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DDT is one of the most widely used insecticides. It is employed in largest volume to control insects that attack corn, cotton, orchards and truck crops. Its extensive use is due, largely, to the following three advantages:

- Effective as both a contact and stomach poison.
- Possesses a low order of toxicity toward animal life.
- Long-lasting residue, toxic to insects.

The last advantage requires a full understanding of each use for which a DDT formulation is intended in order to assure its greatest effectiveness. The use determines the type formulation.

Information on approved formulations and methods of application can be obtained from the U. S. Department of Agriculture, State Agriculture Extension Services and the U. S. Public Health Service.

SANTOBANE*

(Monsanto DDT) is high quality technical grade DDT and may be formulated as a dry dust, as wettable powders, solutions, aerosol sprays, or as emulsions. Since transportation costs are a factor in marketing insecticides, the information in this booklet will help formulators in the development of stable, highly concentrated emulsions and wettable powders which can be diluted for field application. For large scale use, concentrates of DDT which the user can reduce with water or low cost dry inerts are favored as the most economical treatment.

The information in this condensed guide has been prepared to assist you in formulating Santobane for commercial use. You may obtain further technical assistance on your particular production problems by calling your nearest Monsanto office.

*Trade Mark Reg. U. S. Pat. Off.

COMPATIBILITY

Studies by Fleck* and Haller on the compatibility of DDT with various compounds which might be used in commercial formulations showed the following facts:

- 1 With the exception of nicotine, none of the commonly used insecticides caused any decomposition of DDT when mixed with it.
- 2 Some fungicides such as sulfur, Bordeaux mixture and ferric dimethyl dithiocarbamate produced a slight decomposition of DDT.
- 3 Much variation exists in the behavior of solvents toward DDT. Ortho-dichlorobenzene, ethylene dichloride, and naphthalene have a marked deteriorating effect on DDT, particularly in the presence of anhydrous ferric chloride. Some of the higher alcohols and petroleum hydrocarbons have very little effect and the solvents commonly used in formulations show a marked in-

*Industrial & Engineering Chemistry, Vol. 37, No. 4 pages 463-465

hibiting action against the decomposition induced by other materials.

4 Many accessory materials which might serve a purpose in DDT insecticides cannot be so used because of their incompatibility. Aluminum chloride, ferric chloride, kaolin, Fuller's earth, Maryland off-color talc and West Coast basic talcs are particularly unsuitable. Alumina, calcium oxide, hydrated lime, ferric sulphate, U. S. P. talc, and zinc chloride were shown to have no effect on DDT.

Compatibility with Other Insecticides

| | | | |
|----------------------|------------|---------------------------------|------------|
| Benzene Hexachloride | Compatible | Parathion | Compatible |
| Chlordane | " | Pyrethrum | " |
| Cryolite | " | Rotenone | " |
| Dinitros | " | Summer Oils | Caution* |
| Dormant Oils | Caution* | Toxaphene | Compatible |
| Lead Arsenate | Compatible | TEPP (tetraethyl pyrophosphate) | " |

*Dormant and Summer Oils vary widely in composition. When Sulfobane is used with these oils, small amounts of the formulation should be prepared first to test compatibility.

SANTOBANE (Monsanto DDT)

Physical and Chemical Data

Chemical Name: dichloro-diphenyl-trichloroethane

Molecular Weight (100% DDT) 354.43

Specifications:

| | |
|--|--|
| Physical form: | Fine granular powder |
| Color: | White to cream |
| Odor: | Characteristic |
| Setting point: | 89°C minimum |
| Organically bound Chlorine (% by wt.): | 48% minimum to 51% maximum |
| pH of water extract: | 6.0 minimum to 8.0 maximum |
| Stability: | Stable under ordinary atmospheric conditions when stored in a dry place in suitable containers. Not rapidly affected by light or contact with air. |
| True density: | Solid density at 25°C—approx. 1.47 grams per cubic centimeter. Molten density at 85°C—approx. 1.50 grams per cubic centimeter. |
| Bulking value: | Approx. 45 lbs. per cu. foot |
| Packing: | Standard containers—100 pound paper bags. |
| Solubility in water: | Less than 2 p.p.m. at 25°C and less than 5 p.p.m. at 100°C. |
| Vapor pressure: | 0.00062 mm. Hg at 53°C. |
| Shipping classification: | "DDT—dichloro-diphenyl-trichloroethane-Dry" |

F O R M U L A T I O N S

Santobane (Monsanto DDT) must be formulated to be used as an insecticide. The type of formulation—dust, wettable powder, emulsion, oil solution or aerosol—will be governed by the particular use for which it is intended. The most important factors are: kind of insect, the method and rate of application, the crop, and the local seasonal conditions under which the application is made. It is important to adapt the formulation to the types of insect infestation based on an accurate knowledge of the insects' life cycle, and to weigh all the conditions under which an insecticide will be used in given parts of the country and at specific times of the year.

State and Federal Experiment Stations have made definite recommendations for

the control of most insects. These recommendations usually suggest the type of formulation to use as well as the concentration.

Dusts and Wettable Powders

Both dry dusts and wettable powders for water suspension are relatively low in cost.

Dry dust mixtures containing 3-5% DDT are recommended for the control of lice and fleas on livestock, excepting dairy animals or those being finished for slaughter. Dry dust formulations containing DDT may be prepared using several types of inerts.

The usual method of formulating a dry dust for field application is to prepare a dust concentrate containing about 50%

Santobane and dilute the concentrate with additional inert material by thorough mechanical mixing. Suitable inerts include diatomaceous earth, certain neutral clays, talc, or pyrophyllite. With these inerts it is practicable to make concentrated dusts containing as much as 50-75% Santobane simply by grinding the Santobane with the proper weight of inert to give a uniformly sized fine-particle mixture. Several types of mills can be used for grinding the Santobane and inert. The most common are roller and air-attrition types.

Extremely high dust concentrates, containing 90% DDT, can be prepared by using 10% Monsanto's Santocel C as the inert for preparing the concentrate. Santocel C improves the dispersability of the final dust, imparts free flow, and serves as an anti-caking agent. Since it

is extremely light in weight (94% dead air), Santocel C can also be added to dust formulations to adjust the bulk of aerial dusts. (For further information, request the report: THE USE OF SANTOCEL C IN COMMERCIAL INSECTICIDES. Address your request to Monsanto, Eocrett Station, Boston, Mass.)

Particle Size

The concentrate is usually milled to a particle size of 5-10 microns (average) with the maximum particle size ranging from 20-60 microns. After the concentrate is diluted with inert dust for field application, the particle size of the final mixture is generally in the same range as the original concentrate.

Wettable Powders

Wettable powders are the type of

formulation most generally used on crops. They can also be used to control insects in farm buildings, on ornamental plants, and for other general surface spraying. Wettable powders may also be used for spraying livestock (not dairy cattle or animals being finished for slaughter).

Concentrated wettable powders are sprayed as water suspensions. They are prepared in much the same way as dry dusts with the exception that a suitable wetting agent is incorporated in the dry mixture. Wettable powders are most conveniently made up as concentrates containing 50% Santobane and 2-5% of wetting agent. The wetting agent makes the dry concentrate readily wettable and promotes more uniform distribution on the surfaces sprayed.

To prepare a wettable powder, Santobane is mechanically mixed as in a ribbon mixer with the inert and the wetting

agent. The mixture should be milled in a roller or air attrition mill to a fine particle size which will disperse easily when mixed with water. In general, the same inerts are used as when formulating dry dusts.

Wettable powder formulations can be made with varying degrees of dispersibility, suspension stability, and controlled foaming. The proper selection of the wetting agent and its concentration will affect these various characteristics. The properties of wettable powders can usually be modified to meet the end use for which the formulation is designed.

A typical formulation for a 50% DDT wettable powder formulation is as follows:

| | |
|-----------------------------|---------------|
| Santobane | 50% by weight |
| Inert carrier | 45-48% |
| Suspending & wetting agents | 5-2% |

It is usually necessary to mill a wettable powder formulation to a particle size of about 5 microns. This insures a good suspension and other desirable physical characteristics.

A 75% DDT wettable powder can be made using diatomaceous earth or suitable clay as the inert material. A 90% DDT wettable powder concentrate can be prepared using Monsanto's Santocel C (8%) as the inert and 2% wetting agent. Santocel C imparts free-flowing characteristics, serves as an anti-caking agent, and does not affect the wetting or dispersion characteristics of the wettable powder formulation. No matter what inert is used, it is important to select the proper wetting agent.

Monsanto supplies a number of wetting agents which have proved highly satisfactory in wettable powder concen-

trates. They impart fast wetting, good dispersion, stability and improved spreading. In general, the combinations shown on the following page give somewhat better results than any single wetting agent alone.

In commercial practice the quantity of DDT dust formulation to be applied is usually based on so many pounds of actual DDT per acre. The quantity depends on the crop and the insect to be controlled. For example, to control European corn borer 1½ to 2 lbs of technical DDT per acre per application is recommended. In terms of a 10% DDT dust, it would be necessary to apply 15 to 20 lbs per acre.

Combinations of insecticides are frequently used to control a wide range of insect pests. For example, one combination used for dusting cotton is called

| | | |
|-------------------|--------|--|
| Santomerse* No. 3 | 1-3% | Based on the total weight of wettable powder |
| Areskap 100 | 0.5-1% | Based on the total weight of wettable powder |
| Santomerse No. 1 | 2-5% | Based on the total weight of wettable powder |
| Areskap 100 | 1% | Based on the total weight of wettable powder |
| Areskap 100 | 1-2% | Based on the total weight of wettable powder |

*Trade Mark Reg. U. S. Pat. Off.

3-5-40, signifying 3% gamma isomer BHC, 5% DDT technical, 40% Sulfur, the balance being inerts. This combination controls boll weevils, bollworms, thrips, fleahoppers, aphids and mites, and is usually applied at the rate of 10-15 lbs. per acre.

DDT wettable powders are generally recommended for use on the basis of so many lbs. per given quantity of water to be sprayed at a given rate per acre. Where 1½ lbs. of technical DDT is specified per acre for corn borer control, 3 lbs. of 50%

wettable powder dispersed in 100 gallons of water and sprayed at the rate of 100 gallons of water and sprayed at the rate of 100 gallons per acre would give the desired treatment.

Solution Formulations

Santobane formulations in the form of organic solvent solutions are generally used for the control of insects in homes, farm buildings and for other pest control work. Since solutions contain organic solvents or petroleum solvents such as

kerosene, they may be harmful to vegetation and therefore are not recommended for crop work.

The amount of Santobane in the spray solution can be varied to meet a wide variety of uses in the field. The solution concentrate itself can also be prepared with a considerable variation in the toxic content.

Solution formulations are usually made by dissolving the solid Santobane in an organic or petroleum solvent to make a solution concentrate. The amount of Santobane in the concentrate must be chosen to meet the recommended dilution for a given use. For use in the household insecticide field, a dilute solution containing about 5% Santobane is usually prepared.

The choice of a solvent will depend

upon the ability of the solvent to dissolve the required amount of Santobane, its odor, flammability, volatility, toxicity and cost. Another factor that must be considered is the probable effect of the solvent upon the surface to be sprayed.

Refined, odorless kerosene is the solvent most commonly used for one-step preparation of solutions containing less than 5% Santobane. Since refined kerosene will dissolve less than 5% DDT, concentrated solutions must be made up with an auxiliary solvent. Such concentrates can then be diluted down to required strength with kerosene.

The table on the following pages lists the approximate solubility of Santobane in a number of available solvents:

Approximate Solubility of Santobane in Certain Solvents

Organic Solvents

| <i>Solvent</i> | <i>Grams Per 100 ML. at 23°—25°C.</i> |
|-----------------------------|---|
| Cyclohexanone | 115-120 |
| Dioxane | 110-115 |
| Methylene Chloride | 101-106 |
| Chloroform | 94-96 |
| Benzene | 90-92 |
| Methyl Ethyl Ketone | 90-93 |
| Monochlorobenzene | 82-84 |
| Acetone | 76-78 |
| Toluene | 75-77 |
| Gamma Valerolactone | 68-70 |
| Ethyl Acetate | 64-66 |
| Xylene | 62-64 |
| Trichlorobenzene, Technical | 50-52 |
| Bethyl Acetate | 48-50 |

| | |
|-------------------------------|-------|
| Carbon Tetrachloride | 45 |
| Amyl Acetate | 42-44 |
| Benzyl benzoate | 42-44 |
| Dibutyl phthalate | 38-40 |
| Diethyl phthalate | 38-40 |
| Dimethyl phthalate | 36-39 |
| Ether | 32 |
| Diacetone alcohol (technical) | 16-18 |
| Ethyl alcohol (95%) | 1.5 |

Typical Petroleum Solvents

| <i>Solvent</i> | <i>Grams Per 100 ML. at 23°—25°C.</i> |
|---|---|
| Secony Vacuum, Sovatoll S | 50-52 |
| Amso Solvent B, American Mineral Spirits Co. | 42-44 |
| Secony Vacuum, P.D.—844C | 40-42 |

| | |
|---|-------|
| Soco-by Vacuum, Sovasol 74 | 33-35 |
| Shell, E407 Solvent | 33-35 |
| Amsco Solvent D, American Mineral Spirits Co. | 32-34 |
| Amsco Solvent F, American Mineral Spirits Co. | 32-34 |
| Amsco Special Solvent D, American Mineral Spirits Co. | 28-30 |
| Phillips Aromatic Oil—Grade I | 28-30 |
| Bayou State—"A" Neutral | 8-10 |
| Bayou Oil Co. | 8-10 |
| Stoddard Solvent | 8 |
| Kerosene, crude | 8-10 |
| Kerosene, refined odorless (Deobase) | 4-5 |

Special Solvents

| Solvent | Grams Per 100 mL. at 23°—25°C |
|--|----------------------------------|
| Velsicol AR50 (Chiefly mono and di methylnaphthalenes) | 65-68 |
| Monsanto Aroclor 1221 | 46-48 |

| | |
|----------------------------------|-------|
| Monsanto Aroclor 1242 | 30-38 |
| Monsanto Aroclor 1248 | 33-35 |
| Pine Oil (Hercules "Narmor" 303) | 13-15 |
| Linseed oil (raw) | 12-14 |

Space Sprays

Solution formulations designed to kill only by contact with the spray itself can be made up with Santobane alone or with the addition of a knockdown agent. Such solutions contain relatively low concentrations of Santobane and can be made by dissolving the toxic materials directly in the solvent.

Typical Formulations:

- With Santobane only
- Santobane—1% by weight
- Refined, odorless kerosene—99% by weight

ever a temporary oily film or dust deposit is objectionable.

Combinations of DDT with other insecticides is now common practice. To control boll weevils and bollworms on cotton, emulsion concentrates containing 2 lbs. of DDT and 1 lb. of Aldrin per gallon or 1 lb. of DDT and 2 lbs. of Toxaphene per gallon are used in sprays.

Emulsion concentrates can be made by combining a wide variety of solvents and emulsifying agents. No one emulsifying agent will work equally well with all solvents, and the quality of the final ready-to-use emulsion will depend upon the correct combination and concentration of solvent and emulsifier.

Monsanto supplies a number of emul-

Emulsion Formulations

Emulsions possess many of the advantages of both dusts and solutions. In addition, emulsions usually permit better coverage and are easier for the user to prepare for application. Since an emulsifying agent must be incorporated in the emulsifiable concentrate, the cost of formulation may be somewhat higher. However, since the dilution for field use is made with water, the somewhat higher cost of the concentrate is justified. Emulsions can be used where there is danger of fire (spraying enclosed areas) or crops (which are susceptible to damage by organic solvents), and in barns, industrial buildings, and where-

The U. S. Department of Agriculture suggests a deposit of 200 mg of DDT per square foot of surface for a satisfactory residual treatment. This deposit is equivalent to the dispersion of approximately one quart of a 5% formulation for each 250 square feet of surface.

Typical Formulations:

A. Strong solutions containing Santobane only

| | |
|---------------------------|---------|
| Santobane | 5% |
| Auxiliary Solvent | 10%-6% |
| Refined odorless kerosene | 85%-95% |

B. Strong solutions containing Santobane and some knockdown agent

| | |
|---------------------------|-----|
| Santobane | 5% |
| Pyrethrum (20-1) | 5% |
| Auxiliary Solvent | 10% |
| Refined odorless kerosene | 80% |

With a knockdown agent Santobane—1% by weight Pyrethrum (20-1)—5% by weight Refined, odorless kerosene—94% by weight

Other knockdown agents such as Alkthrin, Lebane, Lindane and Thalle may be used in lieu of Pyrethrum. Consult manufacturers of these products for recommended usage with DDT.

Residual Sprays

Residual sprays are used to apply a toxic coating to a surface which remains lethal to insects over extended periods of time. The quantity of Santobane in such sprays is higher than used in space sprays and the ultimate insect mortality is outstanding, since the Santobane toxic poison and a stomach poison.

emulsifying agents for formulating Santobane concentrates. Among them are Santomerc No. 3, Areskap, and Emulsifier L. If requested, Monsanto will give

technical assistance to formulators on selecting dependable emulsifying agents and determining the concentrations required.

Typical Formulations:

Stable emulsions ready to dilute for field use can be made up as follows:

| | | |
|-----------------|----------------------|---|
| Santobane | 25% by weight | } Requires vigorous agitation upon dilution. |
| Xylene | 65% by weight | |
| Santomerc No. 3 | 10% by weight | |
| or | | |
| Santobane | 25% by weight | } Requires very little agitation upon dilution. |
| Xylene | 72.5-71.0% by weight | |
| Emulsifier L | 2.5-4.0% by weight | |

Emulsifier L can be used with a number of other solvents, among them aromatic petroleum distillates. On diluting such concentrates containing Emulsifier L, stable emulsions are obtained that can be kept over a long period of time with no more than mild intermittent agitation.

For quick breaking emulsions—sulfonated oils, triethanolamine oleate, and soap can frequently serve as the emulsifier.

Aerosols

Insecticide "bombs" have obtained a wide popularity. Although formulations for aerosol dispersion are more expensive to prepare, mist dispersion is a highly effective method of controlling insects in a room or other confined space.

To date, aerosols have not proved practicable for any other use.

One pound of a standard aerosol is sufficient to treat a space of 150,000 to 250,000 cubic feet. To prepare an aerosol formulation, three elements are needed:

1. A good solvent which will hold the required amount of Santobane in solution.
2. A low-boiling point liquid to serve as the propellant.
3. A container capable of withstanding the pressure developed by the propellant and equipped with a quick release needle valve for dispensing.

In aerosols, a knockdown agent is desirable and most currently used formulations contain pyrethrum or some other

fast acting insecticides in addition to the Santobane.

Typical Formulations:

| | |
|---|-----|
| Pyrethrin Extract (20-1) | 1% |
| Santobane | 3% |
| Hydrocarbon distillate, such as A.P.S. 202 | 12% |
| Dichlorodifluoromethane such as Freon 12 | 84% |

Since the needle valve on aerosol dispensers can become plugged if solid material is present in the formulation, it is

advisable to filter the formulation before loading the container.

The aerosol "bomb" is covered by patents assigned to the Secretary of Agriculture, and licenses for manufacture must be obtained from that Department. Standards have been prescribed and a number of formulations have been approved.

Monsanto's Santobane is sufficiently pure to be used in the preparation of formulations for aerosol bombs.

INSTRUCTIONS FOR HANDLING SANTOBANE

1. Santobane and its formulations are not to be taken internally. Should Santobane be accidentally swallowed, an emetic should be administered and a physician called.
2. Prolonged contact of Santobane solutions with the skin may be harmful, and many of the commonly-used DDT solvents themselves are irritating to the skin. When handling these, frequent washings with soap and warm water are advisable. Suitable respirators and protective garments should be provided for workmen engaged in continuous spraying or formulating operations where sustained contact or splashing of solutions is apt to occur. Solvent formulations of DDT should NEVER be applied on the skin or coat of animals.
3. Long continued inhalation of Santobane dust or vapor from solution formulations may be dangerous. Adequate ventilation should be provided and suitable respirators worn by operators working in atmospheres carrying appreciable quantities of Santobane in any form.
4. Most solvent formulations of Santobane are somewhat flammable and may ignite under certain conditions encountered in use. Avoid flames and sparks of all kinds when doing space or surface spraying with Santobane solutions.

LABELING OF SANTOBANE FORMULATIONS

Insecticides shipped in interstate commerce are subject to the Federal Economic Poisons Regulations as well as the statutes and regulations of the states involved. Labels must, therefore, meet the requirements of both Federal and State governments. State statutes and regulations are not uniform and it is important to obtain authentic information on the subject from the State authorities where business is contemplated. The Federal law is administered by the U. S. Department of Agriculture, Washington, D. C.

The Federal labeling requirements pertain to ingredient content, efficacy claims, directions for use and precautionary data. The U. S. Department of Agriculture will give advice on the subject of labels. Manufacturers of insecticides are requested by the Department of Agriculture to send copies of all proposed labels as well as formulas of the preparations for which the labels are intended to:

U. S. Department of Agriculture,
Washington 25, D. C.

Santobane is Not Approved for Use on Dairy Cattle or on Animals Being Finished for Slaughter.

Notice:

The information contained in this booklet is to our best knowledge true and accurate, but all recommendations or suggestions are made without guarantee, since the conditions of use are beyond our control. Monsanto Chemical Company disclaims any liability incurred in connection with the use of these data or suggestions.

Furthermore, nothing contained herein shall be construed as a recommendation to use Santobane in conflict with existing patents covering any material or its use.

For technical assistance in preparing Santobane formulations, write or call:

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Santobane

(REG. U. S. PAT. OFF.)

ACTIVE INGREDIENTS

Dichloro Diphenyl Trichloroethane 100%
(DDT - setting Point 89°C Min.)

CAUTION: Santobane (DDT) is toxic and when in solution can be absorbed through the skin. Avoid inhaling dust and mist from spray. Avoid contamination of foodstuffs.

For Use Only in the Manufacture of Economic Poisons

MANUFACTURED BY MONSANTO CHEMICAL COMPANY ST. LOUIS 4, MO.

MONSANTO CHEMICAL COMPANY

This is a reproduction of the Monsanto Santobane container label.