of heavy-oil-A by increasing the boiler burning efficiency

Reports of the heavy-oil-A consumption in the whole facilities and per a visitor,
Comparing before-Vulcan-installation (2007) to after-Vulcan-installation (2008), on the same month of the previous year



In the year of 2007, 19 days in May and 8 days in June are smaller in business days than those for the year of 2008 respectively; thus, the using volume of the heavy-oil-A is also small.

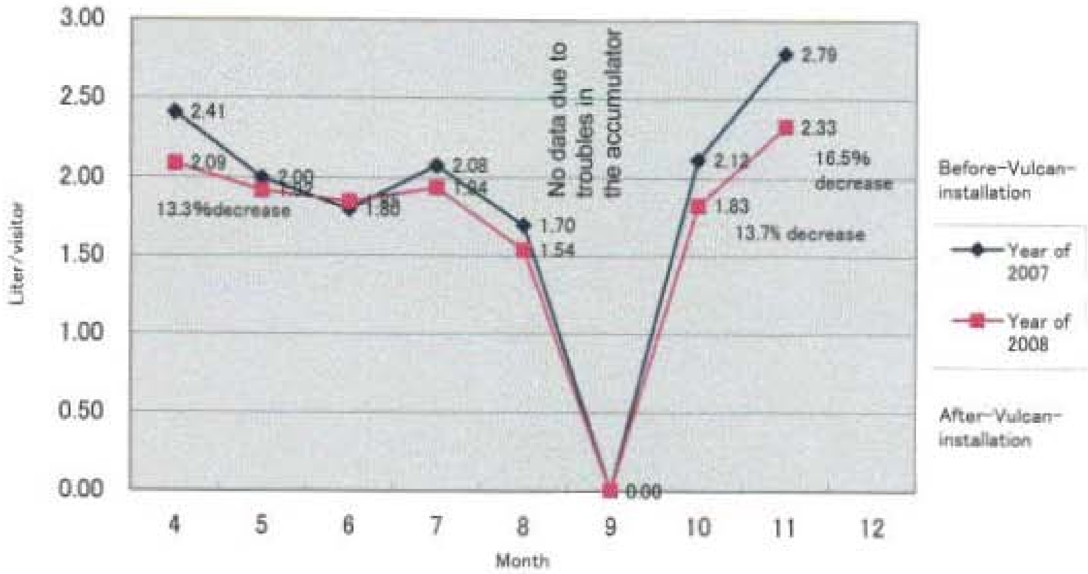
While the number of visitors increased by 9.1% in average, the monthly consumption volume of the heavy-oil-A was decreased by 9% in average.
In five months (April, July, August, October, and November) that have data after installation, 7,841 liters were decreased than the previous year. It means that JPY454,778 could be saved in expenditure, if converted 1 liter at JPY58.

Number of visitors

	4	5	6	7	8	9	10	11
Year of 2007	5,629	1,909	3,790	4,350	4,875	4,875	4,673	4,234
Year of 2008	5,914	5,271	4,749	4,339	5,364	No data	4,774	4,656

No data due to troubles in the accumulator

Using volume of heavy-oil-A per a visitor



In summer or mid-seasons where water temperature is high, no remarkable differences in the heavy-oil-A consumption per a visitor is observed; however, a decreasing effect in the consumption comes out notably in the seasons where water temperature is low.

Validation of effect

Comparing to the before-Vulcan-introduction, the consumption of the heavy-oil-A was decreased by about 9% while the number of visitors increased by 9.1% in average (ratio to the same month of the previous year).
(Omitted are May and June where business days differed remarkably and September that has no data due to the accumulator troubles.)

Presumed monthly cost reduction based on the heavy-oil-A consumption in October and November of the ratio to the same month of the previous year comes to:

	Heavy-oil-A consumption per a visitor (liter/visitor)	Number of monthly visitors (persons)	Unit price of heavy-oil-A (JPY/liter)	Reduced expenses by the introduced Vulcan
October 2008	2.12 ⇒ 1.83	4,774	58	JPY80,299/month
November 2008	2.79 ⇒ 2.33	4,656	58	JPY124,222/month