MGM TRANSFORMER COMPANY

5701 SMITHWAY STREET • CITY OF COMMERCE, CALIF. 90040
(323) 726-0888 • FAX (323) 726-8224
www.mgm-transformer.com

Technical Information for SCR/Rectifier Duty Transformers

MGM Transformer Company, as known by major drives manufacturers, has been among the leaders in the design and manufacturing technology of SCR/rectifier duty transformers, whether 6 or 12, 18 pulse, VFD or PWM drives, for many years. Our experience is vast; built on a solid foundation in the design approach, with installations worldwide.

MGM does not use, nor believe in the transformer de-rating method, for use with AC or DC drives. On the contrary each individual transformer is designed specifically according to the drives harmonic spectrum. The magnitudes of harmonics, depending on the drive, six, twelve or eighteen pulse, fluctuate between the typical and theoretical values of ANSI C57.110-1986 and IEEE Standard 519-1981. See the attached K-factor derivation sheets for these values.

These harmonic values are used to derive a K-factor number rating, strictly to arrive at a guideline for evaluation and sizing of the transformer design. The K-rating for drives, typical and theoretical values range between K-3 and K-9, as shown on the attached sheets. MGM's summations of previous spectrums, for six pulse transformers has resulted in designs at K-7 to K9 ratings. Based on this K-rating the transformer is sized accordingly.

Drives transformers are not necessarily oversized for this application to be suitable for use with non-sinusoidal, harmonic rich loads. Typically the higher frequencies, as in harmonic loads, will elevate the eddy current and stray losses drastically, as per the following explanations.

Every transformer has inherent losses comprised of load loss, IzR loss, plus eddy and other stray losses. The calculated K-factor number is multiplied by the eddy current and stray loss values, to arrive at the elevated eddy and stray loss values. This total loss value is added to the actual transformer losses under full load, and hence, the transformer core and coils must be designed to absorb these excessive losses without overheating or exceeding the required temperature rise. The higher the percentage of stray and eddy current losses, the higher the transformer total losses will be after multiplying by the K-factor number.

The ideal design approach will be to minimize the eddy current and stray losses, on the load-side, before they are multiplied three to nine folds, K-3 or K-9, depending on the harmonic levels. This can be achieved by incorporating the following parameters into the transformer design:

1) Use conductor(s) as thin as mechanically possible to reduce the stray losses due to the skin effect.
2) Use multi-stranded, thin, individually insulated conductors in parallel.
3) Transpose the conductors as many times as possible.

For example: Six pulse 300 KVA total losses would normally include 6 to 7% of the total losses as eddy and stray losses. Choosing 7% eddy current & stray losses and a K-Rating of K-7, the IZR is: 100% - 7% = 93%. Based on this the total losses will be: 93% + (7% x 7), K-7 = 142%. This means it will require 42% more KVA capacity and ventilation to compensate for the additional 42% losses generated by six pulse harmonics. Rather than oversize the transformer by 42% and then de-rate it to a normal 300 KVA, MGM utilized the three aforementioned design steps and designed a 300 KVA transformer with eddy and stray losses not to exceed 2%. Thus, the thermal effects due to harmonic losses are reduced considerably since eddy and stray losses are reduced by two-thirds. (2% x 7 = 14% in lieu of 42%)

In addition, all windings for drives isolation transformers are insulated turn to turn, andseparated over and above the standard insulation and are anchored and tied down rigidly. The coils are wedged between core legs and coils and blocked on top and bottom to prevent any movement or shifting due to short circuit forces or faults, vertical and diagonal, caused by failures of SCRS.

The transformer core flux density also is reduced by 10% from the standard power and distribution designs to alleviate the heating effect caused by impressed voltage distortion on the windings which would cause higher flux density, over excitation, in addition to circulating third harmonic currents that will cause higher core loss and temperature rise.

MGM utilizes the mitered, low flux density, core design and laminates the core laminations one at a time to reduce core and excitation losses along with lowering sound levels. This core construction creates minute air gaps, not big enough to distort core construction and create higher losses or sound level, but enough to offset small amounts of DC component or minor line notching.

If the drives feed back a large DC component to the transformer due to lack of filtering, the transformer core will saturate. Therefore MGM must be informed of heavy notching or high DC current in order to design the core at a much lower flux density and or introduce an air gap to offset the DC component and prevent core saturation.

The core assembly is tightly clamped with structural steel angles or channels, depending on KVA rating to reduce losses and maintain lower sound levels. Then the entire core and coil assemblies are dried out to drive out any possible moisture, varnished with polyester resin and baked. This cycle may be repeated as required by the transformer, voltage class, BIL and environmental conditions.