Role of Ceramics Treatment in Fluidization Method to Remove Scale from Hot Spring Water

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Abstract: In recent years, hot springs have become a part of modern medical rehabilitation and recuperation. Furthermore, hot springs are said to speed recovery from illness and protect against further ailments. The hot springs are inherited natural resource and it is necessary to preserve them for future generations. The study was carried out for the removal test of scale in hot spring by use of the ceramics fluidization treatment device in two locations of the Shiobhitashi hot spring and the Obama hot spring in Japan. The results showed that scale of Shiobhitashi hot spring was characteristic of containing large amount of iron ion and small amounts of calcium ion. The color of scale was reddish brown under the influence of them. However, the scale of Obama hot spring contained large amount of calcium ion, which increased twice as much as that before treatment and the color was white. These results made clear that removal of scale in hot spring by ceramics fluidization took effect on calcium ion. Although chlorine in the sea might increase effects, it should be proved by the continuous experiments.

Key words: Hot spring water, ceramics, scale

INTRODUCTION

As in other places of the world, also in Japan the thermal waters have been created by local geothermal and volcanic activities in certain geological, hydrological and tectonic structures. On account of distribution of 83 active volcanoes along Japan island arcs, Japan is blessed with so many hot springs throughout the country from north to south[2] and there are roughly 150 hot springs with 14000 individual springs. Hot springs are not only water lines that are based on rain water being heated by earth’s magma. Many of the hot springs are virgin water springs (in some of areas when the earth’s core is cooled down and it releases gases and water vapor which turns into hot water) or fossil liquid (when ancient live forms died at the beginning of time the remains dissolved and turned into oil or water). There are various kinds of hot springs in Japan such as acidic, alkaline, sulfuric, ferric, carbonic and so on. White[2], Oki and Hirano[3], Ellis and Mahon[4] and Truesdell[5] attempted chemical classification for hot spring source, respectively. Nakamura[6], Sato[7] and Matsubayashi[8] individually presented 2 to 5 sources with common names for natural waters.

Japanese likes taking the baths from ancient times like ancient Roman and believes its medical effect at any rate[1]. Since mid 1980’s hot spring bathing has become boomed all over the country[9]. These hot springs have also been found to have medicinal properties. The content of gypsum and low salinity make the water ideal for healing bruises, rheumatism, neuralgia, skin diseases, gynecological ailments and other chronic problems.

Formation of scale on the outer layer of bath-tub and sometimes inner side of circulation pipe by which hot spring water is supplied to the bath-tub, becomes a big problem. Usually, scale is formed due to passing of water for long time through a same pipe and staying of water for long duration of time in the bath-tub. It is an urgent social problems to be solved to secure safety and cheaper water and to utilize it. The samples were collected to examine from two different places of Shiobhitashi hot spring, Makizono-cho, Aira-gun, Kagoshima prefecture and the Obama hot spring, Obama-cho, Miramitakaki, Nagasaki prefecture, Japan by using fluidization treatment with granular ceramics of which raw materials were originated from natural silicate minerals.

MATERIALS AND METHODS

Quantify of mineral spring
Shiobhitashi hot spring: Hydrogen carbonate mineral spring (low tonicity-neutral-high hot spring)

Obama hot spring: Sodium chloride mineral spring (isotonicity-weak alkali-high hot spring)

Granular ceramics: The main chemical components of granular ceramics were silica (70.0%) and aluminium
oxide (11.9%). The particles of the powder have massive structure of \(2 \times 10^{-4}\) to \(24 \times 10^{-4}\) m in size. The granular ceramics of 2 mm in diameter with hardness of 7 were made by using the powder and the clay as the bonding agent and sintering at 1200\(^\circ\)C\(^{[10]}\).

**Experimental apparatus:** The treatment device was mounted at the entrance of water storage tank in the hot spring. Water was sampled in it before and after treatment and in a bathtub.

Electrical Conductivity (EC), pH, water temperature and dissolved oxygen concentration (DO) were measured by HORIBA U-10 water quantity checker and the oxidation reduction potential (ORP) by TOA ELECTRONICS PHL-10. The following items of dissolved components were measured.

**Suspended materials:** JIS industrial water test method.

Fe\(^{3+}\), Fe\(^{2+}\): Phenanthrolin absorption spectro photometry
Ca\(^{2+}\), Mg\(^{2+}\), K\(^+\), Na\(^+\): Flame atomic absorption method
Cl\(^-\), SO\(_4\)\(^{2-}\): Ion chromatography
SiO\(_2\): Molybdenum blue absorption spectrophotometry

Test pieces were fitted before and after treatment and the conditions of adhesive scale in hot spring were observed by them.

**RESULTS AND DISCUSSION**

If any kind of water meets two criteria such as water temperature needs to be higher than 25\(^\circ\)C and water must contain a pre-required amount of minerals in 1 kg of hot spring water, that water can be claimed as a hot spring.

In both springs, the concentrations of calcium ion were about 130 mg L\(^{-1}\). More than 1000 mg L\(^{-1}\) bicarbonate was contained in Shihotashi which was 8 times as much as that of Obama hot spring. The concentrations of sodium chloride in Obama were 2345 and 4600 mg L\(^{-1}\), which values were 11 and 26 times as much as that of Shihotashi, respectively (Table 1).

**Shihotashi hot spring:** It has less than 1 g of radical carbon and other mineral elements in each liter of hot spring water. Basically, it is close to the simple spring water as it contains a huge amount of bicarbonate (HCO\(_3\)\(^-\)) ions. Many of them are low temperature water springs. It is good for heart diseases, blood circulation disorders, neurological disorders, female disorders etc. (Table 2).

As Shihotashi hot spring is neutral and hydrogen carbonate mineral spring, pH and DO values increased and the suspended materials decreased after passing through the device during the experimental periods. These facts were agreed with that the water quality became muddy before treatment, but it became clear little by little after treatment\(^{[10]}\). Moreover, almost dissolved components had a tendency to decrease after passing through the device. The test pieces of scale proved that the scale became soft after treatment (Table 3).

**Obama hot spring:** Usually, it contains more than 1 g L\(^{-1}\) of mineral elements. If the water contains more than 1 g but less than 5 g of salt it is weak saltine spring if less than 10 g then it is a salt spring, if more than 10 g then it is strong salt spring (Table 2). Since highly sufficient in keeping temperature it is called warm hot water.

Table 4 shows that pH has a tendency to decrease in contrast with that of Obama hot spring by the treatment. Dissolved oxygen concentration and suspended solid increased, namely the suspension phenomena were observed in the clean bath-tub. Increase of calcium ion indicated the release phenomena of scale.

Granular ceramics have electrical charges at the surface. When water is allowed to pass through ceramics in the fluidization process, friction and collisions are considered to occur continuously among the molecules of water and granular ceramics. It can be presumed that electrochemical reaction takes place in water in form of frictional electricity and piezoelectricity\(^{[8]}\). Moreover,
some physical properties have already been changed with the treatment of ceramics in water[10]. Therefore, the ceramics treated water seemed to increase the activation of water[13] which resultant the reduction of suspended materials causing its resistance against formation of scale inside the water pipe and the outer layer of bath-tub.

REFERENCES


