

The Search for an Economically Viable and Climate-friendly Alternative for Replacing SF₆ in HV Accelerator Applications

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Abstract: A particle accelerator is a machine that uses strong electromagnetic fields to accelerate charged particles to very high speeds and operate at extremely high electronvolt (eV). Many direct voltage industrial accelerators use SF₆ as an insulating medium to withstand the required high voltage thanks to its excellent dielectric strength. However, SF₆ is a potent greenhouse gas (GHG) with a global warming potential (GWP) 23,500 times higher than CO₂ and a long atmospheric lifetime of 3,200 years [1]. Although majority of SF₆ is used in transmission equipment, accelerators can contain large quantity of SF₆.

Dynamitron® accelerators are one type of medium energy, direct voltage accelerators used primarily in crosslinking applications and producing electron beam with an energy up to 5 MeV and 160 mA. SF₆ losses from Dynamitron® are generated in normal operating conditions due to vessel and equipment permeability and during maintenance operations. Technical (over-pressure) or mishandling incidents can also lead to significant SF₆ leaks. Although these incidents are rare they can have serious environmental consequences given the large SF₆ volumes at stake in the Dynamitron® as shown in Figure 1. Thus, there is an urgent need to find a climate-friendly alternative with similar or better insulating strength than SF₆ for use in high voltage accelerator applications.

The LIFE_SF6-Free project has received funding from the LIFE programme of the European Union to identify a shortlist of alternatives for investigation, demonstration, validation and roll-out for replacing SF₆. A high pressure test rig will be designed and developed to determine the breakdown characteristics of alternative gases and their mixtures in comparison to SF₆ using small-scale prototypes. The test data will be used to inform the design of a large-scale industrial demonstrator. Knowledge generated during this project will be disseminated and communicated to the wider audience, local communities, policy makers on climate change, public organisations and relevant industries.

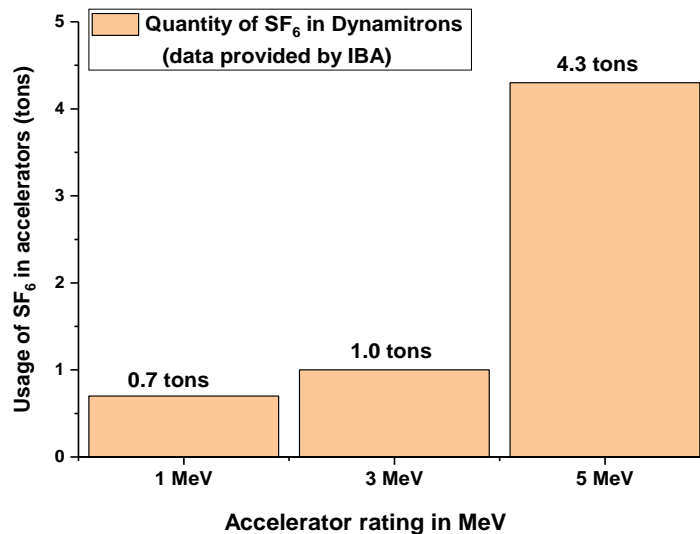


Figure 1. Quantity of SF₆ in typical Dynamitron® accelerators (data provided by IBA)

[1] T.F. Stocker et al. “Climate change 2013: The physical basis”, Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, 2013.