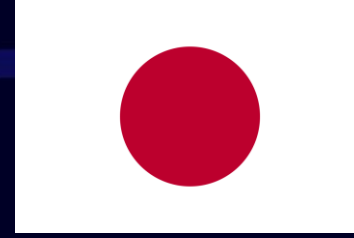


Paris Session  
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# SF6-free Gas Insulated Transformer using Natural Origin Gas

PS 2 Question 2.1  
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Toshiba Energy Systems & Solutions Corporation

## Answer of Question 2.1

### Question 2.1

What possibilities are there for development of new transformer design concepts? In particular, what prospects are there for development of new insulation liquids with improved properties compared with existing liquids? Also, what prospects are there for development of new dry-type transformer technologies? Finally, **what possibilities are there for substitution of sulphur hexafluoride by alternative gases?**

### **Suggestion of SF6-free Gas Insulated Transformer(GIT) using Natural Origin Gas(NOG) Concept**

#### **Advantage of SF6 Gas insulated Transformer**

- ✓ **Non-flammable**  
→ Fire extinguish equipment can be omitted
- ✓ **High explosion-proof performance**  
→ Main tank can be miniaturized
- ✓ **No risk of oil leakage**  
→ Also suitable for waterfront area and hydroelectric power plants

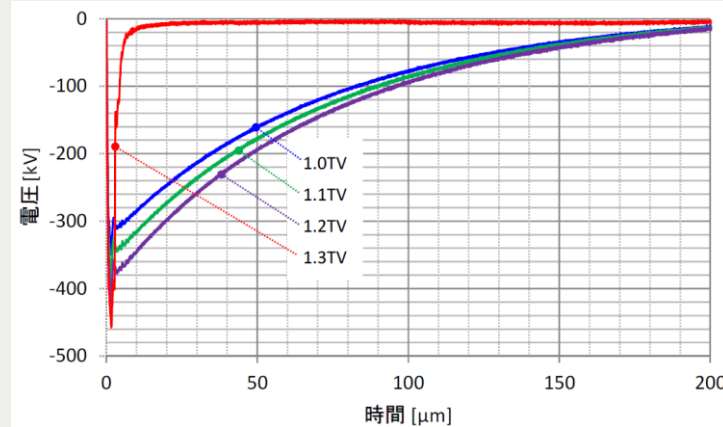
#### **Design concept of SF6-free GIT**

- **Use gas with a low environmental load**
- **Don't lose any of the benefits of SF6 GIT**

# Recent Our Research and Development for SF6-free GIT

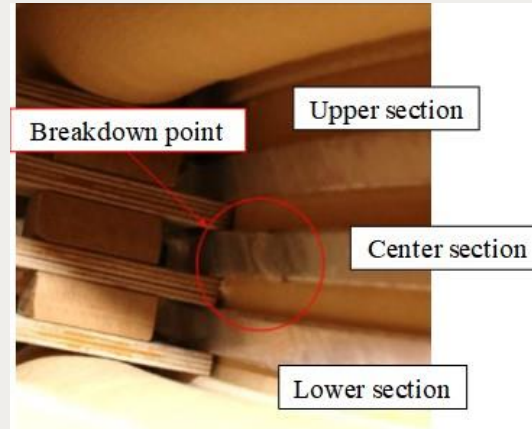
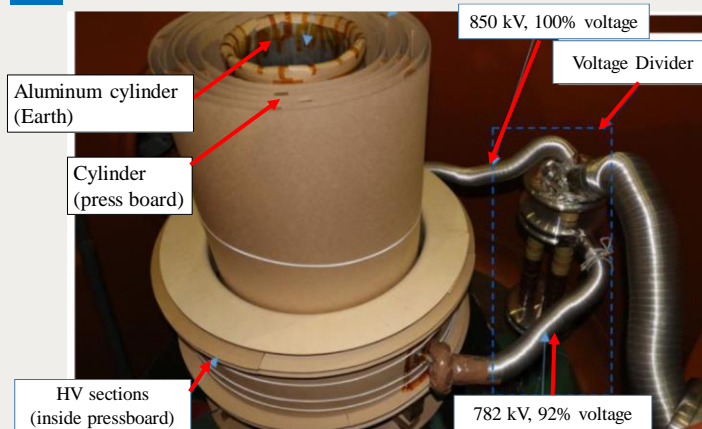
## Accumulated knowledge about natural origin gases through model tests and simulations

### Test of the Dry Air Gas Insulated Transformer



- 66/ $\sqrt{3}$ kV-15/3MVA
- Insulation medium is dry air
- Insulation verification passed
- Self-cooling performance did not pass.

### Test of insulation structure for N2 Gas Insulated Transformer



- Test of the main gap and section to section insulation
- Uses 0.4MPa-G N2 gas for insulation medium
- Breakdown at 900kV LI

## Which Natural Origin Gas is the Reasonable Choice for SF6-free GIT?

“Low GWP and High Stability **N2 and CO2** are reasonable choices”

Increasing gas pressure and design optimization can solve the insulation and cooling performance reduction

	SF6	N2	CO2	Dry Air
GWP	25200	0	1	0
Insulation Level	100%	approx. 30%	approx. 30%	approx. 30%
Heat Capacity	100%	27%	37%	approx. 27%
Stability Level of the Gas	Good	Good	Good	Bad
Safety Level of the Gas	Good	Good	Not Good	Very Good
Handling Level	Bad	Good	Not Good	Very Good

Positive  
 Median  
 Negative

# Comparison of the SF6-free GIT and SF6 GIT (66kV / 20MVA)

**SF6-free GIT will be one of the choices for users who need absolute safety to transformers**

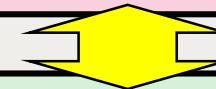
Comparison of SF6 GIT and SF6-freeGIT ratings

		SF6 GIT	SF6-free GIT
Ratings		GDAF - 50Hz - 20MVA - 64.5±7.5kV(Y) - 6.9kV(Y) - (Δ)	
Gas type		SF6 - 0.14MPa-G	<b>N2 - 0.14MPa-G</b>
LI test voltage[kV]	HV	350	<b>250*</b>
	LV	60	<b>40*</b>
Number of radiators		6	<b>16</b>
Number of gas blowers		2	<b>4</b>
Equipment dimensions	W	100%	<b>105%</b>
	L	100%	<b>110%</b>
	H	100%	<b>105%</b>
Gross weight		100%	<b>155%</b>

\*Reduced test voltage level in Japanese standard © CIGRE 2022

## Advantage of SF6-free GIT

- ✓ Low environmental load
  - GWP=1 / 25200 (when using CO2 gas)
  - “Zero Emission” (when using N2 gas)
- ✓ Easy installation and maintenance
  - No gas treatment required
  - Easy to handle



## Disadvantage of SF6-free GIT

- ✓ Applying low **insulation** performance gas
  - Requires the large body size
  - Need to apply reduced test voltage
- ✓ Applying low **cooling** performance gas
  - Weight increase
  - Requires the large cooler bank

# Example of the planned SF6-free Gas Insulated Transformer (66kV / 20MVA)

SF6-free GIT is

**easy installation and maintenance** compared to SF6-GIT although it becomes larger, and a only candidate for the **next generation non-flammable transformer**.

## Typical specification

Primary side	: 66kV class
Secondary side	: 6.6kV class
Voltage adj.	: OLTC
Capacity	: 20MVA
Gas type	: N <sub>2</sub>
Cooling type	: GDAF
Gas pressure	: 0.14MPa-g

