REFERENCE POTENTIAL TRANSFORMER IN CASCADE ARRANGEMENT FOR FIELD APPLICATION

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Abstract: We have developed a series of high stable and accurate potential transformer with cascade arrangement to reduce the size and weight for the on-site calibration and field application. The maximum rated voltages of the PTs were 22 kV, 66 kV and 132 kV with rated burden of 5 VA. The long term stabilities of ratio error of the PTs were less than 0.0033 %, and ratio errors were (- 0.0022 ~ + 0.0442) %. The phase angle errors were less than about - 3 min and the maximum long term drifts were 0.077 min.

Key words: cascade arrangement, PT comparator, on-site calibration, potential transformer, ratio error and phase angle error

1. INTRODUCTION

Potential transformers (PT) are generally used for high voltage measurement application with high accuracy. The primary winding of the PT is connected between high voltage lines, and the secondary winding usually designed so that in normal operation a voltage between 100 V and 120 V is delivered to the instrument load. The primary voltage is can be calculated by the multiplication of the secondary voltage and the transformation (nominal) ratio of the PT. The nominal ratio is the ratio of the rated primary to the rated secondary voltage which can measure accurately.

PT comparator system is essentially used to evaluate the ratio error and phase angle error of the PT under test in power industry. The most widely used method for the calibrating PT by using PT comparator is comparative null method with the reference PT [1]. We have about 20 PT manufacturers in Korea. The PT comparator system of the industries is inconvenient to move to the calibration site for the periodic calibration because they are heavy and large with complicated long wiring.

We have developed a series of high stable and accurate PT with cascade arrangement to reduce the size and weight for the on-site application. They can be used as portable reference PT in the comparator system at voltage range of 11 kV to 132 kV with three PTs.

2. DESIGN OF THE CASCADE PT

The 22 kV PT has 3 ranges of 11 kV, 13.2 kV and 22 kV with a single core in conventional winding as shown in Fig. 1.

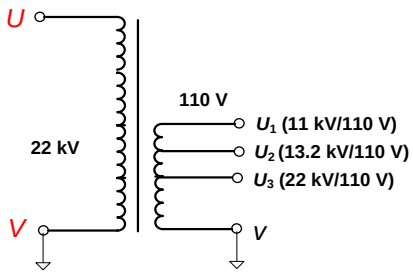

Fig.1. Basic circuit of the 22 kV PT

The 132 kV PT has 2 ranges of 110 kV and 132 kV with cascade arrangement of two 66 kV transformers as shown in Fig. 2. In the cascade arrangement of Fig. 2, the voltage is divided between two transformers so that each takes half of the total. In this way each unit requires insulation corresponding to the lower voltage, with a consequent over-all economy of space and material.

The 66 kV PT has 3 ranges of 33 kV, 55 kV and 66 kV with cascade arrangement of two 33 kV transformers similar to the 132 kV PT.

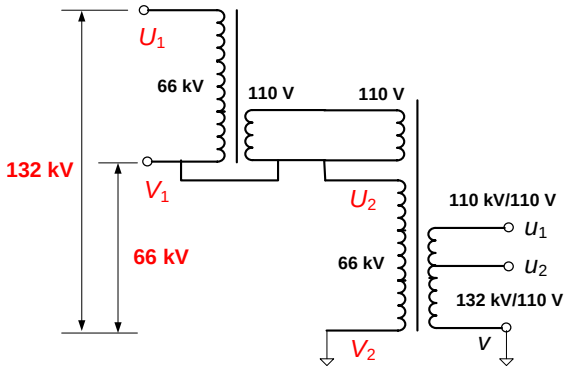

Fig.2. Basic circuit of the 132 kV PT

The resistance of the winding coil, core loss and leakage impedance should be optimizing to reduce the ratio error and phase angle error in the design and manufacturing process. Actual ratio of the PT exceeds the turn ratio by the voltage drop in resulting from the exciting current in the resistance and leakage reactance of the primary winding.

Ratio adjustment performed by removing an equivalent percentage of primary turns. The nominal ratios are 200, 600, 1200 of the 22kV-66 kV-132 kV PT respectively, but the practical winding turn ratios of the three PTs are reduced 0.07 % or 0.08 % from the nominal ratios to compensate of core loss, winding resistance and leakage impedance.

Fig.3. Photos of the 22 kV-66 kV-132 PT

Fig.3 shows the photograph of the three PTs. Air-insulation and mineral-oil-insulation were adopted for 22 kV PT and 66 kV/132 kV PTs respectively. Dual sealing of the oil was used between FRP case and base plate of the PT.

3. PERFORMANCE EVALUATION OF THE PTs

KRISS has been used the PT comparator system with ratio error uncertainty of 0.0050 % and resolution of 0.0001 % up to 240 kV to evaluate/calibrate the ratio & phase angle errors of the PT [2]. The performance of the three PTs were tested at (30 ~ 110) % of the nominal secondary voltage. The long term stabilities of ratio error of the three PTs were less than 0.0033 %, and ratio errors were (-0.0022 ~ +0.0442) %. The phase angle displacements were less than about - 3 min and the maximum long term drifts were 0.077 min. Fig.3 & Fig. 4 show the sample graphs of the ratio error & phase angle error of the 66 kV PT during 13 month.

The performances of the PTs are sufficient as reference PT in the PT comparator system because the ratio errors are less than one to fifth of the commercial 0.2 class PT which is used in the industrial laboratory as their standard PT.

The developed PTs will be applied as a portable reference standard for the on-site calibration of the industrial system. The detailed design and performance evaluation results will be presented in the conference.

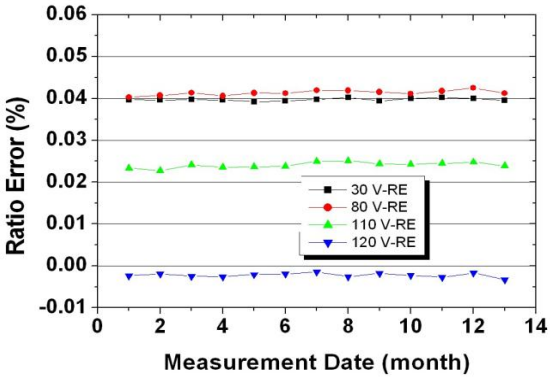

Fig.4. Ratio Error of the 66 kV PT

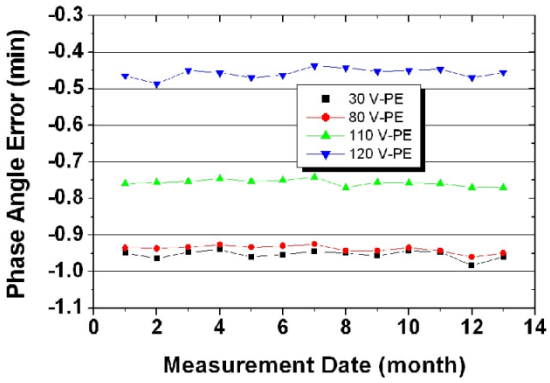

Fig.5. Phase Error of the 66 kV PT

4. CONCLUSION

We have developed a series of high stable and accurate potential transformer (PT) with cascade arrangement to reduce the size and weight for the on-site calibration and field application. The long term stabilities of ratio error of the PTs were less than 0.0033 %, and ratio errors were (-0.0022 ~ + 0.0442) %. The phase angle errors were less than about - 3 min and the maximum long term drifts were 0.077 min. The performances of the PTs are sufficient for on-site and field application in the industrial laboratory.

REFERENCES

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