The SF_6 ReUse Program

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Abstract

Solvay, as a global supplier of new SF_6, has developed the "SF_6 ReUse" program as part of our commitment to protection of the environment and our Responsible Care® program. Previously, Solvay has offered this award-winning program in Europe. Now, for the first time, this program is available in the United States.

The SF_6 ReUse program addresses the reclaiming of used SF_6 gas, analytical services for used SF_6, packaging and transport of used SF_6, and environmental consulting.

This paper outlines the application of the SF_6 ReUse program to the electrical power systems industry.

Background

Solvay Fluor und Derivate GmbH and its North American counterpart, Solvay Fluorides, Inc., manufacture and distribute sulfur hexafluoride, SF_6, worldwide. The primary application of SF_6, for more than 25 years, has been as a gaseous insulator in high voltage transmission and electrical switching gear. Additionally, SF_6 has been widely used as a blanket gas in the manufacture of magnesium, along with other specialized applications such as a filling medium to soundproof windows.

SF_6 has proven to be highly successful and essential in these applications because of its combination of unique properties such as chemical inertness, high thermal stability, non-flammability, and non-toxicity. The less favorable property of SF_6 is its comparatively high greenhouse effect. Expressed as a GWP (Global Warming Potential) value on a scale where CO_2 = 1, SF_6 is 36,500, calculated upon an integrated time horizon of 500 years.

Despite the high GWP value of SF_6, its effective contribution to the anthropogenic greenhouse effect is very low today, due to its negligible concentration in the atmosphere. Because of the high stability of SF_6, its atmospheric lifetime is far beyond 1,000 years. With enrichment effects in the atmosphere, the concentration of SF_6 could build up to problematic greenhouse effect concentrations over the years, even in the case of comparably low annual emissions.

Through the use of SF_6 in closed cycle systems, recycling, and re-use, it is possible to reduce emissions to a minimum, thereby eliminating the need to restrict the use of SF_6 in its main applications.

Solvay, as a global supplier of new SF_6, has developed the "SF_6 ReUse" program as part of our commitment to the protection of the environment and our Responsible Care® program. Previously, Solvay has offered this award-winning program only in Europe. Now, for the first time, this program is available in the United States.

Solvay is the only company worldwide delivering such a complete range of services to meet our customers' SF_6 needs.

The SF_6 ReUse Program

As part of the Responsible Care® program, Solvay's commitment to product stewardship of the SF_6 life cycle is achieved through the SF_6 ReUse program. This program takes into account the following considerations:

A. No release of used SF_6 into the atmosphere
B. Determining the state of the gas and the method of reclaiming
C. Transfilling and storage of the used SF_6
D. Regeneration of SF_6 to a reusable state
E. Certification of reusability of reclaimed SF_6 gas
F. Refilling of electrical equipment with reclaimed SF_6

These issues are detailed below:

A. No Release of SF_6 into the Atmosphere

For ecological and economic reasons, the reclaiming of SF_6 gas from electrical installations is both desirable and practical.

Essential to this "no release" concept is that all SF_6-containing equipment be fitted with an intrinsically safe gas connection. It should be a fail-safe design to prevent unintended errors and discharges into the atmosphere during gas handling. Users can and do stipulate that such a special connection is to be used only for SF_6.

B. Determining the State of the Gas

The recoverable SF_6 gas has to be checked in order to determine the method of regeneration. Gas is checked for:

- Dew point (moisture content)
- SO_2 concentration
- Oil content
- Overall level of SF_6 gas purity

C. Transfilling and Storage of the Used SF_6

Equipment must be available to offload SF_6 gas from gas containing units, without the release of SF_6, and store it in a suitable storage vessel.

Such equipment:

- Must be made of material which will resist the potentially corrosive effects of SF_6 decomposition products
- Requires gas tightness, completely eliminating all possible air contamination of the SF_6 gas
- Requires absolutely oil free design, permitting no oil contamination of the SF_6 gas
- Must be able to handle liquid or gaseous storage of the SF_6
- Must be able to withdraw all of the SF_6 gas from the electrical equipment

- Must be equipped with filter units, as discussed below
- Must be transportable and easy to handle

D. Regeneration of SF_6 to a Reusable State

Operational contamination should first be absorbed with the user's filter unit. Such filters are an integral part of the customer's SF_6 maintenance devices, or are available as separate filter units. These filters should meet the following requirements:

- The filters must remove the contaminants listed
- The filters should be of a cartridge type for safe and easy disposal
- Input and output connections should be equipped with self-sealing couplings to avoid saturation of the filter due to ambient air
- Changing filters should not require disassembly of any fittings, tubing, or any other connection to eliminate the possibility of leakage

E. Certification of Reusability of Reclaimed SF_6 Gas

For both safety and warranty reasons, the purified SF_6 gas should be examined. Ideally, the quality of reclaimed SF_6 would approach the quality of new gas. This determination can only be made by analytical laboratory methods.

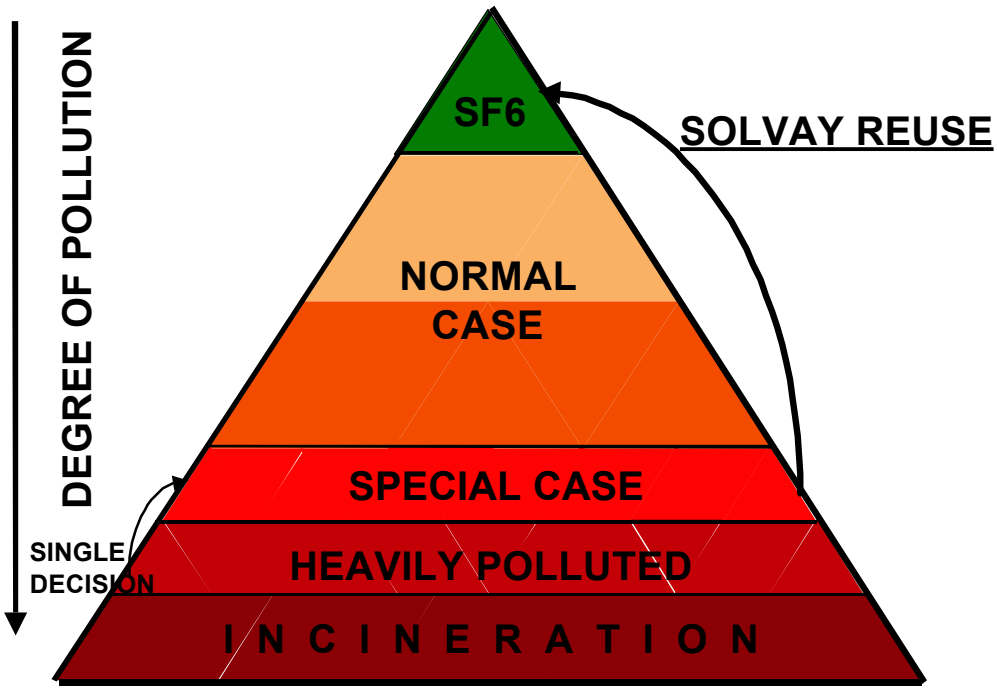
Field-testing devices are available to measure some of the components listed above.

Solvay Fluorides can perform analysis of the reclaimed SF_6 gas upon request.

F. Refilling of Electrical Equipment with Reclaimed SF_6

Equipment to refill electrical equipment from storage vessels with reclaimed SF_6 should have the following features:

- Gas tightness
- Oil free operation
- Safe filling to pre-set pressures
- Easy handling
- Transportability



Case Distinction for the ReUse Program

Prior to removal of the SF_6 gas from the electrical equipment, the condition of the gas should be determined. Based on this condition, the proper course of action can be determined. These cases are illustrated below:

Normal Case

All contaminants are within operational limits and can be removed on site. The following table lists the type of contamination and the method of removal.

Type of Contamination	**Treatment Method**
Moisture/Water Vapor	Adsorption with Molecular Sieve
Gaseous Decomposition Products	Adsorption with Activated Alumina
Solid Decomposition Products	Retaining with Solid Filters

Through the use of an on site purification unit, in more than 95% of all cases, the gas can be returned to a usable state and directly refilled back into an electrical unit.

Special Case

If testing of the gas shows a non-acceptable level of decomposition products, a decision regarding the reclaiming method has to be made depending on the level and type of contamination.

The following table lists types of contamination and methods of removal:

Type of Contamination	**Treatment Method**
SF_6 Mixed with Other Gases	SF_6-Gas Separation Device
Mineral Oil	Activated Charcoal Filter
Other	Single Decision

"Single event" contamination can be the result of extraordinary fault or wrong handling of the gas. In such cases, the customer should contact Solvay and discuss possible solutions. In general, purifying the gas on site with a service device and a separation unit will be the best way to proceed. In most cases, single event contamination can be eliminated by selective treatment, allowing reuse of the gas.

SF_6 gas reclaimed in this way does NOT fulfill all of the quality requirements of DIN IEC 376.

Reconditioning at SOLVAY

Used SF_6 gas can also be shipped directly to Solvay Fluorides. Reclaimed SF_6 gas from Solvay DOES fulfill all the requirements of DIN IEC 376 for new gas.

Because contaminated SF_6 is ultimately fed into running production at Solvay, the supply material must fulfill certain requirements:

- The total amount of degradation products may not exceed 5% by weight
- Inert gas content (air, N_2, O_2, etc.) may not exceed 30% by volume
- CF_4 content may not exceed 5% by volume
- The water content may not exceed 1000 ppm by weight
- The HF content may not exceed 1000 ppm by weight
- The material must be pure in regards to grade (no mixtures), oil free (<0.1%) and non-radioactive
- It must be specified from which area of application the contaminated SF_6 gas originates
- Other impurities (e.g., SOF_2, SO_2F_2) should be discussed in advance with Solvay, to determine if there is a possibility to reclaim the gas

If the product does not correspond to the listed conditions, Solvay can determine to what extent reclaiming is still possible.

Packaging

The customer is responsible for the transfilling of the contaminated SF_6 gas from the switching unit into appropriate special containers. Solvay Fluorides is prepared to assist the customer by recommending the necessary filling equipment.

Suitable packaging includes specially marked 40-kg (with an orange collar) or 600-kg containers (with an orange ring), which must be used exclusively for contaminated material. These containers must comply with the requirements for hydrogen chloride and used SF_6.

Normally these containers are at the customer's disposal from Solvay Fluorides on a temporary loan basis. They are already marked with the specified danger labels No. 6.1 and 8.

Solvay Fluorides, Inc. - USA SF_6 ReUse Program

With the introduction of the SF_6 ReUse Program in the United States, we are proud to offer the following services to our customers:

- Consulting services
- Provision of sample kits to customers and initial laboratory testing of product quality
- Laboratory testing to identify the condition of the used SF_6 including:
  - Moisture (dew point)
  - SO_2 concentration
  - Oil content concentration
  - % SF_6
  - Air (O_2, N_2)
  - CF_4
  - HF
  - Degradation products and impurities
- Special analytical services
- Identification of SF_6 with regard to reconditioning possibilities
- Provision of recovery cylinder kits to customers for return of used SF_6 for reconditioning
- Regeneration of used SF_6 to a certified usable state
- Upon meeting ReUse specifications, acceptance of kilogram to ton quantities
- Assistance with exceptional case material