COMPOSITE MATERIALS FOR FLUID TREATMENT

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates generally to composite materials and to devices that may alter fluid parameters. Devices incorporating the composite materials of the invention are used to deliver, remove, and generate fluid treatment agents (naturally occurring and synthetic chemical and biological agents), and combinations thereof. These materials and devices are applicable to many different fluid treatment situations including those targeting drinking water, process fluids, fuels and emission, beverage production, cleaning operations, and sensing fluid composition. In its more particular aspects, the invention relates to the field of multifunctional composite materials that may be tailored for many different fluid treatment applications.

2. Description of Related Art

Common Fluid Treatment Art

The treatment of fluids involves the removal of dissolved or suspended contaminants, the modification of fundamental parameters such as pH, dissolved gases, dissolved solids content, and temperature, and the incorporation of chemical and biological agents. Standard fluid treatment practice directed at these goals involves the use of many different treatment agents, devices, and techniques. Treatment agents are commonly applied in all three states, gas, liquid, and solid. The nature of the contaminant that must be removed or agent that must be added and the allowable cost of the operation controls the choice of treatment, agent, device, and methods used. Fluids are treated for a wide range of applications including breathing, cleaning, ingestion, cooling, and direct participation in industrial chemical and biological processes.

Delivery of Fluid Treatment Chemicals

Fluid treatment agents are added to fluids to remove contaminants, chemically convert contaminants, and to modify fluid parameters including pH and the composition of dissolved components. For example, chlorine containing compounds are useful for disinfecting fluids and the containers and conduits used to manage the fluids.

Depending upon the scale of the application, the technical experience of personnel conducting the treatment process, and the allowable costs, either solid, liquid, or gaseous forms of chlorine are used. Additional fluid treatment examples include the dosing of flocculating agents to remove small particulate matter suspended in a fluid and the injection of carbon dioxide for beverages production.

Delivery of solid, liquid or gaseous fluid treatment agents to fluids is complicated and requires significant technical experience to complete safely and efficiently. Injection and dosing systems require the combination and optimization of well characterized solutions of treatment agents, pumps, piping or tubing, flow control devices including valves, and often a power source. Typically, the equipment costs and technical skill required to install, operate, and maintain injection and dosing equipment limits the number of suitable application sites. Additionally, incorrect setting of equipment often damages or substantially decreases the lifetime of equipment positioned downstream of the dosing operation.

Furthermore, many dosing and injection operations utilize reservoirs containing concentrated forms of the treatment agents. These reservoirs may pose safety hazards to both

personnel who operate the equipment or those in the vicinity and to equipment that contacts these agents. Spills, splashing, and leaks often require specialized cleanup agents, procedures, and often a distinct team of specially trained personnel. As a result, all fluid dosing and injection systems require constant supervision in order to effectively maintain operations.

Chemical Generation and Delivery

Several important fluid treatment agents may not be stored effectively and must be generated at the location of treatment. Examples include, the on-site generation of chlorine dioxide and ozone. Both are valuable oxidizing agents that may disinfect, breakdown organic compounds, and react with dissolved inorganic compounds. Flocculating agents based on hydroxide precipitates including those containing aluminum and iron are also commonly generated on site to maximize their particulate removal efficiencies. Safety is also a consideration. Transport of reaction precursors in pressurized and concentrated forms is typically hazardous and a significant drawback to the technology.

Chemical and Biological Agent Collection, Sampling, and Detection

There are certain fluid contaminants that pose a hazard at extremely low concentrations. Examples include biological agents, nerve agents, and heavy metals. Since many of these contaminants accumulate in the body and fluid treatment components over time it is important to employ detection methods that are sensitive to very low concentrations of these agents. Commonly some type of contaminant concentrating technique is used to retain and accumulate the agent to facilitate qualitative as well as quantitative analysis. Both solid phase adsorption and liquid based extraction techniques are used for removing contaminants from the fluid and concentrating. Analysis of the concentrated contaminant(s) may involve stripping the contaminant from the concentrating medium, analyzing the collection media directly, or combinations thereof.

Application Space

A wide range of industrial processes and consumer activities involve the use of fluids. In all cases fluids must be tailored for the specific application. These fluids are either prepared and packaged for direct use or equipment and products are fabricated that modify the fluid for its desired purpose at the point of use. Beverage products prepared for ingestion require fluids to be initially purified and then formulated with agents to impart flavor, color, or nutritional benefit. Examples include commercially available ready-to-drink beverages as well as tap water that is treated before entering a complex distribution system. Similar situations exist for pharmaceutical and medical solution preparation.

Many companies produce products that treat gases and liquids at the point of use or the point of entry into an industrial facility, a residence, or the environment. Common examples include breathing air and drinking water. Treatment products for these fluids vary tremendously in function, scale, and cost. In recent years, the desire for air filtration in the home has become more popular as a need has been demonstrated. Products with increasing sophistication are now available, addressing the concerns of both energy efficiency and indoor air quality. Many breathing air and drinking water applications share contaminant types and removal requirements.

Consumers use many types of household chemicals to modify fluids for cleaning in and around the household. Consumers also use many types of solutions for maintaining