6560-50-P

ENVIRONMENTAL PROTECTION AGENCY

40 CFR Part 51

[EPA-HQ-OAR-2021-0420; FRL-8371-01-OAR]

RIN 2060-AV24

Air Quality: Revision to the Regulatory Definition of Volatile Organic Compounds – Exclusion of *(2E)*-1,1,1,4,4,4-hexafluorobut-2-ene (HFO-1336mzz(E))

AGENCY: Environmental Protection Agency (EPA).

ACTION: Final rule.

SUMMARY: On April 28, 2022, the U.S. Environmental Protection Agency (EPA) published a proposed rule seeking comments in response to a petition requesting the revision of the EPA's regulatory definition of volatile organic compounds (VOC) to exempt *trans*-1,1,1,4,4,4-hexafluorobut-2-ene (also known as HFO-1336mzz(E); CAS number 66711-86-2). The EPA is now taking final action to revise the regulatory definition of VOC under the Clean Air Act (CAA). This final action adds HFO-1336mzz(E) to the list of compounds excluded from the regulatory definition of VOC on the basis that this compound makes a negligible contribution to tropospheric ozone (O_3) formation.

DATES: This final rule is effective on [INSERT DATE 60 DAYS AFTER DATE OF PUBLICATION IN THE *FEDERAL REGISTER*].

ADDRESSES: The EPA has established a docket for this action under Docket ID No. EPA-HQ-OAR-2021-0420. All documents in the docket are listed on the *https://www.regulations.gov* Web site. Although listed in the index, some information is not publicly available, e.g., CBI or other information whose disclosure is restricted by statute. Certain other material, such as copyrighted materials, is not placed on the Internet and will be publicly available only in hard copy form. Publicly available docket materials are available electronically through *https://www.reglatons.gov*.

FOR FURTHER INFORMATION CONTACT: Dr. Souad Benromdhane, Office of Air Quality Planning and Standards, Health and Environmental Impacts Division, Mail Code C539-07, Environmental Protection Agency, Research Triangle Park, NC 27711; telephone: (919) 541-4359; fax number: (919) 541-5315; email address: *benromdhane.souad@epa.gov*.

SUPPLEMENTARY INFORMATION:

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I. Does this action apply to me?

Entities potentially affected by this final rule include, but are not necessarily limited to, the following: state and local air pollution control agencies that adopt and implement regulations to control air emissions of VOC; and industries manufacturing and/or using HFO-1336mzz(E)

for use in foam blowing, refrigeration, as well as applications in solvents and aerosol propellants, and other minor uses. Potential entities that may be affected by this action include the following:

Table 1—Potentially Affected Entities by North American Industrial Classification System (NAICS) Code

Category	NAICS code	Description of Regulated Entities
Industry	325120	Industrial Gas Manufacturing
Industry	333242	Semiconductor Machinery Manufacturing
Industry	325998	All Other Miscellaneous Chemical Product and Preparation Manufacturing
Industry	326140	Polystyrene Foam Product Manufacturing
Industry	326150	Urethane and Other Foam Product (except Polystyrene) Manufacturing
Industry	333415	Air-Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment Manufacturing
Industry	3363	Motor Vehicle Parts Manufacturing
Industry	336611	Ship Building and Repairing
Industry	336612	Boat Building
Industry	339999	All other Miscellaneous Manufacturing

This table is not intended to be exhaustive but rather provides a guide for readers regarding entities that might be affected by this deregulatory action. This table lists the types of entities that the EPA is now aware of that could potentially be affected to some extent by this action. Other types of entities not listed in the table could also be affected to some extent. To determine whether your entity is directly or indirectly affected by this action, you should consult your state or local air pollution control and/or air quality management agencies.

II. Background

A. The EPA's VOC Exemption Policy

Tropospheric O_3, commonly known as smog, is formed when VOC and nitrogen oxides (NO_x) react in the atmosphere in the presence of sunlight. Because of the harmful health effects of O_3, the EPA and state governments limit the amount of VOC that can be released into the atmosphere. Volatile organic compounds form O_3 through atmospheric photochemical reactions, and different VOC have different levels of reactivity. That is, different VOC do not react to form O_3 at the same speed or form different amounts of O_3. Some VOC react more slowly or form less O_3; therefore, changes in their emissions have limited effects on local or regional O_3 pollution

episodes. It has been the EPA's policy since 1971 that certain organic compounds with a negligible level of reactivity should be excluded from the regulatory definition of VOC to focus VOC control efforts on compounds that significantly affect O_3 concentrations. The EPA also believes that exempting such compounds creates an incentive for industry to use negligibly reactive compounds in place of more highly reactive compounds that are regulated as VOC. The EPA lists compounds that it has determined to be negligibly reactive in its regulations as being excluded from the regulatory definition of VOC (40 CFR 51.100(s)).

The CAA requires the regulation of VOC for various purposes. Section 302(s) of the CAA specifies that the EPA has the authority to define the meaning of "VOC" and, hence, what compounds shall be treated as VOC for regulatory purposes. The policy of excluding negligibly reactive compounds from the regulatory definition of VOC was first laid out in the "Recommended Policy on Control of Volatile Organic Compounds" (42 FR 35314, July 8, 1977) ("1977 Recommended Policy") and was supplemented subsequently with the "Interim Guidance on Control of Volatile Organic Compounds in Ozone State Implementation Plans" (70 FR 54046, September 13, 2005) ("2005 Interim Guidance"). The EPA uses the reactivity of ethane as the threshold for determining whether a compound has negligible reactivity. Compounds that are less reactive than, or equally reactive to, ethane under certain assumed conditions may be deemed negligibly reactive and, therefore, suitable for exemption from the regulatory definition of VOC. Compounds that are more reactive than ethane continue to be considered VOC for regulatory purposes and, therefore, are subject to control requirements. The selection of ethane as the threshold compound was based on a series of smog chamber experiments that underlay the 1977 Recommended Policy.

The EPA has used three different metrics to compare the reactivity of a specific compound to that of ethane: (i) the rate constant for reaction with the hydroxyl radical (OH) (known as k_{OH}); (ii) the maximum incremental reactivity (MIR) on a reactivity per unit mass

basis; and (iii) the MIR expressed on a reactivity per mole basis. Differences between these three metrics are discussed below.

The k_{OH} is the rate constant of the reaction of the compound with the OH radical in the air. This reaction is often, but not always, the first and rate-limiting step in a series of chemical reactions by which a compound breaks down in the air and contributes to O_3 formation. If this step is slow, the compound will likely not form O_3 at a very fast rate. The k_{OH} values have long been used by the EPA as metrics of photochemical reactivity and O_3-forming activity, and they were the basis for most of the EPA's early exemptions of negligibly reactive compounds from the regulatory definition of VOC. The k_{OH} metric is inherently a molar-based comparison, *i.e.*, it measures the rate at which molecules react.

The MIR, both by mole and by mass, is a more updated metric of photochemical reactivity derived from a computer-based photochemical model, and it has been used as a metric of reactivity since 1995. This metric considers the complete O_3-forming activity of a compound over multiple hours and through multiple reaction pathways, not merely the first reaction step with OH. Further explanation of the MIR metric can be found in Carter (1994).

The EPA has considered the choice between MIRs with a molar or mass basis for the comparison to ethane in past rulemakings and guidance. In the 2005 Interim Guidance, the EPA stated that a comparison to ethane's MIR on the mass basis will strike the right balance between a threshold that is low enough to capture chemicals that significantly effect ozone formation and the threshold that is high enough to allow for the exemption of some other chemicals that may usefully substitute for more reactive compounds. And that EPA will continue to compare chemicals to ethane using k_{OH} expressed in molar basis and MIR values expressed on a mass basis during the review of suggested chemicals for VOC-exempt status.[1]

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[1] Interim Guidance on Control of Volatile Organic Compounds in Ozone State Implementation Plans, 2005, US Environmental Protection Agency, Document # 05-18015 (70 FR 54046). And could be found at this link: https://www.govinfo.gov/content/pkg/FR-2005-09-13/pdf/05-18015.pdf

The 2005 Interim Guidance notes that the EPA will consider a compound to be negligibly reactive if it is equally as or less reactive than ethane based on either k_{OH} expressed on a molar basis *or* MIR values expressed on a mass basis (70 FR 54046).

The molar comparison of MIR is more consistent with the original smog chamber experiments, which compared equal molar concentrations of individual VOC, supporting the selection of ethane as the threshold, while the mass-based comparison of MIR is consistent with how MIR values and other reactivity metrics are applied in reactivity-based emission limits. It is, however, important to note that the mass-based comparison is less restrictive than the molar-based comparison in that more compounds would qualify as negligibly reactive.

Given the two goals of the exemption policy articulated in the 2005 Interim Guidance, the EPA believes that ethane continues to be an appropriate threshold for defining negligible reactivity. And, to encourage the use of environmentally beneficial substitutions, the EPA believes that a comparison to ethane on a mass basis strikes the right balance between a threshold that is low enough to capture compounds that significantly affect O_3 concentrations and a threshold that is high enough to exempt some compounds that may usefully substitute for more highly reactive compounds.

The 2005 Interim Guidance also noted that concerns have sometimes been raised about the potential impact of a VOC exemption on environmental endpoints other than O_3 concentrations, including fine particle formation, air toxics exposures, stratospheric O_3 depletion, and climate change. The EPA has recognized, however, that there are existing regulatory or non-regulatory programs that are specifically designed to address these issues, and the EPA continues to believe in general that the impacts of VOC exemptions on environmental endpoints other than O_3 formation can be adequately addressed by these programs. The VOC exemption policy is intended to facilitate attainment of the O_3 National Ambient Air Quality Standards (NAAQS),

and VOC exemption decisions will continue to be based primarily on consideration of a compound's contribution to O_3 formation. However, if the EPA determines that a particular VOC exemption is likely to result in a significant increase in the use of a compound and that the increased use would pose a significant risk to human health or the environment that would not be addressed adequately by existing programs or policies, then the EPA may exercise its judgment accordingly in deciding whether to grant an exemption.

B. Petition to List HFO-1336mzz(E) as an Exempt Compound

The Chemours Company submitted a petition to the EPA on November 30, 2016, requesting that *(2E)*-1,1,1,4,4,4-hexafluorobut-2-ene (HFO-1336mzz(E); CAS number 66711-86-2) be exempted from the regulatory definition of VOC. The petition was based on the argument that HFO-1336mzz(E) has low reactivity (i.e., 0.011 g of O_3/g of HFO-1336mzz(E)) relative to the MIR of ethane (0.28 g O_3/g ethane). The petitioner indicated that HFO-1336mzz(E) may be used in a variety of applications in foam expansion or blowing agents where it has significant performance and energy-saving advantages. Chemours has developed HFO-1336mzz(E) to support reductions in emissions of greenhouse gases (GHGs). The global warming potentials (GWPs) for HFO-1336mzz(E) are estimated as 26, 7, and 2 for time horizons of 20, 100, and 500 years, respectively, as estimated by Osterstrom *et al*. (2017). The World Meteorological Organization provided a 100-year GWP of 16 in its scientific assessment of O_3 depletion under the global ozone research and monitoring project.[2] Hence, HFO-1336mzz(E) can serve as a replacement for several higher global warming potential (>700 GWP) compounds for use in polyurethane rigid insulating foams, among others, many of which were removed from Significant New Alternatives Policy (SNAP) acceptable lists beginning on January 1, 2017, or January 1, 2020. The Petitioner stated that manufacturers and formulators of polyurethane foams

[2] WMO, 2018. World Meteorological Organization, *Scientific Assessment of Ozone Depletion: 2018*, Global Ozone Research and Monitoring Project – Report No. 58, 588 pp., Geneva, Switzerland, 2018. Available online at: *https://ozone.unep.org/sites/default/files/2019-05/SAP-2018-Assessment-report.pdf*.

and refrigeration equipment need access to HFO-1336mzz(E) to meet VOC limits on their products without impairing performance.

To support its petition, Chemours referenced several documents, including one peer-reviewed journal article on HFO-1336mzz(E) reaction rates (Osterstrom *et al*., 2017). Chemours also provided a supplemental technical report on the MIR of HFO-1336mzz(E) (Carter, 2011a). Per this report, the MIR of HFO-1336mzz(E) is 0.011 g O_3/g HFO-1336mzz(E) on the mass-based MIR scale. This reactivity rate is much lower than that of ethane (0.28 g O_3/g ethane). The reactivity rate k_{OH} for the gas-phase reaction of OH radicals with HFO-1336mzz(E) (k_{OH}) has been measured to be $1.72 \pm 0.42 \times 10^{-13}$ centimeter $(cm)^3$/molecule-seconds at ~300 degrees Kelvin (K) (Osterstrom *et al*., 2017). This k_{OH} rate is lower than that of ethane (k_{OH} of ethane = 2.4×10^{-13} cm^3/molecule-sec at ~298 K) even when uncertainty is considered and, therefore, suggests that HFO-1336mzz(E) is less or equally reactive than ethane. In most cases, chemicals with high k_{OH} values also have high MIR values, but for HFO-1336mzz(E), the products that are formed in subsequent reactions are expected to be polyfluorinated compounds, which do not contribute to O_3 formation (Osterstrom *et al*., 2017; Carter 2011a). Based on the current scientific understanding of tetrafluoroalkene reactions in the atmosphere, it is unlikely that the actual O_3 impact on a mass basis would equal or exceed that of ethane in the scenarios used to calculate VOC reactivity in Osterstrom *et al*. (2017), in line with Baasandorj *et al.* (2011) and Carter (2011a).

To address the potential for stratospheric O_3 impacts, the petitioner contended that, because the atmospheric lifetime of HFO-1336mzz(E) due to loss by OH reaction was estimated to be relatively short and it does not contain chlorine or bromine, it is not expected to contribute to the depletion of the stratospheric O_3 layer (Osterstrom *et al*., 2017; Baasandorj *et al*., 2011).

III. The EPA's Assessment of the Petition

On April 28, 2022, the EPA published a proposed rulemaking (87 FR 25170) seeking comments in response to the petition to revise the EPA's regulatory definition of VOC for

exemption of HFO-1336mzz(E). The EPA is taking final action to respond to the petition by exempting HFO-1336mzz(E) from the regulatory definition of VOC. This action is based on consideration of the compound's low contribution to tropospheric O_3 and the low likelihood of risk to human health or the environment, including stratospheric O_3 depletion, toxicity, and climate change. Additional information on these topics is provided in the following sections.

A. Contribution to Tropospheric Ozone Formation

As noted in studies cited by the petitioner, HFO-1336mzz(E) has a MIR value of 0.011 g O_3/g VOC for "averaged conditions," versus 0.28 g O_3/g VOC for ethane (Carter, 2011). Therefore, the EPA considers HFO-1336mzz(E) to be negligibly reactive and eligible for VOC-exempt status in accordance with the Agency's long-standing policy that compounds should so qualify where either reactivity metric (k_{OH} expressed on a molar basis or MIR expressed on a mass basis) indicates that the compound is less reactive than ethane. While the overall atmospheric reactivity of HFO-1336mzz(E) was not studied in an experimental smog chamber, the chemical mechanism derived from other chamber studies (Carter, 2011) was used to model the complete formation of O_3 for an entire single day under realistic atmospheric conditions (Carter, 2011a). Therefore, the EPA believes that the MIR value calculated in the Carter study submitted by the petitioner is reliable as it was supported by Osterstrom *et al*. (2017).

Table 2 presents three reactivity metrics for HFO-1336mzz(E) as they compare to ethane.

Table 2—Reactivities of Ethane and HFO-1336mzz(E)

Compound	k_{OH} (cm^3/molecule-sec)	Maximum incremental reactivity (MIR) (g O_3/mole VOC)	Maximum incremental reactivity (MIR) (g O_3/g VOC)
Ethane	2.4×10^{-13}	8.4	0.28
HFO-1336mzz(E)	1.72×10^{-13}	1.8	0.011

Notes:
k_{OH} value for ethane is at 298 K and from Atkinson *et al*. (2006; page 3626).
k_{OH} value for HFO-1336mzz(E) is at 300 K and from Osterstrom (2017) and Baasandorj (2011).
Mass-based MIR value (g O_3/g VOC) of ethane is from Carter (2011).
Mass-based MIR value (g O_3/g VOC) of HFO-1336mzz(E) is from a supplemental report by Carter (2011a).
Molar-based MIR (g O_3/mole VOC) values were calculated from the mass-based MIR (g O_3/g VOC) values using the number of moles per gram of the relevant organic compound.

The reaction rate of HFO-1336mzz(E) with the OH radical (k_{OH}) has been measured to be 1.72 x 10^{-13} cm^3/molecule-sec (Osterstrom *et al.*, 2017); other reactions with O_3 and the nitrate radical were negligibly small. The corresponding reaction rate of ethane with OH is 2.4 x 10^{-13} cm^3/molecule-sec (Atkinson *et al.*, 2006). The data in Table 2 show that HFO-1336mzz(E) has a lower k_{OH} value than ethane, meaning that it initially reacts slower than or as fast in the atmosphere as ethane. However, the resulting unsaturated fluorinated compounds in the atmosphere are short lived and react more slowly to form O_3 (Osterstrom *et al.*, 2017; Baasandorj *et al.*, 2011). The mass-based MIR is 0.011 g O_3/g VOC and much lower than that of ethane.

A molecule of HFO-1336mzz(E) is much less reactive than a molecule of ethane in terms of complete O_3-forming activity, as shown by the molar-based MIR (g O_3/mole VOC) values. Likewise, one gram of HFO-1336mzz(E) has a lower capacity than one gram of ethane to form O_3 in terms of a mass-based MIR. Thus, following the 2005 Interim Guidance, the EPA proposes to find HFO-1336mzz(E) to be eligible for exemption from the regulatory definition of VOC based on both the molar- and mass-based MIR.

B. Potential Impacts on Other Environmental Endpoints

The EPA's decision to exempt HFO-1336mzz(E) from the regulatory definition of VOC is based on our findings above. However, as noted in the 2005 Interim Guidance, the EPA reserves the right to exercise its judgment in certain cases where an exemption is likely to result in a significant increase in the use of a compound and a subsequent significantly increased risk to human health or the environment. In this case, the EPA does not find that exemption of HFO-1336mzz(E) would result in an increase of risk to human health or the environment, with regard to stratospheric O_3 depletion, toxicity, and climate change. Additional information on these topics is provided in the following sections.

1. Contribution to Stratospheric Ozone Depletion

The SNAP program is the EPA's program to evaluate and regulate substitutes for end-uses historically using O_3-depleting chemicals. Under section 612(c) of the CAA, the EPA is required to identify and publish lists of acceptable and unacceptable substitutes for class I or class II O_3-depleting substances. Per the SNAP program findings, the ODP of HFO-1336mzz(E) is zero. The SNAP program has listed HFO-1336mzz(E) as an acceptable substitute for a number of foam-blowing end-uses provided in 85 FR 79863, December 11, 2020 (USEPA, 2020).

HFO-1336mzz(E) is unlikely to contribute to the depletion of the stratospheric O_3 layer. The O_3 depletion potential (ODP) of HFO-1336mzz(E) is expected to be negligible based on several lines of evidence: the absence of chlorine or bromine in the compound and the atmospheric reactions described in Carter (2008). Because HFO-1336mzz(E)'s atmospheric lifetime is short relative to the time scale for mixing within the troposphere, it will decay before it has a chance to reach the stratosphere and, thus, will not participate in O_3 destruction.

2. Toxicity

Based on screening assessments of the health and environmental risks of HFO-1336mzz(E), the SNAP program anticipated that users will be able to use the compound without significantly greater health risks than presented by the use of other available substitutes for the same end uses (USEPA, 2020).

The EPA anticipates that HFO-1336mzz(E) will be used consistent with the recommendations specified in the manufacturer's safety data sheet (SDS) (Chemours, 2016). According to the SDS, potential health effects from inhalation of HFO-1336mzz(E) include skin or eye irritation or frostbite. Exposure to high concentrations of HFO-1336mzz(E) from misuse or intentional inhalation abuse may cause irregular heartbeat. In addition, HFO-1336mzz(E) could cause asphyxiation if air is displaced by vapors in a confined space. The Workplace Environmental Exposure Limit (WEEL) committee of the Occupational Alliance for Risk Science (OARS) reviewed available animal toxicity data and recommends a WEEL for the

workplace of 400 parts per million (ppm) (2680 mg/m^3)[3] time-weighted average (TWA) for an 8-hour workday, as later published in 2019 in *Toxicology and Industrial Health* ("Trans-1,1,1,4,4,4-hexafluoro-2-butene," 2019)[4]. This WEEL was derived based on reduced male body weight gain in the 13-week rat inhalation toxicity study (TNO, 2016a, and TNO, 2016b), based on the point of departure of NOAEL of 7500 ppm. This was also the NOAEL for the developmental toxicity study where developmental effects were only observed at maternally toxic levels. The EPA anticipates that users will be able to meet the WEEL and address potential health risks by following requirements and recommendations in the SDS and other safety precautions common to the refrigeration and air conditioning industry.

HFO-1336mzz(E) is not regulated as a hazardous air pollutant (HAP) under title I of the CAA. Also, it is not listed as a toxic chemical under section 313 of the Emergency Planning and Community Right-to-Know Act (EPCRA).

The Toxic Substances Control Act (TSCA) gives the EPA authority to assess and prevent potential unreasonable risks to human health and the environment before a new chemical substance is introduced into commerce. Section 5 of TSCA requires manufacturers and importers to notify the EPA before manufacturing or importing a nonexempt new chemical substance by submitting a Premanufacture Notice (PMN) prior to the manufacture (including import) of the chemical substance. Under the TSCA New Chemicals Program, the EPA then assesses whether an unreasonable risk may, or will, be presented by the expected manufacturing, processing, distribution in commerce, use, and disposal of the new substance. Based on its review of a PMN and a Significant New Use Notice (SNUN) for HFO-1336mzz(E), the EPA has determined that use of HFO-1336mzz(E) in consumer products or use other than as described in the PMN and SNUN may cause serious chronic health effects. To address concerns identified during the PMN

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[3] *Occupational Alliance for Risk Science (OARS-WEELs)*- HFO-1336mzz(E)*, 2018: https://www.tera.org/OARS/PDF_documents/03_trans-1-1-1-4-4-4-hexafluoro-2-butene-(hfo-1336mzz-e).pdf.*

[4] Trans-1,1,1,4,4,4-hexafluoro-2-butene (HFO-1336mzz(E)) (2018). (2019). Toxicology and Industrial Health, 35(3), 204–210*. https://doi.org/10.1177/0748233719825529.*

review of HFO-1336mzz(E), the EPA issued a Significant New Use Rule (SNUR) under TSCA on May 16, 2016, to require submission of a SNUN to the EPA at least 90 days before manufacturing or processing of HFO-1336mzz(E) for any uses in consumer products or any use other than as described in the PMN (81 FR 30451, 30462, May 16, 2016). The required notification will provide the EPA with the opportunity to evaluate the intended use before it occurs and, if necessary, to prohibit or limit that activity to protect against an unreasonable risk. The EPA received a SNUN for a significant new use of HFO-1336mzz(E) in 2017 and modified the SNUR in June 2021 based on its determination for the SNUN (86 FR 30210, 30215, June 7, 2021)[5]. The EPA, therefore, believes that existing programs address the risk of toxicity associated with the use of HFO-1336mzz(E).

The EPA recognizes that both HFO-1336mmz(E) and its atmospheric breakdown product trifluoroacetic acid (TFA) are members of the broad class of compounds known as per- and poly-fluoroalkyl substances (PFAS), even though they are not among the PFAS currently listed or targeted for specific Agency action. Many PFAS are highly mobile in various media; some are volatile and can be transported long distances in air and/or in water and widely distributed in the environment. Some studies suggest that PFAS emitted to air can result in human exposures in other media such as source/surface or drinking waters even though the emissions origin may be distant from receptor water bodies.[6] Some PFAS are persistent in the environment and in the human body and can accumulate over time. There is evidence that exposure to certain PFAS can lead to adverse human health effects (e.g., low infant birth weights, immune system effects, cancer, and thyroid disruption). Numerous states have developed health-based (e.g., drinking water) standards for various PFAS. The Environmental Effects Assessment Panel for the Montreal Protocol (EEAP) has considered the production of TFA as a persistent breakdown product of HFCs and HFOs and has found, “Projected future increased loadings of TFA to

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[5] https://www.govinfo.gov/content/pkg/FR-2021-06-07/html/2021-11768.htm

[6] https://pubs.acs.org/doi/abs/10.1021/acs.est.0c06580

playas, land-locked lakes, and the oceans due to continued use of HCFCs, HFCs, and replacement products such as HFOs are still judged to present negligible risks for aquatic organisms and humans."[7] In its most recent assessment report (2018 Assessment Report), EEAP found, "Overall, there is no new evidence that contradicts the conclusion of our previous Assessments that exposure to current and projected concentrations of salts of TFA in surface waters present a minimal risk to the health of humans and the environment."[8]

3. Contribution to Climate Change

The Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (IPCC AR5) does not provide an estimate for HFO-1336mzz(E)'s GWP.[9] The HFO-1336mzz(E) GWP on a 100-year time horizon was calculated to be 7 in one study by Osterstrom *et al*. (2017) and 32 (atmospherically well-mixed) and 14 (lifetime-adjusted) in another study by Baasandorj *et al*. (2018). However, the WMO (2018) calculated the 100-year GWP for HFO-1336mzz(E) as 16. Species with double bonds assembled in the Intergovernmental Panel on Climate Change Fifth Assessment Report (Table 8.A.1) indicate lower GWP than species without a double bond. Given the presence of a double bond in the HFO-1336mzz(E) molecule, its atmospheric

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[7] UNEP, 2015. Environmental Effects Of Ozone Depletion And Its Interactions With Climate Change: 2014 Assessment of the Montreal Protocol. United Nations Environment Programme (UNEP), Nairobi. This document accessible at: https://ozone.unep.org/sites/default/files/2019-05/eeap_report_2014.pdf.

[8] UNEP, 2019. Environmental Effects and Interactions of Stratospheric Ozone Depletion, UV Radiation, and Climate Change: 2018 Assessment Report of the Montreal Protocol. United Nations Environment Programme (UNEP), Nairobi. This document accessible at: https://ozone.unep.org/sites/default/files/2019-04/EEAP_assessment-report-2018%20%282%29.pdf.

[9] IPCC, 2013: Climate Change 2013: Chapter 8, Myhre, G., D. Shindell, F.-M. Bréon, W. Collins, J. Fuglestvedt, J. Huang, D. Koch, J.-F. Lamarque, D. Lee, B. Mendoza, T. Nakajima, A. Robock, G. Stephens, T. Takemura and H. Zhang, 2013: Anthropogenic and Natural Radiative Forcing. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_Chapter08_FINAL.pdf.

degradation is accelerated, and its atmospheric lifetime is reduced, thereby reducing its long-term GWP. According to the SNAP rule, HFO-1336mzz(E)'s GWP of 16 is lower than the GWPs of some of the substitutes in a variety of foam blowing and refrigeration, solvent, and aerosol propellant end-uses (USEPA, 2020). HFO-1336mzz(E) was developed to replace other chemicals used for similar end-uses with GWP ranging from 1 to 1,300 such as the refrigerant 1,1,1,2-tetrafluoroethane (R-134a), among others. The petitioner claims that HFO-1336mzz(E) is a better alternative to other substitutes in foam expansion or blowing agents for use in polyurethane rigid insulating foams. Specifically, HFO-1336mzz(E) will provide significant performance and energy saving advantages and reduce climate change impacts both directly by its relatively low GWP and indirectly by decreasing energy consumption throughout the lifecycle of insulated foams in several applications.

C. Response to Comments and Conclusion

The EPA received two comments by the close of the public comment period on June 28, 2022, on the notice of proposed rulemaking. However, no specific issues that are relevant to our action to exempt HFO-1336mzz(E) were submitted. No negative comments were received on the proposed action or raised any issues about the PFAS and/or recommendation to address them under the revision of the VOC definition. Details on those comments received and the EPA's responses are provided below.

Comments: The first commenter was the petitioner who supported the proposed action to exempt HFO-1336mzz(E) from the EPA's definition of VOC in 40 CFR 51.100(s). The petitioner insisted that PFAS issues were outside the scope of this rulemaking, referring to other EPA programs that are currently working to address them. The petitioner also mentioned EPA's ongoing efforts in defining what PFAS are, and the agency's testing strategy, adding that HFO-1336mzz(E) is not currently included in the EPA's working definition of PFAS. The second commenter submitted similar supporting arguments on behalf of multiple professional organizations including the U.S. Chamber of Commerce. They stipulated that this rulemaking is

not the proper vehicle for broadly examining questions about properties of PFAS and their chemistry, properties that are not related to the VOC exemption program as we requested in the proposal. They referred to multiple EPA initiatives underway which will provide a better platform to address PFAS issues, urging the exemption of HFO-1336-mzz(E) as the focus of this rulemaking.

Response: The EPA acknowledges the commenters' support to exempt HFO1336mzz(E) from the EPA's regulatory definition of VOC in 40 CFR 51.100(s).

The commenter is correct that HFO-1336mzz(E) does not meet the Office of Pollution Prevention and Toxics' (OPPT) working definition of PFAS.[10] However, EPA notes that this definition may not be identical to other definitions of PFAS used within EPA and/or by other organizations. The term "PFAS" has been used broadly by many organizations for their individual research and/or regulatory needs. Various programs or organizations have distinct needs or purposes apart from the proposed TSCA section 8(a)(7) reporting rule, and therefore, different definitions of the term "PFAS" may be appropriate for other purposes, including this program.[11] At this time, we do not believe it is necessary to consider a definition of PFAS that applies to the VOC exemption process, because the Agency evaluates each chemical substance on a case-by-case basis against the relevant criteria in the 2005 Interim Guidance.

IV. Final Action

The EPA is responding to the petition by revising its regulatory definition of VOC at 40 CFR 51.100(s) to add HFO-1336mzz(E) to the list of compounds that are exempt from the

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[10] OPPT's proposed rule defined PFAS as "any chemical substance or mixture that structurally contains the unit R-(CF2)-C(F)(R′)R″. Both the CF2 and CF moieties are saturated carbons. None of the R groups (R, R′ or R″) can be hydrogen." Toxic Substances Control Act Reporting and Recordkeeping Requirements for Perfluoroalkyl and Polyfluoroalkyl Substances Posted by the Environmental Protection Agency, 86 FR 33926, 33937 (proposed on June 28, 2021).

[11] *See* OECD, Reconciling Terminology of the Universe of Per- and Polyfluoroalkyl Substances: Recommendations and Practical Guidance p. 8 (July 2021), https://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=ENV/CBC/MONO(2021)25&docLanguage=En.

regulatory definition of VOC because it is less reactive than ethane based on a comparison of mass-based MIR and molar-based MIR metrics and is, therefore, considered negligibly reactive. As a result of this action, if an entity uses or produces this compound and is subject to the EPA regulations limiting the use of VOC in a product, limiting the VOC emissions from a facility, or otherwise controlling the use of VOC for purposes related to attaining the O_3 NAAQS, this compound will not be counted as a VOC in determining whether these regulatory obligations have been met. This action would affect whether this compound is considered a VOC for state regulatory purposes to reduce O_3 formation, if a state relies on the EPA's regulatory definition of VOC. States are not obligated to exclude from control as a VOC those compounds that the EPA has found to be negligibly reactive. However, no state may take credit for controlling this compound in its O_3 control strategy. Consequently, reductions in emissions for this compound will not be considered or counted in determining whether states have met the rate of progress requirements for VOC in State Implementation Plans or in demonstrating attainment of the O_3 NAAQS.

V. Statutory and Executive Order Reviews

Additional information about these statutes and Executive Orders can be found at *https://www2.epa.gov/laws-regulations/laws-and-executive-orders.*

A. Executive Order 12866: Regulatory Planning and Review and Executive Order 13563: Improving Regulation and Regulatory Review

This action is not a significant regulatory action and was, therefore, not submitted to the Office of Management and Budget (OMB) for review.

B. Paperwork Reduction Act (PRA)

This action does not impose an information collection burden under the PRA. It does not contain any recordkeeping or reporting requirements.

C. Regulatory Flexibility Act (RFA)

I certify this action will not have a significant economic impact on a substantial number of small entities under the RFA. This action will not impose any requirements on small entities. This action removes HFO-1336mzz(E) from the regulatory definition of VOC and, thereby, relieves manufacturers, distributers, and users of the compound from tropospheric O_3 requirements to control emissions of the compound.

D. Unfunded Mandates Reform Act (UMRA)

This action does not contain any unfunded mandate as described in UMRA, 2 U.S.C. 1531-1538, and does not significantly or uniquely affect small governments. This action imposes no enforceable duty on any state, local or tribal governments, or the private sector.

E. Executive Order 13132: Federalism

This action does not have federalism implications. It will not have substantial direct effects on the states, on the relationship between the national government and the states, or on the distribution of power and responsibilities among the various levels of government.

F. Executive Order 13175: Consultation and Coordination with Indian Tribal Governments

This action does not have tribal implications, as specified in Executive Order 13175. This final action removes HFO-1336mzz(E) from the regulatory definition of VOC and, thereby, relieves manufacturers, distributers, and users from tropospheric O_3 requirements to control emissions of the compound. Thus, Executive Order 13175 does not apply to this action.

G. Executive Order 13045: Protection of Children from Environmental Health and Safety Risks

This action is not subject to Executive Order 13045, because it is not economically significant as defined in Executive Order 12866, and because the EPA does not believe the environmental health or safety risks addressed by this action present a disproportionate risk to children. Since HFO-1336mzz(E) is utilized in specific industrial applications where children are not present and dissipates quickly (e.g., lifetime of 22 days) with short-lived end products, there is no exposure or disproportionate risk to children. This action removes HFO-1336mzz(E) from

the regulatory definition of VOC and, thereby, relieves manufacturers, distributers, and users from tropospheric O_3 requirements to control emissions of the compound.

H. Executive Order 13211: Actions Concerning Regulations that Significantly Affect Energy Supply, Distribution or Use

This action is not subject to Executive Order 13211, because it is not a significant regulatory action under Executive Order 12866.

I. National Technology Transfer and Advancement Act (NTTAA)

This rulemaking does not involve technical standards.

J. Executive Order 12898: Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations

Executive Order 12898 (59 FR 7629, February 16, 1994) directs federal agencies, to the greatest extent practicable and permitted by law, to make environmental justice part of their mission by identifying and addressing, as appropriate, disproportionately high, and adverse human health or environmental effects of their programs, policies, and activities on minority populations (people of color and/or Indigenous peoples) and low-income populations.

The EPA believes that the human health and environmental conditions that exist prior to this action do not result in disproportionate and adverse effects on people of color, low-income populations, and/or Indigenous peoples as we found no data available to support the opposite. Projected effects on the various populations after this action is implemented are not likely to result in new potentially disproportionate and adverse effects. We addressed the human health and environmental risks by this action to the greatest ability feasible, and those risks will not have potential disproportionately high and adverse human health or environmental effects on minority, low-income or indigenous populations (in particular children), because of no possible exposure. This chemical is used in specific industrial applications where children are not present. This action was developed in accordance with agency guidance on environmental justice.

This action removes HFO-1336mzz(E) from the regulatory definition of VOC and, thereby, relieves manufacturers, distributers, and users of the compound from tropospheric O_3 requirements to control emissions of the compound. It will in fact help states focus on more photochemically reactive chemicals preventing more formation of Ozone and consequently more adverse related health and environmental effects.

K. Congressional Review Act (CRA)

This action is subject to the CRA, and the EPA will submit a rule report to each House of the Congress and to the Comptroller General of the United States. This action is not a "major rule" as defined by 5 U.S.C. 804(2).

L. Judicial Review

Under section 307(b)(1) of the CAA, petitions for judicial review of this action must be filed in the United States Court of Appeals for the District of Columbia Circuit Court within 60 days from the date the final action is published in the *Federal Register*. Filing a petition for review by the Administrator of this final action does not affect the finality of this action for the purposes of judicial review nor does it extend the time within which a petition for judicial review must be filed and shall not postpone the effectiveness of such action. Thus, any petitions for review of this action related to the exemption of HFO-1336mzz(E) from the regulatory definition of VOC must be filed in the Court of Appeals for the District of Columbia Circuit within 60 days from the date final action is published in the *Federal Register*.

VI. References

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List of Subjects in 40 CFR Part 51

Environmental protection, Administrative practice and procedure, Air pollution control, Ozone, Reporting and recordkeeping requirements, Volatile organic compounds.

Michael S. Regan,
Administrator.

For reasons stated in the preamble, part 51 of chapter I of title 40 of the Code of Federal Regulations is amended as follows:

PART 51—REQUIREMENTS FOR PREPARATION, ADOPTION, AND SUBMITTAL OF IMPLEMENTATION PLANS

1. The authority citation for part 51 continues to read as follows:

Authority: 23 U.S.C. 101; 42 U.S.C. 7401-7671q.

Subpart F—Procedural Requirements

2. Section 51.100 is amended by revising paragraph (s)(1) introductory text to read as follows:

§ 51.100 Definitions.

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(s) * * *

(1) This includes any such organic compound other than the following, which have been determined to have negligible photochemical reactivity: methane; ethane; methylene chloride (dichloromethane); 1,1,1-trichloroethane (methyl chloroform); 1,1,2-trichloro-1,2,2-trifluoroethane (CFC-113); trichlorofluoromethane (CFC-11); dichlorodifluoromethane (CFC-12); chlorodifluoromethane (HCFC-22); trifluoromethane (HFC-23); 1,2-dichloro 1,1,2,2-tetrafluoroethane (CFC-114); chloropentafluoroethane (CFC-115); 1,1,1-trifluoro 2,2-dichloroethane (HCFC-123); 1,1,1,2-tetrafluoroethane (HFC-134a); 1,1-dichloro 1-fluoroethane (HCFC-141b); 1-chloro 1,1-difluoroethane (HCFC-142b); 2-chloro-1,1,1,2-tetrafluoroethane (HCFC-124); pentafluoroethane (HFC-125); 1,1,2,2-tetrafluoroethane (HFC-134); 1,1,1-trifluoroethane (HFC-143a); 1,1-difluoroethane (HFC-152a); parachlorobenzotrifluoride (PCBTF); cyclic, branched, or linear completely methylated siloxanes; acetone; perchloroethylene (tetrachloroethylene); 3,3-dichloro-1,1,1,2,2-pentafluoropropane (HCFC-225ca); 1,3-dichloro-1,1,2,2,3-pentafluoropropane (HCFC-225cb); 1,1,1,2,3,4,4,5,5,5-decafluoropentane (HFC 43-10mee); difluoromethane (HFC-32); ethylfluoride (HFC-161); 1,1,1,3,3,3-hexafluoropropane (HFC-236fa); 1,1,2,2,3-pentafluoropropane (HFC-245ca);

1,1,2,3,3-pentafluoropropane (HFC-245ea); 1,1,1,2,3-pentafluoropropane (HFC-245eb); 1,1,1,3,3-pentafluoropropane (HFC-245fa); 1,1,1,2,3,3-hexafluoropropane (HFC-236ea); 1,1,1,3,3-pentafluorobutane (HFC-365mfc); chlorofluoromethane (HCFC-31); 1 chloro-1-fluoroethane (HCFC-151a); 1,2-dichloro-1,1,2-trifluoroethane (HCFC-123a); 1,1,1,2,2,3,3,4,4-nonafluoro-4-methoxy-butane ($C_4F_9OCH_3$ or HFE-7100); 2-(difluoromethoxymethyl)-1,1,1,2,3,3,3-heptafluoropropane ($(CF_3)_2CFCF_2OCH_3$); 1-ethoxy-1,1,2,2,3,3,4,4,4-nonafluorobutane ($C_4F_9OC_2H_5$ or HFE-7200); 2-(ethoxydifluoromethyl)-1,1,1,2,3,3,3-heptafluoropropane ($(CF_3)_2CFCF_2OC_2H_5$); methyl acetate; 1,1,1,2,2,3,3-heptafluoro-3-methoxy-propane (n-C3F7OCH3, HFE-7000); 3-ethoxy- 1,1,1,2,3,4,4,5,5,6,6,6-dodecafluoro-2-(trifluoromethyl) hexane (HFE-7500); 1,1,1,2,3,3,3-heptafluoropropane (HFC 227ea); methyl formate (HCOOCH3); 1,1,1,2,2,3,4,5,5,5-decafluoro-3-methoxy-4-trifluoromethyl-pentane (HFE-7300); propylene carbonate; dimethyl carbonate; *trans*-1,3,3,3-tetrafluoropropene; HCF_2OCF_2H (HFE-134); $HCF_2OCF_2OCF_2H$ (HFE-236cal2); $HCF_2OCF_2CF_2OCF_2H$ (HFE-338pcc13); $HCF_2OCF_2OCF_2CF_2OCF_2H$ (H-Galden 1040x or H-Galden ZT 130 (or 150 or 180)); *trans* 1-chloro-3,3,3-trifluoroprop-1-ene; 2,3,3,3-tetrafluoropropene; 2-amino-2-methyl-1-propanol; t-butyl acetate; 1,1,2,2- Tetrafluoro -1-(2,2,2-trifluoroethoxy) ethane; *cis*-1,1,1,4,4,4-hexafluorobut-2-ene (HFO-1336mzz-Z); *trans*-1,1,1,4,4,4-hexafluorobut-2-ene (HFO-1336mzz(E)); and perfluorocarbon compounds which fall into these classes:

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