dioxide in combination with at least ferric oxide; or combinations thereof can be utilized.

[0072] In an embodiment surface modifiers such as the following can be utilized: fine-nanoscale gold; fine-nanoscale platinum; fine-nanoscale gold in combination with ferric oxide or titanium dioxide; titanium dioxide; titanium dioxide in combination with ferric oxide; and combinations thereof. In an embodiment, fine-nanoscale gold; fine-nanoscale gold in combination with ferric oxide or titanium dioxide; titanium dioxide in combination with ferric oxide; and combinations thereof can be utilized. Fine-nanoscale gold, fine-nanoscale gold in combination with ferric oxide or titanium dioxide, and combinations thereof can also be utilized in an embodiment.

[0073] Another exemplary type of concentration agent includes gamma-FeO(OH) (also known as lepidocrocite). Specific examples of such concentration agents can be found in commonly assigned U.S. Patent Application No. 60/977,188, filed Oct. 3, 2007, and entitled "MICROORGANISM CONCENTRATION PROCESS"; the disclosure of which is incorporated herein by reference. Such concentration agents have been found to be surprisingly more effective than other iron-containing concentration agents in capturing gram-negative bacteria, which can be of great concern in regard to food- and water-borne illnesses and human bacterial infections. The concentration agents can further include (in addition to gamma-FeO(OH)) other components (for example, boehmite (α-AlO(OH)), clays, iron oxides, and silicon oxides). In embodiments where such other components are included, they generally do not significantly interfere with the intimate contact of the sample and the concentration agent.

[0074] Gamma-FeO(OH) is known and can be chemically synthesized by known methods (for example, by oxidation of ferrous hydroxide at neutral or slightly acidic pHs, as described for purposes of magnetic tape production in U.S. Pat. No. 4,729,846 (Matsui et al.), the description of which is incorporated herein by reference). Gamma-FeO(OH) is also commercially available (for example, from Alfa Aesar, A Johnson Matthey Company, Ward Hill, Mass., and from Sigma-Aldrich Corporation, St. Louis, Mo.).

[0075] In an embodiment that utilized gamma-FeO(OH) as a concentration agent, the gamma-FeO(OH) is generally in the form of microparticles. In an embodiment, it is in the form of microparticles having particle sizes (largest dimension) in the range of about 3 micrometers (in other embodiments, about 5 micrometers; or about 10 micrometers) to about 100 micrometers (in other embodiments, about 80 micrometers; or about 50 micrometers; or about 35 micrometers; where any lower limit can be paired with any upper limit of the range). In an embodiment, the particles are agglomerates of smaller particles. The particles can include crystallites that are less than about 1 micrometer in size (in an embodiment, less than about 0.5 micrometer in size). The crystallites can be present as acicular crystallites, as raft-like structures comprising acicular crystallites, or as combinations of the acicular crystallites and raft-like structures.

[0076] In an embodiment, the concentration agents have a surface area as measured by the BET (Brunauer-Emmett-Teller) method (calculation of the surface area of solids by physical adsorption of nitrogen gas molecules) that is greater than about 25 square meters per gram (m^2/g); in an embodiment greater than about 50 m^2/g; and in another embodiment greater than about 75 m^2/g.

[0077] An agglomerated form of the particles can provide the adsorptive capabilities of fine particle systems without the handling and other hazards often associated with fine particles. In addition, such agglomerate particles can settle readily in fluid and thus can provide rapid separation of microorganisms from a fluid phase (as well as allowing low back pressure when filtered).

[0078] Another exemplary type of concentration agents includes metal silicates. Specific examples of such concentration agents can be found in commonly assigned U.S. Patent Application No. 60/977,180, filed Oct. 3, 2007, and entitled "MICROORGANISM CONCENTRATION PROCESS"; the disclosure of which is incorporated herein by reference. Exemplary metal silicates can have a surface composition having a metal atom to silicon atom ratio of less than or equal to about 0.5 (in an embodiment, less than or equal to about 0.4; in another embodiment, less than or equal to about 0.3; in yet another embodiment, less than or equal to about 0.2), as determined by X-ray photoelectron spectroscopy (XPS). In an embodiment, the surface composition also includes at least about 10 average atomic percent carbon (in an embodiment, at least about 12 average atomic percent carbon; in yet another embodiment at least about 14 average atomic percent carbon), as determined by X-ray photoelectron spectroscopy (XPS). XPS is a technique that can determine the elemental composition of the outermost approximately 3 to 10 nanometers (nm) of a sample surface and that is sensitive to all elements in the periodic table except hydrogen and helium. XPS is a quantitative technique with detection limits for most elements in the 0.1 to 1 atomic percent concentration range. Exemplary surface composition assessment conditions for XPS can include a take-off angle of 90 degrees measured with respect to the sample surface with a solid angle of acceptance of ±10 degrees.

[0079] When dispersed or suspended in water systems, inorganic materials such as metal silicates exhibit surface charges that are characteristic of the material and the pH of the water system. The potential across the material-water interface is called the "zeta potential," which can be calculated from electrophoretic mobilities (that is, from the rates at which the particles of material travel between charged electrodes placed in the water system). Exemplary concentration agents can have zeta potentials that are more negative than that of, for example, a common metal silicate such as ordinary talc. Yet the concentration agents are surprisingly more effective than talc in concentrating microorganisms such as bacteria, the surfaces of which generally tend to be negatively charged. In an embodiment, the concentration agents have a negative zeta potential at a pH of about 7 (in an embodiment, a Smoluchowski zeta potential in the range of about −9 millivolts to about −25 millivolts at a pH of about 7; in another embodiment, a Smoluchowski zeta potential in the range of about −10 millivolts to about −20 millivolts at a pH of about 7; in yet another embodiment a Smoluchowski zeta potential in the range of about −11 millivolts to about −15 millivolts at a pH of about 7).

[0080] Useful metal silicates include, but are not limited to, amorphous silicates of metals such as magnesium, calcium, zinc, aluminum, iron, titanium, and the like, and combinations thereof. In an embodiment, magnesium, zinc, iron, titanium, or combinations thereof can be utilized. In yet another embodiment, magnesium is utilized. In an embodiment, amorphous metal silicates in at least partially fused particulate form can be utilized. In an embodiment, amorphous, spheroidized metal silicates can be utilized. In yet another embodiment, amorphous, spheroidized magnesium silicate