[0012]

However, Patent Literature 1 describes that the microorganism immobilized carrier should preferably contain a resin in an amount of 70 mass % or more. This means that the carrier is resin-rich and is difficult for microorganisms to adhere to. Another problem is that carbon fibers and activated carbon fibers are costly for use as a material for the carrier.

[0013]

The microorganism immobilized carrier of Patent Literature 2 is produced by carbonizing or graphitizing a formed material of an aggregate employing one or more carbonaceous substances selected from natural graphite, artificial graphite, carbon fiber, coke, carbon black, and precursors thereof. Therefore, the bulk density of the carrier is believed to be at least 1.3 or higher, which means that the carrier will require a large amount of energy when it needs to flow inside a tank and that running cost will be high.

[0014]

Embodiments of the present invention provide a microorganism immobilized carrier that is easy for microorganisms to adhere to, and to reduce the manufacturing cost of the microorganism immobilized carrier and the running cost of an apparatus that uses the microorganism immobilized carrier.

SOLUTION TO PROBLEM

[0015]

According to a first aspect of the present invention, there is provided a microorganism immobilized carrier, including a carbon component and a resin, having a zeta potential of from −25 mV to 0 mV, and containing microorganisms adhered to a surface thereof and/or an interior thereof, wherein the carbon component is isotropic graphite.

[0015a]

According to a second aspect of the present invention, there is provided a microorganism immobilized carrier, including a carbon component and a resin, having a zeta potential of from −25 mV to 0 mV, and containing microorganisms adhered to a surface thereof and/or an interior thereof, wherein the proportion of the carbon component is from 50 weight % to 75 weight %, and the proportion of the resin is from 20 weight % to 40 weight %.

ADVANTAGEOUS EFFECTS OF INVENTION

[0016]

Embodiments of the present invention achieve significant advantageous effects of allowing microorganisms to easily adhere to the microorganism immobilized carrier, and also reducing the manufacturing cost of the microorganism immobilized carrier or the like.

BRIEF DESCRIPTION OF DRAWINGS

[0017]

[Fig. 1] Fig. 1 is a cross-sectional SEM image of a carrier A1.

DESCRIPTION OF EMBODIMENTS

[0018]

A microorganism immobilized carrier is characterized by comprising a carbon component and a resin, having a zeta potential of from −25 mV to 0 mV, and containing microorganisms adhered to a surface thereof and/or an interior thereof.

In the present invention, the term “carbon component” refers to a carbon nano material and a carbon material other than carbon fibers.

When the zeta potential is from −25 mV to 0 mV as in the just-described configuration, the deviation from the zeta potential of microorganisms is small (for example, the zeta potential of nitrifying bacteria is about −22 mV to −27 mV), so it is easier to cause interaction. As a result, a large number of microorganisms can be adhered to the microorganism adhered carrier. Moreover, because the carrier is a mixture of a carbon component and a resin, it is possible to reduce the manufacturing cost (i.e., the material cost) of the microorganism adhered carrier. In particular, for the wastewater treatment plant that uses a large amount of microorganism adhered carrier, the effect of cost reduction is extremely significant.

In addition, the carbon component shows high physical strength and high

TABLE 1

		Carrier A1	Carrier A2	Carrier A3	Carrier Z1	Carrier Z2	Carrier Z3	Carrier Z4	Carrier Z5
Material composition	PVA	30	30	30	30	30	85	10	30
	Isotropic graphite powder (>500 μm)	–	–	–	65	–	–	–	–
	Isotropic graphite powder (2 μm - 500 μm)	65	–	–	–	–	10	85	65
	Isotropic graphite powder (less than 2 μm)	–	–	–	–	65	–	–	–
	Natural graphite	–	65	–	–	–	–	–	–
	Carbon nanotube	–	–	65	–	–	–	–	–
	Citric acid	5	5	5	5	5	5	5	–
	Phosphoric acid	–	–	–	–	–	–	–	5
Physical property	Strength	Very good	Good	Good	Fair	Fair	Good	Poor	Poor
	Floating capability	Very good	Good	Good	Good	Good	Good	Poor	Poor
	Continuous pores	Very good	Good	Good	Poor	Poor	Poor	Poor	Poor
	Zeta potential (mV)	−9.1 mV	−10.1 mV	−9.2 mV	< −25 mV	< −25 mV	< −30 mV	< −25 mV	–
	Number of copies of target gene per 1 g of carrier	1.9×10^9	1.9×10^9	1.9×10^9	1.9×10^8	1.9×10^8	1.9×10^8	Unmeasureable	Unmeasureable

[0061]

As clearly seen from Table 2 above, it is observed that the carrier B1 showed a lower bulk density and a higher water absorption rate than the carrier A1. This is believed to indicate that a large number of pores are formed inside the carrier by agitating the paste with a foaming machine and thereafter preparing pellets by drawing. It should be noted, however, that the carrier B1 showed a lower swelling rate and a lower durability. The sedimentation property was also lower.

[0062]

The carrier B2, which used starch as the pore forming agent, showed a higher bulk density, a higher swelling rate, a higher durability, and a higher sedimentation property than the carrier B1. On the other hand, the water absorption rate was lower.

[0063]

It was also observed that the carrier B3, in which the cross-linking agent was changed to formaldehyde and the amount of the added cross-linking agent was increased (PVA and isotropic graphite powder were reduced in amount) relative to the carrier B2, showed a remarkably higher water absorption rate than the carrier B2. Although the bulk density was slightly lower than the carrier B2, the swelling rate, the durability, and the sedimentation property were almost equal.

INDUSTRIAL APPLICABILITY

[0064]

The present invention is applicable to a wastewater treatment apparatus that uses nitrifying bacteria or the like.

CLAIMS

1. A microorganism immobilized carrier, characterized by comprising a carbon component and a resin, having a zeta potential of from −25 mV to 0 mV, and containing microorganisms adhered to a surface thereof and/or an interior thereof,

wherein the carbon component is isotropic graphite.

2. A microorganism immobilized carrier, characterized by comprising a carbon component and a resin, having a zeta potential of from −25 mV to 0 mV, and containing microorganisms adhered to a surface thereof and/or an interior thereof,

wherein the proportion of the carbon component is from 50 weight % to 75 weight %, and the proportion of the resin is from 20 weight % to 40 weight %.

3. The microorganism immobilized carrier according to claim 1 or 2, wherein the carbon component has a particle size of 1 μm to 1000 μm.

4. The microorganism immobilized carrier according to claim 1 or 2, wherein the microorganisms are nitrifying bacteria.

5. The microorganism immobilized carrier according to claim 2, wherein the carbon component is graphite.

6. The microorganism immobilized carrier according to claim 5, wherein the graphite is isotropic graphite.

7. The microorganism immobilized carrier according to any one of claims 1 to 6, wherein the interior thereof includes continuous pores, and the pores have a diameter of from 1 μm to 1000 μm.