Fighting Ozone Depletion

In our featured article, we discussed the ozone layer and the depleting levels of ozone that were discovered in the 1970s. The most likely culprits behind the depletion were chlorine and bromine species, which can react with and destroy ozone molecules if they reach the stratosphere.[1] One chlorine or bromine atom can destroy thousands of ozone molecules, extinguishing them far quicker than they can be naturally produced.[2] As a result, many substances that have the potential to release chlorine and bromine to the stratosphere were classified as ozone-depleting substances (ODS).

In 1987, many countries joined together to sign the Montreal Protocol to protect the stratospheric ozone layer by phasing out the production and use of ODS. The United States ratified the Montreal Protocol in 1988 and amended the Clean Air Act to add protections for the ozone layer in 1990. These legislative items enforce bans on the production and import of ODS, defines labelling for ODS, establishes programs for determining alternatives to ODS and much more. To increase awareness, September 16 has been established worldwide as "Ozone Day."

ODS are classified as regulated substances in the U.S. and further subdivided based on their ozone-depleting ability. Substances like chlorofluorocarbons (CFCs) and halons have a large ability to destroy ozone and are classified as Class I substances.[3] Class I ODS have been banned in the United States since 1996.[3] Class II ODS are transitional substitutes utilized to ease the process of phasing out Class I substances.[4] This class of ODS consists entirely of hydrochlorofluorocarbons (HCFCs) and have less ozone-depleting ability than Class I substances.[4] The use of HCFCs has been nearly completely eliminated through 2020, with the final stages of phaseout occurring by 2030.[4] Regulations have been put in place for hydrofluorocarbons (HFCs) as well. These substances typically offer greatly reduced ozone-depletion ability, but are powerful greenhouse gases as a tradeoff.[5] HFCs are often grouped with perflourocarbons (PFCs) and sulfur hexafluoride (SF_6) as fluorinated greenhouse gases (F-GHGs), which are some of the most potent and longest lasting greenhouse gases.[6] SF_6 has a few uses in the laboratory and should be used sparingly and carefully.

The results from the efforts to protect the ozone layer have been slow-to-form, but promising. The phaseout timeline needed to effectively remove harmful ODS from mass production and use has made it hard to find short-term results. Compounding this issue is the amount of time many of these ODS will persist in the environment. CFCs with the most ozone-depleting potential have lifetimes of approximately 50-100 years.[7] Even the less-damaging HCFCs can persist for up to 25 years.[7] HCFC use and production has only drastically declined in the past few years and CFCs have only been banned for about 25 years.[7] This means these substances will continue to deplete ozone in the stratosphere for at least the next couple decades.[7]

Yet the reduction in ODS has provided a glimpse of hope for the ozone layer. Concentrations of CFCs and other ODS near ground-level have decreased, which should lead to lower concentrations in the stratosphere in the years to come.[8] Models project the atmospheric concentrations of CFCs and ODS to return to pre-1980 levels in the mid-21st century.[9] This should be accompanied by a lessened depletion of ozone and the restoration of the ozone layer.[9] Although we may still be a few decades away, it seems the ozone layer is on a good track for recovery.[9]