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TEMPERATURE RISE

General

An isolation transformer's main purpose is to transfer electrical energy from the primary coil to the secondary coil (input to output). In doing this, the transformer converts some of the electrical energy into heat energy. Transformers develop heat in the same manner as lightbulbs. Lightbulbs have a certain amount of resistance and when a voltage is developed across the lightbulb some of the energy is converted into heat. Transformers also have a resistance and when the power supplied from the transformer is increased, the amount of energy converted to heat also increases. This is where efficiency, maximum temperature rise, and insulation system temperatures are important in regards to isolation transformers.

Efficiency

Equipment is desired to operate at a high efficiency. The efficiency of a transformer is determined by its output power and its losses. Fortunately, losses in transformers are relatively small. The losses in a transformer come from the coils, skin effect, and excitation of the core. The loss due to the coils is equal to the square of the current times the resistance of the conductor (I^2 x R). This value varies upon changes in the load. Skin effect is caused by high frequency currents traveling on the outer portion of the conductors (see Harmonics Application Note UK#12). As the harmonic content increases, the losses due to skin effect also increases. K-rated transformers are ideal in these applications. The core loss is typically constant from no load to full load. The actual losses depend on the type of steel used and the way it is manufactured. A high grade silicon steel assembled in an interwoven pattern produces low excitation losses. What these losses add up to is heat. A transformer with a low efficiency has more losses, generating more heat than a transformer with a high efficiency. This additional heat is dangerous. The lifetime of electrical devices decreases rapidly when the temperature limit is exceeded. To keep low efficient transformers cool manufacturers use fans, water cooling systems, and air conditioners. These cooling devices bring additional cost and maintenance.

Temperature Limits

Transformers are designed to a maximum temperature rise value. This value is usually 80° C, 115° C, or 150° C. These values are usually based on a maximum ambient temperature of 40° C, thus a transformer with a 115° C maximum temperature rise will not reach a temperature above 155° C (the total temperature is equal to the temperature rise plus the ambient temperature).

The insulation of the conductors also have a maximum temperature value. This value is usually 200° C or 220° C. This is the maximum temperature that the insulation can reach without degrading. Once this temperature is exceeded, the life expectancy of a transformer will be cut in half for every 10°C to a point where the insulation degrades, destroying the transformer and usually anything connected to it.

Transformers with a low efficiency emit a lot of heat and need cooling devices to get rid of the excess heat. These devices are costly and usually need constant maintenance. Also, if one of these cooling methods fail, the transformer runs the chance of being destroyed by the excess heat.

A desirable indoor dry type transformer is convection (self) cooled and has a maximum temperature rise of 115° C with an insulation temperature of 200° C. Beware of the 80° C rise transformers. They are often a 115° C rise transformer that has been de-rated, providing a costly approach.

Ultra-K

The *Ultra-K* manufactured by Controlled Power Company is a K-rated shielded isolation transformer, manufactured with high grade M-6 silicon steel and has a maximum temperature rise of 115° C with a 200° C insulation system. The *Ultra-K* doesn't require any fans for cooling because it is 98% efficient providing in excess of 200,000 hours MTBF. It is offered in K-factors of K-4, K-7, K-13, and K-20 to handle the heat generated by harmonics. The *Ultra-K* has double or triple shielding for optimal noise attenuation and comes with the option of a high frequency filter and TVSS for surge suppression.

Summary

Transformers with efficiencies less than 96% produce an excessive amount of heat and usually have an unsatisfactory temperature rise and insulation system. A respectable transformer is one which has a maximum temperature rise of 115° C and a 200° C insulation system that doesn't require fans or any other cooling device. Controlled Power Company manufactures the *Ultra-K* to exceed these specifications.

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