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21089

DP/ID/SER.A/1729
10 May 1995
ORIGINAL: ENGLISH

REGIONAL NETWORK ON PESTICIDES FOR ASIA AND THE PACIFIC

DP/RAS/93/061

**Subprogramme of Farmer Centred Agricultural Resource
Management Programme (FARM)**

**Technical report: Workshop on Development and Production of User and
Environment Friendly Formulations and Quality Control,
New Delhi, 20-25 February 1995***

Prepared for the Governments of the Member States of the Regional Network (Afghanistan, Bangladesh, People's Republic of China, India, Indonesia, Islamic Republic of Iran, Malaysia, Myanmar, Nepal, Pakistan, Philippines, Republic of Korea, Sri Lanka, Thailand and Viet Nam) by the United Nations Industrial Development Organization, acting as executing agency for the United Nations Development Programme

**Based on the work of Dr. P. K. Garg of India, Chairman,
Ms. Bella Fe D. Carmona of the Philippines, Co-Chairman
and Mr. Shou Huizhong of China as Rapporteur**

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Vienna**

* This document has not been formally edited.

V.95 53872

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I. INTRODUCTION

Agriculture remains the backbone of the human and economic activities in the developing countries of the Asia and the Pacific Region. There has been significant progress in agricultural production during the second half of the 20th century as a result of the 'Green Revolution', thus many food deficit countries of Asia have not only become self-sufficient but also food exporting countries. This has been possible through harnessing improved cultivation practices and growing of high yielding varieties of crop aided by proper plant protection technology.

However, intensive farming practices coupled with unscientific and over use of pesticidal chemicals have caused environmental concerns. The pesticide industry in the developed world has been making steady progress in the field of development and production of low risk/low volume user and environment friendly pesticide formulations. The water based formulations are good examples of such recent developments in formulation technology which are user and environment friendly and offer good opportunities to many of the RENPAP member countries to replace the hazardous formulations with these new varieties of formulations.

The Government of India has offered the facilities created at the Institute of Pesticide Formulation Technology to serve as the Technical Coordinator Unit of RENPAP on

development of environment friendly pesticide formulation technology and quality control. This Institute hosted this workshop from February 20-25, 1995 with the following objectives:

Objectives

The main objectives of the Workshop was to assist the member countries in strengthening capabilities of their pesticide formulation industry and the quality control inspectorate. The Workshop covered :

1. development of new generation formulations like suspension concentrates, water dispersible granules, concentrated and micro-emulsions, controlled release formulations including encapsulations etc.
2. adoption of new technologies for size reduction and blending needed by the formulation industry.
3. scientific utilisation of surfactants and adjuvants
4. quality Control of Pesticides including instrumental analysis and specifications
5. review of follow up actions taken by the member countries in respect of the various recommendations made by the previous workshop on the subject.

The list of participants is attached at Annexure I of the report.

II. OPENING OF THE MEETING

In his welcome address Mr. Vinay Kohli, Joint Secretary, Dept of Chemicals & Petrochemicals, Ministry of Chemicals & Fertilizers, Govt. of India emphasised the goal of the workshops to strengthen regional capability on the production of user and environment friendly pesticide formulations. He assured that his Govt. is committed to provide continued support for the successful promotion of the various activities of the RENPAP programme.

The UNIDO representative welcomed the participants on behalf of Mr. Mauricio de Maria Y Campos, Director-General of UNIDO and conveyed their gratitude and appreciation to the Govt. of India, especially the Institute of Pesticide Formulation Technology for organising the workshop. He said that he was happy to participate in this workshop because it is for the first time that RENPAP is conducting a workshop for the benefit of the member countries on "User and Environmentally Friendly Pesticide Formulations and Quality Control". Once again he said, it shows that the RENPAP network is reacting to the fast development in the agrochemical technology and to the genuine concern of the environmentalists and the public over the use of agrochemicals especially pesticides.

He mentioned that today it has become a taboo to talk about pesticides but it also should be borne in mind that man has been using synthetic pesticides for the last 50 years to

protect his crops from devastation from pests and protect him from vector borne diseases. Their use however harmful to the environment and the ecosystem, was justified at that time, in the 1940s, 1950s and the 1960s and even in the early 1970s. If one looks at those pesticides such as DDT, BHC, aldrin and dieldrin etc. most of the people here in one way or the other owe their lives to these chemicals. However, today with the greater knowledge and firm evidence about the side effects of these chemicals which are still in the ecosystem and getting into the food chain are causing genuine concern. Without becoming paranoid about this, one should take necessary measures to reduce or eliminate the use of these chemicals in order to reduce or eliminate the risks associated with these. Today, the mercury based compounds are already fully banned and soon organochlorines will disappear. However, it will take decades before the planet is freed of these persistent organochlorines. In order to be on the watch out, countries should develop awareness to ecotoxicity and environmental monitoring so as to reduce the risks of persistent organic / inorganic pollutants to man and the environment.

He was happy that this network RENPAP is making its valuable contribution in projecting a balanced outlook to technology development in pesticides and their use in an user and environmentally friendly manner. In this context he wanted to refer to a statement made by the previous UNDP Resident

Representative, Mr. Dessau who said that RENPAP was an excellent example of the regional network flowing into the national projects to promote safety in the development of agrochemicals. In this connection he wanted to refer to the country projects in Pakistan on ecotoxicology, in China on Sustainable Development of Agrochemical Industry and here in India the Institute for Pesticide Formulation technology which is a leading institute in Asia on Formulation technology.

He stated that this workshop is one of those which will once again demonstrate that technology exists to promote risk reduction in the production and use of agrochemicals. Apart from this he said, RENPAP has organised workshops and expert group meetings on topics such as bio-and botanical pesticides in support of Integrated Pest Management (IPM), industrial hygiene and occupational safety in pesticide production and many more in the future are to be conducted, all aimed to promote integrated safety based on Brussels Guidelines and also in support of Agenda 21.

He stated that a major challenge lies ahead because less than 50% of the agrochemicals applied in the field actually reach the target and the rest end up in the ecosystem. Any success in this area could vastly reduce unnecessary exposure of the planet to manmade chemicals. In this context UNIDO is promoting low risk pesticides in the developing countries. At the moment the developing countries have

access mainly to high volume / high risk/ low value pesticides damaging the environment. To day India is expanding fast in agrochemicals and its products are in good demand in the industrialised countries due to their quality and price and he hoped that this workshop organised under the auspices of RENPAP and the country project Institute of Pesticide Formulation Technology will catalyze the member governments to promote risk reduction in agrochemical production and use.

Shri K K Mathur, Secretary, Deptt. of Chemicals & Petrochemicals, Ministry of Chemicals & Fertilizers, Govt. of India, extended warm welcome to the delegates from the member countries of the Network to the capital city of India.

He mentioned that the Asia and the Pacific region occupies 23% of the global land area but nearly 54% of the world population lives here depending primarily on agriculture. In order to obtain food self-sufficiency in the region, they have little choice but to adopt plant protection measures. He pointed out that pest management has another significance in this region particularly for controlling vector borne diseases of human beings and animals.

He emphasised that the judicious use of modern pesticides is an important adjunct to modern agriculture and public health. The discovery of DDT, BHC and 2,4-D during the

Second World War gave promise for greatly enhanced agricultural productivity of banishing such villains as the house fly, the cockroach, the bedbug and the louse and of eradicating the scourges of malaria, typhus and yellow fever.

He mentioned that he has no doubt that pesticides are essential for agricultural productivity and health programmes and they will be required in future also. The developing countries, so far, he said, are using only about 20% of the global pesticide production. However, as everyone involved in agriculture knows that in order to achieve steady annual increase in production, enormous efforts are required together with the application of new technologies aimed at increasing yields and adjusted to the state of development of a particular country. There has been tremendous technological improvement in the field of pesticides. Though the use of many pesticides has increased but it is important to note that the application rate has been significantly reduced due to the discovery of low volume and high potency pesticides. Thanks to the increasingly sophisticated analytical methods, today extremely small quantities of pesticides can be detected which would have been absolutely impossible only a few years ago.

He mentioned that while the benefits accruing from use of pesticides are quite evident, it is equally important to be

vigilant about the possible hazards due to the use of these chemicals. He said that industrial activity is vital for agricultural growth and prosperity and pointed out that sometimes industrial activity results in potential danger to the ecological system and clean environment. He mentioned about the enforcement of legislation on Environment (Protection) Act and Prevention of Food and Adulteration Act. Water Pollution Boards have been set up to work out the ways and means to minimise the contamination of the water resources. He also emphasised the Insecticides Act, 1968 and the Insecticides Rules, 1971 to regulate the import, manufacture, sale, transport, distribution and use of pesticides and for prevention of risk to human beings, animals and environment. India has Pesticides Labs under expert analysts for quality control and for monitoring pesticides in food and in environment. Residue labs have also been set up under All India Coordinated Research Projects of Indian Council of Agriculture Research.

He also emphasised the major thrust of Indian strategy for plant protection under the Integrated Pest Management approach. This approach encompasses the use of cultural, mechanical and biological methods in addition to the judicious use of pesticides, proper water and fertilizer management and adoption of suitable agronomic practice. He said that having done considerable research work, India has

adopted the IPM approach to minimise the reliance on the chemical pesticides to have a clean environment.

He also emphasised that bio-technology is the fastest growing industry in the world and all sincere efforts are being made to evaluate its feasibility in developing countries like India. India is also in the process of introduction of naturally occurring microbial pesticides and bio-pesticides in a big way.

He said that India through its own efforts in the 50's and 60's has brought agriculture to the forefront and the chemical producers have played a major role despite the fact that they had to be content with the production of older generation and persistent pesticides. However, in the wake of awareness for the protection of man and environment, he pointed out that Govt. of India is strongly encouraging the industry to move towards safer and cleaner technology to produce environment and user friendly products for the benefit of farmers and stressed that the Indian programmes alongwith RENPAP would positively contribute to the objectives of the RENPAP and also to the overall objectives of the FARM programme which is mainly intended for the benefit of resource poor farmers in the watershed upland and rainfed low land agricultural system.

He was happy to note the focus of the pesticide sub-programme on the industrial safety on the one hand and

effluent treatment pollution control, occupational health safety and industrial hygiene on the other. Many of the countries in the Asia and the Pacific region continue to use production routes and produce pesticides which are not only hazardous but also unclean. Although some of the countries have enacted laws for safety in production, occupational health safety, industrial hygiene and effluent control at the production sites and production of user and environment friendly products, the implementation of laws have been rather tardy. He suggested that the member countries of this region would, therefore, gain from this Workshop for augmenting their capability for the production of safe and user friendly pesticides to protect the environment by adopting effluent treatment measures and promotion of environment and user friendly pesticides including bio-botanical pesticides.

Regarding the Institute of Pesticide Formulation Technology which is a UNDP/UNIDO project and Govt. of India project for assisting the Indian pesticide industry to develop and produce user and environmentally friendly pesticides formulations, he reiterated full support from his Department for achieving the objectives and serving the industry in a more fruitful way. He also pointed out that the Institute which has been designated as the Technical Coordinating Unit of RENPAP is not only serving the Indian pesticide industry but also the pesticide industry of the Asia and the Pacific region.

He hoped that this Workshop organised by the Institute would be able to generate a lively discussion on the need for user and environment friendly water based pesticide formulations and help in quickly moving into the production of these which would help in preserving the environment and providing the farmers with safer and user friendly products.

Mr. Hans-C von Sponeck, Resident Representative, UNDP, inaugurating the Workshop on Development and Production of Environment and User Friendly Pesticides and Quality Control emphasised the need for preserving the environment through adoption of technologies for producing user and environment friendly pesticide formulations. He also emphasised the need for making such products available to the farmers at a reasonable price besides educating them in the judicious use of these products. He appreciated the role being played by the country project Institute of Pesticide Formulation Technology in not only meeting the needs of the Indian pesticide industry but also that of the member countries of the Regional Network on Pesticides for the Asia and the Pacific region. He expressed his happiness to see the participation of all the member countries of the Network and said that he would be writing to the Resident Representatives of the CAS countries of the Asia for joining the Pesticides Network activities. He expressed his pleasure to note that the faculty is mostly composed of experts and suggested that in the future programmes, experts from the

member countries of the Network could be associated for conducting such workshops. He advised the participants to interact closely with the faculty and reap maximum benefit for upgradation of formulation technology and quality control measures in their own countries. While inaugurating the programme, he wished that it results in fruitful technological exchanges for the overall benefit of the member countries of the Network in the field of development and production of user and environmentally friendly pesticide formulations.

III. ADOPTION OF AGENDA

The Agenda as presented was adopted unanimously which is placed at Annexure II.

IV. ELECTION OF OFFICER BEARERS

Dr. P.K. Garg of India was elected as the Chairman, Ms. Bella Fe D. Carmona of Philippines as Co-Chairman and Mr. Shou Huizhong from China as the Rapporteur.

V. COUNTRY REPORTS

Country reports presented by the delegates are summarised below :

Bangladesh

The Government of Bangladesh is interested to introduce user and environment friendly pesticides. At present eight

multinational and national companies are formulating EC, SL and granular pesticides by importing technical grade materials and other ingredients from abroad. Bangladesh does not produce any technical grade material and imports some finished products also. Quality of the pesticide is ensured through the enforcement of Pesticide Ordinance 1971 and Pesticide Rules 1985. The pesticide industry in Bangladesh need introduction of newer technology for the production of environment and user friendly pesticide formulations. Bangladesh Government would welcome any institutional assistance in the form of additional equipments required for newer technology.

India

India has become self-sufficient in pesticide production and supply. Consumption of pesticides has increased from 2000 MT in 1955 to above 75,000 MT in 1992-93. Finished formulated pesticides are locally produced from technical grade pesticides and the domestic market is one of the fastest growing one in the Asia and the Pacific region. India is exporting technical grade pesticides to US, UK, USSR, Japan, Belgium etc. and the export value has touched US \$ 100 million.

Around 147 pesticide chemicals have been registered with the Central Insecticide Board of Govt. of India and about 60 technical grade pesticides are manufactured by various industrial units. The supply of technical grade materials registered an overall increase of 37% over 1985.

In order to prevent risk to human beings, animals and the ecosystem at manufacturing level, import and transportation and application of pesticides, Govt. of India has enforced various legislations.

Out of the 133 pesticides registered (complete registration) under the act, 18 are not approved for use, 12 are banned, 12 are under restricted use and 17 are currently under the active review of the Govt. of India for evaluation and placement in banned / restricted list.

The Institute of Pesticide Formulation Technology, a country project of UNIDO is actively engaged in the development and production of safe, effective, economical and environmentally friendly pesticide formulations meeting the needs of the Indian pesticide industry.

Indonesia

In Indonesia pesticides are used in agriculture, forestry, public health programme, household etc. Since pesticides are poisonous, they have to be handled very carefully in order to get more benefit with less negative impact.

Production of registered pesticides are screened under vigil quality assurance which confirm to the National & International Standards.

At present there are 18 pesticide formulation plants and 5 industries manufacturing pesticides (a.i.) in the country. Liquid pesticide formulations are basically oil concentrates (OC), emulsifiable concentrates (EC), Water Soluble Concentrates (WSC), Oil Solution Concentrate (OSC), where as solid formulations are of dust (DP), wettable powders (WP), granules (GR), tablets (TB). Granular formulation is the most favoured formulation because of its ease in application by the farmer, more efficacious, less polluting and easy availability of raw materials indigenously.

In dealing with quality control of pesticides, several regulations were issued by Government such as the law of the Republic of Indonesia No. 12 of 1992 on Crop Cultivation system the Government decree No. 7 of 1973 in the context of

sale, storage and use of pesticides and the decree of Minister of Agriculture on the control of pesticide which explain necessity of quality control of pesticides. Quality starts at the inflow of raw material till the finished product reaches end users (farmers). Basic problem in development of new formulation is the lack of R&D facilities and technical expertise in Indonesia.

Malaysia

Malaysia is basically an importer of pesticides. Pesticide industry is characterised by its heavy dependence on imported technical active ingredients and foreign technology. The principal legislation for the control of pesticides in Malaysia is the Pesticide Act 1974 that regulates the manufacture and import of pesticides and ensure quality of pesticides. Indigenous capability of the country is to produce older formulations like aqueous solution, wetttable powders and emulsifiable concentrates. Also there is an increasing trend in the use of water based formulations in the last 5 years. Other more user friendly formulations such as water dispersible granules, water soluble granules, micro-encapsulated formulations have also been introduced in the local market. This workshop was considered to be very timely but would be more meaningful if such technologies could be transferred to the pesticide industry in developing countries like Malaysia.

Myanmar

There is no manufacturer of technical grade material in the country. Moreover, a pesticide formulation plant has been established with the assistance of UNIDO/UNDP and is now producing EC formulation using imported technical material. Government is much concerned with the safety and toxic effects of older pesticides. Use of organochlorine pesticides are substantially replaced by the OPs and the

synthetic pyrethroids. Botanical pesticides such as neem pesticides are being increasingly used in Myanmar since 1988. Pesticide legislation in the country is in force through Pesticide Law (1990). Quality of the pesticide is ensured under the act as per the FAO & WHO specifications.

Nepal

Nepal is basically an importer of pesticides. There is only one plant in the country producing 700 MT of BHC and malathion dust and 5000 KL of Methyl Parathion EC. Pesticide consumption in the field of agriculture is quite low (26 gm/ha) but is expected to increase in the near future due to increase in commercial farming. Regulation of pesticide production, information, sale and distribution and promotion of environment friendly pesticides and utilization of indigenous plant as Botanical pesticides are promoted in the country through the Pesticide Act 1991 and Pesticide Regulation 1994. Limited facilities are available for chemical analysis work. Quality of Pesticide is ascertained mostly using bio-assay and field bio-efficacy testing.

Pakistan

Pakistan basically depends upon the import of technical grade & formulated pesticides to meet its requirements. There has been a five fold increase in the usage of pesticides since 1981. The Govt. has Country promulgated pesticide ordinance 1971 and pesticide Act 1973 which control the pesticide import, manufacture, marketing, storage and use. There is one functional lab in the country for testing of pesticide for registration and quality control purposes.

Philippines

Fertilizer and Pesticide Authority (FPA) have been created through Presidential Decree 1144 to regulate fertilizers,

pesticides and other agricultural chemicals. The law provide powers to FPA to exercise control over quality, use levels, claims, labelling, packaging and advertising and thus ensures that the interest of the end users are protected. Among the various formulations like granules, dust, wettable powder, soluble concentrates, EC, ULV etc available / used in the country EC is the most favourable followed by granules. More polluting with high risk formulation like dust is allowed for rodenticide use only.

To ensure quality products to the farming community, FPA implements quality control programme of pesticide formulations at various levels viz at pre-registration, post registration at production sites, quality control on imported technical/ finished products and quality control monitoring at the dealers' level. A number of laboratories are in operation to enforce the quality control standards of pesticides in the country. However it need upgrading in terms of available equipments / facilities qualified manpower.

Non availability of adequate data for registration purposes of newer type of formulation, low financial and technical support on development work on new product, dependence on import of raw material are some of the major problems the industry is facing in the Philippines.

Sri Lanka

Sri Lankan government policy towards introduction of user and environment friendly pesticide formulation is to cut down toxic chemicals (class IA and IB), adoption of newer formulations like flowables in place of ECs, granules in place of WP, to promote botanical pesticides and strict adherence to the legislation. In total there are 82 agro pesticide active ingredients are registered in the country, out of which 35 are agro-insecticides, 27 fungicides, 19

herbicides and rest are household insecticides. To ensure availability of quality products to the farming community, quality control check is imposed at various levels. Actions for testing are taken immediately on receipt of any field complaint.

Thailand

Pesticide needs of Thailand are met through the import of technical grade materials and sufficiently large quantities of formulated products. The country has an annual production capacity of 15 million liters of EC and SL formulations and around 20,000 tonnes of solid formulations like granules, wettable powders and dusts. Production and trade of pesticides are enforced by the "Dangerous Articles Act of 1993 which governs the handling, import, export, transportation and registration of finished products.

Some 25 toxic pesticides have been banned for the reasons of health and environmental hazard. Because of the detrimental effects of pesticides and resistance development, Thai government advocates the farmers to use judiciously and safe pesticides. Government promotes the use of botanical pesticides and biological measures and thus there are 5-6 bio-botanical pesticide producing plants in Thailand which provide user & environmentally safe alternatives.

Vietnam

Chemical pesticides play an important role in pest control programme in Vietnam. Government's new policies and regulations on pesticides emphasize conservation of natural enemies by correct and selective use of pesticides. Government policies also encourage utilisation of bio-botanical pesticides. At present there are 140 chemicals registered with 361 trade names. Govt. have banned some 22

toxic pesticides. The demand of pesticides is met through the import of technical grade as well as formulated pesticides. Import comprises of 80% insecticides, 12% fungicides and 7% herbicides. Government attaches much importance to the quality of the pesticidal products. Both national and international specifications are followed to ensure quality of pesticide formulations using advanced and latest analytical tools.

VI. TECHNICAL SESSION

The Technical session comprised a series of lectures followed by practical exercises. Summary of the various lectures delivered by the experts are presented here.

CONVENTIONAL FORMULATIONS

Dr. Roger Weckensdorf UNIDO Consultant, while introducing the concept of pesticide formulation read out an article "Formulation is a complex juggling act", an extract of which is reproduced below:

"an anonymous bar room philosopher once said it is not what you have got but what you do with it that counts" while something else was probably on their mind, they would easily have been talking about formulation".

He said that modern formulators must juggle factors such as user and environmental safety, physico chemical properties of both the active ingredients and formulants, cost, dose

rate and marketing messages while eyes firmly trained on regulations and competitor activities.

He explained in details about the pesticide formulations which are cheap and easy to produce e.g. dust, emulsifiable concentrate and wettable powder giving the advantages and disadvantages of each type of these formulations.

WATER DISPERSIBLE POWDER

Dr.G.Krishnamurthy, General Manager of Montari Industries made a presentation on development and manufacture of water dispersible formulation of pesticides.

He said that WP is similar to the dust formulations except that it is formulated alongwith the surfactants for dilution with water into a final spray. WP is a homogeneous mixture of pesticide in a filler and it is in the form of a fine free flowing powder which on stirring with water gives a stable suspension. WP normally has the following composition:

- Active ingredients
- Carrier/dilutants
- Surface active agents - wetting agents and dispersing agents.

Chemical stability of any formulation is related to the compatibility of the toxicant with the inert ingredients and surfactants added. The characteristics like acidity, alkalinity, moisture content of these material affect the chemical stability of the toxicant.

The quality of the wettable power is checked by the rapidity of the wetting when mixed with water and suspensibility in water up to the required dilution for field application. The wettability of the product can be enhanced with the addition of good wetting agent. These agents reduce the interfacial tension between the particle and the water. The suspensibility of the powder depends upon its particle size, finer the particle size better will be the suspensibility. The desirable particle size for good suspensibility should be below 325 mesh.

Dispersibility of the powder is to form good dispersion in water. Cohesive forces between the particles causes flocculation or aggregation of particle after dispersion. To overcome the tendency particles to flocculate, dispersing agents are incorporated in the formulation. Excessive foaming in dispersion is a nuisance and is undesirable, since it interferes with the spray performance. The dispersing agents also helps in reducing the sedimentation which is a function of the particle size.

Wettable powders are made using micro-pulverizers with air classifier or fluid energy mill with classifier depending upon the availability of the equipment. The toxicants along with the carriers/preceptated silica is preblended with surfactants and the preblended material is fed to the micro pulverisier or fluid energy mill and ground to fine powder to achieve uniformity and consistency in quality.

Wettable powder is generally used in seed treatment as well as in a variety of spraying requirements.

He explained the advantages and disadvantages of WP formulations.

Advantages: Cheap and easy to produce and pack, easy to handle, frost tolerant, no solvent.

Disadvantages: Produces dust, difficult to measure and mix, not eco friendly.

The lecture was followed with hands on training on the development of water dispersible powders of isoproturon 75% WP and the same was demonstrated to the delegates.

EMULSIFIABLE CONCENTRATES

Dr.V K Belavadi, General Manager, India Glycols Limited delivered a talk on development and manufacture of emulsifiable concentrates. He said that EC formulation is one of the most popular formulations of the pesticide industry. The basic objective of this type of formulation is that it has a uniform distribution of small concentration of toxic substances over a large surface area in the field in a cost effective way. It is defined as a formulation of insoluble toxicant mainly in aromatic solvents and emulsifiers (surfactants) to be sprayed after emulsifying in water. It is similar to the oil concentrates with the exception that it contains a surfactant or emulsifier to permit the dilution of the concentrate with water for application in the field. The solvents used in these

formulations should be immiscible with water. The solvents generally used in this formulations are xylene, heavy aromatic naphtha type and aliphatic range of kerosene. EC formulations cover wide range of toxicants, viz. organo chlorine, organic phosphorous and synthetic pyrethroids. The choice of the solvents depends upon its (1) cost, (2) availability, (3) phyto-toxicity, (4) volatility, (5) cold stability and (6) water stability. Surfactants/emulsifier play an important role in EC formulations as it alters the properties of the interfacial tension remarkably.

The surfactants used in the formulations are hydro-philic (water loving or oil hating group) and hydro-phobic (water hating or oil loving group). Such compounds have the nature to gather around the interface between two different material altering the properties of the interface remarkably. They are anionic and non-ionic type of surfactants blended in most cases. An optimum blend is made to balance the required emulsion properties. Anionic surfactants are avoided due to degradation of toxicants in EC. Choice of surfactants to be used is important for developing emulsifiers for pesticides ECs. One of the methods used is determination of HLB values. It is very important to determine the emulsifier blend used in EC formulations, which gives a bloom when EC containing the emulsifier blend is dispersed in water, i.e. there should be emulsification and it should be stable when kept over a period of time.

Advantages and disadvantages of the above formulations are:

Advantages: Easy to produce, easy to handle and mix, useful for water insoluble, low melting active ingredients, high efficacy.

Disadvantages: Expensive to pack and transport, frost sensitive, risk of thickening, may corrode plastic and metal, can cause phyto-toxicity, often volatile and not environment friendly.

The lecture was followed by practical demonstration as well as hands on training provided by preparing a fenvalerate 20% EC in the presence of the delegates.

FORMULATION PROCESSING TECHNIQUE

Mr. R P Luthra, Dy. General Manager, Hindustan Insecticides Limited gave a talk on processing technique in pesticides formulations. He said that pesticides are seldom used in full strength but are used as formulation. For formulating, it is necessary to know the physico-chemical properties of toxicant and characteristics of formulation before they are applied. The commonly used types of formulations are dusting powders, Water dispersible powders, Emulsifiable concentrates (EC), Granules, soluble powders, oil emulsions, liquid fumigants and baits.

Liquid formulations are the one which are used most commonly and are economical and convenient to use.

Emulsifiable concentrates are formulated by simply mixing active ingredient, emulsifier and solvents. The equipments

required are mixing tanks, pumps, flow meters, filters, ventilation/fume extraction system, weighing machines, hot water batch and storage tanks.

For small scale operations, the active material received in drums are handled using barrel pump and for large scale operations, the solvents and active ingredients are supplied by using static pumps and pipeline network. Flow meters are used for measuring the quantities to be charged. The storage tanks for flammable materials are stored outside the plants and equipments should be well grounded to avoid static charge while handling these. Flame proof electrical equipments/accessories should be used in all such cases.

Pesticides which are crystalline in nature and insoluble in water can be formulated as Suspension concentrates. The equipment used for formulating such types of formulations are high speed bead mills, in the presence of dispersing agent and anti-settling agents. The particle size achieved is about one micron.

Micro Emulsions are fine droplets in the form of emulsions which could be either water in oil or oil in water. If the pesticide is liquid with relatively low viscosity, it can be directly emulsified into water using suitable surfactants or polymer, however, if the pesticide is viscous in nature, a small quantity of solvents like xylene or iso parafinic oil is added to lower the viscosity. The equipment used are mixing tanks fitted with high speed stirrer and associated tanks.

Suspo Emulsions are mixture of suspension concentrates and oil in water (EW) emulsions. These formulations require simple equipment for processing like mixing tanks with high speed stirrer mixing tanks, dosing tanks, etc.

Micro encapsulation is the packaging of liquid-solid-gases in small containers with particle size ranging from 5-50 microns. The processing of CS is done in situ. The two phases of water soluble and oil soluble active ingredients are reacted in a reactor where pesticides phase react with the water interphase forming a polymer sheath around the pesticides droplet. During mixing of the two phases the pH is adjusted to 7.5 by adding neutralising agents.

The processing of solid formulation starts with the receipt and storage of raw materials like clays/carriers which are stored in silos and used as required. The toxic material in the form of liquid is handled through drums and pumping system. Solid toxic materials should never be handled manually. The best method is to use small storage hopper with bottom discharge outlet located at a central point. Metering pumps are utilised for pumping known quantity of liquid ingredient or solution of solid ingredient. Ribbon blenders, drum and coneblender, plough sheer mixer are used for mixing the solid. The high speed hammer mill, pulveriser mills, Pin Mill, Disc Mill, Ultra Fine Mill, Blast Mill, Raymond Mill, Impex Mill, Fluid Energy Mill are used as grinding equipment. The type of mills to be used depends upon the quality of product.

Dust formulations are generally made by first making the dust concentrate followed by dilution with carrier to desired concentration. The equipment used for this formulation are grinding mill, blender, etc.

Water Dispersible Powders

Water dispersible powders are formulated by mixing technical material, dispersing agents, wetting agents, anticaking agents and carriers. The milling process where liquid technical material is used is the same as that of the dust formulation. The formulation processing for solid technical material involve use of impex mills and fluid energy mill. The particle size achieved is 325-400 mesh depending upon the hardness of technical material.

Granulated products

There are two methods of formulating granules namely, extrusion and spray methods. The spray method involve spraying of technical material or its solution at a granular carrier like clay, silica sand, etc. Organic carriers derived from Soyabean, Tobacco, Walnut, shell, etc. are also used.

Water dispersible granules is a newer type of formulation which is convenient to use as it is very free flowing yet readily dispersible when added to spray tanks. These formulations are processed either by agglomeration, pressure compactation, dehydration of premix or dispersion. The equipment used are Bead Mill, selverson mixer etc.

Operational procedures

Before starting manufacturing of the product, it is important to settle operational specifications like

- Promotion of Safety and high efficiency.
- adjustment of operating methods to avoid the production loss.
- training of workers to maintain and improve the process.
- application of methods of quality control.

The operational specification covering the following items are very essential -

- name and purpose of formulation
- recipe and formulation specification
- raw materials and container specification
- setting up of formulation procedure
- instructions for safety and industrial hygiene
- procedures for quality and process control
- emergency procedures
- maintenance instructions
- training of operators

Whatever be the processing technique selected, the effluent disposal must be kept in mind so that contamination of environment through disposal of effluent, washings, etc. is avoided. A well designed system for effluent treatment must be set up in every formulation unit. Similarly, a system should be incorporated for safe disposal of empty containers of toxic materials and other toxicants.

USER AND ENVIRONMENT FRIENDLY FORMULATIONS

Dr.B Sugavanam, UNIDO introducing the concept of users and environment friendly pesticide formulation vis-a-vis conventional formulation explained the merits of new generation pesticide formulations in view of the freedom from dust handling, water based, low packing volume, maximum efficacy with minimum active ingredients, minimum exposure hazard and minimum use of flammable toxic and lastly petroleum solvent. These new formulations are relevant to the farming community needs and the needs of the environment. As farming has become more sophisticated, consideration of the needs of safety of the user of pesticides in addition to the biological requirement of crop and pest has also gained considerable significance. The current trend in replacing older persistent with newer, more potent, short lived and more specific materials has paved the way for the production of more sophisticated user and environment friendly formulations.

SUSPENSION CONCENTRATES

Dr.P K Ramdas, R&D Manager of Institute of Pesticide Formulation Technology delivered a talk on suspension concentrates. He said that suspension concentrate formulation of pesticide is eco-friendly and popularly known as flowable. It is a stable dispersion of micronised active ingredient in a liquid medium which is generally water. The average particle size of the dispersed solids is around 2

microns. The concentration of the pesticide in SC formulations is usually between 20% to 60% (w/w). The main advantages of these formulations compared to the conventional WPs are freedom from dust, handling ease, low packing volume, excellent spray tank dilution properties and improved biological activity owing to the finer particle size coupled with better adhesion, resulting in lower dose requirements.

In general any pesticide which is chemically stable in water can be formulated as an aqueous flowable provided its melting point is above 60 degree C and solubility in water is less than 200 ppm. Some examples for the pesticides which can be formulated as SC include Carbaryl, Isoproturon, Sulphur, Lindane, Atrazine, Carbendazim, etc. The technical pesticide is thoroughly mixed in a solution of the dispersing agent in water containing some anti-freeze like glycols, using a high shear mixer.

The resulting slurry is wet-milled, using a small media bead mill like Dyno-mill, to an average particles size of around 2 microns. Finally, a structuring agent like those based on polysaccharides, is incorporated into this dispersion to avoid settling of the particles.

CONCENTRATED EMULSION AND MICRO EMULSION

Dr. Patanjali of IPFT delivered a talk on Concentrated Emulsion and Micro Emulsion. He said that these formulations are eco-friendly as these are water based formulations.

Most of the liquid formulation of pesticides are emulsifiable concentrates. In these formulations, pesticide is dissolved in organic solvent and after that some suitable emulsifiers are added to have stable emulsions on dilution with water at the time of application. Because of the use of organic solvents like aromax, kerosene, CIX, Xylene, etc., these formulations create problem associated with flash point, transportation, storage, irritation to the eyes at the time of application, environmental and health hazard during production and application. Scientists at IPFT have developed a product by replacing the organic solvents with water to have concentrated emulsion formulation. Concentrated emulsion of pesticides are the stable emulsions of the pesticides in water prepared with the help of wetting and dispersing agents replacing emulsifiable concentrate(EC) by concentrated emulsion (popularly known as EW). The organic solvents are replaced with water in these formulations. Most of the problems created by EC formulations are avoided, since all emulsions are kinetically stable, the scientists have gone a step ahead to produce another type of formulation called as micro emulsions.

Micro emulsions are clear suspension of liquid pesticides in water. These formulations are thermo-dynamically stable. Micro emulsions have very low particle size (10 A - 1000 A). So penetration into the target organism is faster, hence bio-efficacy is much better as compared to any other type of

formulation. It is also known that by using micro emulsion of pesticides, it is possible to reduce the dosage of pesticides required in the field thereby reducing the load on the environment.

No additional equipment is required and these formulations can be produced in the existing emulsifiable plants by developing good recipe and skilled manpower.

GRANULES AND MICRO-ENCAPSULATION

The lecture was delivered by Dr. Roger Weckensdorf. He explained that the conventional formulations such as WP, EC granules, etc. are fully active when applied under proper environmental conditions but can be subjected to losses due to volatility, leaching to the soil, chemical or microbial degradation etc. To compensate for these losses, the conventional formulations are applied at a rate which is higher than needed to control the pest. This excess dosages increase the cost of pesticide application as well as environmental contamination. The controlled release (micro encapsulated) formulations are a suitable remedy for these problems. These formulations increase the activity periods of pesticides, thereby lesser dosages of pesticides are required which reduces environmental pollution and improve economy in pesticide usage. A technique has been developed by which water insoluble pesticide can be encapsulated in a organo-silicone polymer by a simple process. The organo-silicone monomer is cross-linked and

polymerised by an acid catalyst at the time of encapsulation. The insecticides cypermethrin and chloropyrifos have successfully been encapsulated by this technique. The results of bioefficacy studies has showed the chlropyrifos formulation against roaches produce better bioefficacy than its conventional formulation. Similarly, cypermethrin formulation shown bioefficacy against housefly better than its WP formulation. The encapsulation of thiocarbamate by this process resulted in formulations which are superior to EC.

The advantages and disadvantages of this type of formulations are as under:

Advantages: Easy to produce, low dusting, easy to handle, low solvent.

Disadvantages: Needs expensive production equipment, frost sensitive, may thicken at higher temperature, expensive to pack.

WETTABLE GRANULES

Dr. Roger Weckensdorf, delivered a talk on wettable granules. He said that these granules are also called Water Dispersible Granules (WG). Wettable granules are slowly becoming more popular in plant protection. In this type of formulation the advantages of liquid and solid formulations are combined together. WG formulations are free flowing products with fixed bulk density and can be measured volumetrically. These granules contain much less dust, 2-3

times less voluminous and leave less residues in empty packaging when compared to wettable powder. The high processing cost is more or less balanced by the reduced storage cost due to the higher bulk density. Disposal of used packaging material is easier as compared to those of the liquid products.

The advantages and disadvantages of this type of formulations are:

Advantages : Low dusting, cheap to pack, easy to handle and measure, frost tolerant, no solvent required.

Disadvantages : Needs expensive processing equipment.

Delegates were also given hands on training in the laboratory for water dispersible granules of isoproturon using fluid bed granulation equipments. Suspension concentrate of isoproturon was used for water dispersible granules.

QUALITY CONTROL AND ANALYTICAL PROCEDURES

The first requirement for achieving the biological objective of pesticide formulation is its active ingredient content. All official regulations and all commercial transactions are based on a desired or on a granted pesticide content. A perfect method of analysis should fulfil the following requirements:

- Accuracy : giving the true value

- Precision or reproductivity
- Repeatability
- Specificity.
- Practicality
- Economy.

In order to achieve the above, the active ingredient content of the pesticides is determined using fairly sophisticated analytical equipments, namely spectrophotometer, GLC or HPLC.

SPECTROPHOMETIC METHOD OF ANALYSIS

Prof. M C Jain of Indian Agriculture Research Institute delivered a lecture on the theoretical aspects of spectrophotometric analysis. He said that the spectrophotometric analysis is based on the absorption of a radiation law of Lambert - Beer. The development of improved spectrophotometric equipment has coincided with both the development and the need for colorimetric, UV and IR procedures. Indeed, these spectrophotometric methods brought on one hand, more specificity in the determination of the active ingredient in formulation products and on the other hand, a decreasing in the detection limits and an increasing of the sensitivity, allowing to determine the pesticide residues.

The spectrophotometric methods involve three regions in the radiation spectrum:

- ultraviolet 185-400 nm formulations and residue methods.
- visible 400-800 nm mainly residue methods.
- infrared 800nm-1600 um mainly formulations methods

In the UV range dispersion of the light is achieved by prisms, and the absorption measurements are based on a single beam crossing alternatively the reference and the sample solution. A better knowledge of the laws of refraction and diffraction now permits to provide high resolution over the entire wavelength range either by prisms but more precisely by gratings.

UV spectrophotometers are widely used for the determination not only of active ingredient in technical and formulated products, but also for pesticide residues. These methods are more or less specific, but as many compounds absorb UV light, care must be taken to avoid interferences especially in the process of residues analysis.

In the visible spectrophotometry, one has to produce a color by treating the substance to be determined by a suitable reagent.

The improvements of the IR instrumentation have followed the progresses recorded in the UV and visible spectrophotometry.

Two classes of apparatus are available depending on their resolution power. These apparatus work as a single beam or double beam system like the UV and visible spectrophotometers. But presently, double beam apparatus are preferred because these offer additional advantages.

IR spectroscopy combines both the aspects : qualitative and quantitative analysis. For the identification of unknown molecules, it is necessary to use apparatus giving high resolution spectra with a very fine structure, but these are quite expensive.

GAS CHROMATOGRAPHIC METHOD OF ANALYSIS

Dr.S Y Pandey of the Institute of Pesticide Formulation Technology gave a talk on Gas Chromatographic method of analysis of active ingredients in pesticide formulations. He said that chromatography is a technique of separation and is an analytical procedure in which the flow of a liquid or a gas promotes the separation of substances by differential migration from a narrow zone in a porous sorptive medium. Gas Chromatography is a method of separation of vaporised component which are distributed between a fixed stationary phase and a moving inert gas phase. The stationary phase is a stationary bed of large surface area and the moving phase is a gas which percolates through the stationary bed.

Gas chromatography is a technique for separating volatile substances by percolating a gas stream over a stationary phase. There are two types of gas chromatography.

a) Gas solid chromatography (GSC) (*Adsorption chromatography*). In this chromatography, the stationary phase is a solid. This depends upon the adsorptive properties of the column packings to separate samples, primarily gases, common packings are : Alumina, silica gel, molecular sieve and charcoal.

b) *The stationary phase is liquid.* The liquid is spread as a thin film over an inert solid and the basis of separation is the partitioning of the sample in and out of this liquid film. It is utilised for the analyses of gases, liquids and solids.

Gas liquid chromatography is more versatile than GSC because of the large number of available solvents having widely different separating characteristics whereas in GSC there is relatively little choice of adsorbents. However, GSC is useful for separating very low boiling components such as permanent gases and light hydrocarbons.

In GLC the components to be separated are carried on through the column by an inert gas (carrier gas). The sample mixture is partitioned between the carrier gas and a non-volatile solvent (stationary phase) supported on an inert solid (solid support). The solvent selectively retards the sample components, according to their distribution coefficient until they form separate bands in the carrier gas. These

component bands leave the column in the gas stream and are recorded as a function of time by a detector.

GLC is a most powerful and versatile tool in the pesticide analysis. With this technique macro-as well as microquantities of pesticides can be analysed. There is high degree of accuracy and precision in the analysis carried out.

GLC can be used for (i) Separation of pesticides (ii) Qualitative analysis and (iii) Quantitative analysis.

GLC analysis can be used for the analysis of pesticide formulations and residues including metabolites.

Most formulations contain substances like carriers, solvents, stabilizers, wetting agents, synergists, etc. which may interfere with the GLC analysis. Therefore, pesticides must be extracted from the matrix and impurities removed prior to the final analysis. The sample analysis is carried out by using FID or TCD detectors which give greater linear response. Internal standard like Di-n-butyl phthalate is used to nullify the effect of minor fluctuations in the sensitivity of the equipment.

Pesticide residue analysis includes the analysis of pesticides and their degradation products which are usually present in parts per million (ppm) or parts per billion (ppb) levels. Therefore, very sensitive methods capable of detecting nanogram or picogram levels of pesticides, are used. The choice of detector depends on type of the compound, sensitivity required and nature of impurity. In

case of organochlorine pesticides, residues have been quantitated by GLC using a hall detector and surface band carbowax 20 M, whereas in case of organo phosphorous pesticides, the flame-photometric phosphorous and sulpher-specific detectors and phosphorous-specific thermionic detectors continue to be preferred for the quantitative analysis.

Gas chromatographic techniques, because of their superior resolving power reasonably high sensitivity and universal acceptance, continue to be widely employed for the separation and determination of pesticides. It offers both qualitative and quantitative analysis with speed, accuracy, precision and sensitivity. TCD and FID detectors are used for formulation analysis because of high linearity range and ECD, HECD, AFID, FPD and NPD for pesticide residues, because of high sensitivity. Compounds which are polar, heat unstable and having poor resolution or low sensitivity can also be analysed by GLC after proper derivatization.

APPLICATION OF HPLC IN PESTICIDE ANALYSIS

Prof. N K Roy of Division of Agri. Chemical, IARI gave a talk on the application of HPLC in the analysis of pesticide formulations.

Chromatography basically involves separation due to differences in the equilibrium distribution of sample components between two different phases. In HPLC one of the phases will be stationary while the other is mobile liquid

phase. The sample components will move through the column when they are in the liquid mobile phase. The velocity of migration of the component is a function of the equilibrium distribution between the mobile phase and the stationary phase. The components having distribution favouring the stationary phase will move slowly down the column than those with distribution favouring the mobile phase.

Modern HPLC has rapidly advanced as a result of phenomenal growth in the instrumentation (detectors, data processors, pumps, etc) technology of the production of special stationary phases and the column packing technique. It has now attained an equal stature with gas chromatography.

The rapid analysis, easy monitoring, mild conditions, use of ordinary solvents and precise identification of compounds has made high performance liquid chromatography (HPLC) to be widely used technique in the pesticide analysis.

Formulation analysis by HPLC requires minimum time in sample preparation. Many pesticides that are difficult to analyse by GC or other techniques are readily analysed by HPLC. Colorimetric or spectrophotometric methods are frequently employed to technical or single ingredient formulations whereas HPLC is very useful for mixtures and provides greater specificity through separation of interferences.

In India, HPLC is now a days used in pesticide residue and formulation analysis and its potential application in this area have been well documented. This technique is particularly useful for the heat labile and non-volatile

pesticides such as carbamates and urea herbicides. Wherever there is a doubt in analysis, HPLC can be used as confirmatory technique to solve the ambiguity. The most important feature of HPLC is that in many cases it offers a simpler or time saving approach to the same analysis done by GC.

Analysis of pesticide residues is sometimes complicated by the concurrent presence of additional industrial chemicals in the samples. It may be necessary to separate the pesticides from the other chemical contaminants before quantitation is done.

HPLC instrument using wide variety of highly efficient columns including microbore, can provide the resolution required for the difficult separation of mixtures. Sensitivity is adequate for the detection of various classes of insecticides, herbicides fungicides and rodenticides in both technical and formulated products with the development of variable wavelength U.V., photodiode and in combination with mass spectrometric and fluorescence detectors.

The use of HPLC in pesticide residue analysis; is becoming common practice in India in many laboratories because of the advantage of low temperature operation and for non volatile and heat labile pesticides such as carbamates and urea group of herbicides.

PESTICIDE ANALYTICAL REFERENCE STANDARDS PREPARATION,
STORAGE AND HANDLING

Dr. S Y Pandey also gave a talk on Pesticide Analytical Reference Standards Preparation, Storage and Handling. The role of the pesticide analytical chemist, he said, is to produce qualitative and quantitative data for utilisation in some type of decision making. In the surveillance or monitoring situation, the analytical data may provide the basis for a pesticidal profile in some segment of the environment, in the regulatory situation, the data are used as the basis for judgement, of whether or not established standards are being met. Whatever be the eventual use of the analytical data, these must precisely define the qualitative and quantitative pesticidal content of a given substrate if they are to be of any value.

The availability of pure standards is more important in liquid chromatography (HLPC) than gas chromatography (GC) and colorimetry since the detector response for solutes can vary dramatically particularly with ultraviolet detectors.

Although reference materials have been produced for more than 70 years, their importance and usefulness in validating analytical measurements was not fully accepted until about 15-20 years ago. Since then, there has been a significant increase in their use and there are now at least 130 producers of certified reference materials of all types in the western world alone.

A material or substance one or more properties of which are sufficiently well established is normally used for the calibration of a method or for assigning values to materials.

Uses

Certified reference materials are used for four main purposes:

- a) Calibration and verification of measurement process under routine conditions.
- b) Internal quality control and quality assurance scheme.
- c) Verification of the correct application of standardised methods.
- d) Development and validation of new methods of measurement.

There are usually four stages employed in the preparation of a reference standard solution. These stages are:

- Primary standard as received from manufacturer.
- Concentrated solution.
- Solution of intermediate concentration.
- Final working standard solution or mixture.

A primary pesticide standard is that material which is received from the manufacturer. Many analytical grade standards are of high purity, 98% or more of the active ingredient component.

Storage facilities of pesticide primary standards is of utmost importance. Most of the organo-chlorine compounds are sufficiently stable at room temperature. Storage in tightly sealed container is adequate. However, a number of organo-

phosphorus compounds are subject to a wide variety of oxidation, rearrangements and hydrolytic reactions. Those should be stored in the refrigerator in an air-tight outer container such as a wide mouth mason jar in a dessicator to minimise moisture absorption and cross contamination from air-borne vapors. Refrigerated storage also minimises the odor problem which can be significant with most of organophosphate compounds.

Because of the amount of dilution required, it is a good analytical practice to make at least two and quite frequently three dilutions of the primary standard to arrive at a final concentration that is suitable for use. The final dilution is made directly on the primary standard after weighing and transferring to a volumetric flask.

The analytical balance used for weighing pesticide standards should be micro or at least semi-micro type and be capable of a precision of ± 0.05 mg. The balance should be calibrated periodically or auto-calibrated.

Working standard mixture should not contain any compound which produce peak overlap with any other compound in the mixture when chromatographed on any of the working columns used in the laboratory.

SAFETY ASPECTS IN PESTICIDE FORMULATION

Shri V N Dutta of the Institute of Pesticide Formulation Technology while delivering a lecture on Safety Aspects in

Pesticide Formulation explained that there are three common hazards in all pesticide plants i.e.

- i) health hazard
- ii) fire and explosion hazard; and
- iii) hazard to the environment.

These hazards become more frequent if the plants are poorly maintained and or there are improper operational instruction or shielded people.

The people working in these plants may be affected by dermal contact or by inhalation or by ingestion.

Therefore, formulation plants need to be designed in such a way that the workers are not exposed to the vapours or dusts during operation. They would need to be protected by personal protection equipments as well. The buildings should be designed in such a way that there is good natural ventilation system.

The workers should be educated about the hazards involved and they be informed about the properties of the materials they are handling. They should be medically examined periodically and antidotes of the pesticides be made available all time so that any effected person could be immediately treated.

Fire and explosion in a formulation plant can occur due to sparks discharged by static electricity build up. Static electricity generation takes place when any of the following operation in a pesticide plant takes place:

- 1) when any solvent is pumped from one tank to another.

- 2) when powder from plastic bag is poured out.
- 3) transfer of non-conductive liquid in a glass or plastic pipe.
- 4) when a liquid is atomised.
- 5) when liquids are mixed and stirred in a vessel.

The static electricity build up can discharge into various types of sparks which may be sufficient to ignite powders or vapours and lead to fire and explosion, therefore, adequate precaution would need to be taken to avoid such accidents.

PESTICIDE PACKAGING TECHNOLOGY IN INDIA

Er.Vidya Charan Bhargava, Joint Director (P&P), Central Insecticide Laboratory, Directorate of Plant Protection, Quarantine & Storage delivered a lecture on Pesticide Packaging Technology in India.

The packaging of pesticides registered under the Insecticides Act, 1968 is a statutory requirement. The packaging and labelling requirements of the pesticides are a statutory stature of the Act. By the very nature, pesticides are toxic substances and need to be used judiciously with great care to safeguard the users, animals, wildlife, birds and the environment at large from the associated hazards. It is in this background that packaging and labelling of the pesticides have become more important. Starting from the manufacturing to the end-users/farmers, pesticide packages may have to travel from one part to the other part of the country through different modes of

transportation such as bullock cart, cycles, trucks, trains, aeroplanes and ships, etc. It is, therefore, necessary to consider suitable pesticides packaging materials/containers after subjecting these to various tests relating to packaging technology, chemico-physical properties, compatibility-inter reaction between content and container, storage, transportation, handling, use, disposal, shelf-life etc. The Registration Committee(RC), constituted under the Insecticides Act, 1968 approves the packaging requirements after critical evaluating the scientific data/information furnished by the applicants for registration of their pesticides. Accordingly, conditions on the Certificate of the Registration are laid down regarding packaging indicating the relevant Indian Standards on Packaging. Generally, packaging requirements of pesticides are being finalised by the Bureau of Indian Standards' (BIS), Subcommittee on Packaging in consultation with statutory bodies and other agencies/authorities dealing in the subject. The following standards have been published by the BIS so far:

1. IS:8190(Part-II)-1988 Amendment or revision thereof
in any - Solid pesticides.
2. IS:8190(Part-II)-1988 Amendment or revision thereof
if any - Liquid Pesticides.
3. IS:8190(Part III)-1979 Amendments or revision thereof
if any - Household pesticides.

4. IS:8190 (Part-IV)-1988 Amendments or revision thereof
if any - Fumigants.

The details regarding specification, construction, design, test methods, etc. are mentioned in these standards/specifications. After critically evaluating the different types of the hazards during transportation, handling, storage, disposal, these Indian Standards are finalised. It has also to be borne in mind that while the pesticides package basically should be sturdy in design it should also be easy to dispose. The various factors concerning re-use of empty pesticides containers are also considered. However, empty pesticides containers are not permitted for re-use under any circumstances.

Under the Act, pesticides are necessarily to be sold in original containers. No insecticide is sold or allowed to be sold in a loose/repack container at the level of distributor, dealer, etc. Technical grade pesticides are packed up to 200 litres in a container.

The international scenario is witnessing a change in the packaging system not only from the viewpoint of safety in handling toxic chemicals but also in the disposal of used containers to avoid environmental damages. Even the chances of adulteration can be eliminated by improving the quality of packaging materials and systems.

Keeping in view the aims and objectives of the Insecticides Act, 1968, Central Insecticides Laboratory(CIL) was

established having four scientific divisions to discharge various statutory duties. Packaging and Processing Division is one of the Divisions of the laboratory which is engaged in the analysis of packaging and labelling of samples received for carrying out the various investigations/studies with reference to pre and post registration verifications of conditions laid down in the certificate of registration.

VII. CONCLUSIONS & RECOMMENDATIONS

Conclusions

The Workshop on Development and Production of User and Environment Friendly Pesticide Formulation made a balanced approach to the development of new generation pesticides formulations within the concept of Integrated Pest Management (IPM). The Workshop dealt with some of the limitations of the newer generation pesticide formulations and the role of conventional pesticides formulations in view of the advantages the newer generation pesticides have over the conventional one in safety aspects. Developing countries of the region having local facilities and expertise could make an important contribution to the region in the development of newer generation pesticide formulations to ensure safety and to prevent environment hazard due to the use of the toxic chemicals. Areas such as water based pesticide formulations namely aqueous suspension concentrate, concentrate emulsions, micro emulsion, water

dispersible granules and micro encapsulation including biocides have been highlighted as the priority areas where national, regional and international agency could play an important role in promoting information exchange training, R&D and transfer of technology. The major thrust is to develop the new generation pesticide formulations through a sound scientific programme approach to meet the emerging needs of controlling pest, diseases etc. as well as protecting the environment from undesirable pollution.

RECOMMENDATIONS

The Workshop

Recognising the need for replacing the hazardous and persistent pesticide formulation with user and environmentally friendly water based formulations, the workshop

recommends UNDP/UNIDO/ RENPAP extends all technical assistance to the member countries to produce user and environmentally friendly pesticide formulations in replacement of the conventional hazardous ones.

The Workshop

Recognising the need for quality assurance of pesticide formulations

recommends UNDP/ UNIDO/ RENPAP extends assistance for creation of a regional centre for depository of reference standard materials in the region. It further recommends that all technical support is extended to the member countries for harmonising the toxicity procedures including analytical techniques in line with the CIPAC collaborative studies by extending the RENPAP membership to those countries of the network which are yet to join.

The Workshop

Recognising the value of exchange of information strengthening of network for promoting technological development in the member countries

recommends UNDP/ UNIDO/ RENPAP to formulate strategies in order to strengthen the exchange of information on production and quality control of new generation pesticide formulations.

EVALUATION OF WORKSHOP WAS CARRIED OUT ACCORDING TO UNDERSTANDARD QUESTIONNAIRE. 16 PARTICIPANTS RETURNED THE QUESTIONNAIRE AND THE SALIENT FEATURES OF THEIR ANSWERS ARE SUMMARISED BELOW:

Introductory Information Received by candidates in home country	a) Aims of the Training	Sufficient B	Insufficient 3	Missing -		
	b) Content of the Programme	B	3	-		
	c) Level of the Programme	M	2	-		
What is your opinion of the total duration of Course						
See your opinion about the daily schedule						
Did you feel that the training corresponded to your professional needs	Very large extent 1	Large Extent 3	Sufficient Extent 2	Small Extent -	Very small extent -	
	Much too high -	Too high -	Adequate B	Too low -	Much too low -	
What do you think of the general level of the training		Too high -	Adequate B	Too low -	Much too low -	
Which subjects of the programme did you find most valuable		Newer Formulations B	Analytical Quality Content/ Laboratory 4	Safe Packaging 1	Safety aspects 1	
Which subjects of the programme did you find least valuable			Analytical Part 1	Formulation Process Too 2	Lectures not well presented 1	
Any relevant subjects that were not adequately covered on the programme			Yes 6	No B	No B	
Which changes would you have preferred in the methods of instruction		a) Lectures	No change 2	More 3	Less 1	
		b) Graph Works		9	6	1
		c) Demonstration		8	7	1
Did you have sufficient time for professional exchange of views with		Yes	Programme Staff B	Fellow Participants B		
		No	1	1	1	
How much did you benefit from the exchange of views with		A Great Deal 1	Much 2	Somewhat 3	Little -	Very little -
Did you find the contents of the programme relevant to conditions in your company (franchise)		Very Great Extent 4	Great Extent 4	Sufficient Extent 8	Too small Extent -	
Do you feel that by participating in this programme you have benefited professionally		Very Great Extent 2	Great Extent 9	Sufficient Extent 5	Small Extent -	Very Small Extent -
Do you think you will have an opportunity to apply your newly acquired knowledge and experience in your present job		Very Great Extent 1	Great Extent 8	Sufficient Extent 6	Small Extent 1	Very Small Extent -
Will you be in a position to transfer your acquired knowledge to others in your home country		Very Great Extent 3	Great Extent 5	Sufficient Extent 6	Small Extent 1	Very Small Extent 1
How well has transfer been done		Day to day work (Colleagues & Subordinates) 2	Specific Training Activities inside present employment 5	Specific Training Activities outside present employment 1		

WORKSHOP ON DEVELOPMENT AND PRODUCTION OF USER AND ENVIRONMENT FRIENDLY PESTICIDE FORMULATIONS AND QUALITY CONTROL, NEW DELHI-20-25, FEBRUARY 1995

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23. **Dr. Bhimsen .K.C.**
Chief Plant Protection Officer,
Deptt. of Agriculture Deptt.
Nepal
24. **Mr. M.A. Malek**
Director,
Plant Protection Wing,
Min. of Agriculture
Bangladesh
25. **Mr. Jawaid Akhtar,**
FMC Ltd.,
Lahore, Pakistan
26. **Mr. Paras Hinger,**
Manager, Quality Control Pesticides India,
PB No. 20, Udaisagar Road,
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27. **Dr. P.K. Garg,, Chief Quality Assurance Manager,**
Rallis India Limited, SCF No. 20, Sector No. 17,
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28. **Mr. S.S. Arora,**
Kanoria Chemicals,
India

WORKSHOP ON DEVELOPMENT AND PRODUCTION OF USER AND ENVIRONMENT FRIENDLY PESTICIDE FORMULATIONS AND QUALITY CONTROL, NEW DELHI-20-25, FEBRUARY 1995

PROGRAMME

Day 1, February 20, 1995

08.45	-	09.00	Registration
Inaugral Session			
09.30	-	10.30	
10.30	-	10.45	Tea/Coffee
10.45	-	11.15	Key-note Address
11.15	-	11.30	Election of the Office Bearers, Adaptation of the Agenda
11.30	-	13.00	Country Reports
		*	Afghanistan
		*	Bangladesh
		*	P.R. China
		*	India
13.00	-	14.00	Lunch
14.00	-	15.00	Country Reports
		*	Indonesia
		*	Iran
		*	Malaysia
		*	Myanmar
15.00	-	15.30	Tea/Coffee
15.15	-	17.30	Country Reports
		*	Nepal
		*	Pakistan
		*	Philippines
		*	Republic of Korea
		*	Sri Lanka
		*	Thailand
		*	Vietnam

Day 2 - February 21, 1995

Conventional Formulations Chairman - Dr. B.S. Parmar

0930	-	1015	Wettable Powder Formulations
1015	-	1030	Discussion
1130	-	1145	Tea/Coffee
1145	-	1130	Emulsifiable Concentrates
1130	-	1145	Discussion
1230	-	1245	Formulation Processing Technique Discussion
1245	-	1345	Lunch

Laboratory Exercises

1345	-	1500	Wettable Powder Formulations
1500	-	1515	Tea/Coffee
1515	-	1700	Emulsifiable Concentration Formulations

Day 3, February 22, 1995

Newer Environmentally Friendly Formulations

Chairman - Dr. B. Sugavanam

0930	-	1020	Suspension Concentrate Formulations
1015	-	1030	Discussion
1130	-	1145	Tea / Coffee
1145	-	1130	Concentrated Emulsions & Microemulsions
1130	-	1145	Discussions
1145	-	1230	Granules & Microencapsulations
1230	-	1245	Discussions
1245	-	1345	Lunch

Laboratory Exercises

1345	-	1500	Suspension Concentrates
1500	-	1515	Tea/Coffee
1515	-	1700	Concentrated Emulsions and Micro Encapsulations

Day 4, February 23, 1995

Newer, Environmentally Friendly Formulations (Contd.)

Chairman : Mr. Roger Weckensdorf

0930 - 1015 Wettable Granules
1015 - 1030 Discussions
1030 - 1045 Tea/Coffee

Laboratory Exercises

11.15 - 1245 Wettable Granules
1245 - 1345 Lunch

Quality Control & Analytical

Procedures

1345 - 1430 Spectrophotometric Methods
1430 - 1445 Tea/Coffee

Laboratory Exercises

1445 - 1700 Spectrophotometric Methods

Day 5, February 24, 1995

Quality Control and Analytical Procedures (Contd.)

Chairman - Prof. A.S.N. Murthy

0930 - 1030 Gaschromatographic Methods
1030 - 1045 Discussion
1045 - 1100 Tea/Coffee
1100 - 1200 HPLC Methods
1200 - 1215 Discussion
1215 - 1245 Reference Standards
1245 - 1345 Lunch

Laboratory Exercises

1345 - 1515 Gas Chromatographic Methods
1515 - 1525 Tea/Coffee
1525 - 1700 HPLC Methods

Day 6, February 25 1995

Packaging and Safety Chairman - Dr. V. Raghunathan

0930 - 1015 Safe Packaging of Pesticides Formulations
1015 - 1030 Tea/Coffee
1030 - 1115 Safety Aspects of Pesticide Formulation Manufacture
1115 - 1130 Discussions
1145 - 1245 Feedback from Participants & Recommendations
1245 - 1400 Lunch
1500 - 1700 Valedictory Session

UNIDO COMMENTS

The report clearly reveals the trend in pesticide technology in moving towards user and environment friendly formulations. As risk reduction is of primary importance, even conventional low toxicity formulations are also important. In this respect the document gives a balanced report of both conventional and newer and safer pesticide formulations.

The inaugural functions in which many representative spoke, clearly stress the role the government and the industry have to play to make sure the workers in the production and the user end are not exposed to toxic chemicals and also the pesticides used are not wasted and allowed to escape to the environment causing chronic ecological damage.

The workshop was timely in the sense the region is still very much unaware of changes taking place in pesticide formulation which is becoming a major area of R&D for improving safety.

Recommendation made in the workshop will have to be discussed in the next PMC meeting for implementation by the member countries.