Solvents Industry Group
Solvent Profiles

WHAT IS A VOC?

One of the most commonly used terms in the solvents industry is "VOC," as in "reduced-VOC," "non-VOC," and "VOC content." Most people in the industry know that VOC stands for volatile organic compound, but many do not fully understand what VOCs are and why they receive so much attention. This bulletin briefly outlines some of the basic concepts, definitions, and regulations associated with VOCs.

With certain important exceptions discussed below, the solvents used in products such as coatings, inks, adhesives and consumer products are classified as VOCs. Unless they are controlled (by either an incinerator or closed-loop vapor recovery system on a painting operation, for example), these solvents are emitted into the air after they perform their function. Thus, solvent emissions from products are one of several significant sources of VOC emissions.

VOCs and Ozone Formation

It is well known that the impact of ozone is different depending on where in the atmosphere it is located. Ozone in the upper atmosphere, or stratospheric ozone absorbs UV light and protects the earth from harmful ultraviolet radiation. Ground level ozone, or tropospheric ozone, on the other hand, is the main component of smog and thus has adverse effects on human health.

Ozone is formed in the atmosphere when UV light from the sun reacts with oxides of nitrogen (NOx) from automobiles, manufacturing plants, power generation facilities, or other emissions even when VOCs are not present. When VOCs are present, the overall equilibrium between ozone and NOx is shifted and more ozone may accumulate.

There are many contributors to VOCs in the atmosphere, including natural or "biogenic" sources, such as trees and vegetation. Man-made sources such as vehicle emissions, petroleum refining and combustion also contribute to VOC levels. The use of organic solvents contributes to VOC emissions if they evaporate into the air. In most rural areas of the country, biogenic VOCs predominate over man-made VOCs. These areas often have limited NOx concentrations, due to the presence of fewer automobiles, manufacturing plants, power generating facilities, and other sources. Thus, reducing man-made VOCs in rural areas is not expected to provide the same benefit as in urban areas.

Some areas of the country do not meet national standards for ground-level ozone and are referred to as "ozone non-attainment areas." Under the Clean Air Act (CAA), these areas generally are required to reduce VOC emissions (not including vehicle emissions) by 3% each year until the national standard is met. To achieve these CAA national standards and reach ground-level ozone attainment levels, virtually all sources of man-made VOC emissions are regulated, including solvent uses.

Definition of VOC

Because VOCs are subject to regulation, the question "What is a VOC?" is a crucial one. The EPA has established a general definition of VOC that is very broad. In effect it states that "any volatile compound of carbon" is classified as a VOC for regulatory purposes, unless it appears on a list of compounds that have been specifically exempted (See 40 CFR 51.100(s)).

EPA's VOC regulations, however, do not always apply to all compounds that meet the very broad definition found at 40 CFR 51.100(s). For example, for regulations involving paints and coatings, there is a specific test method, known as Test Method 24, that generally determines what is to be treated as a VOC (See 40 CFR part 60, Appendix A). Test Method 24 is a collection of ASTM test methods that define the VOC content of a coating formulation. Generally, any non-exempt compound (discussed further below) that is "picked up" by these test methods is considered a VOC for purposes of regulating coating formulations.

Individual states may have their own VOC definitions, including their own list of exemptions. Although state definitions (including exemptions) are generally the same as the EPA definition, a solvent user should be aware of the precise definition that applies in his or her state and/or end use category.

EPA regulations include a list of compounds that are explicitly exempted from regulation as VOCs, even though they are "compounds of carbon." In fact, there are two lists: a short list of compounds such as carbon monoxide and carbon dioxide that historically have not been regulated as VOCs; and a longer list of compounds that EPA has classified as "negligibly reactive." Negligibly reactive compounds are compounds that, based on EPA studies, have been found "not to contribute appreciably to ozone formation." This list of compounds (often referred to as "VOC-exempt compounds") was established by EPA and is modified by regulation.

Although there are only a few VOC-exempt solvents at this time, they can be useful in a number of products, because they function as solvents but are not counted as VOCs for regulatory purposes. Product formulators must, however, consider the characteristics or properties of the components in a formulation, not just whether they are VOC-exempt. Careful selection of each component in a formulation is needed to develop effective, efficient, and economical products that perform well and meet applicable regulatory requirements.

All VOCs are Not Alike

Traditionally, VOCs have been regulated using a mass-based approach limiting the mass percentage of VOCs in various products or formulations, such as paint. Under this approach, VOCs are either considered reactive and therefore subject to VOC regulation, or negligibly reactive and thus exempt from VOC regulation. This mass-based approach treats all non-exempt VOCs alike in their ability to contribute to ozone levels. However, scientists concur that VOC contribution to ozone accumulation actually varies considerably.

After years of scientific study, a new paradigm is emerging in the approach to improving air quality and reducing ground level ozone – namely, using relative photochemical reactivity as a way to differentiate between VOC molecules. (See the American Solvents Council Article, "Photochemical Reactivity- A New Paradigm for VOC Regulation of Solvents.")

Photochemical Reactivity

Regulations that take into account a compound's reactivity can offer a viable science-based approach that can in fact lead to a higher reduction of ozone creation potential.

EPA has been studying reactivity for years through the Reactivity Research Working Group (RRWG), which is comprised of academics, research scientists and industry. Modeling has demonstrated that reactivity-based limits can be effective in reducing ozone in non-attainment areas such as urban environments. The RRWG and others have also addressed the need for developing scientifically valid "reactivity scales." One of the most common scales in use today is the Maximum Incremental Reactivity (MIR) scale.

The MIR scale measures the *relative* photochemical reactivity of solvents on a common, continuous scale. MIR values are usually expressed in units of grams of ozone formed per gram of VOC reacted.

Thus, a reactivity-based approach provides the ability to differentiate between more reactive and less reactive VOCs. Control of VOCs in this manner should:

? Lead to a higher reduction in ozone creation potential in a more efficient, cost-effective and expeditious manner.

? Increase formulation flexibility, and maintain/improve product performance.

? Result in additional benefits to the overall environment.

CARB Aerosol Coatings Reactivity Regulation

Difficult reformulation challenges led the California Air Resources Board (CARB) to conclude that it may not be feasible to achieve additional VOC reductions using a traditional mass-based program for aerosol coatings. Working with industry and scientists, CARB developed a reactivity-based aerosol coatings rule, which was approved by EPA in September 2005. The CARB rule encourages reductions in the use of higher reactivity VOCs in aerosol coatings yielding greater reductions in ozone levels than would have been achieved by traditional mass-based regulations. CARB estimates this new rule will achieve the equivalent of an additional 3.1 tons per day of VOC reductions in California as compared to a mass-based approach. CARB is now working on a reactivity-based VOC rule for AIM coatings, which is expected in 2007.

EPA Interim Guidance Policy – Sets Direction for Future VOC Control

The EPA believes that reactivity-based approaches, such as the one developed by CARB, should be more efficient and effective than traditional approaches that do not distinguish among VOCs. As a result, the EPA updated its VOC policies by endorsing photochemical reactivity as a sound science-based approach for VOC control. This policy update was published in the Federal Register in September 2005 as guidance for states to pursue reactivity-based approaches in their State Implementation Plans (SIPs).

Conclusion

It is well understood that VOCs differ in their impact on ozone formation. There is sufficient scientific information to support relative photochemical reactivity-based approaches for VOC control in many applications. The EPA Interim Policy Guidance of 2005 clearly encourages reactivity-based approaches for SIP development. Reactivity-based VOC regulations have the potential to improve ozone air quality to a far greater degree than reliance on a mass-based approach, and can result in additional benefits to the overall environment.

To go beyond the federal regulations and learn more about specific VOC control requirements in your area, contact your state or local air quality control agency about specific programs in place.

Please visit www.americanchemistry.com/solvents for more information about VOCs and other solvent topics.

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