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Soil-Based Biofiltration for Air Purification:Potentials for Environmental and Space LifeSupport Application

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ABSTRACT

Soil biofiltration, also known as soil bed reactor (SBR), technology was originally developed in Germany to take advantage of the diversity in microbial mechanisms to control gases producing malodor in industrial processes. The approach has since gained wider international acceptance and continues to see improvements to maximize microbial and process efficiency and extend the range of problematical gases for which the technology can be an effective control. We review the basic mechanisms which underlay microbial soil processes involved in air purification, advantages and limitations of the technology and the current research status of the approach. Soil biofiltration has lower capital and operating/energetic costs than conventional technologies and is well adapted to handle contaminants in moderate concentrations. The systems can be engineered to optimize efficiency though manipulation of temperature, pH, moisture content, soil organic matter and airflow rates. Soil air biofiltration technology was modified for application in the Biosphere 2 project, which demonstrated in preparatory research with a number of closed system testbeds that soil could also support crop plants while also serving as soil filters with airpumps to push air through the soil. This Biosphere 2 research demonstrated in several closed system testbeds that a number of important trace gases could be kept under control and led to the engineering of the entire agricultural soil of Biosphere 2 to serve as a soil filtration unit for the facility. Soil biofiltration, coupled with food crop production, as a component of bioregenerative space life support systems has the advantages of lower energy use and avoidance of the consumables required for other air purification approaches. Expanding use of soil biofiltration can aid a number of environmental applications, from the mitigation of indoor air pollution, as a method of reducing global warming impact of methane (biogas), improvement of industrial air emissions and prevention of accidental release of toxic gases.

KEYWORDS

Soil Biofiltration, Indoor Air Quality, Bioremediation, Ecological Engineering, Air Pollution, Purification, Bioremediation

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References

[1] [1] H. L. Bohn, "Consider Biofiltration for Decontaminating Gases," Chemical Engineering Progress, Vol. 42, No. 4, April 1992, pp. 34-40.

[2] W. J. Mitsch, "Ecological Engineering: The Roots and Rationale of a New Ecological Paradigm," In: C. Etnier and B. Guterstam. Eds., Ecological Engineering for Wastewater Treatment, Bokskagen, Gothensburg, 1991, pp. 19-37.

[3] M. Gandolla and M. Aragno, "The Importance of Microbiology in Waste Management," Experientia, Vol. 48, 1992, pp. 362-366. doi:10.1007/BF01923430

[4] D. A. Carlson and C. P. Leiser, "Soil Beds for the Control of Sewage Odors," Journal of the Water Pollution Control Federation, Vol. 38, No. 5, 1966, pp. 829-833.

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[5] H. L. Bohn, G. K. Prososki and J. G. Eckhardt, "Hydrocar- bon Absorption by Soils as the Stationary Phase of Gas-Solid Chromatography," Journal of Environmental Quality, Vol. 9, No. 4, 2008, pp. 563-565. doi:10.2134/jeq1980.00472425000900040005x

[6] J. M. Lynch, "Soil Biotechnology: Microbiological Factors in Crop Productivity," Blackwell Scientific Publications, Oxford, 1993.

[7] C. Etnier and B, Guterstam, "Ecological Engineering for Wastewater Treatment," Bokskagen, Gothensburg, 1991.

[8] A. W. Busch, "Aerobic Biological Treatment of Waste Waters," Oligodynamics Press, Houston, 1971.

[9] G. Leson and A. M. Winer, "Biofiltration: An Innovative Air Pollution Control Technology for VOC Emissions," Journal of the Air & Waste Management Association, Vol. 41, No. 8, 1991, pp. 1045-1054.

[10] T. Godish, "Indoor Air Pollution Control," Lewis Publishers, Chelsea, 1989.

[11] D. Mathsen, "Evaluating Compost and Biofilter Aeration Performance," Biocycle, Vol. 45, No. 6, 2004, pp. 20-25.

[12] H. L. Bohn and R. K. Bohn, "Soil Bed Scrubbing of Fugitive Gas Releases," Journal of Environmental Science and Health, Vol. A21, 1986, pp. 561-569.

[13] J. Nikiema, L. Bideau and J. Lavoie, "Biogas: A Real Problem; Biofiltration: A Promising Solution," In: J. S. Devinny, Ed., Proceedings 2004 Conference on Biofiltra- tion for Air Pollution Control, USC Center for Sustain- able Cities and Department of Civil and Environmental Engineering, Los Angeles, 2004, pp. 73-80.

[14] M. L. Bradford and R. Krishnamoorthy, "Consider Bioremediation for Waste Site Cleanup," Chemical Engineering Progress, Vol. 87, No. 2, 1980, pp. 80-85.

[15] D. H. Kampbell, J. T. Wilson, H. W. Read and T. T. Stocksdale, "Removal of Volatile Aliphatic Hydrocarbons in a Soil Bioreactor," Journal of the Air & Waste Man- agement Association, Vol. 7, No. 10, 1987, pp. 1236-1240.

[16] C. Van Lith, G. Leson and R. Michelson, "Evaluating Design Options for Biofilters," In: F. E. Reynolds, Ed., Proceedings 1996 Conference on Biofiltration, University of Southern California, The Reynolds Group, Tustin, 1996, pp. 102-127.

[17] J. Devinny, "Topics for Research in Biofiltration," In: D. S. Hodge and F. E. Reynolds, Eds., Proceedings 1995 Conference on Biofiltration, University of Southern California, The Reynolds Group, Tustin, 1995, pp. 6-13.

[18] E. R. Rene, D. V. S. Murthy and T. Swaminathan, "Steady- and Transient-State Effects during the Biological Oxidation of Gas-Phase Benzene in a Continuously Oper- ated Biofilter," Clean Technology and Environmental Policy, Published 2009 online.

[19] B. C. Wolverton, "Foliage Plants for Removing Indoor Air Pollutants from Energy-Efficient Homes," Economic Botany, Vol. 38, 1983, pp. 224-228. doi:10.1007/BF02858837

[20] M. Nelson, W. F. Dempster, N. Alvarez-Romo and T. MacCallum, "Atmospheric Dynamics and Bioregenerative Technologies in a Soil-Based Ecological Life Support System: Initial Results from Biosphere 2," Advances in Space Research, Vol. 14, No. 11, 1994, pp. 417-426. doi:10.1016/0273-1177(94)90331-X

[21] M. Nelson and W. F. Dempster, "Living in Space: Results from Biosphere 2 ' s Initial Closure, an Early Testbed for Closed Ecological Systems on Mars," In: C. R. Stoker and C. Emment, Eds., Strategies for Mars: A Guide to Human Exploration, AAS Publication, San Diego, Vol. 86, 1996, pp. 363-390.

[22] J. P. Allen and M. Nelson, "Biospherics and Biosphere 2, Mission One (1991-1993)," Ecological Engineering, Vol. 13, 1999, pp. 15-29. doi:10.1016/S0925-8574(98)00089-5

[23] R. Frye and C. Hodges, "Soil Bed Reactor Work of the Environmental Research Laboratory of the University of Arizona in Support of the Biosphere 2 Project," In: M. Nelson and G. Soffen, Eds., Biological Life Support Systems, NASA Conference Proceedings 3094, Synergetic Press, Oracle, 1990, pp. 33-40.