[0080] Submicron separation or dialysis may be performed using, for example, PTCE membranes formed by exposing polycarbonate films to collimated, charged particles from a nuclear pile. The charged particles pass through the polycarbonate to leave sensitized tracks. The polymer tracks are then dissolved with an etching solution to form the pores. PTCE membranes are available commercial through, for example, GE Osmonics Labstore of Minnetonka, Minn., which offers 400 nm and 100 nm pore opening products.

[0081] During operation, the rotary system (not shown) rotates the clectrophoresis apparatus **90** at sufficient speeds to help drive fractionalization. From 10 to 20 rotations per minute (rpms) are exemplary speeds, although speeds outside this range may be employed. The rotary system may operate intermittently, and may change the rotational direction between clockwise and counterclockwise. It has been found that pH levels on the order of 6.8 to 8.8 are particularly advantageous, as are temperatures around room temperature.

[0082] It has been found that water may experience electrolysis in this operation, creating hydrogen and oxygen gases in the housing **82**. It is useful to intermittently vent the zones **95-98** of hydrogen, oxygen, and any other gases present during stage **14**. The venting may take place, for example, during intermissions between rotating periods, e.g., when the rotational direction is reversed.

[0083] Returning now to the flow diagram of FIG. **1**, fractions from one or more of the respective zones **96**, **97** are separately or together subjected to dialysis stage **16**. Generally, an object of dialysis stage is to at least partially separate the CNTs from the detergent (e.g., SDS) and the buffer (e.g., tris-glycine). An exemplary apparatus for performing dialysis stage **16** is shown in FIG. **8** and generally designated by reference numeral **100**. In the process illustrated in FIG. **1**, the dialysis stage **16** may include two sub-steps performed consecutively.

[0084] The dialysis apparatus **100** shown in FIG. **8** includes a cylindrical housing **102** having end closures **103** and **104** at its opposite ends. The housing **102** and end closures **103**, **104** may be made of any suitable material, such as polycarbonate and other materials mentioned herein or otherwise suitable for the intended application. Although not shown, a rotational mechanism or system is included to rotate the cylindrical housing **102** about its longitudinal axis. A rotational device similar to that shown in FIG. **2** and described above may be used.

[0085] A filter cartridge **106** is received in the cylindrical housing **102** and generally centered along the length of the housing **102**. The filter cartridge **106** includes an annular membrane mount **108** for retaining a plurality of filter cassettes **110**, **112**. The filter cassettes **110**, **112** may have a similar construction as described above with respect to cassettes **92-94** and shown in FIGS. **7**A and **7**B.

[0086] Upstream from the filter cartridge **106** and the first filter membrane cassette **110** is a first zone or compartment **114**. Between the first and second filter cassettes **110**, **112** is a second zone or compartment **116** generally contained in the filter cartridge **106**. A third zone or compartment **118** is positioned downstream from the second filter cassette **112** and the filter cartridge **106**. The filter cartridge **106** may further include spacer rings between the filter cassettes **110-102**, and fasteners (e.g., bolts) for securing the filter cassettes **110-112** to the membrane mount **108**. It should be understood that the filter cartridge **106** may contain additional filters to subdivide the chamber **116** of the filter cartridge **106** into more zones or compartments.

[0087] First, second, and third entry/drainage/venting ports **114***a*, **116***a*, **118***a* extend from outside the cylindrical housing **102** to zones **114**, **116**, **118**, respectively, for permitting the introduction, venting, and removal of material from zones **114**, **116**, **118**. Although not shown, removable caps are provided for creating a fluid-tight seal at the ports **114***a*, **116***a*, and **118***a*. If the cartridge cassettes **110**, **112** are placed so closely together so as not to create spacing for aligning the entry/drainage/venting port **116***a* with zone **116** directly, then access ports (see comparable structure of FIG. **7**B, reference numerals **92***f*, **92***g*) of the filter cassettes may be aligned with the port **116***a*. The spacing between cartridge cassettes **110-112** may be particularly limited in instances in which the filter cartridge **106** includes additional (e.g., more than two) cartridge cassettes.

[0088] In the first "sub-step" of the dialysis stage **16** of FIG. **1**, zones **114**, **116**, **118** are each partially filled through their respective ports **114***a*, **116***a*, **118***a* with water and ethanol for separating the CNTs from the buffer, such as glycine. Zone **116** serves as a loading zone to receive the CNT fraction obtained from zone(s) **96** and/or **97** of the electrophoresis apparatus **80**.

[0089] To separate the buffer (e.g., tris-glycine) from the CNTs, a relative low concentration of aqueous ethanol may be used. For example, a 20 v/v % to 40 v/v % of ethanol in water is particularly useful for this stage. By starting the dialysis steps with 20-40% EtOH in water, glycine and Tris remain in solution and are dialyzed away from the sample.

[0090] Rotation of the dialysis apparatus **100** causes the buffer to be stripped from the CNTs and passed through the membranes of the cassettes **110**, **112**. The membrane pore (that is, mesh) size is selected to block passage of the CNTs. Pore sizes of 0.1 nm to 10 nm have been found especially useful. The membrane pore sizes of the cassettes **110**, **112** may be the same or different from one another.

[0091] Dialysis membranes useful in this another other stages described herein include cellulose ester filters, which are commercially available through Spectrum Laboratories, Inc. offering a 50,000 MWCO (estimated <6 nm) membrane and a 5,000 MWCO (estimated <0.1 nm) membrane.

[0092] Without necessarily wishing to be bound by any theory, it is believed that the ethanol breaks down the water structure, inhibiting micelle formation and breaking the micelles into smaller units. It should be understood that materials other than ethanol may be selected, such as isopropyl alcohol, methanol, acetonitrile. The dialysis apparatus **100** may be operated at speeds of, for example, about 40 to about 80 rpm, for example, about 50 rpm to about 60 rpm for each sub-step of dialysis stage **16**. The dialysis apparatus **100** direction of rotation may be periodically reversed to promote cleaning and reduce clogging of the filters.

[0093] In the second "sub-step" of the dialysis stage **16**, a higher concentration aqueous ethanol solution is used to separate the CNTs from the SDS detergent. The ethanol solution may contain, for example, about 80 v/v % or more ethanol to water. Generally, the procedures described above for the first "sub-step" are practiced for the second "sub-step" to migrate the SDS through filter membrane cassettes **110**, **112** (see arrows **120**, **122**) as CNTs are retained in center com-