An Innovative Design of Three Phase 315 KVA, 11/0.433KV Oil Immersed Distribution Transformer

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Abstract: A Three Phase Distribution Transformer is widely used in urban as well as rural area for power supply. It is also used in many industrial purposes to run many appliances. A three phase 315KVA, 11/0.433kV distribution transformer. Winding design and performance practice for power and distribution transformers has focused in the differences between rectangular core and coils and layer windings common in the production of distribution transformers [3].

I. INTRODUCTION

A three phase 315kVA, 11/0.433kV Distribution transformers which has per phase voltage 250V. The high side 11000V having U-phase, V-phase, W-phase. While low voltage side 433V there is four terminal i.e., N-phase, U-phase, V-phase, W-phase. Each terminal along with Neutral caries 250V. The increasing demand of electricity oil immersed 3- phase Transformer in an economic way the cost optimization of the transformers design by reducing the mass of active part has become vital importance.
Transformer design technique, designer had to rely on their experience and judgment to design the required transformer [1].
Several design procedure for low frequency transformers have been developed in past research. Mathematical design calculation using MS- excel in an attempt to eliminate time consuming calculations associated with reiterative design procedure.
The power scenario in India, as on March 31, 1988, the total installed capacity in India was 88,861MW. New power projects expected are over 2700MW. By 2010 AD, the expected requirement of power would be around 200,000 MW, which means there will be almost 100% more generation over the next 10/12 years.
With the addition of 100,000MW more power, we may expect enormous requirement of power and distribution transformers in India.
The transformer emits no-load and load losses. It is necessary to keep these losses at a minimum to reduce the line losses [2]. The configuration of connection for distribution transformer in India is usually ‘Delta’ in primary and ‘Star’ in secondary with a vector group Dyn-11. The huge numbers of distribution transformers are required for electrification of any country [6]. It is estimated that number of distribution transformer installed in electrical distribution Network is growing approximately 1.5% per annum [7]. Around 15% of investment in transmission System goes towards transformer [8].

Thermal design and operation considerations

Rectangular core and coil design are frequently used for distribution transformer design and offer advantages of reduction in direct labor and material when compared to circular core and coils with disc and helical winding usually wound with sheet conductors for the LV winding. The rectangular core design reduces the core window and result in a result in reduction of core losses compared to a circular winding design.

II. MATHEMATICAL CALCULATIONFOR TRANSFORMER

Description of basic details:
V/T, volts per turn or E_t
C_d, current density in winding (A/mm2)
CD, core diameter in mm.
LL, Load loss or copper loss
NLL, No-load loss or core loss
A/L, axial Length of coil.
R_l, Radial build of coil
g, Gap between LV/HV winding in mm.
E_t or V/T, Volt per turn.
Ag, cross-sectional area of core in centimeter.
B_m, Flux density in tesla.
F, frequency=50 Hz.
Stacking factor= 0.97

V/T	A CM	B_m T	NLL W	LL W	IR W
6.250	171.71	1.640	467	2532	2335

Impedance value Z% = 4.44
Density of copper, Cu= 8.9 g/cm^3
Density of core steel (iron) in 7.65g/cm^3
Resistivity of copper is 21*10^{-9} ohm-/mm^2
Grade of core is MOH 0.23

Rated Current AMP. Line Phase	LV	HV
	16.53----9.5	420.01
Resistance /PH At 75ºC	LV	HV
	4.6014	0.002035

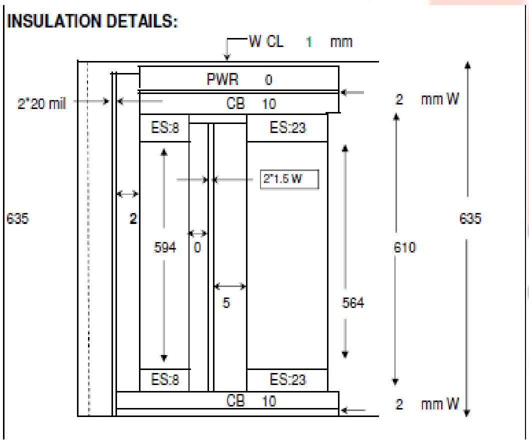
Core diameter, CD= 4.44 * f * B_m * A_g * 0.97 * 10^{-4}

Weight of complete set of core in kg
= (3* W/H * 4 * C/L) + (2 * Width of 1st step * 0.86) * gross are of core * density of core material * 0.97 * 10^{-3}

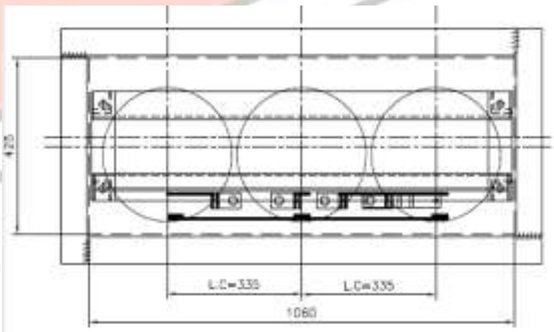
Weight of copper conductor,
=3 * 3.142* mean diameter of coil * turns * conductor area * density of copper * 10^{-6}

Size of copper conductor:
LV- 9.00*3.3/ 0.35PI Strip wire.
HV-3.00/0.30 PI Round wire

Total number of LV turn is 40. And total number of HV turn is 1848. Which has seven tapping position at different tap number in the winding of coils. And has no transposition in the winding. Temperature rise of oil is 45ºC and winding temperature rise 40ºC.



Geometry of core type transformer



LV/HV connection

TAPPING: OCTC

POSITION	% TAPPING	RATIO	HV VOLTS
1	5.00	47.18	11550
2	2.500	46.10	11275
3	0.000	45.00	11000
4	-2.500	43.90	10725
5	-5.000	42.80	10450
6	-7.500	41.70	10175
7	-10.000	40.62	9900

III. RESULT AND DISCUSSION

The 315KVA, 11/0.433KV Distribution Transformer works on guaranteed losses in Efficiency level-1

COST ESTIMATION:

CORE (KGS.)	COPPER (KGS.)	INSULATION (KGS.)	OIL (LTR.)	MS ITEM (KGS.)
469	505	32.3	415	900
161/kgs	415/kgs	125/kgs.	42.5/kgs	85/kgs
75509/=	209575/=	40375/=	17637/=	76500/=
TOTAL: = 4, 19,596.00 (Indian rupees) Not including labor charges, GST tax, and break down charges.				

IV. CONCLUSION

This paper proposed to design a 315kVA, 11/0.433kV, Delta/Star, Distribution Transformer with the guaranteed losses. Total loss of the 315kVA, 11000/433V transformer is about **2532**W at 100% Load. Resistance per phase at 75ºC on LV side 0.002035 ohms and on HV side 4.6014 ohms. And if we use FR3 oil which is made of grown soya beans and has fire point 360ºC and Environmental Friendly. Proven to increase the life of transformers paper insulation material by decades, increasing the transformer asset's life

V. FUTURE SCOPE

In the Design of 315kVA, 11/0.433kV Distribution Transformers we can minimize the losses by using a better quality of CRGO and copper(PICC) and increase the life of transformer by using a better quality of insulating oil i.e., Edible oil instead of mineral oil. Edible oil not only increase the life of Transformers but also environmental friendly.

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