

## CELLS ON ROTATING FIBERS FOR CLEAN FUELS

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### INTRODUCTION

Rotary biological contactors have been made 10 feet in diameter but the discs are plastic. Fibers have more surface area. Half a pound of celite trapped in the fibers has the area of a football field so more cells can be immobilized. This concept is covered by a Clyde patent (1). Another patent (2) describes photo production of hydrogen and a third (3) cane fibers from the discs. Sulfur can be removed from coal and methane converted to methanol. In a recent 28 page booklet (4), several observations were made:

- pg. 6. At current rates, there will be 13,000 to 23,000 deaths in California from cancer.
- pg.18. About one billion gallons of gasoline would be displaced by clean fuel in 1997, increasing to about 11 billion by 2006.
- pg.21. The year 2000 marks the first year in which all vehicles for sale in California would either be LEVs (low emission vehicles) or ULEVs (ultra low emission vehicles).

### ALCOHOL FROM SUGAR

Parekh and Wayman (5) describe fermentation of glucose to ethanol in 15 minutes as "remarkable", using Zymomonas in a 4 inch diameter unit of rotating fibers (Fig. 1). In a letter they say the CO<sub>2</sub> came off so fast it's like an "explosion". They did not use Celite entrapped in the fibers. Celite is not expensive and neither is polyester fiber. Eight inch diameter units have been run by Clyde using Reemay polyester (6) type 2033 which is only 70 cents per sq. yard. Typar style 3301 from the same company is only 42 cents per sq. yard. Larger units are now being constructed. To provide stiffness, the fiber can be stapled to a screen.

### ALCOHOL FROM WOOD

Wyman et. al. (7) say that SSF (simultaneous saccharification and fermentation) has great potential for production of ethanol at competitive prices. The key to this process is the ability to rapidly convert the sugars because they inhibit the conversion. They do it in 7-12 days, but Chen and Wayman (ref. 8 and Fig. 1) do it in 2 days using rotating fiberglass discs.

### HYDROGEN

Several investigators have described hydrogen production from algae. Laws (9) describes the advantages of a flashing light which can be done in a rotary biological contactor. Weetal (10) also has a method. Greenbaum (11) also has a method and Mitsui at the University of Miami has written several articles. Veziroglu, also at the University of Miami, is the

editor in chief of a hydrogen journal. Nelson (12) at Argonne Lab. said one problem was availability of CO<sub>2</sub> but large amounts of that are produced in an alcohol plant.

#### COAL

Thiobacillus ferrooxidans grows on fibers as in patent 4,530,763 and it removes pyrite from coal. Pseudomonas and Phanerochaete chrysosporium solubilize coal and the former removes organic sulfur (13). Loganback from Morgantown (14) describes biotreatment of syngas.

#### METHANE

Large amounts of methane are flared (wasted) from oil refineries, since it cannot be economically transported. Lipscomb from the University of Minnesota (15) has a bacterium which converts methane to methanol, but burning methanol in a car or turbine produces formaldehyde. Methanol can be converted to clean burning hydrogen and CO with a 30% increase in energy (because waste heat is utilized) as in patent 4,420,462 where the catalyst can easily be removed out the bottom (Fig. 2). In other designs, catalyst is inside the tubes, but when the tubes expand with heat, the pellets pack in, and when the tubes cool they crush the catalyst.

#### REFERENCES

1. 4,407,954
2. 4,446,236
3. 4,600,694
4. Low Emission Vehicles/Clean Fuels and New Gasoline Specifications, by Air Resources Board, 9528 Telstar Ave., El Monte, Cal.
5. Parekh, S., Parekh, R., and Wayman, M. Ethanolic Fermentation of Wood-derived Cellulose Hydrosylates by Zymomonas mobilis in a Continuous Dynamic Immobilized Biocatalyst Bioreactor. *Process Biochem.* June '89 p. 88-91.
6. Reemay Co. Industrial Road. P.O.Box 511, Old Hickory, TN 37138
7. Wyman, C. et.al. The Impact of Glucosidase in the Simultaneous Saccharification and Fermentation Process. Paper given at the AIChE 1990 meeting in Orlando in March.
8. Chen, S. and Wayman, M. Continuous Production of Ethanol from Aspen Cellulose by Co-immobilized Yeast and Enzymes. *Process Biochem.* Dec. '89 p. 204-207.
9. Laws. *Biotech and Bioeng.* 25, 2319-2335
10. Weetal. *Biotech and Bioeng.* 23, 605-614
11. Greenbaum, E. *Photochem. and Photobiol.* Oct. '89 p. 571-576
12. Nelson. Availability of CO<sub>2</sub> in the Southwest
13. Srivastava, R. et.al. Coal Bioprocessing: A Research-Needs Assessment. *Chem. Eng. Progress* Dec. '89 p.45-53
14. Talk 100A, Amer. Inst. Chem. Eng. Orlando, Mar. 1990
15. Talk given at Midwest Biotech. Symp. May 1990, St. Paul