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Technical Report*

Prepared for the Government of the Republic of India
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Based on the work of Mr. Curt Thies,
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433

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This report summarizes results of my recent UNIDO mission to India. I was at the National Chemical Laboratory (NCL), in Poona, India, from Wednesday, January 7, 1987, through Tuesday, January 13, 1987. The NCL staff was most courteous and helpful to me during the visit. I was verbally briefed on the status of the UNIDO controlled release programs for Abate and carbofuran. I examined samples of the devices being fabricated, toured the facilities in which the work was being done, and thoroughly read recent summary reports of the two programs. I also presented three lectures designed to give an overview of microencapsulation (copy of schedule is attached).

Because the Abate and carbonfuran programs are in separate groups, I shall discuss them separately.

Abate Program

The Abate program is located in the Entomology Section. All personnel directly involved in it are entomologists. They have focused their efforts on fabricating reservoir devices loaded with Abate. The devices are then evaluated under man-made test conditions at NCL and field conditions elsewhere. The group has accumulated sufficient data to establish that an Abate controlled release device can provide upto four month of mosquito larvae control in small bodies of water, particularly potable water. They are to be commended for this aspect of their work.

It is not clear to me that the device being used by this group is practical for large-scale use. The current device is a plastic sphere which is filled by hand with a hydrogel; a portion of the hydrogel is removed to create a reservoir which is loaded with Abate. The device is then re-sealed with hydrogel. Assorted arms on the device are sealed with an impermeable coating which is removed in the field immediately

before use. The entomologists claim that they can make well over 100 devices per day by hand, which may be true. However, I view their device design and fabrication approach as most undersirable. The current device is to me not suitable for large-scale production at reasonable cost. I recommend that the entire concept, performance, and manufacture of their device be scrutinized carefully by a team of engineering and production personnel capable of assessing the feasibility of this approach. I believe that a device more suited to commercial manufacture is needed if their interesting controlled release results are to be transferred successfully to the field.

I suggest that some sort of bar-shaped or cylindrical device that combines an Abate core, hydrogel barrier and plastic sheath fabricated by a continuous extrusion process could be developed. The device should fragment into numerous smaller particles that remain suspended in water. Fragmentation would eliminate the problem of people near the treatment sites taking the devices out of the treatment sites. An example of such a device is the toss-it brick or bar fabricated from plaster and loaded with Altosid. This device is sold by the Zoecon Division of Sandoz.

In summary, I recommend that the feasibility of the Abate-loaded controlled release device produced at NCL, Poona, be assessed by a team of experts experienced in commercialization of agricultural products. The recommendation generated by this team will provide the foundation on which the next step in the program is built.

Carbofuran Program

The carbofuran encapsulation program is located in the Polymer Division of NCL. It is staffed by organic polymer chemists. This group is to be commended for focussing its attention upon the development of low-cost encapsulation technology suitable for agricultural applications. Various

field test data indicate that their formulations have some promise for enhancing crop productivity. Further field test data will define more precisely the range of applications for which their formulations are best suited. Such tests will consume large amounts of capsules, so it is important to recognize that pilot plant quantities of capsules of standard quality must be provided to the field testing groups.

I am not convinced that the organic polymer chemists in this group are equipped by experience and training to develop the technology to the point that large-scale amounts of capsules of consistent quality can be produced consistently.

It has been my experience that most encapsulation processes developed at the bench level have a degree of product variability until major process parameters are well-defined and controlled. I was assured that such work had been done, but I did not see the actual data that convinced me an adequate understanding of the process parameters was in hand. This type of data accumulation and assessment requires input from process engineers. Accordingly, I recommend that the group of organic polymer chemists should be associated much more closely with a team of experienced process engineers. The engineers' function would be to define process conditions that would enable NCL to provide product of consistent quality to agricultural field test stations.

Before concluding this report, it is appropriate to mention that I discussed with NCL personnel possible future directions that their controlled release work could take. One project suggested by Dr. R. B. Mitra was the encapsulation of adult mosquito control agents like Sumithion or a pyrethroid. The capsules would be designed to be sprayed on the interior walls of residences and release their active agent over a 3 to 4 month period. This type of project appeals to me because it has enormous potential public health

benefits and builds on the controlled release technology base that NCL has been constructing. If the current urea-formaldehyde encapsulation technology was not applicable, it would not be difficult to explore other encapsulation processes (e.g., interfacial polymerization or complex coacervation). It would be important to recognize in such a project that formulating the micro-capsules so they can be sprayed onto a variety of surface and be stuck there would take some thorough work. The effect of the binder used to cause the capsules to stick to the walls on active agent release must be defined. It should also be recognized, that failure of controlled release devices to function as planned must be explained. This should involve reclaiming test devices like capsules after various steps in the field tests followed by assays of what is in the capsules after use. This type of performance analysis requires one to be able to reclaim devices like capsules in large enough quantities for analytical personnel to perform a satisfactory assay. Needless to say, there are a number of interesting fundamental and applied problems of this type that NCL personnel are equipped to tackle.

Respectfully submitted by

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