WILSON POWER SOLUTIONS
Responsible Power Engineering

EXCEEDS
STRICT TIER 2 (2021) EU ECO DESIGN SPECIFICATIONS

WILSON e² AMORPHOUS

AMORPHOUS METAL CORE TECHNOLOGY:

TRANSFORMING ENERGY EFFICIENCY OF POWER DISTRIBUTION NETWORKS

DR LORE GROHMANN OF WILSON POWER SOLUTIONS EXPLAINS HOW SUPER LOW LOSS AMORPHOUS DISTRIBUTION TRANSFORMERS HELP IMPROVE THE ENERGY EFFICIENCY OF SMALL POWER DISTRIBUTION NETWORKS.

Despite the generally high operational efficiency of distribution transformers, a considerable loss of energy occurs due to the large numbers of distribution transformers installed across global distribution networks: It is commonly estimated around 3% of all electricity generated worldwide (˜25 GW) is wasted through transformer operating losses.

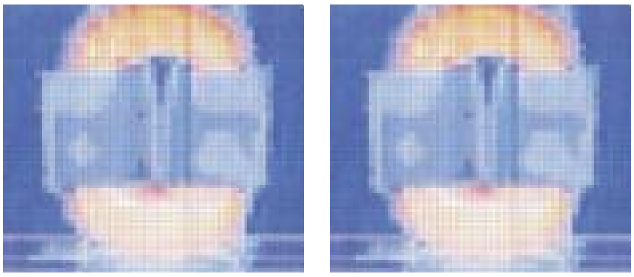
According to a 2008 study by SEEDT (Strategies for development and diffusion of Energy-Efficient Distribution Transformers) around 4.6 million distribution transformers are installed in the EU. Their losses exceed 38 TWh/year - this is more than the entire amount of electricity consumed by Denmark (or 8.5% of the electricity consumed in the UK) and equates to 30million tonnes of CO_2.

Improving transformer efficiency by reducing these unnecessary losses constitutes a simple and effective way of improving energy efficiency across distribution networks. How?

REDUCING TRANSFORMER LOSSES

Two types of losses are inherent in the running of distribution transformers: no-load losses that occur in the transformer cores due to hysteresis and eddy current losses which are constant and present as soon as the transformer is energised and load losses that occur in the transformer's electrical circuit due to resistive losses that are a function of loading conditions.

The main no-load loss is core loss, which is associated with the time- varying nature of themagnetising force and results from hysteresis and eddy currents in the core materials. Core losses are dependent upon the excitation voltage and can increase sharply if the rated voltage of the transformer is exceeded. Hysteresis losses can be reduced by selecting lowcore losses material (such as amorphous metal), while eddy currents can be lowered by reducing lamination thickness.



CRGO CORE AMORPHOUS CORE

Fig 1 - Infrared imagery showing heat loss in a CRGO transformer core (left) in comparison with amorphous core material

The major source of load losses for distribution transformers is I2R losses in the windings. Load losses can be reduced by selecting lower-resistivity materials for the windings, by reducing the total length of thewinding conductor, and by using a conductor with a larger cross-sectional area. Eddy currents are controlled by subdividing the conductor into strands and insulating the conductor strands in addition to conductor shape and orientation.

WHAT ARE AMORPHOUS METALS?

The amorphous metal used in transformer cores is a unique alloy of Fe-Si-B (iron, silicon and boron) that is produced by extremely rapid solidification from the alloy melt. This causes themetal atoms to form a random or amorphous pattern (amorphous is of Greek origin meaning no structure), as opposed to conventional cold-rolled grain-oriented (CRGO) silicon steel (a Fe-Si alloy), with its organised crystalline structure.

The absence of a crystalline structure in amorphous metal allows easier magnetisation of the material that result in lower hysteresis losses. Eddy current losses are also reduced in amorphous metal due to the thinness of its laminations and a higher electrical resistivity (130 μΩ- cm opposed to 51 μΩ-cm in CRGO).Core losses in amorphous metal core transformers are therefore reduced by up to 75% compared to CRGO transformers.

INITIAL PURCHASE PRICE VERSUS TOTAL COST OF OWNERSHIP (TCO)

Historically customers have looked for the lowest possible purchase price, largely ignoring the cost of losses over the lifetime of the transformer. However, increasing electricity costs and environmental concerns alongside continued pressure to increase efficiency of operations have led customers who operate their own transformers to evaluate losses. Rather than basing purchasing decision on the purchase price alone, themajority of today's customers chose products with reduced losses that provide themost attractive total cost of ownership (TCO).

But beware: The label 'lowloss' or 'super lowloss' transformer can be misleading: Because no minimum performance standards or energy efficiency labels for energy efficient distribution transformers currently exist in the EU, manufacturers can promote products with only slightly improved loss values as 'lowloss' or 'super lowloss' alternatives. That's why customers wishing to improve their TCO by specifying lowloss or super lowloss products should ask for a detailed breakdown of loss values to be able to make an informed purchasing decision.

WHY DOES YOUR ENERGY ACCOUNT INCLUDE TRANSFORMER LOSSES?

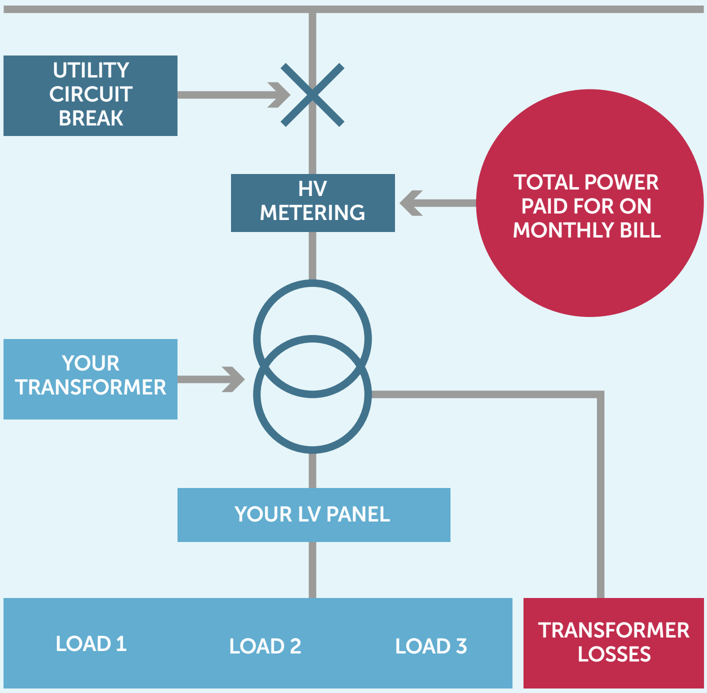


Fig 2: Schematic illustration of why transformer losses add to your electricity costs

COMPARE TRANSFORMER LOSSES

KVA	PRE 2015 STANDARD LOSS CRGO TRANSFORMER		WILSON E1 - TIER 1 2015 ECO DESIGN COMPLIANT		WILSON E1 - TIER 2 2021 ECO DESIGN COMPLIANT	
	Core Losses NLL	Load Losses LL	Core Losses NLL	Load Losses LL	Core Losses NLL	Load Losses LL
315	600	5350	360	3900	200	2800
500	900	7400	510	5500	300	3900
800	1150	11000	650	8400	425	6000
1000	1350	12500	770	10500	500	7600
1250	1575	16000	950	22000	550	9500
1500	1700	21000	1125	13140	625	11282
1600	1800	21700	1200	14000	630	12000
2000	2300	24000	1450	18000	850	15000
2500	3000	28000	1750	22000	900	18500

Table 1: Transformer loss comparison. Figures correct at date of first publication, May 2016, All values given in Watts [W]

SUPER LOW LOSS AMORPHOUS METAL CORE TRANSFORMERS

Super lowloss amorphous core transformers combine conductors having lowcurrent density with amorphous core technology to significantly reduce load and no load losses when compared with standard CRGO products.

The use of high quality copper conductors has been widespread in Europe and the US to reduce load losses with products being promoted as 'lowloss' transformers.

Amorphous metal core technology has been intensively deployed in countries with notoriously overstretched supply networks (i.e. India) for over two decades and has a proven track record of performance.

Super lowloss transformers combine the two loss reducing approaches, hence the name 'super lowloss amorphous transformers'.

The initial costs of a super lowloss amorphous core transformer are higher than that of a standard CRGO transformer. There are two reasons for this: Firstly, the amorphous material is more expensive than silicon steel and the saturation magnetic flux density of amorphous steel is lower than that of silicon steel so that more amorphous material is required to produce the core and secondly high conductivity materials are more expensive than lesser rated conductors. However, the higher upfront investment is offset by lower operating costs with typical payback periods of less than three years (based on loss savings alone).

Where a site can benefit from a reduction in site supply voltage, significant additional savings can be made and payback is achieved much sooner, in some cases withinmonths.

According to the voltage management document by theCarbon Trust, annual energy savings of close to £4,000 can be achieved through replacement of a standard loss 1000kVA Transformer with a super lowloss equivalent.

Despite its slightly wider footprint the Wilson e2 is interchangeable with most existing installations enabling straight forward transformer replacements.

In addition to the reduced transformer losses the Wilson e2 super low loss amorphous transformer comes with an extended tapping range as standard, allowing for easy adjustments to supply site voltage.Where supply voltage fluctuates or a stable output voltage is required the Wilson e2+ comes with an on load tap changer that reacts to fluctuations ion supply and adjusts output to provide stabilised voltage to site.

Launched in 2009,Wilson Power Solutions have today supplied over 650 super lowloss amorphous transformers and helped organisations including leading supermarket giant Tesco, the Natural History Museum and the NHS reduce operating costs and associated emissions.

SUMMARY

Standard type distribution transformers are silent energy guzzlers that contribute to a considerable loss off energy across global distribution networks.

Improving the energy efficiency of distribution transformers in operation is an easy and cost effective way of helping to meet emission targets and reduce operating costs.

Super lowloss amorphous core transformers are certain to play an important role in making power distribution networks more efficient, reduce carbon emissions and save operating costs.

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Wilson Power Solutions Limited
Westland Works, Westland Square, Leeds LS11 5SS UK
T: +44 (0)113 271 7588 E: info@wilsonpowersolutions.co.uk