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Copper's Key Role in Power Transformers

A step towards reliability, circular economy, and net zero emissions

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As India continues to develop, the demand for energy exponentially increases. With this growth comes the paramount need for efficient and sustainable power systems. Power transformers, integral to the energy grid, play a crucial role in ensuring electricity is reliably distributed.

The International Energy Agency (IEA) projects a substantial expansion of global power grids by more than 80 million km until 2040. This rapid growth is expected to significantly increase the demand for copper globally, including India, particularly in critical grid infrastructure components such as transformers. Among materials used in transformers, copper stands out for its exceptional conductivity and reliability. It is also a circular material that can be infinitely recycled, without losing its chemical or physical properties.

Power transformers are made to last a long time, typically 30-40 years. Transformers can be damaged if they are made of sub-standard materials, leading to lose connections and corrosion. Copper's high conductivity, durability, and resistance to corrosion extend the operational life of these systems.

Copper: A Logical Choice for Power Transformers

Power transformers are designed with huge tolerances for short circuits because of the grid size and magnitude of current flow in case of fault. Windings must be both, large enough to handle these currents and strong enough to withstand mechanical loads they impose. Copper's superior conductivity makes it ideal to design optimal size power transformers that are easy to transport and install. Copper is stronger than other alternative materials, and hence, better withstands stress imposed by fault currents. Given the coil is stronger and less likely to deform, the transformer life is extended and life-cycle maintenance cost is reduced.

Summary table of levels of re-use in circular economy

Liquid immersed transformers					
Mineral Oil	Same reuse	~70%	Natural Esters	Same reuse	
	Downgraded use	~30%		Downgraded use	<30%
	Incineration	-		Incineration	>70%
Copper Coils	Same reuse (1a purity)	~90%	Alu Coils	Same reuse (Alu ?)	- (not today)
	Downgraded use	10%		Downgraded use	100%
Magnetic Steel	Same reuse	?			
	Downgraded use	?			
Other Steel	Same reuse	100%			
Porcelaine	Downgraded use	100%			
Wood, paper, etc	Incineration	100%			
All other plastics, etc	No use	100%			

Circular Economy and Closed-Loop Systems: A Sustainable Future

The philosophy of a circular economy, particularly transformers, involves designing products with their entire life-cycle in mind. This includes considering how materials like transformer windings can be recovered and reused at the end of a product's life. This approach not only involves recycling windings but also reusing other transformer components such as the core and tank through the remanufacturing processes.

Most copper winding from transformers are recycled at the highest purity level (99.9%). Copper can be melted down and used again for electrical applications, including transformer windings, without further purification.

A practical example of this closed-loop business model is RecyCâbles, a joint venture (JV) between SUEZ and Nexans, which focuses on collecting, recovering, and processing materials from used cables, including copper. This initiative has already resulted in new cables with 99.9% pure copper, demonstrating the potential of closed-loop recycling in minimising emissions and contributing to a sustainable future.

Recycling copper in power transformers offers significant environmental benefits such as energy savings, reduced greenhouse gas emissions and preserving natural resources. This also reduces the need for new copper extraction, minimises waste and supports the broader goal of reducing emissions in the power sector.

Conclusion

Copper's role in power transformers is critical not only for its superior electrical properties but also for its contribution to sustainability through recycling and circular economy practices. As the energy sector continues to evolve, the integration of copper in power transformers exemplifies how technological efficiency can align with environmental sustainability. By maximising the reuse and recycling of copper in transformers, we can reduce waste, conserve resources and contribute to a future of reliable, efficient and sustainable energy distribution.