# Choice PBO Quotes:

From IPCS:

International Programme on Chemical Safety (IPCS) is a collaborative venture of

WORLD HEALTH ORGANIZATION

UNITED NATIONS ENVIRONMENT PROGRAMME

INTERNATIONAL LABOUR ORGANISATION

IPCS INCHEM is a means of rapid access to internationally peer reviewed information on chemicals commonly used throughout the world, which may also occur as contaminants in the environment and food. It consolidates information from a number of intergovernmental organizations whose goal it is to assist in the sound management of chemicals.
http://www.inchem.org/documents/jmpr/jmpmono/v072pr27.htm

Breakdown by photolytic mechanisms is extremely slow (Fishbein and Gaibel, 1970), and exposure to sunlight and normal lighting conditions does not degrade piperonyl butoxide. Under extreme conditions of intense light, small (<3%) quantities of unknown products were produced.

However, piperonyl butoxide inhibits microsomal oxidation of a wide variety of compounds which are detoxified by hydroxylation reactions. This effect can explain the ability of piperonyl butoxide to prolong the action of barbiturates and zoxazolamine, slow the metabolism of benzpyrene and enhance the toxicity of pyrethrins. In addition, piperonyl butoxide has been shown to induce glucuronyl transferase following prolonged exposure (Lucier et al., 1971). Treatment of mice by intraperitoneal injection resulted in a biphasic action on microsomal enzyme activities (Skrinjaric-Spoljar et al., 1971; Mathews et al., 1970; Kamienski and Murphy, 1971); activity returned to levels that were higher than normal after 24 to 72 hours. These in vitro studies were substantiated by in vivo tests on hexabarbital sleeping time. In addition to affecting microsomal enzymes, oral administration of piperonyl butoxide at 1 gm/kg to rats resulted in an increased level of neutral lipid in blood, several other tissues and organs. No fat deposition was noted in liver, kidneys, thymus or testis, but an increased level was observed in blood, heart, spleen, pancreas, lungs and adipose tissue (Albro and Fishbein, 1970).

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From: Pesticide Action Network:
http://www.pesticideinfo.org/Detail_Chemical.jsp?Rec_Id=PC33240
PBO Breakdown

**Physical Property Data Related to Water Contamination Potential**

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| Water Solubility (Avg, mg/L) | 14.0 |
| Adsorption Coefficient (Koc) | 1,805 |
| Hydrolysis Half-life (Avg, Days) | 250.0 |
| Aerobic Soil Half-life (Avg, Days) | 79.0 |
| Anaerobic Soil Half-life (Avg, Days) | 927.0 |

## Water Solubility

The water solubility of a pesticide is a measure of how readily the chemical will dissolve in water and is typically expressed as the maximum amount of the pesticide that will dissolve in one liter of water. Typical concentration units are mg per liter (mg/L) which is approximately equal to parts per million (ppm) or micrograms per liter (ug/L), which is approximately equal to parts per billion (ppb). The larger this number is, the more water soluble the pesticide, and the more readily the pesticide will be transported away from the application site by stormwater or irrigation water runoff. The California Department of Pesticide Regulation has determined that pesticides with a water solubility greater than 3 mg/L have potential to contaminate groundwater. In reality, pesticides with water solubilities less than 3 mg/L have been found in groundwater, so this is no guarantee (1).

For more about how California Department of Pesticide Regulation uses these physical properties to regulate pesticides as groundwater contaminants, see the California Regulations page.

*Reference:*

1. J. E. Barbash and E.A. Resek, *Pesticides in Ground Water: Distribution, Trends, and Governing Factors,* Volume 2 in the series *Pesticides in the Hydrologic System,* U.S. Geological Survey, Ann Arbor Press (Chelsea, MI, 1996).

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## Half-Life

Half-life is defined as the time (in days, weeks or years) required for half of the pesticide present after an application to break down into degradation products. This time is often expressed as a range (for example, 1-3 days, 2-4 years, etc.) because the rate of pesticide breakdown depends on a variety of factors including temperature, soil pH, soil microbe content and whether or not the pesticide is exposed to light, water and oxygen. It is worth noting that many of the breakdown products themselves are toxic and may have significant half-lives as well. There are several different types of half-lives:

- **Soil half-life:** The amount of time required for half of the pesticide to degrade in soil. This half-life is governed by the types of soil organisms that are present that can break down the pesticide, the soil type (e.g., sand, loam, clay), pH, and temperature. The California Department of Pesticide Regulation has determined that pesticides with an aerobic soil half-life greater than 690 days or an anaerobic soil half-life greater than 9 days have potential to contaminate groundwater.
- **Photolysis half-life:** The amount of time required for half of the pesticide to degrade from exposure to light. The California Department of Pesticide Regulation has determined that pesticides with a hydrolysis half-life greater than 14 days have potential to contaminate groundwater.
- **Hydrolysis half-life:** The amount of time required for half of the pesticide to degrade from reaction with water. The California Department of Pesticide Regulation has

determined that pesticides with a hydrolysis half-life greater than 14 days have potential to contaminate groundwater.

For more about how California Department of Pesticide Regulation uses these physical properties to regulate pesticides as groundwater contaminants, see the California Regulations page.

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## Adsorption Coefficient, $K_{oc}$

The adsorption coefficient, $K_{oc}$, is a measure of how strongly a chemical adheres to soil in preference to remaining dissolved in water. In more general terms, this parameter is often called $K_d$, a distribution coefficient that provides a measure of how a substance is distributed between any two different media--air/water, water/soil, or two different immiscible solvents.

$K_{oc}$ is formally defined as the ratio of the mass of pesticide adsorbed per unit mass of soil to the mass of the pesticide remaining in solution at equilibrium. Because it is a ratio of masses, the number is unitless. The value is dependent on the type of soil and the soil pH, so it is not uncommon to see a range of values reported in the literature.

Pesticides with high $K_{oc}$ values are typically not very water soluble and will preferentially adhere to soils rather than be dissolved in water. This means that pesticides in this class are unlikely to be carried off-site in runoff as dissolved substances; instead, they are transported on sediment particles. For some example values consider DDT with a $K_{oc}$ of 100,000 (adheres strongly to soil). Diazinon has a $K_{oc}$ of 1,580 and is readily transported as the free substance dissolved in water. The California Department of Pesticide Regulation has determined that pesticides with a $K_{oc}$ less than 1,900 have potential to contaminate groundwater.

For more about how California Department of Pesticide Regulation uses these physical properties to regulate pesticides as groundwater contaminants, see the California Regulations page.

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## Vapor Pressure, Vp

The vapor pressure of a pesticide is a measure of how readily it will evaporate. This parameter predicts the volatility of the chemical and allows determination of which pesticides might be prone to volatilize and drift off-site after application.

Formally, vapor pressure is defined as the pressure exerted by the pure substance in a closed system at equilibrium. Vapor pressure varies with temperature, increasing as the temperature increases and decreasing as the temperature decreases.

Vapor pressures are expressed using a variety of units, including pascals (Pa), millimeters of mercury (mm Hg, equivalent to Torr, named after the Italian chemist Torricelli who invented the barometer), pounds per square inch (psi), and atmospheres (atm). If you plan to compare vapor pressures, be sure they are all in the same units before proceeding. Some conversion factors are given below:

1 Pa = 1 kg/m-$s^2$

1 Pa = 7.5 x $10^{-3}$ mm Hg (Torr)

1 kPa (kiloPascal) = 1000 Pa = 7.5 mm Hg (Torr)

1 mPa (milliPascal) = 0.001 Pa = 7.5 x $10^{-6}$ mm Hg (Torr)

1 atm = 101.325 kPa (kiloPascal)

1 atm = 14.70 psi

1 atm = 760 mm Hg (Torr)

Typically pesticides with vapor pressures greater than $10^{-6}$ mm Hg can readily volatilize and drift away from the application site.

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## Octanol-Water Partition Coefficient, $K_{ow}$

The octanol-water partition coefficient, $K_{ow}$, is a measure of how a chemical will distribute between two immiscible solvents--water (a polar solvent) and octanol (a relatively non-polar solvent). The $K_{ow}$ value provides information on the polarity of the pesticide and is often used as a model for how the pesticide may be distributed in body tissues, e.g. blood vs. fat tissue. Pesticides with a long half-life and high $K_{ow}$ have been shown to bioaccumulate in the food chain.

In more general terms, this parameter is often called $K_d$, a distribution coefficient that provides a measure of how a substance is distributed between any two different media--air/water, water/soil, or two different immiscible solvents.

$K_{ow}$ is formally defined as the ratio of the concentration of pesticide in the octanol layer to the concentration of the pesticide dissolved in the water layer. Because it is a ratio of concentrations, the number is unitless. The value is dependent on temperature.

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## Predicting Water Contamination Potential

California Department of Pesticide Regulation has developed a method to estimate water contamination potential based on the water solubility, half-life, and $K_{oc}$ of pesticide chemicals. This method is described in detail on the California Regulatory Information page.

Other factors also play a role in determining whether a pesticide is likely to contaminate water, in particular the total amount used, the setting in which it is applied, and the product formulation.

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## Data Sources for Physical Property Data

Physical property information was obtained from the California Dept. of Pesticide Regulation, which collects this information as part of the registration process. For pesticides evaluated through DPR's Groundwater Protection Program, we use the Specific Numerical Values published in the DPR Well Inventory reports. For more detail on Specific Numerical Values and links to the Well Inventory Reports, see the California Regulatory Information page.

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- *Last updated July 20, 2005 .*