CELLS ON FIBERS FOR WASTE CLEAN UP

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INTRODUCTION: Fibers have a large surface area so many cells can be immobilized. Sulfur can be taken out of coal, metals removed from wastewater, pulp mill effluent decolorized, and a non-corrosive road deicer made.

At a recent conference in Boston (1) uses and methods of making CMA (calcium magnesium acetate) were discussed. Beer told how(2) calcium acetate could be sprayed into burning coal to remove 70% of the sulfur in the stack gas. Acid rain causes much damage to trees and lakes. Yang (3) described methods of making CMA from lactose (cheese whey) with organisms on cotton. Chapter 16 of a new book (4) teaches producing CMA from glucose with cells on rotating fibers, covered in Clyde's patent 4,407,954. CMA is also a non corrosive road deicer. Salt causes millions of dollars damage to bridges, cars and plant life. Using woody biomass or old newspapers as a raw material would reduce the cost.

Patent 4,530,763 describes removing uranium and other metals from wastewater. Recently it has been found that when a strip of Tyvek® fiber with Zymomonas mobilis on it was put into lead and six valent chromium, the metals got not only on the section immersed, but climbed right up the fiber and got on the fingers of the holder, all in a couple seconds. The EPA will soon lower the limits on lead in drinking water, and Cr6 is also very toxic.

Thousands of lawsuits have been filed against paper mills for putting deadly dioxin into rivers. It also gets in milk cartons, fish, tea bags, and diapers. The fungus Phanerochaete chrysosporium grows on fibers and high area Celite entrapped in fibers, to decolorize pulp mill effluent. When an RBC (rotary biological contactor) is run half full and a light shone in the top, the light hits a thin moving film. UV light destroys dioxin. In most photo reactors, colored solution blocks the light.

Methanol can be made from coal(5) and dissociated to clean burning CO and H_2 with 20% increase in energy (because waste heat from the exhaust is utilized) as in patent 4,420,462.

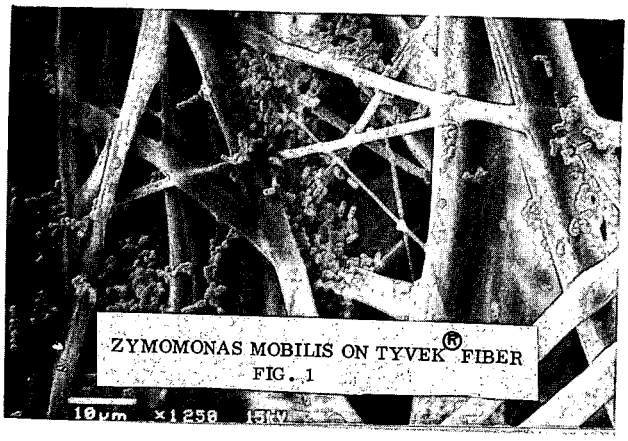
Wayman (6) confirms that sugar can be fermented to alcohol for gasohol in 15 minutes. Dale (7) reports that when yeast is immobilized on fiber, high rates of mass transfer are achievable even at low agitator speeds.

Old cars and trucks that use leaded gasoline put the lead into air and rain washes it into drinking water supplies. If gasohol were used this would not be a problem. Sugar can be converted to alcohol as follows:

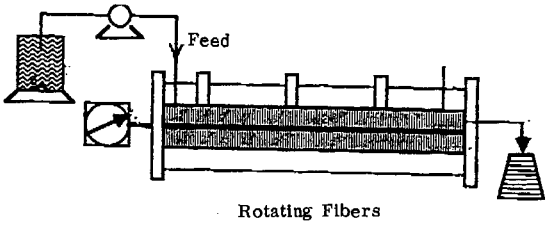
A few spoons of Celite®(from Manville Company, Denver, CO) are slurried in water and poured into a fermenter with rotating fibers (Reemay 2033 from Reemay Co. Old Hickory, Tenn.) of polyester. The unit is sterilized and Zymomonas mobilis (NRRL 14023, US Department of Agriculture, Peoria, Il.) is added. It takes about 30 hours for the cells to grow and attach to the fibers, and then the fermenter is flushed with four times its volume of nutrient which is 10% glucose, 10g/l yeast extract (from Difco) and 1 g/l of three salts $(NH_4)_2SO_4$ $MgSO_4$, and KH_2PO_4. If the pH is lower than 6, K_2HPO_4 is used instead of KH_2PO_4. After flushing, aliquotes are taken and in 10 minutes 4% ethanol is measured by HPLC. This is an 80% yield, since one mol of glucose is fermented to two of ethanol and two of CO_2 and the molecular weights of these are about the same (46 and 44) so the theoretical yield is 51 g/l. The unit can then be run for several weeks with residence times of 10 minutes. Some alcohol can be stripped off and sugar recycled. If 96% yield is desired, it can be run with a 15 minute residence time as Wayman did. We believe that this reactor design is so efficient because nutrients have intimate contact with cells, and the same thing should apply to other applications. Membranes are expensive but Tyvek® fiber from DuPont is not (only 75¢/sq.yd) and it has small pores and many fibers so we plan on using Tyvek® in place of Reemay. Zymomonas on Tyvek is shown in Fig. 1.

REFERENCES

1. The conference was held in Boston May 14-16 and sponsored by Northeastern University.
2. J.M. Beer is from the Combustion Research Institute at MIT in Cambridge.
3. Shang Yang is from the Chem. Eng. Dept. at Ohio State Univ. in Columbus.
4. The CMA book is published by Elsevier and edited by Don Wise at Northeastern University.
5. The book HOW TO PRODUCE METHANOL FROM COAL is published by Springer Verlag and Emil Supp from Lurgi GmbH is the author.
6. Wayman M. et al Process Biochem. June '89 pg. 88-91
7. Dale,B. and Bringi,V. Biotech. Progress May/June '90 pg. 205-209



ZYMOMONAS MOBILIS ON TYVEK® FIBER
FIG. 1



Rotating Fibers