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Pesticide Information Leaflet

Department of Entomology
College Park, MD 20742
(301) 405-3913

College of Computer, Mathematical & Natural Sciences
College of Agriculture & Natural Resources

Check out the Pesticide Education and Assessment Program web site at http://pesticide/umd.edu

No. 29: How to Read a Material Safety Data Sheet (MSDS)

Amy E. Brown, Ph.D., Coordinator
and
Elizabeth Ingianni, M.S., Program Assistant
Pesticide Education and Assessment Programs
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BACKGROUND

The Material Safety Data Sheet (MSDS) can be a very useful document to learn about a specific chemical such as a pesticide (herbicide, insecticide, fungicide, rodenticide, disinfectants, etc.) or other potentially hazardous substance. The MSDS provides information about the product's composition, physical and chemical properties and hazards, toxicological information, and first aid procedures. Manufacturers of these substances are required to develop and provide upon request a MSDS for each product.

Commercial establishments using pesticides and other products are required to keep MSDS and make them available to workers or others potentially exposed to the substance, its diluted end product, or its residues.

Because there is no standardized form for the MSDS, and because the information is presented in technical terms, it can be difficult for readers without specialized scientific training to decipher the MSDS. This leaflet explains how the MSDS is derived and arranged, and helps the reader interpret the information contained in the MSDS.

Ideally, the MSDS is used in combination with reading the pesticide label. See ***Pesticide Information Leaflet No. 28: How to Read a Pesticide Label*** for important information on this topic.

DEVELOPMENT OF THE MSDS

Pesticide manufacturers must perform a wide range of tests before their products can be registered with the U.S. Environmental Protection Agency (EPA) for use in the United States. The MSDS reflects the results of these tests on the *formulated* product.

However, most people are not exposed to the concentrated product as formulated

because many commercial pesticides and some homeowner products need to be diluted (usually with water or a horticultural oil) before they are applied. Additionally, once liquids have dried on the application site, residues are much less available for transfer to humans, pets, other animals, etc. Residues of both liquid and dry materials also degrade over time. This means that exposure often involves a lower amount or dose of the chemical than what is reflected in the MSDS.

One of the most basic concepts of toxicology is the dose-response relationship: generally, the lower the dosage one is exposed to, the smaller the likelihood of experiencing any adverse effects. The Hazard Communication Standard of the Occupational Safety and Health Act requires the MSDS to be made available to workers in manufacturing or to any end-user who handles the end-use formulated material. These people may be exposed to higher dosages. However, because most other people are exposed to diluted products or to residues rather than to the undiluted product for which the MSDS was developed, most incidental exposure does not equate to the work place exposure information presented in the MSDS. Therefore, the information should be interpreted with this in mind.

COMPONENTS OF THE MSDS

The information contained in the MSDS may appear under different headings or be presented in different orders, but the elements of the MSDS are the same.

Chemical product identification

This section identifies the ingredients in the product by common (generic) name, percentage of both the *active ingredient(s)* and *inert ingredients*, and, often, synonyms or brand names of other products with the same composition. The active ingredient is the component that actually controls the pest, while an inert ingredient is one that serves another purpose in the formulation, such as consistency or texture, but for which no toxic activity against the pest is claimed. While inert ingredients do not directly contribute to killing or controlling the pest, they may have effects on humans or other non-target animals and plants.

Historically the exact identification of inert ingredients has been considered proprietary information and thus not required to be listed on either the label or the MSDS. However, EPA maintains a list of inert ingredients considered not to present excess hazards; registrants choose from this list when they formulate products.

This section of the MSDS may also provide information about the class of chemical, such as "organophosphate insecticide" or "chlorophenoxy herbicide." Chemicals in a particular class all share certain characteristics, and this information may be helpful to the health care professionals and others.

Physical and chemical properties

This section describes the product's physical appearance and provides information about how the product behaves under certain physical and chemical conditions. Particularly relevant for many applications are the measures for solubility in water, vapor pressure, stability, and melting/freezing point.

Water solubility, or how readily a substance dissolves in water, is a factor in how likely it is to be carried off site in run-off water or in leachate. In general, the lower the solubility, the more likely the substance is to bind to

soil particles or organic matter instead of dissolve in water. A relatively high solubility in water can be a benefit in the case of human exposure, however, because products that are water soluble will be excreted in the urine rather than stored in body fat.

A substance's *vapor pressure* helps determine whether the chemical is likely to evaporate or volatilize; in other words, how likely it is to form a gas. Other factors involved include temperature; how tightly the substance binds to soil particles, plants, or the site of application; and how much water is present (combined with the substance's water solubility). Products with relatively high volatility are more likely to be detected through smell than products with low volatility. Some MSDSs provide information about the odor of a product, which may range from practically odorless to very apparent.

Stability as well as *boiling and freezing points* of a substance determine the temperature range at which a product should be stored. Freezing and excessive heating may degrade the product, resulting in a loss of efficacy against the pest.

Fire and explosion hazards

Some substances can spontaneously catch fire at certain temperatures. In such cases, the MSDS will identify this temperature, called the *flash point*. The MSDS may also list conditions to avoid, such as materials that are incompatible with the product. For example, some substances can react with galvanized containers to form hydrogen gas, a highly combustible material; therefore, these substances should not be stored in galvanized containers.

Toxicological information / Human health data

The MSDS identifies by what route(s) of exposure the product may be harmful. Routes include *ingestion* (through the mouth), *dermal* (through the skin), and *inhalation* (by breathing the product's vapors).

The MSDS also summarizes the results of toxicological tests performed on laboratory animals and extrapolates the results to determine the potential for effects on humans. The toxicological tests required by EPA include *acute toxicity* (effects from a single exposure, apparent within 24 - 48 hours after exposure), *chronic or delayed toxicity* (effects from repeated exposure over time, which may not be apparent for weeks to years after exposure), *oncogenicity* (ability to cause tumors), *carcinogenicity* (ability to cause malignant tumors, or cancer), *teratogenicity* (ability to cause birth defects), and *fetotoxicity* (other adverse effects on the fetus, such as low birth weight or spontaneous abortion). Symptoms of acute overexposure are usually identified in the MSDS. The MSDS also lists medical conditions that may be aggravated by exposure to the product.

Acute toxicity by oral or dermal exposure is provided in terms of the LD_{50}, or Lethal Dose 50%. The LD_{50} equals the dosage at which 50% of the test animals died as a result of the exposure. Inhalation toxicity is provided in a similar term, the LC_{50}, or Lethal Concentration 50%. Because the lethal dose varies with the body weight of the animal (or human), the LD_{50} value is expressed as milligrams of active ingredient per kilograms of body weight (mg/kg). Similarly, the LC_{50} is expressed as milligrams of active ingredient per liter of air (mg/L). Note that there is an inverse

relationship between the LD_{50} or LC_{50} value; in other words, the smaller the value, the more toxic the substance.

The LD_{50} and LC_{50} are best used to compare the acute toxicity of one product to another. EPA categorizes pesticides' acute toxicity as follows:

Acute Toxicity Category	**LD_{50}**	**Amount estimated to cause death in adult human**
I. extremely toxic	less than 50	a few drops to a teaspoon
II. moderately toxic	50 to 500	over 1 teaspoon to 1 ounce
III. slightly toxic to relatively nontoxic	more than 500	more than 1 ounce

It is important to remember that a substance's level of acute toxicity provides information ONLY about its ability to cause short-term adverse effects. The level of acute toxicity is not related to its ability to cause chronic or delayed effects or allergic responses. Chronic effects may sometimes occur through very different biochemical processes than acute effects. Thus, it is quite possible for a Category III "relatively nontoxic" pesticide to have adverse long-term effects or allergic reactions, or for a Category I "extremely toxic" pesticide to have no known long-term or allergic effects.

The MSDS usually also provides specific information about the product's ability to cause other adverse effects, such as eye and skin irritation or allergic responses. Allergic responses are not related to the chemical's level of acute toxicity or to its ability to cause chronic effects. Allergic reactions to pesticides, like allergic reactions to any allergen (pollen, dust, animal fur, food components, etc.) are idiosyncratic – that is, they are peculiar to the individual. One person may have no allergic reaction while someone else exposed to the same substance under exactly the same conditions may have a serious reaction. Because allergic responses are so individual, they are difficult to test for under laboratory conditions.

Cholinesterase inhibition

Cholinesterase is an enzyme necessary for proper nervous system transmission. If a pesticide can bind to cholinesterase, its MSDS will identify it as a cholinesterase inhibitor. See ***Pesticide Information Leaflet No. 7: Cholinesterase Testing*** or ***No. 30: Cholinesterase Monitoring: A Guide for the Health Professional*** for more information on this subject.

Regulatory levels and classifications

Regulatory limits are often set on the amount of time a worker in a manufacturing plant can be exposed to a particular compound. Some substances have been classified with regard to their ability to act as carcinogens (cancer-producing substances). Sometimes the terms used sound similar and can be confusing, but they have been set by different agencies for subtly different situations. Terms used on the MSDS may include the following:

Occupational Safety and Health Administration (OSHA) Permissible Exposure Limit (PEL). The PEL is a regulatory limit (time-weighted average, or TWA, concentration of a substance in the air) that must not be exceeded during any 8-hour work shift of a 40-hour work week. PEL concentrations are given in parts per million (ppm) or in milligrams per cubic meter (mg/m^3).

Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV). The TLV is a guideline for safe exposure based on an 8-hour TWA exposure. The TLV is given in the same units (ppm or mg/m^3) as the PEL. This information is not a legal standard, but a recommendation for use by industrial hygienists and other similar experts for assessing workplace safety in the absence of regulatory limit such as the PEL.

Carcinogen classification. EPA and other agencies use a classification system to rate the human carcinogenic potential of compounds. The levels of carcinogenicity under this system are "known" (Group A), "probable" (Group B), and "possible" (Group C) human carcinogens. Probable human carcinogens are further refined as Group B1 (probable human carcinogens with limited human evidence) or B2 (probable human carcinogens with sufficient evidence in animals but inadequate or no evidence in humans).

Personal protection recommendations

The MSDS will specify any special personal protective equipment (PPE) to wear while handling the concentrate product. Many products do not require special protective equipment while others require chemical-proof gloves, goggles, respirators, or other gear. Remember that the equipment listed is for handling the product as formulated. Refer to the pesticide label to check whether gear listed on the MSDS is required to be worn while handling the diluted product.

Emergency and first aid procedures

The MSDS provides specific information about first aid and emergency treatment for product exposures and adverse effects. If the chemical is a cholinesterase inhibitor, the MSDS will so state, and treatment information for the physician will be provided. (See ***Pesticide Information Leaflet No. 7: Cholinesterase Testing***, for more information on cholinesterase inhibitors.)

Ecological or environmental hazards

EPA requires toxicological testing on plant and animal indicator species. The MSDS provides information on acute and chronic effects on wildlife in terms similar to those used to describe acute and chronic effects on humans.

Spills, fires, and accident procedures

The MSDS contains directions for cleaning up spills and leaks, as well as special information for fire fighters. This information may be necessary in the event of an emergency and should be stored in an area that is easily accessible in a pesticide emergency.

Storage and disposal

The MSDS includes directions for proper storage and disposal of the pesticide. Storage and disposal information on the MSDS is usually quite general, but can sometimes be very specific.

SUMMARY

The MSDS provides important information about pesticide ingredients. Using it in conjunction with the product label will provide not only a good description of the potential risks, but also appropriate and required exposure minimization measures that will help reduce any such risks. For details on the pesticide label, see ***Pesticide Information Leaflet No. 28: How to Read a Pesticide label***.

SOURCES

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