Product Stewardship for SF_6

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Introduction

The manufacturers in the chemicals industry see it as their task to minimize any health, safety and environmental risks which may be related to their products and, at the same time, to meet the needs of their customers and the public for safely usable and environmentally safe products. In the framework of the initiative RESPONSIBLE CARE the concept of PRODUCT STEWARDSHIP has become an important building block towards sustainable development. (1) Product responsibility for SF_6 is concretized in a large number of practical precautions which Solvay Fluor und Derivate - has developed and implemented with - but always for - the users of SF_6.

Product Stewardship

The following aspects are decisive for the application of product stewardship:

- Anchoring in the company
- Safety and environmental protection as goals
- Communication
- Co-operation

Anchoring in the company

The RESPONSIBLE CARE guidelines of the Solvay Group express the commitment of the top management and employees - to the following principles:

- Solvay wants the company's products to be useful to people and the environment.
- Solvay wants to account for what happens to the company's products after they have been used.

Solvay wants to continuously add to its knowledge about the environment, health and safety and is prepared to engage in open and fair dialogue.

The business goals of Solvay Fluor and Derivate also state:

- Continue to improve the quality of our products and services.

On the basis of our own commitments the anchoring is built into the company which is necessary for the implementation of RESPONSIBLE CARE.

Safety and environmental protection

The commitments of Solvay Fluor und Derivate GmbH to protect people and the environment are demonstrated in many practical activities. Since the end of the 60's Solvay Fluor und Derivate is a worldwide supplier of SF_6

and, as early as the late 80's, started with the development of the SF_6 ReUse Concept (3). The SF_6 ReUse Concept foccuses on SF6 comming from - electrical switchgears as this is worldwide by far the main application for - SF_6 -.

In these electrotechnical applications. - SF_6 can demonstrate its extraordinary characteristics and advantages, such as chemical durability, substantial thermal stability and non-flamable nature.

A less favorable feature - of SF_6 is related to its long atmospherique lifetime and comparably high contribution to global warming. As a necessary consequence, handling SF_6 requires a closed cycle minimizing emissions where ever possible and exhausting its reuse potential. The SF_6 ReUse Concept consists of three subsections of the used SF_6 product cycle. The first subsection assumes the on-site reclaiming - of the contaminated goods - involving the use of appropriate equipment. If reclaiming on-site is no longer possible, the second subsection takes effect.

In detail, this consists of:

- Environmental consulting
- Analytical services of used SF_6
- Providing - appropriate packaging and transport of used SF_6
- Reclaiming and reuse

Environmental consulting

An example of environmental consulting is e.g. the regular Solvay Flour publication "SF_6 Newsletter". The goal of this newsletter is to keep the SF6 community updated about changes in - environmental policy factors for SF_6 -, e.g. due to the Kyoto Protocol and to address related issues of common interest Another part of environmental consulting consists of taking up questions from customers or the public directed to Solvay Fluor und Derivate as an SF_6 producer.

Analtical services

Enables customers to have analyses carried out by Solvay Fluor und Derivate when they have no analysis facilities or too little experience with used SF_6. The necessary equipment (lecture bottle with adapter) is kept on hand.

Providing - appropriate packaging and transport

Solvay Fluor und Derivate has a permit for special compressed gas container for transporting used SF_6 from electrical substations. These compressed gas containers are different from the containers for new SF_6 in compliance with IEC 376 due to their thicker walls (taking into account the larger concentrations of corrosive products). The valves of these SF_6 ReUse compressed gas containers (DIN 477 side connector no. 8) are also different than for new manufactured SF_6 (DIN 477 side connector no. 6).

Reclaiming and reuse

The used SF_6 delivered in the SF_6 ReUse containers is fed into the production process after precleaning. The big advantage of this is that the degradation products of SF_6 are thermocally cracked and transformed into new SF_6.

If a residue-free reuse of the used SF_6 is no longer possible, this quality can be disposed of in the framework of the third section of the SF_6 ReUse concept by means of incineration at Solvay. This has been necessary only once now.

Communication

The communication process must be considered as an important part of the SF_6 product responsibility program. This describes the degree of knowledge of all the parties involved (manufacturers, shipping companies, professional associations and user) including those precautionary measures recommended for SF_6 and

instructions on how to safely handle this product. The success of a good communication process depends on writing complete and meaningful information.

Safety specifications sheets and accident reference sheets for SF_6 and used SF_6 are understood as basic. That is why we are only mentioning the folder "Declaration regarding SF6 in electrical switch equipment and switchgears" (4) in this context. This folder was issued by german elecrical associations (VDEW (Vereinigung Deutscher Elektrizitätswerke e.V.) and ZVEI (Zentralverband Elektrotechnik und Electroindustrie)) in cooperation with switchgear manufacturers, power companies and a- SF_6 manufacturer. In this folder all the parties involved voluntarily committed themselves to take all the steps made possible by the current state of the art to avoid SF_6 emissions.

Co-operation

The development and introduction of the SF_6 ReUse Concept and the above quoted folder "Declaration ..." are examples of successful intercompany and cross-industry co-operations.

Thanks to a proposal initiated by Solvay Fluor und Derivate in the spirit of the principle of product responsibility, ABB, PreussenElektra, RWE Energie and Siemens, in a joint project, went one step further: to overcome a one-sided view of the environment confined to substance-related global warming potential, an live cycle assessment study was developed. This involved a realistic "power grid for electrical power supply" which was completely analyzed taking into account criteria such as primary energy consumption, space requirements, potential global warming effects, potential contribution to acid rain and potential eutrophic impact. The intention was to create a platform for a documented environmental discussion and, in addition, to illustrate - options for additional ecological optimizing. The live cycle assessment study was carried out in compliance with the requirements contained in the international standard DIN EN ISO 14040 and accompanied and evaluated by an external, independent expert from the TÜV NORD compliance testing agency.

The Live Cycle Assessment Study

The live cycle assessment study is designed to reflect conditions in Germany; the technologies included correspond to today's state of the art. The study compares different switchgear technologies with and without the use of SF_6 on the level of the switch bays as well as on the level of a real city power supply grid.

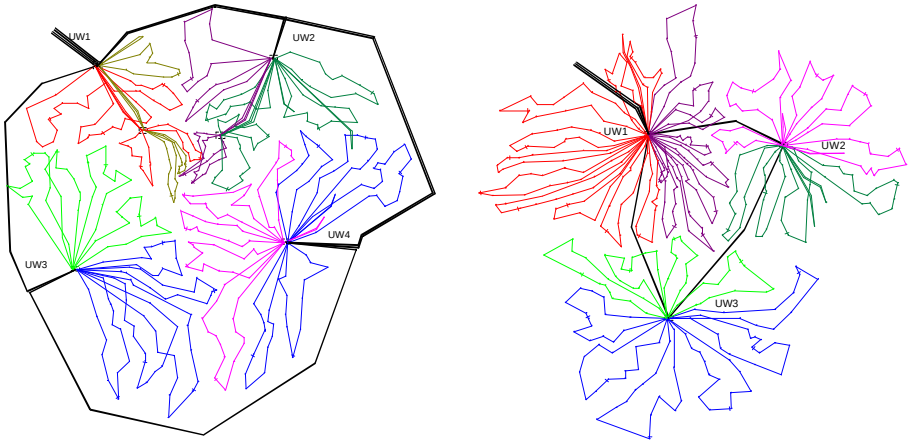
On the level of switch bays the study examines:

- conventional weather-protected technology with SF_6-free equipment
- weather-protected technology with SF_6 equipment (circuit breakers and transducers)
- SF_6-insulated, metal encapsulated switch bays.

On the level of the power grids - starting from the given load profile of a German city roughly 40 km² in size with approximately 130,000 inhabitants, a peak load of 120 MW and consumption of 400 GWh in the first year of the study (annual load growth of 1.5 percent) - two alternative supply models are compared:

- Power is fed into four air-insulated 110/20 kV transforming substations (AIS) at the edge of town with the appropriate amount of space and distributed over the 20 kV network. The 110 kV substations are connected with overhead transmission lines.
- Power is fed through 110 kV cable into three clearly consumer-proximate SF_6 gas-insulated 110/20 kV transforming substations (GIS) and distributed through the 20 kV grid.

In both cases the power is accepted from the superimposed mixed network in a 380/110 kV transformer substation at the edge of town. Both grids are designed so that the supply quality of the consumers is identical; different failure probabilities of the different sorts of operating equipment are taken into account and compensated during the grid layout work. The grid layout is economically optimized in terms of investment volume and costs. The time period of the study corresponds - to treat all the switch bay variations studied adequately . to 30 years of the typical life of air-insulated, high-voltage switchgears. SF_6-insulated switchgears can generally be used at least an additional 10 years.

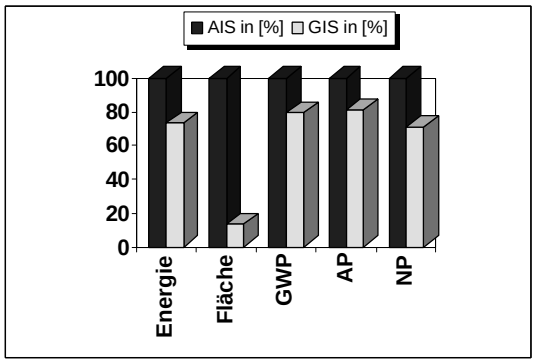


Topology of the grid variants: AIS grid (left) and GIS grid (right). Exemplary for a distribution voltage of 20kV. TS stands for transformer substation. The left exhibit shows that for AIS variants the four air-insulated TS's are located on the edge of town. In the GIS variant shown on the right, the three SF_6-insulated TS's within the city limits and thus arranged near the consumers. - Thick lines represent 110kV high-voltage, overhead lines (AIS grid) and cable (GIS grid); thin lines are medium-high voltage cable. While the 110 kV overhead lines of the AIS grid (without SF_6) surround the city, the 110kV cable of the GIS grid (with SF_6) are run into the city, a fact which enables the operator to cut mains leakage.

Results of the ecological assessment

On the level of switch bays the use of SF_6 technology always provides advantages in four out of five criteria of the live cycle assessment study: for primary energy expenditure, space requirements, acidification and eutrophic potential. Switchgears with substantial rates of utilization and/or low SF_6 dissipation rates also deliver an ecological advantage in terms of potential global warming.

On the crucially decisive power grid level the study produces the following picture:
The layout of the power grid using GIS technology (with SF_6) compared with the layout of the same grid using AIS technology (without SF_6) provides a 27 percent reduction in primary energy expenditure, roughly 86 percent reduction in space requirements, a reduction in global warming potential (GWP) by some 21 percent, a decrease in acidification potential (AP) by approximately 19 percent and a drop in europhic potential (NP) by roughly 29 percent. Extensive scenario calculations prove the reliability and applicability of the results.



The use of GIS switchgears in the power grid studied lowers all the potential environmental impacts studied. The graph shows the relative environment impact potentials in the first year of use of the grid variants (dark bars=AIS variants, light bars=GIS variants).
An increase in the power capacity of the grid by roughly 50 percent (i.e. an improved exploitation of the grid) leads, thanks to SF_6 technology to an additional 5 percent reduction in the parameters primary energy expenditure, global warming potential (GWP), acidification potential and nutrification potential (NP).

The most important reason for these reduction are: due to the substantially better insulation and extinguishing characteristics of SF_6 in comparison to air, stations and equipment in the GIS variant can be made with less material and energy than those in the AIS alternative. Even more decisive is that, due to the compact construction of the GIS components, the 110/20 kV transforming substations can be erected directly at (inner-city) load centers. So the energy is delivered to city centers at high voltage with negligible mains leakage and from there through short medium voltage lines to the consumers.

Conclusion

The use of SF_6 technology leads to clear, ecological advantages in comparison to the use of SF_6-free switchgears and equipment. This means that SF_6 technology is also sensible for urban power supply from an ecological point of view. This is conditional on the use of GIS stations which guarantee correspondingly low SF_6 emissions and, on the other hand, the vigorous use of SF_6 ReUse concept for a closed SF_6 cycle. The technical and logistical prerequisites for this are in place.

It can also quite apparent: an approach to environmental protection which is limited exclusively to global warming potential of one unit by weight of SF_6 is inadequate for the purpose of assessing SF_6 use in high and medium voltage technology. Only an extensive study made of all the relevant environmental criteria in respect to whole power grids with the help of an live cycle assessment study can provides reliable results - and these results are positive for SF_6.

Summary

PRODUCT STEWARDSHIP as a concept which covers the whole life cycle of products can deliver important contributions to sustainable design development of product systems able to meet future needs: against the backdrop of the goals set and frameworks provided by society and public policy, solutions are achieved by voluntary co-operation among companies -, solutions which will also mean continuous improvements in environmental protection and safety.

The "SF_6 ReUse Concept", the "Declaration regarding SF6 in electrical switch equipment and switchgears" and the developed live cycle assessment study "Supplying power using SF_6 technology" demonstrate, how PRODUCT STEWARDSHIP can be translated into concrete actions - and which ecological improvements, based on the use of SF_6 technology, are already possible today and will be possible tomorrow. Indeed evaluation of recent atmospherice measurements indicate a reversed trend in annual emission of SF_6 into the atmosphere by 27 % between 1995-1998.

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