



PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : B01D 17/00, 17/038, C10G 33/06, 32/00	A1	(11) International Publication Number: WO 97/40903 (43) International Publication Date: 6 November 1997 (06.11.97)
(21) International Application Number: PCT/US97/07181 (22) International Filing Date: 29 April 1997 (29.04.97) (30) Priority Data: 08/640,129 30 April 1996 (30.04.96) US (71) Applicant (for all designated States except US): ENERGY BIOSYSTEMS CORPORATION (US/US); 4200 Research Forest Drive, The Woodlands, TX 77318 (US). (72) Inventors; and (75) Inventors/Applicants (for US only): YU, Li-Qun [CN/US]; 3029 Blue Bonnet, Houston, TX 77025 (US); MEYER, Todd, A. [US/US]; 11 Rosewater Place, The Woodlands, TX 77381 (US); BOLSOM, Brian, R. [US/US]; 94 West Elm Crescent, The Woodlands, TX 77392 (US). (74) Agents: ELMORE, Carolyn, S. et al.; Hamilton, Brook, Smith & Reynolds, P.C., Two Militia Drive, Lexington, MA 02173 (US).	(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, HU, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ARIPO patent (GH, KE, LS, MW, SD, SZ, UG), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG). Published With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.	
(54) Title: OIL/WATER/BIOCATALYST THREE PHASE SEPARATION PROCESS		
(57) Abstract A method and an apparatus for separating a water/organic/solid emulsion, wherein the solid comprises particles having a length of about 50 μm or less, are disclosed. The method comprises the steps of (1) directing the water/organic/solid emulsion from an emulsion source through a first hydrocyclone; (2) inverting the phase of the overflow emulsion from the first hydrocyclone; (3) directing the overflow emulsion through one or more subsequent hydrocyclones arranged in series; and (4) collecting the aqueous phase and the organic phase. The solid can be a biocatalyst, such as an intact bacterial, fungal or yeast cell. The organic phase is a liquid material substantially comprising carbon, which is substantially immiscible with water, such as petroleum. The apparatus of the present invention comprises a hydrocyclone series comprising two or more hydrocyclones connected in series, wherein the intake tube of the first hydrocyclone is connected by a line to an emulsion source; and a means for inverting the phase of the emulsion, interposed in the hydrocyclone series. The hydrocyclones series can comprise one or more de-oiling hydrocyclones, one or more dehydrating hydrocyclones or a combination thereof. The means for inverting the emulsion can be any means for sufficiently agitating the emulsion.		