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EXTENDED RANGE CURRENT TRANSFORMER

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ABSTRACT The current grade of current transformer manufacturers are not produced high accuracy and extended range of current Transformer. These special current transformers ratio error are always stable ± 0.15 when the primary current changes between 1% and %200. Commonly uses current transformer classes are 0.3 for IEEE standards (1) and 0,2s & 0,5s for IEC standards (2-3). These standards do not guarantee that the current ratio error rate remains at the same value as the primary current changes between 1 % and % 120. Experimental and analytical studies have been carried out on methods in which amper winding , silicon steel and nanocrystalline steel cross section in order to reduce the cost, produce the same quality product in a shorter time with precise and continuous measurement.

KEYWORDS : current transformer, instrument transformer, extended range transformer

INTRODUCTION

All equipment used in the smart grid system; measurement of numerical data of extended range current transformers (ERCTs) of error class is in more accurate and precise results with the contributions to consumers, producers and network. The transformers produced with the sensitive error class used in the electricity distribution system and its transmission affect the sensivity of the line and measurement quality of the system and thus more efficient control of the energy. Instrument current transformer plays the important role a current in its secondary winding proportional to alternating current flowing in its primary. This kind of transformers are commonly used in metering and protective relaying in power plants and substations where ERCTs facilitate the safe measurement of large currents, generally use in presence of the high voltage. These standard accuracy classes (0,2s & 0,5s) are used in the market to meet the standards of silicon steel, in order to meet 0,15 class value, silicon steel alone are not sufficient for designing ERCTs. Producer need to use a special nanocrystalline material to obtain 0,15 accuracy class values. All of the current transformer manufacturers in world can not be done nano materials in their own production facilities, it comes from abroad to order in the desired size with very long periods of time. It is aimed to supply the materials to the national market by annealing the nano material and winding in the desired dimensions (4-5).

Using the nanocrystalline steel, we have obtained stable results when the primary current changes between 1 % and % 200. In this project,we compared 0,2 and 0.15 class current transformers current errors and phase displacement results.

CURRENT TRANSFORMER STRUCTURE

Current transformers are low - power transformers whose primary windings are in the main circuit and whose secondary windings are relays or controllers. They isolate the instrument and protection practically short circuited through the connected instruments, meters, circuit from the primary side and protect the devices against overload according to the transformers. Current transformers can have several secondary windings with cores of identical or different characteristics completely isolated, magnetically, from each other. Therefore for example, they can be fitted with two instrument cores of different accuracy classes or with instrument and protection cores having different overcurrent factors(6).

Current Error

The error which a transformer introduces into the measurement of a current and which arises from the fact that the actual transformation ratio is not equal to be rated transformation ratio.

The current error expressed in percent is given by the formula :

$$\varepsilon = \frac{K \times Is - Ip}{Ip} \times 100\%$$

ε = % current error

K = the rated transformation ratio
Ip =the actual primary current
Is = the actual secondary current (when Ip is flowing under the conditions of measurement)

Phase Displacement *(Δφ)*

In an ideal transformer , the positive direction of the primary and secondary currents is the phase difference between the primary and secondary currents when the difference is selected to be zero. If the secondary current is in front of the primary current, this angle is expressed as positive. Angle error is defined as centi-radians or minutes.

TABLE – 1
RATIO ERROR&PHASE DISPLACEMENT

Accuracy class	Ratio error ± %					Phase displacement									
						±Minutes					± Centiradians				
	at current (% of rated)					at current (% of rated)					at current (% of rated)				
	1	5	20	100	120	1	5	20	100	120	1	5	20	100	120
0,2 S	0,75	0,35	0,2	0,2	0,2	30	15	10	10	10	0,9	0,45	0,3	0,3	0,3
0,5 S	1,5	0,75	0,5	0,5	0,5	90	45	30	30	30	2,7	1,35	0,9	0,9	0,9
0,1		0,4	0,2	0,1	0,1		15	8	5	5		0,45	0,24	0,15	0,15
0,2		0,75	0,35	0,2	0,2		30	15	10	10		0,9	0,45	0,3	0,3
0,5		1,5	0,75	0,5	0,5		90	45	30	30		2,7	1,35	0,9	0,9
1		3,0	1,5	1,0	1,0		180	90	60	60		5,4	2,7	1,8	1,8

CURRENT TRANSFORMER MAGNETISATION MATERIAL COMPARISON

The current transformers structures usually consist of magnetic material which is silicon-iron alloy. However it is used other magnetic materials for reducing electrical losses(mW/kg). These materials are amorphous materials and nanocrystalline alloys whose permeability is very high. These nanocrystalline materials are much more expensive than silicon-iron magnetic steel but measuring current transformers performance is much more precise and stable measurement (7). The components of these two materials are different from each other and different from the annealing methods and curie temperature results values was investigated with using Omicron CT Analyzer in Figure.1

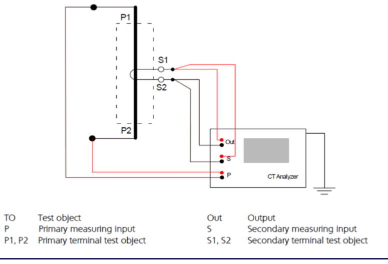

Figure 1: Omicron electronic CT Analyzer Connection Diagram

COMPARATIVE ANALYSIS

In the present study, effect of nanocrystalline steel and silicon iron material with same amper winding on the current transformers current error and phase displacement was investigated with using Omicron CT Analyzer. We tested first three samples 1-3 with the percentages of nano material were 20 % by rate of total using magnetic materials. The other three samples 4-6 tested using only silicon iron material. Tests were performed for constant burden which is 15 volt-amper. We measured the current ratio error in $\pm$0.15 % at between 1 % and 200 % of rated current and phase displacement in (min) at 1 % and 200 % rated current.

TABLE – 2
SAMPLES RATIO ERROR

		Current ratio error in % at % of rated current							
Sample	VA/cosPhi	1	5	10	20	50	100	120	200
1	15 VA	0.078	0.072	0.076	0.091	0.108	0.118	0.120	0.111
2	15 VA	0.033	0.034	0.056	0.079	0.101	0.110	0.112	0.099
3	15 VA	-0.040	-0.012	0.032	0.073	0.115	0.125	0.129	0.066
4	15 VA	0.036	0.051	0.059	0.077	0.094	0.058	0.039	-0.240
5	15 VA	-0.303	-0.232	-0.178	-0.135	-0.098	-0.109	-0.111	-0.224
6	15 VA	-0.200	-0.106	-0.049	0.007	0.038	-0.016	-0.044	-0.108

TABLE – 3
SAMPLES PHASE DISPLACEMENT

		Phase displacement in [min] at % rated current							
Sample	VA/cosPhi	1	5	10	20	50	100	120	200
1	15 VA	6.430	4.071	2.617	1.599	0.719	0.567	0.583	1.519
2	15 VA	8.729	3.695	2.144	1.322	0.666	0.681	0.755	1.881
3	15 VA	15.839	6.299	3.636	2.106	1.222	1.995	2.494	5.191
4	15 VA	7.24	4.80	3.27	1.77	0.87	2.70	4.08	4.48
5	15 VA	12.67	3.81	1.95	0.97	0.62	2.01	2.88	4.33
6	15 VA	15.67	4.98	2.17	0.62	1.19	3.70	4.98	3.63

CONCLUSIONS

After all the review, this paper comes to the conclusion that if these two materials combined then the efficiency of the energy measurement of the current transformers can be improved. This kind of extended range of current transformers deliver savings through improved accuracy metering and reduced inventory. The advantages of this transformers are reduce stock quantity, total cost and increase revenue, improved accuracy across a wide current range. In today's conditions, energy protection has a very important role with sensitive measurement devices.

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