

Product for the bactericidal treatment of fluids

Products are known for the bactericidal treatment of water, consisting of active carbon impregnated with silver in the form of salts obtained by immersing the carbon in a solution of silver nitrates.

Such a product has drawbacks: salting-out of nitrates and salting-out of silver. This is because the impregnation does not make it possible to obtain sufficient bonding between the silver and the carbon and salting-out is inevitable.

The use of this product in the field of potable water is therefore limited because the concentration of dissolved silver is limited to 0.01 ppm.

In the laboratory, it is known for active carbon to be hot metallized with metallic silver in a chamber in which a very high vacuum has been created. In this chamber, the silver is evaporated in order to be able to penetrate the carbon. This process allows good diffusion of the silver into the pores of the carbon but the poor bonding of the silver to the carbon results in salting-out of the dissolved silver. The internal structure of the active carbon is completely upset and exhibits significant pollution. This product obtained is more friable and becomes spent with the passage of water. This application does not allow a stable product to be obtained and the manufacture of this product is very difficult, since it takes a long time to obtain the vacuum, and therefore not industrializable.

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The object of the present invention is to propose a product which, after treatment, has a much greater bactericidal and bacteriostatic power than the known products and is virtually free of any pollution. Since the bactericidal power depends on the effective surface area of the product, the latter must have a very high useable active surface area.

The product for the bactericidal treatment according to the invention is distinguished by the fact that it consists almost exclusively, on the one hand, of a porous support of defined external and internal specific surface depending on the requirements and, on the other hand, of a metal covering said specific surface as a thin film of approximately uniform thickness over the entire specific surface, this metal being bonded to the porous support by strong bonding of the covalent-bond type.

Since the metal is strongly bonded to the porous body, there is no risk of it becoming detached and it may be present as a very thin film of the order of 5 to 10 Å. The product is very pure.

The porous support may be inorganic or organic, especially synthetic. It may, for example, consist of active carbon, pumice stone, rock, synthetic resin, etc.

The product has a remanence, that is to say a preservability, inhibiting any subsequent contamination of the fluid treated.

The metal may, for example, be pure metallic silver, or copper, nickel or any other metal having the desired effects.

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Such a product is obtained by injecting the metal, particularly silver, in atomic form into a porous body, for example active carbon powder immersed in a plasma.

Two examples of how to obtain a product according to the invention, consisting of active carbon and of silver, will be described below.

Example 1:

The active carbon, in powder form, was treated in a radiofrequency (13.56 MHz) capacitively coupled discharge in a reactor. The configuration was chosen so as to obtain a high self-polarization voltage across the space-charge sheath.

The gas used in the reactor is argon - with a flow rate of 20 sccm corresponding to a pressure of 1 Pa - and the RF electric power coupled to the gas is 400 W. This coupling takes place through an L-type impedance-matching box. Since the space-charge sheath has a width of approximately 1.5 cm, the intensity of the electric field in the sheath is $5.3 \cdot 10^4 \text{ Vm}^{-1}$. Under these conditions, the density of the plasma is estimated to be 10^{10} cm^{-3} .

The active carbon powder particles are immersed in the plasma where they are consequently subjected to continuous ion bombardment. The effect of this bombardment is to heat the carbon within the actual plasma. The ion flux reaching the surface of the carbon powder particles is estimated to be $7.3 \times 10^{12} \text{ ions.s}^{-1}$.

The silver is injected in atomic form into the gas phase. The effect of the plasma is to create anchoring sites for the silver atoms. This anchoring

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therefore results in strong C-Ag atomic bonding of the covalent-bond type. Thus, the silver aggregates observed in a scanning electronic microscope are firmly bonded to the carbon support and cannot be "salted-out".

The physico-chemical analyses carried out on the carbon powder particles thus treated show a proportion of silver of 57% on the external surface of the carbon. As regards the proportion of silver which diffuses into the volume of the carbon, through the pores of the powder particles, this may be modulated by varying the physical parameters of the discharge. In addition, X-ray fluorescence analyses reveal a very negligible, if not zero, level of pollution compared with that of powder particles treated by chemical impregnation means. This result is due to the fact that the carbon powder particles are exposed to a controlled gaseous environment - in the example in question an inert gas - serving only as a carrier for the metallization. Consequently, any pollution is reduced as far as possible.

It should furthermore be pointed out that this process is integrated: no post-treatment, for example thermal post-treatment, is necessary. The powder particles are treated in one go for a well-defined time, for example 20 minutes.

Example II:

Argon is injected via the base of the reactor, by pumping at the top of the reactor. The virgin active carbon, coming from calcined coconuts, and the N6-grade pure silver (that is to say silver having a purity equal to 99.9999%) are placed in powder form in a rotary drum allowing these powders to be bathed in a

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plasma remote from the pumping valve. A high-intensity electric field is created in the reactor in order to levitate the powder particles in the plasma. Under these conditions, the plasma density is approximately 10^{-9} cm^{-3} and the electron and ion temperatures are 3 eV and 0.03 eV, respectively.

The active carbon granules are immersed in the plasma and, consequently, subjected to continuous bombardment by silver ions. The effect of this bombardment is to raise the temperature of the carbon to approximately 900°C.

The working parameters are as follows:

- argon flow rate: approx. 9 sccm (cm^{-3} per minute);
- working pressure: 2 Pa;
- plasma excitation power: 100 W;
- self-polarization voltage: $1.2 \times 10^5 \text{ Vm}^{-1}$;
- deposition time: 25 minutes
- deposited thickness: 5 to 10 Å.

The deposited thickness is therefore nanometric. It corresponds to an internal density of Ag of greater than 4%.

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CLAIMS

1. A product for the bactericidal treatment of fluids, consisting of a porous support coated with a metal, wherein the metal covers the internal and external specific surface of the porous body as a thin layer of approximately uniform thickness over the entire specific surface, that is to say also the internal surface of the pores, the metal being bonded to the porous support by strong bonding of the covalent-bond type.
2. The product as claimed in claim 1, wherein the metal is pure metal silver (Ag^0), copper or nickel.
3. The product as claimed in claim 1 or 2, wherein the porous support consists of active carbon.
4. The product as claimed in one of claims 1 to 3, which has a remanence inhibiting any subsequent contamination of the fluid treated.
5. A process for obtaining the product as claimed in one of claims 1 to 4, consisting in depositing a metal as a thin film on a porous support by treating the porous support in a cold-plasma reactor by immersing the porous body in an inert-gas plasma, wherein the metal is injected in atomic form into the gas plasma, subjecting the porous support to an electric field of greater than 10^4 Vm^{-1} .
6. The process as claimed in claim 5, wherein the porous support is treated in a reactor having a space-charge sheath with a width equal to approximately 1.5 cm.
7. The process as claimed in claim 5, wherein the inert gas is argon.

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ABSTRACT

The invention concerns a product for the bactericidal treatment of fluids, characterised in that it consists almost exclusively of a porous support with inner and outer specific surface determined according to needs, for instance activated carbon and of a metal, for instance silver, covering said specific surface in a thin layer substantially uniform over the whole specific surface, said metal being bound to the porous support by strong bonds such as covalent bonds. The product is obtainable in a cold plasma reactor.

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