

NAME : Manuel Naef  
 COUNTRY : Switzerland  
 REGISTRATION NUMBER : 7437

GROUP REF. : A3  
 PREF. SUBJECT : PS2  
 QUESTION N° : 12

## Carbon Footprint of SF<sub>6</sub> Alternatives for HV GIS Gas Handling Concepts for C4-FN Mixtures

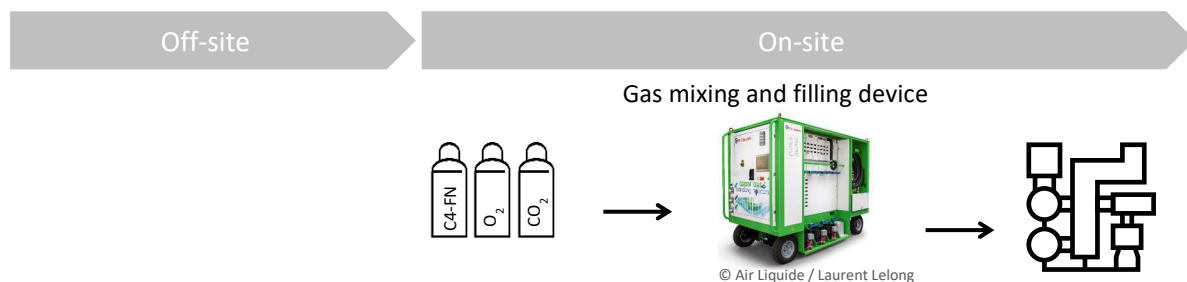
**Question:** In different projects, different practices of mixing gas components are reported. Authors of 10102 prefer off-site mixing, whereas authors of 10656 describe on-site mixing as “most beneficial”. Can specialist (e.g., authors of 10799, 10966) report on experiences in other projects?

### Practices of mixing and filling C4-FN mixtures

We can distinguish between two common practices for the preparation of the required gas mixture consisting of C4-FN, CO<sub>2</sub> and O<sub>2</sub>: on-site mixing and off-site mixing.

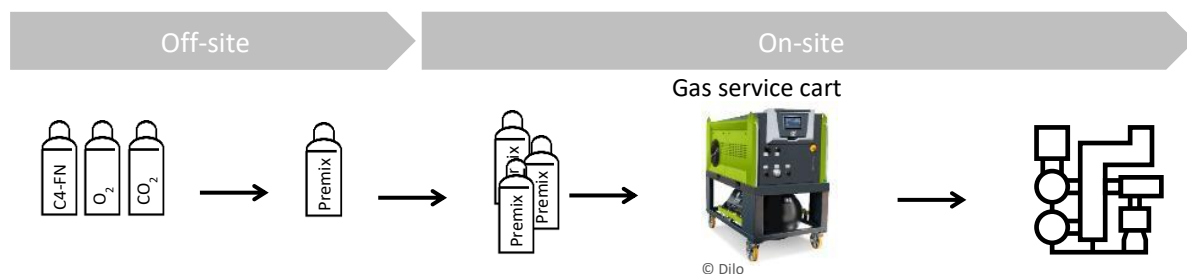
#### On-site mixing

The gas is mixed directly on site from the pure components (C4-FN, CO<sub>2</sub>, O<sub>2</sub>). This is done with a gas mixing and filling device that can mix the gases and directly pump them into the gas-insulated switchgear.



#### Off-site mixing

In this case the gas is already mixed off-site (e.g. at third party supplier) and cylinders with this premix are purchased. On-site, the premixed gas is filled into the high voltage equipment using for example a gas service cart. The premixed gas can be used in gaseous state or partially liquefied (higher storage pressure, requires homogenization).



### Commissioning: on-site mixing preferred

During installation and commissioning, typically large volumes of gas mixture need to be provided for the GIS application. From the comparison of different practices regarding logistics, economic and ecologic aspects as well as complexity on-site, preparing the gas mixtures directly on-site was identified as most beneficial. It allows for easy procurement of the substances, since the commonly used industrial gases CO<sub>2</sub> and O<sub>2</sub> can be purchased locally, avoiding long transport.

### Service activities: off-site mixing preferred

During service activities on the substation, typically only limited amounts of gas need to be handled, for example during top-up. A gas handling cart is used, that combines all the functions that are typically needed for handling gas (gas recovery, topping-up, evacuation). Top-up directly from gas cylinder with premixed gas (in gaseous state) using pressure regulator is also possible.

### Initial filling with Hitachi Energy GIS: on-site mixing

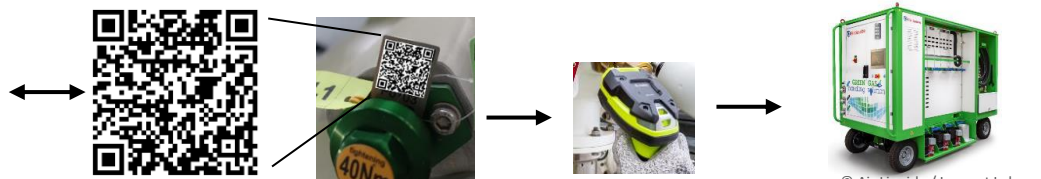
The gas is mixed directly on-site from its components (C<sub>4</sub>-FN, CO<sub>2</sub>, O<sub>2</sub>) using fully automated device. The gas mixture composition is given by QR-Codes that allow automatic adjustment of the gas mixture with the filling device. The filling device is designed for easy operation during filling of the gas, touchscreen with state-of-the-art HMI / GUI. As the initial filling is done by the GIS manufacturer, there is no need for the operator of the GIS to have the gas mixing machine.

### Gas inlet connection and Gas ID

DN20 couplings are used, with different thread M48x2 (SF<sub>6</sub>: M45x2) and different colour (green) to avoid interchanging with SF<sub>6</sub>. At each gas inlet connection, a QR-code is attached that contains the gas mixture information and can be read by the gas mixing and filling device. The information on the QR-code is not encrypted, it can also be read with common smart phones.

Example: Gas mixture 3.5% mol C<sub>4</sub>-FN, 10% mol O<sub>2</sub>, 86.5% mol CO<sub>2</sub>, pressure 910 kPa abs

```
<R2>Modules  
<CL>1  
<C4%>3.5  
<O2%>10  
<CO2%>86.5  
<NP>910
```



Gas inlet connection with gas ID

Gas mixing and filling device

### Remarks

- HV equipment is compatible with all filling methods (gas mixing, premixed gaseous, premixed partially liquefied)
- The filling method has no influence on the gas quality in the GIS