THE ULTIMATE TRANSFORMER

A PRESENTATION BASED ON THE DYNAPOWER CORPORATION ULTRACAST EPOXY CAST COIL TRANFORMER

HISTORY

The first electrical transformers, circa 1890, were dry-type units, limited in voltage rating by the insulating value of existing materials with their relatively low temperature ratings, and limited in power by both air as a cooling medium and the temperature rating of wire insulating. BIL ratings were quite low as well. The next step was a relatively simple one – put the transformer core-and-coil assembly in a medium with higher specific heat and greater insulating (dielectric) value than air – like mineral oil. This increased the BIL and permitted higher operating voltages, but did little for the temperature rating. As time went on, progress was made with "upgraded" insulation that permitted 65˚C rise operation, silicon steel for cores that resisted the "aging" or loss of permeability that required periodic re-coring of early designs, and new types of insulating materials. The earlier ratings of Class A equipment went to Class B as permissible temperatures increased. Finally, the flammability limitations of liquids appeared solved with the development of chlorinated liquids that had extremely high flash points. Up until 1972, thousands of liquid-filled transformers were manufactured with these liquids, for use inside buildings and outdoors where they were considered equally safe.

Meanwhile, with the development of films and aramid papers (such as Mylar for Class F and Nomex for Class H) in the 1960's, and higher temperature rated varnishes and wire film coatings, more applications were delegated to newer, more reliable dry-type transformer designs. The higher temperature rated insulation permitted greater efficiency from less materials, often in smaller, lighter weight, less expensive units. In addition, the elimination of liquids was desirable where environmental considerations or flammability posed greater problems than cost or size.

With the discovery of the adverse effects of chlorinated liquids or askarels, generally referred to as PCB's, dry-type technology began to make real inroads into existing indoor applications. Finally, this trend led to more work in developing a better dry-type transformer, one so reliable and fireproof that it could be installed into buildings as they were constructed. This required elimination of practically all known types of liquids, and greater efforts to use the advantages of dry-type units while eliminating or at least greatly reducing their shortcomings. Epoxy resins were new and promising.

The cast coil technology was developed in Europe in the 1950's and the overwhelming majority of these transformers are still in service. The early development in this country was in the 1960's and involved U.S. as well as European manufacturer's licenses. Here too, well of 90% of the units make are still in service. This premium transformer was slow to get general attention despite many advantages due largely to the premium price. Because it was cast in epoxy, the most chemically resistant of the coatings in general use, it had the greatest appeal in industries with hostile, sometimes corrosive, environments.

Early interest came from pulp and paper mills, petrochemical plants, and mining and refining facilities. The thorough application and penetration of epoxy by vacuum casting also made the coils impervious to moisture and resistant to salt – ideal characteristics for replacing other technologies in facilities close to waterways, ocean beaches, and in the myriad of water treatment plants then (and now again) springing up throughout the country.

Manufacturers of these “ultimate” transformers learned that better marketing in the form of educating users and consultants would accelerate the normal development of the increasing number of applications. Once informed of the availability of a transformer with long life, one that did not need expensive vaults indoors, that required almost no regularly scheduled maintenance, and that was at home outdoors as well as inside buildings and factories, owners encouraged specifiers to insist on cast coil transformers. Present day cast coil technology has combined with computer technology to permit “tailored” designing of units that meet dimensional restrictions (retrofits) are highly efficient (evaluated losses), and can have maximum efficiency at the normal operating level of the particular application and location. True cast coil transformers have coils that are cast in epoxy under vacuum, in a mold. There are other technologies claiming the advantages, even the name of cast coil, but which are not.

The relatively thick epoxy coatings and the strong adhesive nature of this material holds every turn of each coil against the crushing forces of power surges and short circuits, making it ideal for traction drive service and extremely low impedance designs. The use of fillers such as wollastonite were found to improve the properties of adhesion to the conductor, arc resistance, heat conductivity and produce a higher temperature rating. High voltage disc windings that utilize the “upset” winding technique permit discs to be brought closer together and appear as plates in a capacitor, with the epoxy that fills the spaces between them serving as dielectric. This capacitance serves to form a “snubber” circuit, effectively reducing the often destructive peak of voltage spikes due to lightning and switching surges. The smooth outer surfaces of the epoxy casting do not hold dust and other contamination, and permit cleaning as may be needed by use of ordinary compressed air, water and most detergents.

There is no doubt that the advantages of cast coil transformers far outweighed the initial cost, particularly in process industries where the cost of lost product and profit in a service interruption is many times the cost of the transformer. By offering BIL levels equal to those in liquid-filled units, and by eliminating over 90% of the causes of failure of ordinary dry-type transformers, the cast coil technology would reasonable be expected to produce transformers with greatly extended life expectancy, as a group and in individual applications. In fact, for hostile environments, they have a life expectancy far exceeding anything produced by previous technological advances. By eliminating liquids and given the relatively inert nature of the epoxy, and the fact that they are considered nonflammable and self-extinguishing, it would appear that cast coil units also hold the promise of long trouble-free association with their environment, and simple landfill disposal when their useful life is over.

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