



TOGETHER
for a sustainable future

OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.



TOGETHER
for a sustainable future

DISCLAIMER

This document has been produced without formal United Nations editing. The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations Industrial Development Organization (UNIDO) concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries, or its economic system or degree of development. Designations such as “developed”, “industrialized” and “developing” are intended for statistical convenience and do not necessarily express a judgment about the stage reached by a particular country or area in the development process. Mention of firm names or commercial products does not constitute an endorsement by UNIDO.

FAIR USE POLICY

Any part of this publication may be quoted and referenced for educational and research purposes without additional permission from UNIDO. However, those who make use of quoting and referencing this publication are requested to follow the Fair Use Policy of giving due credit to UNIDO.

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

18961

UNIDO'S PROGRAMME ON BIOROR*

Increasing production and transport of oil in large quantities have increased the frequency of oil spills and associated environmental pollution. The Exxon oil tanker's spill in Alaska resulted in a large-scale contamination of the sea and beaches, causing death and destruction to birds and marine life and threats to human health. The spillage from the supertanker Mega Borg and smaller spills in Texas, Rhode Island, the Delaware Bay, and off the east coast of England, point to the fact that accidents occur with increasing frequency as international trade in oil increases. In these cases limited applications of microbial surfactants had been made and the preliminary results were found satisfactory. Microbial remediation was also tested some time ago very effectively by the Kuwait oil company using a surfactant produced by the Kuwait Institute of Scientific Research (KISR).

Bio-surfactants compare favourably with chemical surfactants because they are easy to produce, highly effective at low concentrations and are biodegradable. Bioremediation can also be used to desulfurize high-sulfur oil or reduce the viscosity of heavy oil. Recovery of oil could be effected simultaneously with bioremediation, for example, in removal of oil sticking to barrels, tanks or tankers, and in desludging of tanks. There are some ten varieties of microorganisms that can be employed. Besides, different types of

* Bioremediation and Oil Recovery

surfactants could be tailor-made for different types of oil, using genetic engineering techniques.

Bioremediation uses microorganisms to get rid of toxic chemicals. In cleaning-up oil spills, mainly on land, it involves the stimulation of naturally occurring oil-eating microbes with specially formulated liquid fertilizers containing nitrogen and phosphorus. It rapidly speeds up the degradation of oil and reduces a months-long process to a matter of days. The bacteria turn hydrocarbons in the oil into carbon dioxide and water, and the cell mass produced serves as food for sea life.

Some of the microbial strains recently isolated at the University of Texas are reported to metabolize wide variety of crude oils. Consequently, they live as long as the oily substrate is available and then die thereafter thus obviating any persisting contamination. Such organisms are particularly appropriate as their use does not lead to any disturbance of ocean ecology, a factor one must consider in using non-indigenous bacteria.

It is therefore vitally important for oil exporting and importing countries to develop capabilities in research and development and application of this technology.

The following will be the basic components of the BIOROR programme - a promotional programme of UNIDO.

1. Demonstration Projects

The projects would involve demonstration of large-scale production of microbial surfactants or biopolymers (polysaccharides such as xanthan gum) that are often used in oil recovery. The fermentative production and separation and purification of such compounds would be demonstrated to interested countries, and may serve in the training of their personnel. Similarly, use of surfactants to clean-up drums and barrels contaminated heavily with oil will be shown in pilot plant studies to demonstrate feasibility of their uses in oil transport and clean-up.

2. Short- and Long-term Training

The programme envisages offering short (three to four weeks) and long-term (six months to one year) training programmes to members of OPEC countries in the area of oil pollution control, including oil spill clean-up and oil recovery. The short-term training will be given in a number of regional workshops that UNIDO will sponsor using highly knowledgeable, well-known biotechnologists as trainers. The workshops will deal with both hands-on laboratory techniques, including those of recombinant DNA, genetic engineering and hydrocarbon microbiology, as well as theoretical lectures on the principles on such techniques. Both theoretical and practical laboratory lessons will allow comprehensive training in DNA sequencing, site-directed mutagenesis, transposition mutagenesis, chemostatic selection of oil degrading microorganisms, hydrocarbon analysis and characterization, etc. The longer term training will be carried out in well-known laboratories in the United States or

Europe. In addition, both short-term and long-term training may be conducted in one of the two Components of the UNIDO-sponsored International Center for Genetic Engineering and Biotechnology (ICGEB) (New Delhi and Trieste) in the programme areas. Long-term training will be appropriate only after the trainees have attended one or two short-term training courses to develop a strong basis of the biotechnology principles and techniques.

3. Follow-through after Short-term and Long-term Training

Once the trainees have received appropriate training, they are expected to initiate research and development in this area as well as train other colleagues. This process will require setting up of appropriate laboratory facilities, buying quality equipment, training people in the use and maintenance of such equipment, having reliable supply of biotechnological reagents, enzymes, monoclonal antibodies, etc. Often in developing countries where the trainees may come from, establishing such infrastructural facilities is difficult because of lack of availability of information, brochures, price catalogues, operation manuals, servicing facilities, etc. The UNIDO programme will provide such facilities and information on request from the trainees. In addition, small-scale technical problems in the setting up of such facilities that may require advice from experts will be addressed and solutions suggested.

UNIDO proposes to assist, through Trust Fund arrangements, institutions of oil producing countries which wish to develop a local institutional capability in this area.

4. Applications and Analytical Capability Building

Once the trainees are successful in building their laboratories and initiate research and development work in oil pollution control/oil recovery, it is likely that they will develop interesting microorganisms or interesting products for which large-scale fermentation facilities or field testing through analytical evaluations will be necessary. For trainees from large oil companies, the latter may not be a major problem, but for trainees coming from small institutions or where trainees may have developed a completely new product line, various tests need to be conducted to determine the effectiveness of the product or its toxicity or its potential applications in non-target areas. UNIDO will maintain a list of advisers/corporations/universities/research organizations where such analytical testing or large-scale production can be conducted without any fear of loss of intellectual property rights. UNIDO will also help the trainee institution in installing such capabilities by providing the expert advice/information regarding the setting up of such facilities.

5 Consulting Services

UNIDO will have a list of world-renowned, highly respected consultants in the area of hydrocarbon microbiology, genetic engineering, oil recovery/pollution control areas who will routinely offer their expertise to members of OPEC countries on specific problems requiring a quick solution. Such experts in many cases may offer the expertise of their laboratories to train trainees in specific problem solving so that a permanent solution to the

problem may emerge, without the trainee's institution having to buy highly sophisticated, expensive equipment.

Prof. A. Chakrabarty has kindly agreed to advise UNIDO in the formulation and implementation of the BIOROR programme.

6. Emergency Assistance

UNIDO expects to maintain a roster of experts in the area of biotechnological approaches to oil spill, tank/tanker clean-up as well as MEOR (microbial enhanced oil recovery), who can provide expert assistance to countries on an emergency basis. An example will be the recent major oil spill in the Gulf Area that threatens the ecological balance and the environmental health of the entire region. The use of chemical surfactants to disperse the spill in this region is inappropriate and unacceptable, since such chemicals are long-lasting and toxic. Microbial surfactants, which are as effective as chemical surfactants in their ability to disperse oil, are, however, highly biodegradable and non-toxic. Thus such natural surfactant products should be the choice for application for dispersion of oil spills in an ecologically sensitive area such as the Gulf. Through its consultants UNIDO also proposes to help countries to obtain specialty products on a short notice emergency basis. UNIDO also proposes to promote under the BIOROR programme the collection of specialized microorganisms capable of producing biopolymers such as xanthan gum at a high yield, for rapid dewaxing of high paraffin crudes or for desulfurization of high sulfur oil. Such microorganisms or their products such as the surfactants or biopolymers can be made available to the countries for

specific purposes of pollution control or for developing higher quality oil that may draw a premium price.

Resources

To undertake an effective programme of this type, resources of the order of US\$ 10 million will be required for a five-year period so that developing countries acquire the necessary capabilities in this respect in the interests of their economies and environment.

Contact

For further information, please contact the Biotechnology and Genetic Engineering Unit, Industrial Technology Development Division, UNIDO, Vienna, Telefax 2307355, Telephone 211310 (ext. 5351).