SF_6

SULFUR HEXAFLUORIDE

WHAT IS THIS GAS?

Origins	Sulfur hexafluoride (SF_6) is unique because it is only sourced anthropogenically. There are no known natural sources of SF_6. It is a stable, fluorinated compound, indicating it has a long atmospheric lifespan. The main use of SF_6 is in electric power systems in materials and processes such as circuit breakers, gas-insulated substations, switchgear, and electronic manufacturing.
What is the current PPM of this gas? And the atmospheric trend since 1700 and since 1960?	In 2020, there was approximately 9×10^{-6} PPM of SF_6 in the atmosphere. Prior to this, in 1986, 3.8×10^{-6} PPM was measured in the atmosphere. Preindustrial measurements of SF_6 indicate that there were 0 PPM in the atmosphere. SF_6 is anthropogenic and was not introduced for use until the 1950s.
Why is this gas important to climate change? How long does it remain in the atmosphere?	SF_6 raises concerns about climate change partially because of its long lifespan. SF_6 can survive in the atmosphere for 3,200 years, meaning it accumulates over time. SF_6 has a GWP (compared to CO_2) of nearly 23,000 over a span of 100 years. Given its potency and ability to contribute to the global temperature increase, SF_6 was added to the Kyoto Protocol (focuses on reducing emissions). Although the 1997 Kyoto Protocol was not signed by the US, 5.2% of collective GHG emissions in industrialized countries were to be reduced when compared with 1990 emissions.
What is an appropriate PPM goal to meet 1.5 degree threshold?	There is not a PPM specific value to meet the 1.5-degree threshold, however, it is important to note that the EPA's mandates as well as contributions from the Kyoto Protocol have reduced SF_6 emissions (as measured in 2018) by 76%.

REDUCTION POTENTIAL

Can emissions be reduced?	Emissions can be reduced by adjusting equipment and limiting the chances of something occurring that contributes to the emittance of SF_6. For example, equipment leakages increase as parts age. Equipment leakage can also happen during manufacturing, installation, during maintenance /servicing, as well as de-commissioning. Proper handling-training for employees and SF_6 capture are other reduction strategies.
Can emissions be captured at source?	SF_6 emissions can be captured at point-source; capture and recycling of SF_6 is common in the United States. According to the EPA there has been a significant reduction in the number of emissions created specifically by equipment leakage. Unintentional leaks accounted for 14% of SF_6 emissions in 2008, yet they were reduced by over 40% between 2008-2010 thanks to these practices.
Can this gas be removed from the atmosphere or ocean?	SF_6 emissions can be prevented from entering the atmosphere through capture and emission reduction. In the ocean, however, SF_6 is used to study circulation. SF_6 can be intentionally injected into the ocean to make note of the moving path of the ocean, as well as the pollutants that travel these paths. Environmental concerns regarding SF_6 pertain to atmospheric warming potential, not the ocean.

TECHNOLOGY REMAINS IN DEVELOPMENTAL STAGES

What are current and potential removal technologies?	There are a few ways to remove SF_6 or treat it. Decomposition is a removal strategy which uses plasma and results in (close to) 100% decomposition. This indicates that there is very minimal waste involved. Another strategy is adsorption using inorganic matter such as zeolites and pillared clays. A potential technology is the separation via gas hydrate which would theoretically allow SF_6 to be separated, recovered, and reused.
Which of these technologies are potentially scalable?	The process of decomposing SF_6 using plasma has the ability to decompose close to 100% of SF_6. A number of other toxic gases are produced in the process, however. Adsorption does not have a high level of efficiency because the organic materials have a low adsorption rate. During most of these processes, sludge, a hazardous material, is produced. Other technologies have been cultivated to potentially decompose SF_6 using this sludge by product. This would work on the basis that sludge could be used to decompose other materials such as hydrogen sulfide.

FOR EACH TECHNOLOGY:

What are the uses of the removed gas?	Uses for removed SF_6 include off site reconditioning and destruction in addition to on site recycling. Destruction can create a lot of pollution via more SF_6 emissions. Reconditioning does not create large amounts of pollution; it also allows for reuse of SF_6 in a high purity.
If the use is sequestration, what is the sequestration time frame?	SF_6 does not get sequestered, instead it can be "refurbished" for reuse at a high purity. Recycled sulfur hexafluoride can be reused for the same purposes non-recycled SF_6 is used for (electrical switchgear, electrical insulation, and circuit breakers). Newly developed recycling methods have allocated for a 99.99% purity of SF_6 that can be reused.
What is the net energy requirement to process removal?	An exact value of energy requirement is not widely known information. During the decomposition process, however, SF_6 is decomposed during a period of dissociation which is induced by electron impact. Fast moving electrons remove other electrons from the SF_6 compound to decompose it.

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