FUSION TECHNOLOGY DESCRIPTION

EUROfusion
TECHNOLOGY TRANSFER PROGRAMME

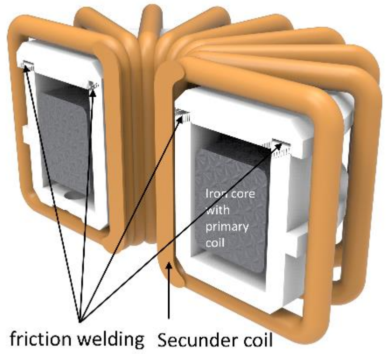
High Voltage Insulation Transformer Using Friction Welding

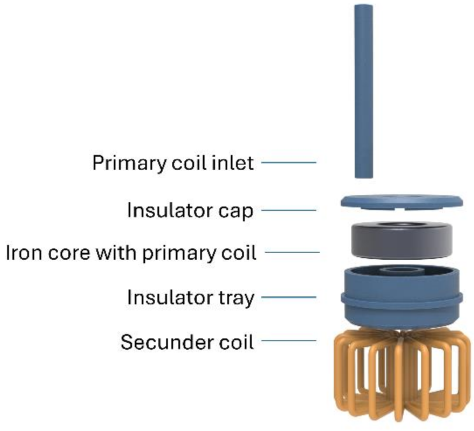
For the purpose of fusion research (W7X, ASDEX-U), the HUN-REN has developed a new insulation method for high voltage transformers. This method deviates from the traditional use of resin casting or oil-based insulation, by using rotary friction welding (FSW) to join the new transformer's architecture components within a mechanically robust assembly with optimal insulation. This technology enables the production of transformers that are not only lighter and more compact but also offer enhanced performance characteristics such as superior insulation capabilities and increased efficiency. Transformers have been successfully produced and tested with power ratings up to 10kVA and insulation capabilities of up to 120kV and are now suitable for a wide range of applications such as ion sources for accelerators and applications involving the insulation of heating and high-voltage components

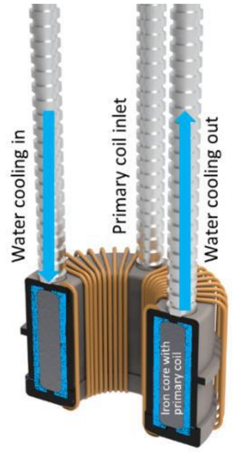
Description of the technology

The technology revolves around high-voltage insulation transformers utilizing friction welding for coil insulation. Traditionally, the insulation of transformer coils against high voltages has been achieved using resin casting or oil-based solutions, leading to drawbacks like increased size, weight, cost, and extended manufacturing times. The innovative solution replaces these traditional methods with a mechanically robust assembly with optimal insulation that uses rotary friction welding (FSW) to join the components.

The solution involves the construction of a transformer case comprising three main parts: the primary coil inlet, insulator cap and insulator tray. These components are interconnected through rotary friction welding, effectively enclosing the toroidal iron core along with the primary coil. Additional inlet pipes can be applied to facilitate (deionized) water cooling for the iron core and primary coil. Various methods are available for cooling the secondary (outer) coil. The institute has successfully produced transformers with power ratings up to 10kVA and insulation capabilities of up to 120kV using this innovative approach.







The reduction of weight and size is game-changing, with a transition from 30 to 5kg for the weight and dividing by two the dimensions of the apparel (@ a 1kVA/120kV transformer). More information with the specifications of the transformer :

- Primary coil voltage : 230 VAC (or any, on request)
- Secondary coil voltage – any, on request
- Insulating capability : 120 kV as standard, higher voltage on request
- Max. power : up to 10kVA (higher on request)

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Innovation and advantages of the offer

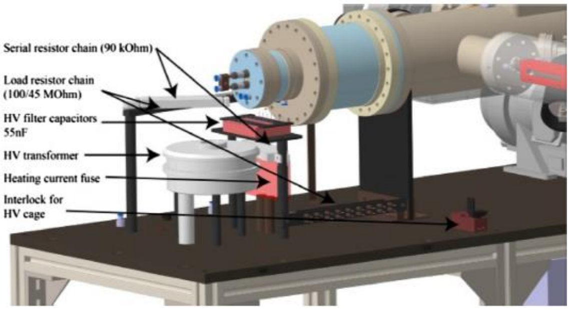
The major innovation is the use of friction welding to achieve electrical insulation, which disrupts with conventional methods. This approach not only simplifies the assembly process but also significantly enhances the transformer's performance and reliability. The key advantages of this technology include reduction of cost (compared to resin or oil-based insulation methods), efficient insulation (near-theoretical insulation values of approximately 20-40 kV/mm), dual cooling systems (both primary and secondary cooling mechanisms included), easier installation and maintenance (reduction of space and weight), and improved efficiency and flexibility (higher efficiency compared to non-toroidal transformers, easy replacement of the secondary coil). High TRL is also important value for quick market access.

Non-fusion Applications

This technology is suitable for a wide range of applications requiring high voltage insulation transformers. Examples include ion sources for accelerators and applications involving the insulation of heating and high-voltage components in High Energy Physics, Renewable Energy Systems, Electric Vehicle Charging Stations, Medical Equipment, Industrial Automation, and every other industry that uses insulation on high voltage infrastructures.

EUROfusion Heritage

The technology has been experimented and used with success for years for fusion research (ASDEX-U, 1kVA, ~5years, Wendelstein 7-X, 1kVA, ~8years). A good example is the use of the HV transformer as a key components of the HV system of W7-X alkali beam injector as described in the publication Measurement of edge plasma parameters at W7-X using alkali beam emission spectroscopy, G. Anda, Fusion Engineering and Design, Volume 146 Part B https://doi.org/10.1016/j.fusengdes.2019.03.042. This work received support within the framework of the EUROfusion Consortium (Grant Agreement No 101052200 — EUROfusion).



HV system of W7-X alkali beam injector

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EUROfusion TECHNOLOGY TRANSFER PROGRAMME

Annex for internal use – Additional information

Technology Provider

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Technology Readiness Level and collaboration opportunities

☐	☐	☐	☐	☐	X	X	☐	☐	1kVA/120kV - TRL 7
TRL1	TRL2	TRL3	TRL4	TRL5	TRL6	TRL7	TRL8	TRL9	10KVA/120kV – TRL 6

Collaboration opportunities: R&D collaboration, licensing agreement, patent sale

This technology/know-how is available for further adaptation and fine tuning to meet specific requirements. It could be used in all industries that uses insulation on high voltage infrastructures.

IP Status

☐ Copyright
☒ Design Rights
☐ Exclusive Rights
☐ Granted patent or patent application essential
☐ Other (registered design, plant variety, etc.)

☐ Patent(s) applied for but not yet granted
☒ Patents granted
☒ Secret Know-how
☐ Trademarks

Other technical expertise's of the technology donor

The research area of the HUN-REN CER Fusion Plasma Physics Department is the advancement of controlled fusion energy production: develops and builds plasma diagnostic and technology systems, performs and evaluates measurements on the world's largest fusion experiments. The major activities are cryogenic pellet production, acceleration and interaction with the plasma, plasma diagnostics using video cameras and Beam Emission Spectroscopy, modelling activities for beam-plasma interaction, 3D printing of fusion device models or development of a 35 keV proton source as the input beam to accelerator driven compact neutron generators

Contact of the broker

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