

Study Committee A1

Rotating Electrical Machines

Paper ID: A1-11063

EXPERIENCE WITH CO2 FREE GENERATOR OPERATION

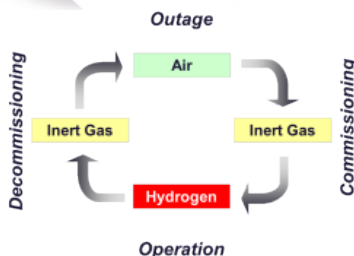
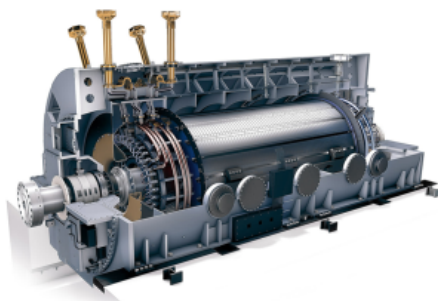
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Motivation

- 67 countries have already committed to net-zero emissions and the pressure that governments are putting on companies to reduce carbon emissions is growing.

- Japan committed to become a decarbonized society, the Prime Minister announced the commitment to be full carbon neutral by 2050.
- China aims to peak Carbon Dioxide emissions by 2030 or earlier and to achieve carbon neutrality before 2060.
- The European Union proposed an increase of the EU 2030 climate target to 55% emissions cuts and committed to becoming Carbon Neutral by 2050.
- The Nigerian state of Lagos (most populous region on the African continent) committed to be Carbon Neutral by 2050.
- Canada's prime minister committed to establish a net zero emissions goal by 2050, with legally binding five-yearly carbon budgets.
- Chile aims for a phase-out of coal by 2040 and for carbon neutrality by 2050

Generator Purging Process



Method / Approach

- Common practice is to use CO₂ for purging generators due to its physical parameter and density difference in comparison to other gases applied for generators.
- Siemens Energy developed, tested and verified an alternative solution by purging without CO₂

Gas Data					
	Hydrogen (H ₂)	Air	Argon (Ar)	Carbon Dioxide (CO ₂)	Nitrogen (N ₂)
critical temperature	-239.9 °C	-140.73 °C	-122.43 °C	+31.0 °C	-146.9 °C
density, gaseous at 0°C and 1.013 bar	0.08988 kg/m ³	1.293 kg/m ³	1.784 kg/m ³	1.977 kg/m ³	1.250 kg/m ³
density ratio to air at 0°C and 1.013 bar	0.0695	1	1.38	1.53	0.97
thermal conductivity at 25°C and 1 bar	1861*10 ⁻⁴ W/mK	260*10 ⁻⁴ W/mK	178.2*10 ⁻⁴ W/mK	164.0*10 ⁻⁴ W/mK	258.3*10 ⁻⁴ W/mK

Validation

- first validated in the generator test bed at a Siemens Energy factory
- followed by practical tests successfully performed in commercially operating power plants.
- Currently there are several hundred units globally using this advanced technology. Some units have used argon right from the start of their operation, while other units were converted from CO₂ to argon purging.
- The earliest installations have accomplished more than two decades of successful operation.

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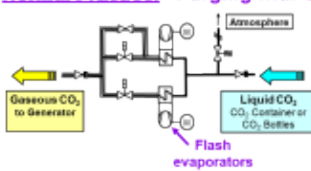
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EXPERIENCE WITH CO₂ FREE GENERATOR OPERATION continued

Simplified overview

Normal Practice: Purging with CO₂



Siemens-Patent: Purging with Argon



Advantages

- Saves outage time
Fast Inertisation
- Increases Safety:
Purging every time possible
without use of electrical energy
No evaporation necessary
- More Reliability
Simplified system
- No strain on the atmosphere
No greenhouse gas
- Less dangerous for the staff
Argon is non-poisonous

Experience



Patented Design currently installed in around **200 Units** globally

• Austria	• Slovakia	• Bangladesh
• Belgium	• Spain	• China
• Czech Republic	• Sweden	• Korea
• Finland	• Turkey	• Malaysia
• France	• United Kingdom	• Pakistan
• Germany		• Singapore
• Hungary	• Abu Dhabi	
• Netherlands	• Bahrain	• IRA
• Norway	• Egypt	
• Poland	• Iran	• Argentina
• Portugal	• Iraq	• ...
• Russia	• Israel	
	• Oman	

- **First Installation 1998**
- **Cumulated operational experience exceeds in total 1400 years**

Main Motivations:

- ✓ Safety
- ✓ Costs
- ✓ System Simplification

Conclusions

- Well established advances process with excellent operational experience
- Safer, cheaper, simpler, faster, environment friendlier
- Helps operators to reach net zero target
- The sooner this is implemented the faster the goal can be reached
- Applicable on various types of generators