



US006863815B1

(12) **United States Patent**
Smith

(10) **Patent No.:** **US 6,863,815 B1**
(45) **Date of Patent:** **Mar. 8, 2005**

(54) **SMALL-SCALE HYDROGEN-OXIDIZING-DENITRIFYING BIOREACTOR**

(75) **Inventor:** **Richard L. Smith, Boulder, CO (US)**

(73) **Assignee:** **The United States of America as represented by the Secretary of the Interior, Washington, DC (US)**

(*) **Notice:** Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) **Appl. No.:** **09/662,507**

(22) **Filed:** **Sep. 14, 2000**

(51) **Int. Cl. 7** **C02F 3/00**

(52) **U.S. Cl.** **210/601; 210/748; 210/170; 210/603; 210/615; 210/631**

(58) **Field of Search** **210/601, 748, 210/170, 603, 615-617, 631, 611**

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,709,364 A	1/1973	Savage	
3,829,377 A	8/1974	Hashimoto	
3,846,289 A	11/1974	Jeris et al.	
3,943,038 A *	3/1976	Morinaga	
4,043,936 A	8/1977	Francis et al.	
4,124,481 A	11/1978	Ramer	
4,337,142 A *	6/1982	Knudson et al.	208/433
4,469,599 A	9/1984	Gros et al.	
4,505,819 A	3/1985	Barnes et al.	
4,696,747 A	9/1987	Verstraete et al.	
4,957,514 A *	9/1990	Golden et al.	95/98
5,087,354 A *	2/1992	Montagnon et al.	210/108
5,192,441 A	3/1993	Sibony et al.	
5,206,168 A	4/1993	Boyle	
5,352,608 A *	10/1994	Kaplan et al.	435/262

5,362,636 A *	11/1994	Yokomori	
5,811,255 A *	9/1998	Hunter	
6,077,429 A *	6/2000	Frankenberger et al.	210/605
6,214,607 B1 *	4/2001	Logan	435/262.5
6,238,564 B1 *	5/2001	Tanaka	
6,387,262 B1 *	5/2002	Rittmann et al.	210/321.89
6,423,533 B1 *	7/2002	Gearheart et al.	435/262.5

FOREIGN PATENT DOCUMENTS

JP	59177385 A *	10/1984	C25B/9/00
JP	404094799 A *	3/1992	

OTHER PUBLICATIONS

Grant & Hackh's Chemical Dictionary, 5th ed., McGraw-Hill Book Co., definition of "hydrolysis," at p. 293.*

Egli, C., Tschan, T., Scholtz, R., Cook, A. M., & Leisinger, T. Transformation of tetrachloromethane to dichloromethane and carbon dioxide by *Acetobacterium woodii*, Applied and Environmental Microbiology, 54, 2819-2824, 1988.*

* cited by examiner

Primary Examiner—Chester T. Barry

(74) *Attorney, Agent, or Firm*—Anne M. Kornbau

(57) **ABSTRACT**

A method for treating nitrate-contaminated water comprising treating said water with hydrogen-oxidizing denitrifying bacteria in the presence of hydrogen. The apparatus for use in this method preferably comprises:

- (a) a pure culture of autotrophic, hydrogen-oxidizing denitrifying bacteria;
- (b) a hydrogen generator;
- (c) a flow-through bioreactor; and
- (d) a filtration unit.

11 Claims, 3 Drawing Sheets