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DESCRIPTION

METAL POWDER FOR DECOMPOSITION OF ORGANIC HALOGEN AND METHOD FOR MANUFACTURING THE SAME

Technical Field

The present invention relates to metal powder for decomposition of organic halogen to decompose organic halogen compounds which contaminate environment such as soil, river water, ground water, atmosphere and gases and so on in high speed.

Background Art

In recent years, contamination of soil, ground water, and so on by organic halogen compounds represented by organic halogen compound such as tetrachloroethylene (hereinafter referred to as PCE), trichloroethylene (hereinafter referred to as TCE), dichroloethylene (hereinafter referred to as DCE) and so on have become manifest, which is taken up as a social problem.

Meanwhile, various methods for remedying these organic halogen compounds have been devised.

For instance, a method of an aerobic or anaerobic decomposition process has been described in the Official Gazette of Japanese Patent Laid-open No. Hei 7-178395.

Still further, for instance a method of oxidative decomposition process using a photocatalyst has been described in the Official Gazette of Japanese Patent Laid-open No. Hei 7-144137.

Yet further, for instance, a method of reductive decomposition

process by spongy iron powder (hereinafter referred to as iron powder) has been described in the Official Gazette of Japanese Patent Laid-open Hei 11-235577.

In addition to the above, for instance, in the Official Gazette of Japanese Patent Laid-open No. 2000-5740, it has been disclosed that iron powder containing copper (hereinafter referred to as copper-containing iron powder), prepared by metal copper being combined in an amount of 0.2 wt% to 20 wt% on a metal iron powder surface, makes it possible to enhance decomposition activity of metal iron powder for organic halogen compounds

In order to remedy contamination of soil, ground water, and so on contaminated by organic halogen compounds, such a technical method described above has been disclosed or proposed. However, since organic halogen compounds are so various, there still exist some organic halogen compounds for which remediation with such a technical method is still difficult.

In other words, there still exist organic halogen compounds to be described later, which are difficult to be decomposed even by using iron powder or copper-containing iron powder which is presently thought to be promising as a decomposition and remediation method for organic halogen compounds.

Disclosure of the Invention

The present invention has been developed in the above background, and the object of the invention is to provide metal powder capable of decomposing and remedying various range of organic halogen compounds including organic halogen compounds which are difficult to be decomposed

by a conventional decomposition and remediation method in high speed.

The present inventors first prepared various iron powder samples, and carried out measurement of decomposition rate of TCE which was selected as a typical organic halogen compound, using the above-described iron powder samples.

The result shows that the above-described iron powder and the copper-containing iron powder have relatively large decomposition rate.

However, the result also shows that it is still difficult even for these iron powder and copper-containing iron powder to decompose and remedy organic halogen compounds such as monochlorobenzen (hereinafter referred to as MCB) and so on which are difficult to decompose and remedy in high speed.

Here, the present inventors conducted structural analysis and electrochemical analysis for particles of the iron powder and the copper-containing iron powder, and after much trial and error based on the results of the above analyses, finally have come up with metal powder capable to decompose and remedy organic halogen compounds difficult to decompose and remedy such as MCB and the like in high speed and have completed the present invention.

That is, a first invention is to provide metal powder for decomposition of organic halogen comprising at least two kinds or more of metal elements, the respective metal elements forming phases, the respective metal elements therein serving as major constituents thereof, and the metal powder containing the phases,

wherein difference in standard oxidation-reduction electric potential between any two kinds among the above-described metal elements is 778 mV

or more in absolute value.

The metal powder of this constitution for decomposition of organic halogen has capability to decompose and remedy hardly decomposable organic halogen compounds for which an iron powder or a copper-containing iron powder having 777 mV or less of the difference in standard oxidation-reduction electrical potential in absolute value is difficult to decompose.

As a result, the metal powder of this constitution for decomposition of organic halogen compounds exhibits a great effect on remediation of soil, ground water, or the like contaminated by the hardly decomposable organic halogen compounds.

A second invention is to provide the metal powder for decomposition of organic halogen described in the first invention, wherein at least two kinds of phases among the aforementioned phases expose themselves on the surface of the metal powder.

The above-described metal powder of this constitution for decomposition of organic halogen can decompose organic halogen compounds around the metal powder effectively.

As a result, the metal powder of this constitution for decomposition of organic halogen realizes the reduction of the decomposition and remediation time, reduction of the usage of the metal powder, and so on when remedying soil, ground water, or the like contaminated by the above-described hardly decomposable organic halogen compounds so as to exhibit its effect in reduction of operation cost.

A third invention is to provide the metal powder for decomposition of organic halogen described in the first or second invention, wherein the metal powder for decomposition of organic halogen has a structure such that the

other phases are combined to the surface of at least one phase among the above-described phases.

The metal powder of this constitution for decomposition of organic halogen can reduce the content ratio of a metal element which is a major constituent of the above-described other phase in the metal powder, while keeping the difference in standard oxidation-reduction electric potential in absolute value between a metal element which is a major constituent of at least the above-described one phase and a metal element which is a major constituent of the other phase.

As a result, the metal powder of this constitution for decomposition of organic halogen can restrain increase of the manufacturing cost of the metal powder without reducing the capability to decompose and remedy the hardly decomposable organic halogen compounds when high cost metal element is used as a major constituent for the above-described other phase.

A fourth invention is to provide the metal powder for decomposition of organic halogen described in any invention from the first invention to the third invention, wherein at least one phase comprises Co or Al as its major constituent.

The metal powder of this constitution for decomposition of organic halogen is stable as a metal powder and easy in handling and storage.

As a result, the metal powder of this constitution for decomposition of organic halogen exhibits its effect on reduction of the operation cost on remediation of soil, ground water or the like contaminated by the hardly decomposable organic halogen compounds.

A fifth invention is to provide the metal powder for decomposition of organic halogen described in any invention from the second invention to the

A seventh invention is to provide the method for manufacturing the metal powder for decomposition of organic halogen described in any one from the first invention to the fifth invention, wherein the method allows one phase among the above-described phases to come into contact with other phases so that the other phases are combined to the one phase.

According to this manufacturing method, it is not required to consider the easiness of dissolving the metal which is a major constituent of the other phase into acid or difference in the ionization tendency.

Therefore, the method defined in the seventh invention is a desirable method when considering a wide range of combination of metals as a base metal and an combining metal.

An eighth invention is to provide a method for remedying soil, and/or ground water, and/or surface water, wherein the method uses the metal powder for decomposition of organic halogen described in any invention from the first invention to the fifth invention.

Brief Description of Drawings

FIG. 1A, FIG. 1B, and FIG. 1C are graph charts showing a measurement result of a decomposition process of a contaminant using a GC-MS device;

FIG. 2A, FIG. 2B, and FIG. 2C are graph charts showing a measurement result of a decomposition process of a contaminant using a GC-MS device;

FIG. 3A, FIG. 3B, and FIG. 3C are graph charts showing a measurement result of a decomposition process of a contaminant using a GC-MS device; and

possible to manufacture metal powder for decomposition of organic halogen capable of decomposing even hardly decomposable organic halogen compounds.

In other words, the present inventors come up with the idea that iron powder prepared by selecting such a combination of two metals that can give difference in standard oxidation-reduction electric potential of 778 mV or more, more preferably 900 mV or more in absolute value, that is higher than 777 mV, the value being the difference in standard oxidation-reduction electric potential between iron and copper which were the major constituent of the base metal phase and the major constituent of the combining metal phase in the aforementioned copper-containing iron powder respectively, and by allowing the base metal phase in which one metal element is a major constituent to be combined by the combining metal phase in which the other metal element is a major constituent among the combinations of these metal elements could be metal powder for decomposition of organic halogen capable of decomposing and remedying even hardly decomposable organic halogen compounds.

Further, it is preferable to increase the decomposition and remediation rate of the above-described organic halogen compounds or to reduce the manufacturing cost of the metal powder by preparing metal powder in which two kinds or more of combining metal phases are combined to the base metal phase or at least one kind or more of combining metal phase(s) is/are combined to two kinds or more of base metal phases. In this case, it is sufficient if difference in standard oxidation-reduction electric potential in an absolute value between any two kinds of metal elements which are a major constituent of the base metal phase or the combining metal phase is 778 mV

PCB, dioxin, and so on as well as PCE, TCE, cis-1,2-DCE, trans-1,2-DCE. Especially, it is suitable for decomposition of chlorinated organic compounds.

Further, the metal powder samples described above are capable to remedy soil, ground water, and surface water mixedly contaminated by heavy metal(s) and organic halogen compound(s).

When a hardly decomposable organic halogen compound described above comes in contact with the particle surface of a metal powder sample prepared by the above-described method, the contact is thought to be carried out in a form of gas adsorption if the hardly decomposable organic halogen compound is volatile, or in a form of contact accompanying when flowing or mixing if it is non-volatile.

Hardly decomposable organic halogen compounds which are gas-adsorbed to or allowed to contact with the particle surface of the metal powder sample are decomposed according to the interaction between constitution, surface conditions of the metal powder sample and constituent elements, three-dimensional structure of the organic halogen compound. This interaction means direct effect of the metal powder sample on halogen element in organic halogen compounds, effect on double bond portions, effect to form various complex structures, and the like. It is considered that according to the combination of the metal powder samples and the organic halogen compounds, combination of these effects differs which results in difference in its decomposition effect.

When remediation treatment for soil, ground water, gas, and so on contaminated by various organic halogen compounds is carried out using the above-described metal powder for decomposition of organic halogen compound is carried out, for instance, the following methods are desirable.

chlorinated compounds at the concentration of 25.6 mg/L for cis-1,2-DCE, 22.2 mg/L for MCB, 26.12 mg/L for 1,2-DCB, 26.12 mg/L for 1,3-DCB, and 26.6 mg/L for DCM were prepared.

In the meantime, as in Example 1, 0.5 g of the sample was thrown in a 100 ml phial, 50 ml of the above-described contaminant solution for the test was thrown therein and the phial was stirred and shaken after hermetically sealed. At every predetermined intervals of time, gas in the head space portion of the phial was taken as a sample, and qualitatively and quantitatively analyzed with GC-MS (gas chromatograph-mass spectroscope equipment) equipment and the half-life of decomposition of the test contaminant was measured from the concentration of the organic chlorinated compound in the head space portion gas and the above-described stirring and shaking treatment time.

The test result will be explained using FIG. 4.

FIG. 4 is a table showing the measurement result of the half-life at the time when the above-described iron powder sample and the copper-containing iron powder sample decompose the organic chlorinated compounds which are the above-described test contaminants.

From the result in FIG. 4, it was found that the half-life at the time when the iron powder sample and the copper-containing iron powder sample decompose cis-1,2-DCE, MCB, 1,2-DCB, 1,3-DCB, DCM were 3 days or more, or the decomposition was found to make scarcely progress.

As explained above, the present invention have invented metal powder for decomposition of organic halogen in such a manner that in order to decompose and remedy a wide range of organic halogen compounds including organic halogen compounds which are difficult to be decomposed

by a conventional method for decomposition and remediation, metal powder containing at least two kinds or more of metal elements, the respective metal elements forming phases, the respective metal elements therein serving as major constituents thereof, and the metal powder containing the phases,

wherein difference in standard oxidation-reduction electric potential between any two kinds among the above-described metal elements is 778 mV or more in absolute value.

It has become possible to decompose and remedy organic halogen compounds including the above-described hardly decomposable organic halogen compounds by using the above-described metal powder for decomposition of organic halogen.

major constituents of the phases exposing on the surface of said metal powder is 778 mV or more in absolute value.

6. A method for manufacturing the metal powder for decomposition of organic halogen according to any one of claims 1 to 5, wherein said method utilizes the difference in ionization tendency between one phase among said phases and other phases so that said other phases are combined to said one phase.

7. The method for manufacturing the metal powder for decomposition of organic halogen according to any one of claims 1 to 5, wherein said method allows one phase among said phases to come into contact with other phases so that said other phases are combined to said one phase.

8. A method for remedying soil/ground water/surface water, wherein said method uses the metal powder for decomposition of organic halogen according to any one of claims 1 to 5.