INFLUENCE OF ASYMMETRY OF PRIMARY WINDIND ON LOAD OF CURRENT TRANSFORMER

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ABSTRACT

Asymmetry of winding can be introduced during technology process or may result from electro dynamical force in current transformer during short circuit conditionsmodel of current transformer with coaxial winding and rectangular core havehave been investigated . Impedance resistance and reactance of windings havebeen measured at symmetrical andasymmetrical position of primary winding.Electro dynamical force acting on primary winding at a given asymmetry have been investigated . Comparison of the result of calculations and measurements have been presented . Influence of asymmetry of primary winding on inductance of secondary winding and summary burden of current transformer have been estimated.

Keywords: current transformer,coaxial winding,symmetrical andasymmetrical

1- Introduction

Instrument transformer are important source of information about energetic system condition. They must fulfill the requirements of exact transformation of voltage and currents and be resistant to hazards in energic systems. Exact transformation of current-by-current transformation depends, amongst others, on impedance of secondary winding and impedance connected to the secondary terminals. Reactance of secondary winding of current transformer can change under influence of displacement of primary winding. Caused by electro dynamical force. Primary small axial asymmetry can rise during repeated short circuit currents. Reactance of secondary winding, summary load and electro dynamical forcesrise. Analysis of load of current transformers and electrodynamicalforces, caused by asymmetryof windings,can beuseful for designer and user of current transformers.

2- Method of Investigation

The models of current transformers with rectangular core and coaxial cylindrical windings were investigated. The laboratory balance was used . The secondary winding war fixed inasymmetrical position in the window of the core, the primary winding war movable. The current and voltage drops on the winding were measured the symmetrical and asymmetricalposition of the primary movable coil. The electromagnetic axial force acting of primary winding in asymmetrical position weremeasured. The results of measured and calculated force have been compared, thereactance of the coils were estimated. The mechanical force between coaxial winding was

$$F_{\Sigma.} = 0.5I_1^2\frac{\Delta L_1}{dS} + I_1 I_2\frac{\Delta M}{dS} + 0.5I_2^2\frac{\Delta L_2}{dS} \quad (1)$$

The position and self-impedanceof secondary coil was constant and rise of inductance of that coil was caused by changesofmutual impedanceof coil, therefore:

$$F_{\Sigma.} = 0.5I_1^2\frac{\Delta L_1}{dS} + I_1^2\frac{\Delta M}{dS} \quad (2)$$

$$\Delta L_2 = \Delta M \quad (3)$$

And mechanical force actingon primary winding due change ofself-inductance of that coil was:

$$F_1 = F_2 - I^2\frac{\Delta M}{dS} \quad (4)$$

Where

$F_{\Sigma.}$ Summary mechanical force in N

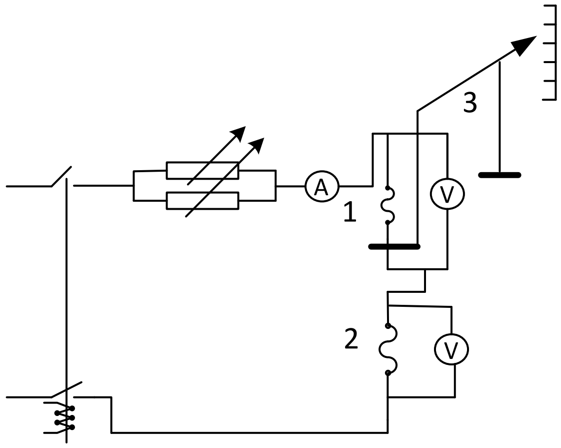
F_1 Mechanical force of primary winding due to change of self-inductance in N

L_1, L_2 Inductance of primary and secondary windings I VS / A

dS Displacement of primary coil in m

I Current A

3-The Measuring Circuit



1. The movable primarycoil
2.The fixed secondary coil
3.The laboratory balance

Fig.1 The measuring circuit

The measuring accuracy depends on balance sensitivity $\frac{\Delta F}{F}$ error of displacement of primary coil $\frac{dS}{S}$error of measurement of current $\frac{\Delta I}{I}$ and error of voltage measurement $\frac{\Delta V}{V}$ .The errors were respectively
0.5 %, 2.0 %, 5% and the total systematic error in extreme case can be $<$ 5 %

4-The Tested Objects

Data of tested models of current transformers are presented in the table 1 the tested

Object is shown on fig. 2

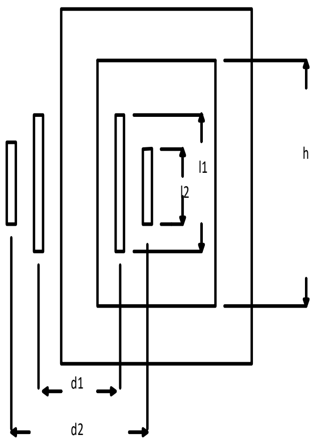


Fig.2 The tested model of current transformer

l_1, d_1-length and mean diameter of primary coil

l_2, d2- length and mean diameter of secondary coil

h -height of the core window

Table 1 The models parameters

Model	Diameter of Primary coil		Diameter of secondary coil		Height of Core window	$\frac{L_1}{L_2}$
	cm		cm		cm	
	l_1	d_1	l_2	d2	h	
1	4.6	16	21.2	8.8	24.6	4.6
2	4.6	16	16.0	9	17.9	3.48
3	4.6	16	9	9.2	12.0	2.0

Transformation ratio of models was 5A/5A. Equal number of primary and secondary turns

190 , 950 ampere-turns

5-The Results of Measurements

The results of measurements are presented in table 2 and in fig.4

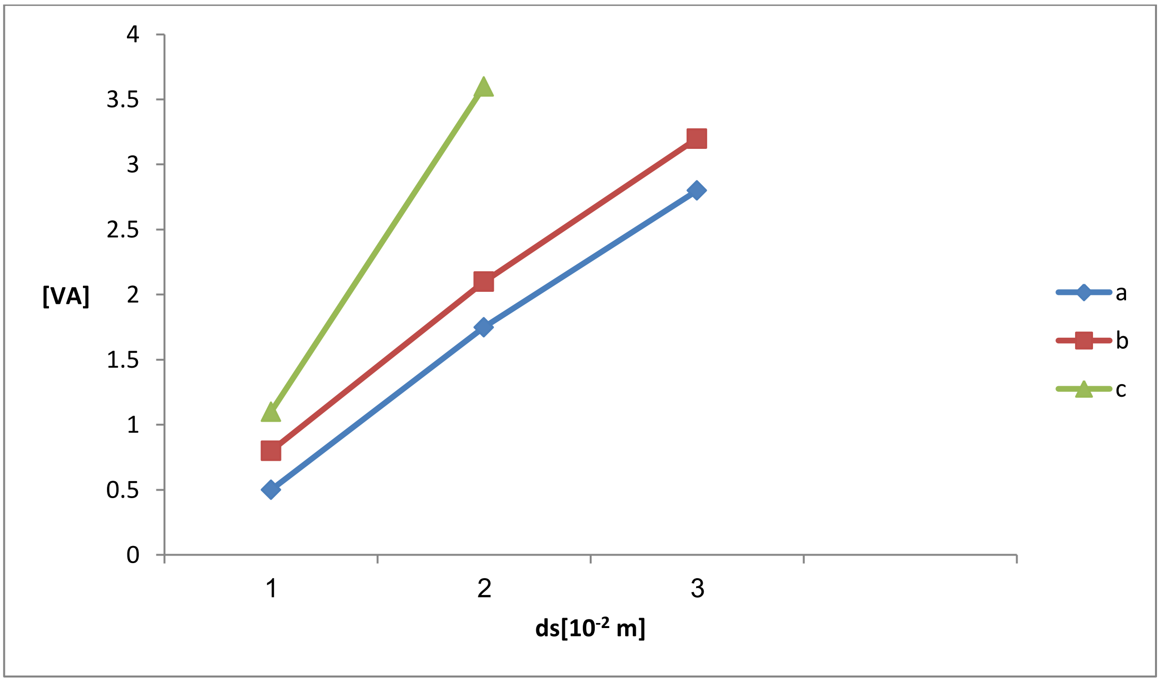


Fig. 3 rise of load of CT versus asymmetry of winding a-model 1,b-model 2, c-model 3

Table 2 MeasurementsResults

No	Mod	I A	*d* s cm	X_1 Ω	l_1 m H	dl_1 m H	L_2 m H	dl_2 m H	X_2 Ω	ΔX_2 Ω	Load VA	F_{mesr} N	F_{calc} N	F N
1	1	10	0	1.55	4.94	-	408	-	.128	-	-	-	-	-
2	1	20	1	1.57	5.01	0.07	.470	0.062	.148	.02	. 5	2.45	2.56	1200
3	1	20	2	1.64	5.23	0.29	.632	0.024	.198	.07	1.75	4.91	5.14	3000
4	1	20	2.5	1.68	4.35	0.41	.160	0.35	.24	.01	2.8	6.19	6.13	4800
5	2	20	0	1.328	4.28	-	.945	-	.297	-	-	-	-	-
6	2	20	1	1.368	4.34	0.11	1.022	0.077	.321	.024	.8	3.43	3.6	2300
7	2	20	2	1.454	4.63	0.4	1.213	0.288	.381	.081	2.1	6.86	6.68	4200
8	2	20	2.5	1.55	4.93	0.7	1.231	0.365	.410	.113	3.2	8.58	8.52	6200
9	3	10	0	1.07	3.41	-	1.44	-	.452	-	-	-	-	3800
10	3	20	1	1.12	3.56	0.15	1.58	0.14	.495	.037	1.1	5.88	5.92	7000
11	3	20	2	1.28	4.01	0.66	1.95	0.51	.612	.154	3.6	11.76	11.7	1800

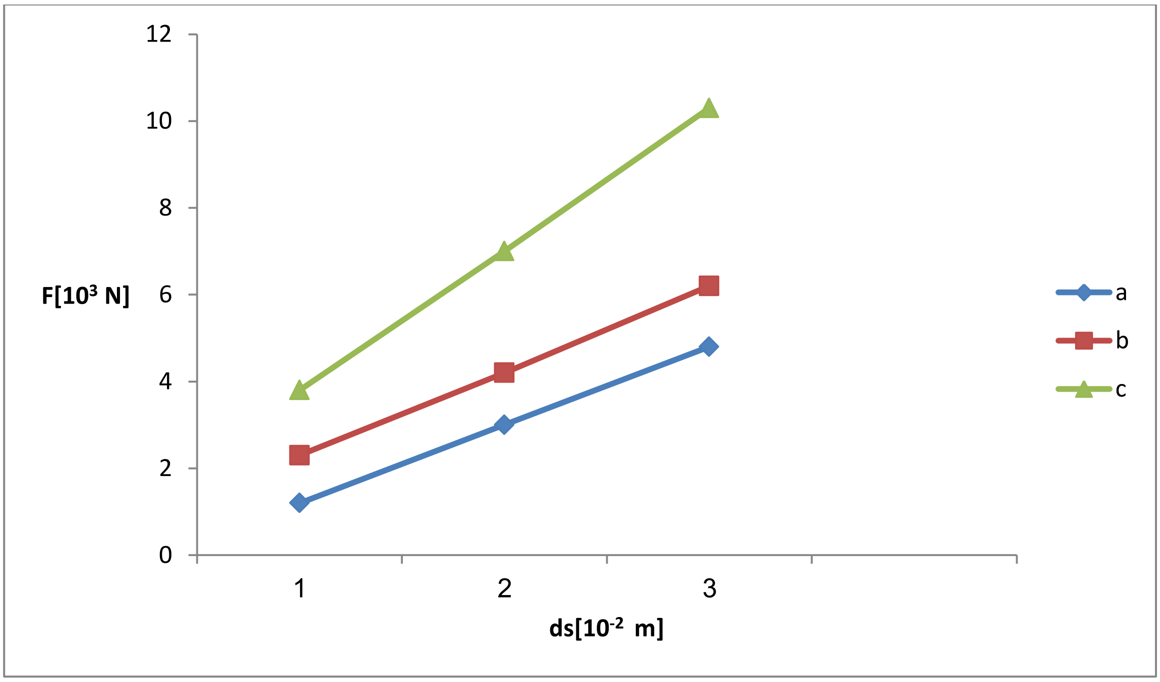


Fig.4 electro dynamical force F on primary winding at 100*I_{n} versus asymmetry of windingds

4. Conclusion

1. A symmetry of primary windy in current transformers caused rise of summary load of load transformer
2. The rise of summary load of current transformer depends on changes of mutual inductance between coils fig.3
3. The greater inductance of secondary winding, and greater mutual inductance, the greater changes of load of current transformer at asymmetry of primary winding. The mechanical axial force in current transformer can be dangerous in a short circuit conditions , fig.4

5.References

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