Volatile organic compounds (VOCs)

What are VOCs?

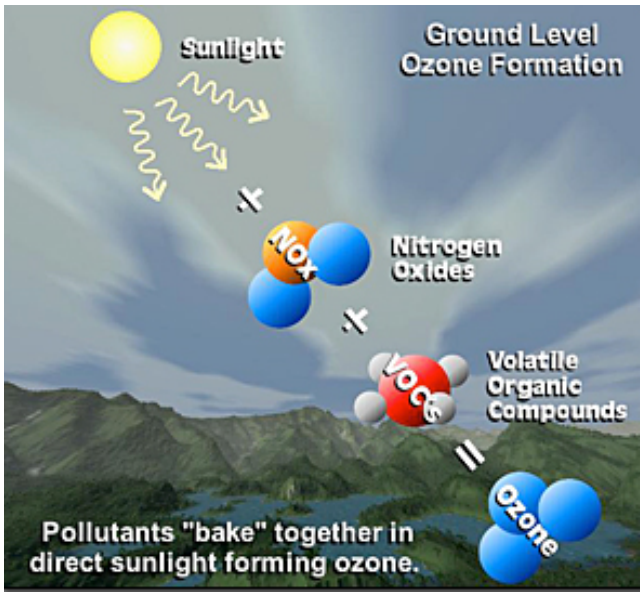
These volatile carbon-containing compounds quickly evaporate into the atmosphere once emitted. While coming from certain solids or liquids, VOCs are released as gases.

Why are VOCs of concern?

VOCs are a source of indoor and outdoor pollution.

As an indoor pollution, VOCs may be referred to as volatile organic chemicals. Indoors, VOCs evaporate under normal indoor atmospheric conditions with respect to temperature and pressure.

As an outdoor pollutant, VOCs are of concern due to their reaction with nitrogen oxide (NOx) in the presence of sunlight. The reaction forms ground-level ozone (O3) – the main component of smog. If levels are high enough, this ground-level ozone can be harmful to human health and vegetation, including crops.



Because of the relationship with the formation of ground-level ozone, VOCs are regulated by the 1990 Clean Air Act and certain State laws. This Act requires every state to submit a State Implementation Plan (SIP) outlining achievements and maintenance of federal ambient air quality standards, including the standard for ozone.

Sources of VOCs

Man-made VOCs are typically petroleum-based and are a major component of gasoline. In this situation, VOCs are emitted through gasoline vaporization and vehicle exhaust. Burning fuel, such as gasoline, wood, coal, or natural gas, also releases VOCs. VOCs are used in solvents and can be found in paints, paint thinners, lacquer thinners, moth repellents, air fresheners, wood preservatives, degreasers, dry cleaning fluids, cleaning solutions, adhesives, inks, and some, but not all, pesticides. Major sources of VOCs and NOx involve emissions from industrial facilities and electric utilities, motor vehicle exhaust, gasoline vapors, and chemical solvents. Pesticides containing solvents typically release high rates of VOCs. The active ingredient in certain pesticides may contain VOCs, as well. Solid formulations release the lowest amount.

In nature, VOCs can originate from fossil fuel deposits, such as oil sands, and can be emitted from volcanoes, vegetation and bacteria. Trees even produce different types and amounts of VOCs.

Health Effects from VOCs and Ground-Level Ozone

The harmful effects of exposure to VOCs vary according to the specific compound – ranging from no effects to highly toxic effects. This variance is related to the nature of the VOC, the level of exposure to the VOC, and the length of exposure to the VOC.

With short-term exposure, the consequences can encompass eye and respiratory tract irritation, headaches, dizziness, visual disorders, fatigue, loss of coordination, allergic skin reactions, nausea, and memory impairment. Long-term contact with VOCs can damage the liver, kidneys and central nervous system.

Ground-level ozone can lead to harmful effects in humans, especially children, as their lungs are still developing. Older adults, individuals with lung disease, and even healthy people active outdoors are at risk, as well. These effects can be particularly unhealthy on hot, sunny days in urban settings, when levels are typically at an increase. Keep in mind

that ground-level ozone can be transported by wind, resulting in high levels of ground-level ozone in rural areas.

The effects of breathing ground-level ozone can be acute in nature or exacerbate chronic conditions, like asthma, emphysema and chronic bronchitis. Acute problems can include shortness of breath, pain with deep inhalation, chest pain, coughing, and/or sore or scratchy throat. Ground-level ozone inhalation can further lead to airway inflammation, damage, infection susceptibility, and even permanent lung scar tissue with repeated exposure.

Ecosystem and Environmental Effects from Ground-Level Ozone

Ecologically, ground-level ozone can damage sensitive vegetation, especially during growing season, thereby harming the associated ecosystem. These ecosystems could include forests, parks, wildlife refuges and wilderness areas. Elevated levels of ground-level ozone can result in reduced agricultural crop yields and commercial forest yields.

Specifically, after an adequate amount of ground-level ozone enters the leaves of a plant, the damage can include:

- Interference with the susceptible plant's ability to produce and store food leading to a reduction in growth.
- Hindrance with the photosynthesis process, reducing the plant's ability to process carbon dioxide and subsequently reducing the amount of oxygen released.
- Causation of visible injury to the leaves of plants and trees.

Repeated exposure to ground-level ozone over time results in sensitive plants and trees developing disease, insect damage, cumulative damage from other pollutants, decreased ability to compete, and increased impairment from harsh weather. Harm at the level of plants and trees can evolve into detrimental consequences at the ecosystem level, such as loss of species diversity, decrease in habitat quality, and changes to water and nutrient cycles.

How Can Growers Reduce VOC Emissions?

1. Incorporate Integrated Pest Management (IPM) Practices

   In general, an IPM utilizes practices such as cover cropping, crop rotation, insect baiting, pest exclusion, sanitation, release of natural enemies, and mating interference with pheromones. These practices are considered reduced risk practices.

   If planned correctly, an IPM can facilitate a reduction in the number of applications of pesticides that contain VOCs. How so?

   - Correct and scientific pest monitoring – Prevents unnecessary pesticide applications.
   - Crop sanitation – Removes overwintering sites and shelters for pests.
   - Habitat provisions for beneficial insects – Reduces pest populations.

   Utilizing IPM practices can also help decrease air pollution. As previously discussed, practices that reduce VOC emissions lead to a reduction in ground-level ozone development. In addition, by applying pesticides less frequently, application equipment is operated less often,

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Examples of Ozone-Damaged Vegetation




leading to a decrease in the burning of fossil fuels like diesel fuel, which reduces VOC and NOx emissions, particulate emissions, and dust.

2. Reduce Pesticide Amounts

   In addition to reducing the number of pesticide applications, a grower can also reduce the amount of pesticides applied – again, reducing VOC emissions.

   Reducing the amount of pesticides used can be accomplished by either decreasing the number of applications or treating a smaller area of acreage. The decreased use of application equipment is again a factor. While reducing VOC emissions, other benefits seen may include cost savings, fuel use reduction and less soil compaction. Other tools for reducing the amount of pesticides applied are spot treatments, when applicable; pest population remote sensing; and application equipment target-sensing. Another benefit of these practices is the decline in off-site pesticide transfer.

3. Utilize Other Pesticide Formulations

   With respect to liquid formulations, emulsifiable concentrates (ECs) emit the highest amount of VOCs, mainly due to the inclusion of solvents in their formulation. Lower VOC emissions are seen with solids, such as granules or wettable powders.

Resources

For more information on ground-level ozone, visit the U.S. Environmental Protection Agency website.

For more information on VOC Emissions from pesticides, including VOC emissions calculators for non-fumigants and fumigants, visit the California Department of Pesticide Regulation (DPR) website.

For California DPR's complete literature on reducing VOC emissions from agricultural pesticide applications, see the Conservation Management Practices Guide.