TECHNOLOGY

Industrial Products from Natural or Waste Materials

We often hear of warnings coming from various quarters that a world energy crisis would develop over the next ten years. A considerable amount of scientific and technological research is being directed towards finding a solution to this problem. The attention of eminent scientists and scientific organisations has been drawn to investigate the possibility of using solar energy, wind power, nuclear energy, geo-thermal energy and energy in oceans, as substitutes for conventional petroleum fuels. A large group of scientists, engineers and businessmen met recently at the Royal Society in London to examine the opportunities for making substitute fuels, chemicals, pharmaceuticals and food stuffs by the application of industrial microbiology or biotechnology. While reviewing the present position of biotechnology, the speakers at the Royal Society meeting have made valuable suggestions concerning the activities which should be given priority in research and development work in this field.

Biotechnology is the technique of obtaining valuable materials needed by man using cheap and readily available raw materials which have hitherto been considered as waste materials and readily renewable natural raw materials. The raw materials in biotechnology are certain waste products which are normally discarded as garbage, renewable plant materials such as starch, sugar and cellulose, and discarded hydrocarbon residues of oil refineries. The agents that convert these materials into useful products are micro-organisms found in nature. For example, it is well known that the sweet toddy tapped from palm trees in this country are converted into useful products like alcohol, treacle, jaggery, sugar and vinegar by the action of micro-organisms. Starch and sugar are further subjected to the action of micro-organisms to obtain alcohol which is now coming into vogue as a fuel. Bio-gas has come into prominence recently as a fuel in a product obtained from cowdung and garbage or organic waste materials through biotechnology.

Biotechnology has several advantages over traditional technology. The raw materials are cheap and are readily available. They are also renewable in a relatively short period of time. The agents required for this technology can be bred rapidly and easily. Another special advantage is that, unlike as in other technologies, biotechnology causes the least amount of environmental pollution.

Ethyl Alcohol and Single Cell Protein

Two examples may be cited to illustrate the success already achieved by the application of biotechnology in the production of materials useful to man and which hold out greater promises for the future. One is the bulk manufacture of ethyl alcohol by a fermentation process for achieving self-reliance in fuel. Brazil has already launched a massive programme to substitute alcohol for petroleum in motor vehicles. While making a big saving in foreign exchange needed for importing petrolem fuels, such a scheme could also boost rural development and make the best possible use of the crops like sugar cane and manioc that provide the carbohydrates for conversion. Thus, biotechnology indirectly contributes in some measure to rural transformation too in developing countries. Another successful product of biotechnology is the single cell protein. According to a technique developed by a British firm, the starting material for this product is methanol or methyl alcohol which is converted to a bacteria which is then harvested as a single cell protein (called PRUTEEN) used for animal feed.

A major problem faced in the application of biotechnology on a large industrial scale is that even though the raw materials are cheap, the cost of production is very high. For instance, the production of alcohol (to be used as a fuel) in the U.K. from sugar cane is estimated to cost about Rs. 10,300 per ton. (It was recently reported in the local press that it costs about Rs. 50.00 to produce a gallon of alcohol in our own sugar factory.) Attempts are now being made to find ways and means of reducing the present high cost of production in biotechnology.

A considerable amount of energy is needed to produce premium fuels such as alcohol. Biotechnology hopes to provide the answer to this problem by using low grade sources of energy such as garbage and hydrocarbon residues to convert agricultural products into a premium energy resource.

The key to the economic success of biotechnology lies in the capacity to obtain high yields of the bacteria, fungi, and yeasts that are responsible for the biochemical processes. While micro-organisms have been harnessed for fermentation for generations in traditional micro-biological industries such as brewing and baking, recent advances in enzyme engineering and genetic manipulation are transforming the way bacteria, fungi and yeast can be used to make more complex and newer products. There is considerable scope in the future for improving the production yields by modifying operating conditions and developing novel strains of micro-organisms by genetic manipulation.

An important goal for biotechnology is to increase the growth of crops and yields. This can be achieved by raising the efficiency of biological nitrogen fixation. Today, agriculture depends very heavily on synthetic fertilizers for its nitrogen. The ammonia based fertilizer industry has grown so rapidly during the past that it now consumes about two million barrels of oil a day. It is expected that the agricultural nitrogen input will have to double by 2,000 A.D and the demand for oil as a raw material for fertilizer production will also increase proportionately. In such a situation, the use of oil for fertilizer production will not be economically feasible and alternative sources of raw materials and techniques will have to be found. Today, the need has arisen

(*Continued on page* 19)

(*Continued from page* 20)

to replace oil as the chief raw material with atmospheric nitrogen, and use microbiological techniques for fixation of atmospheric nitrogen. A short-term move in this direction would be to return to crop rotation and grow exotic legumes, grasses and woody plants that have a high nitrogen symbiosis. A medium-term plan would be to invest more on plant breeding and genetic manipulation of the appropriate bacteria to increase the nitrogen uptake. It is necessary to find a more effective long-term solution to the problem. This long-term solution, which could also, in the long run, probably be the only solution, will be for scientists to devise more imaginative methods of manipulating plant genomes to fix nitrogen independently.