



US005560737A

United States Patent [19]

[11] **Patent Number:** 5,560,737

Schuring et al.

[45] **Date of Patent:** Oct. 1, 1996

- [54] **PNEUMATIC FRACTURING AND MULTICOMPONENT INJECTION ENHANCEMENT OF IN SITU BIOREMEDIATION**
- [75] Inventors: **John R. Schuring**, Blairstown; **David S. Kosson**, Neshanic Station; **Conan D. Fitzgerald**, Maplewood; **Sankar Venkatraman**, Piscataway, all of N.J.
- [73] Assignee: **New Jersey Institute of Technology**, Newark, N.J.
- [21] Appl. No.: **515,463**
- [22] Filed: **Aug. 15, 1995**
- [51] Int. Cl.⁶ **B09C 1/08**; E21B 43/12; E21B 43/26
- [52] U.S. Cl. **405/128**; 166/53; 166/246; 166/308; 210/747; 405/258; 405/263
- [58] **Field of Search** 405/128, 130, 405/258, 263; 166/53, 177.5, 246, 250.15, 308; 210/611, 747

[56] **References Cited**

U.S. PATENT DOCUMENTS

4,945,988	8/1990	Payne et al.	405/128 X
5,032,042	7/1991	Schuring et al.	405/258
5,133,625	7/1992	Albergo et al.	405/263
5,178,491	1/1993	Graves et al.	405/128
5,180,013	1/1993	Abdul	166/53 X
5,249,888	10/1993	Braithwaite et al.	405/128
5,277,518	1/1994	Billing et al.	166/246 X

OTHER PUBLICATIONS

R. L. Valentine et al. (1986) "Biotransformation", *Vadose Zone Modelling of Organic Pollutants*, eds. Stephen Hern et al., Lewis Publishers, Inc. Michigan, Chapter 9.

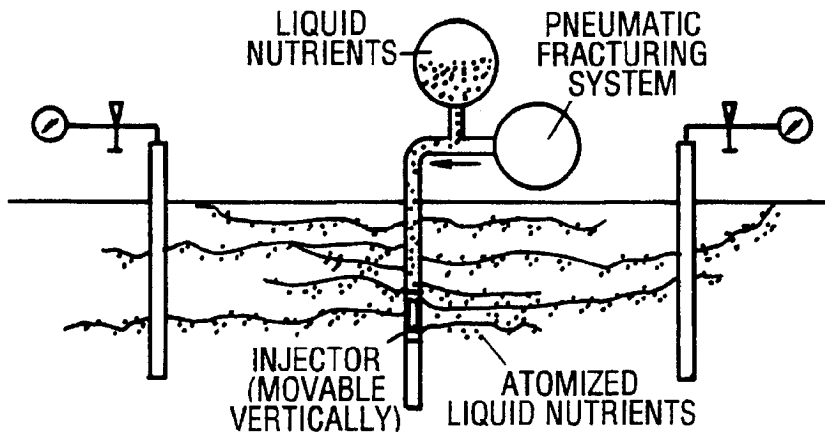
- R. Wetzel et al. (1985) "Demonstration of In Situ Biological Degradation of Contaminated Ground Water and Soils", Sixth National Conference on Management of Uncontrolled Hazardous Waste Sites, Washington, D. C.
- V. Jhaveri et al. (1985) "Bioreclamation of Ground and Ground Water by In Situ Biodegradation" Case History, Sixth National Conference on Management of Uncontrolled Hazardous Waste Sites, Washington, D. C.
- P. Yaniga et al. (1986) "Aquifer Restoration Via Accelerated In Situ Biodegradation of Organic Contaminants", Seventh National Conference on Management of Uncontrolled Hazardous Waste Sites, Washington, D. C.
- Evans et al. (1991) "Anaerobic Degradation of Toluene by a Denitrifying Bacterium", *Appl. Env. Microb.* 57(4):1139-1145.

Primary Examiner—George A. Suchfield
Attorney, Agent, or Firm—Klauber & Jackson

[57] **ABSTRACT**

A method and apparatus are disclosed for reducing or eliminating non-naturally occurring, subsurface, liquid contaminants from one or more soil formations, which involves the steps of pneumatically fracturing the soil formation to produce a fracture network; simultaneously or subsequently inserting into said fracture network and throughout adjacent portions of the soil formation, a pressurized gas stream, and introducing into the pressurized gas stream a mixture of one or more liquid amendments, wherein said pressurized gas, in conjunction with said liquid amendments, has an oxygen or other electron acceptor content sufficient to promote the growth of aerobic or other microorganisms in said fracture network, and wherein the pressurized gas has a sufficiently high gas to liquid ratio to atomize the liquid amendments, whereby the amendments are distributed throughout the soil formation.

17 Claims, 6 Drawing Sheets



STEP B - PNEUMATICALLY INJECT BIOLOGICAL AMENDMENTS ON A PERIODIC BASIS