Assessment of the Atmospheric Impact of $CF_3CF_2CH_2OH$, Potential Substitute of Greenhouse Gases

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The great impact of the ***chlorofluorocarbons*** (CFCs) on the ozone (O_3) layer was discovered at the end of last century. After the Montreal Protocol (1989), ***hydrochlorofluorocarbons*** and ***hydrofluorocarbons*** (HCFCs and HFCs) were presented as good substitutes of CFCs, since they are rapidly removed from the troposphere by reaction with hydroxyl (OH) radicals due to the replacement of some (or all) Cl atoms by H atoms. As a result, HCFCs and HFCs neither reach the stratosphere nor deplete stratospheric O_3. Nevertheless, these compounds are significant contributors to the Earth's global warming due to their strong absorption in the IR region [1]. Therefore, they are considered as greenhouse gases (GHGs). Recently other fluorinated compounds, such as $CF_3CF_2CH_2OH$, have been proposed as GHG, such as HFCs, substitutes in a variety of industrial applications (e.g., paints, coatings, polymers, adhesives, etc.). The assessment of the environmental impact of a potential GHG substitute requires the knowledge of the atmospheric lifetime (τ) from the rate coefficients (k_i) for the likely physical chemical removal processes:

UV Photolysis:

$$CF_3CF_2CH_2OH + h\nu(\lambda \geq 290\ nm) \rightarrow \text{Photoproducts} \qquad k_{Photol}(\lambda) \qquad (1)$$

Reaction with an oxidant:

$$CF_3CF_2CH_2OH + \text{Oxidant} \rightarrow \text{Products} \qquad k_{Oxid} \qquad (2)$$

Wet deposition is not an important removal process for $CF_3CF_2CH_2OH$ [2]. Therefore, it is important to evaluate the absorption processes by measuring the absorption cross sections, σ_λ, in the UV-visible and IR region. The determined σ_λ allow the estimation of the photolysis rate, J ($= \int k_{Photol}(\lambda) d\lambda$), and the global warming potentials (GWPs) of $CF_3CF_2CH_2OH$, respectively. For those reasons, UV and IR σ_λ were determined in the 200-400 nm range and between 4000 and 400 cm^{-1}, respectively. Absorption of $CF_3CF_2CH_2OH$ is negligible in the actinic region ($\lambda \geq 290$ nm), while it strongly absorbs in the IR region. Moreover, absolute rate coefficients for the gas-phase reaction (2) with OH radicals (k_{OH}) were determined by pulsed laser photolysis/laser induced fluorescence (PLP-LIF) technique as a function of T and pressure (263–350 K and 43–214 Torr). Our results are compared with previously reported k_{OH} at lower (5-40 Torr) and higher (760 Torr) pressures [3,4]. The atmospheric lifetime of $CF_3CF_2CH_2OH$ was estimated to be of 3 months and its GWP was calculated to be negligible relative to CFC-11 ($CFCl_3$) at several time horizons (TH). We conclude that $CF_3CF_2CH_2OH$ can be an "environmentally friendly" substitute of HFCs.

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