POWER TRANSFORMER AND ON LOAD TAP CHANGER

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Abstract

On-load tap changing transformers play important roles in any modern power system since they allow voltages to be maintained at desired levels despite load changes. Traditionally, on-load tap changer is a complex mechanical device, which has some deficiencies. On-load tap changer of a transformer is presented, which can eliminate excessive conduction losses and suppress the arcing in the diverter switch, which is inherent in traditional on-load transformer tap changers. The OLTC provides uninterrupted voltage is regulation of transformers under load. The transformer is equipped with a tapped winding whose tapping's are connected with the tap selector of the OLTC. Most of the current commercially available automatic voltage regulators, just measure the low voltage side of the power transformer in order to control OLTC position. In this to improve tap-changer control in order to perform properly also during a stressed situation in the 230/33 kV regulating power transformer for the substation.

Keywords: *load changes, tap changer, diverter switch, voltage regulation, power transformer for substation*

1. Introduction

A tap changer is a mechanism in transformers which allows for variable turn ratios to be selected in discrete steps. Transformers with this mechanism obtain this variable turn ratio by connecting to a number of access points known as taps on primary or secondary winding. These systems usually posses 33 taps (one at the Centre "Rated tap and sixteen to increase and decrease the turn ratio) and allow for ±8% variation (each step proving 1.65% variation) from the nominal transformer rating which, in turn, along for stepped voltage regulation of the output.

Tap changers are often placed on the high voltage (low current) transformer winding for easy access and to minimize the current load during operation. ON-Load Tap Change: Most of the Generating Station, Substation system having Power Transformer with On-Load Tap Changer (OLTC).

Not only in Generating Station Transformer but also in Distribution Class Transformer too. In this substation, there are three windings; such as primary winding, secondary winding and tertiary winding. Among them, we will neglect the tertiary winding which is used for residential houses.

Power transformer

Power transformer is an electric device which is used to step up or step down the voltage level of the supply fed to its primary winding. The stepping up or down depends upon the number of turns of primary and secondary winding. If the number of turns on both the windings is same, and the losses of transformer are negligible, we may Conclude that the voltage across each of the winding is same. In this case the transformer is just utilized in isolating two electrical circuits. Generally power transformer is used in stepping up the voltage of the supply in order to decrease the transmission losses and then stepping.These are mainly used in distribution side to interface step up and stepdown voltages. The life span of these type of transformers is around 30years.Based on ranges, the power transformers are classified into three types.

Small power transformers (500-7500KVA), Medium power transformers (100MVA) and Large power transformers (100MVA and beyond). These transformers transform the voltage and depend on the principal of faradays laws of induction. It holds a low voltage, high current circuit at one side of the transformer and on the other side of the transformer it holds the high voltage low current circuit.

Power transformer design

The skeleton of the power transformer is designed with metal which is laminated by sheets. It is fixed into either a core type or shell type. The skeletons of the transformer are wound and connected using conductors to make three 1-phase or one 3-phase transformer. Three 1-phase transformers requires each bank isolated from the additional and thus offer continuity of service when one bank flops. A single 3-phase transformer, whether the shell or core type, will not function even with one bank out of service.The 3-phase transformer is inexpensive to make and it has a smaller footprint, and functions comparatively with higher efficiency.

Fig. 1 power transformer

Power transformer specification

Power transformers can be designed as either a single phase or a three-phase configuration. There are numerous important specifications to identify when searching for power transformers. The specifications of power transformer include a maximum power rating, maximum secondary current rating, maximum voltage rating and o/p type. Power transformer specifications mainly include

➢ Phase is 3Ø

➢ Frequency if 60Hz,50Hz

➢ Primary Voltage is 22.9 kV

➢ Secondary Voltage is 6.6/3.3 kV

➢ Tap Voltage 23.9-R22.9-21.9-20.9-19.9kV ➢ Vector Dd0, Dyn11, etc.

S.NO	NAME PLATE	RANGE
1	MAKE	CROMPTON CREAVES
2	MVA	100
3	CONNECTION SYMBOL	YNaod11
4	FREQUENCY	50HZ
5	Kv (NO LOAD)	HV 220, IV 132, LV 11
6	AMPERES	HV 262.4, IV 437.4, LV UNLOADED
7	PHASES	HV 3, IV 3, LV 3
8	TYPE OF COOLING	ONAN/OFAF ONAN RATING : 50% OFAF RATING : 100%
9	KVP	BIL HV LINE-900KVP NEUTRAL-35KVP IV-550KVP
10	OIL QUANTITIES : TRANSFORMER(TOTAL) COOLING PLANT OLTC(3-POLES)	 33830Lt 29.60Ton 3430Lt 3.00Ton 510Lt 0.45Ton
11	WEIGHTS: CORE AND WINDINGS (UNTANKING) COMPLETE TRANSFORMER INCLUDING OIL COOLING PLANT INCLUDING OIL OLTC WITH OIL(FOR EACH POLE) TRANSPORT WITH OIL (HEAVIEST PACKAGE) TRANSPORT WITH OUT OIL (HEAVIEST PACKAGE)	 39.80 Ton 99.20 Ton 10.50 Ton 0.39 Ton 84.60 Ton 59.30 Ton
12	RATING/DIAGRAM DRG NO	T6B1018H/T62B1019H
13	MAKER 'S SERIAL NO	24444
14	YEAR OF MANUFACTURE	1983
15	CUSTOMER 'S REF	CPT 211/APT 74/80/34 67/82/ CRM GRVS-8, Dt :17.0.1982

Fig.2 power transformer specification

0n load tap changer

The development of large power supply system with more convenient power control calls for an ever-growing introduction of methods of on load tap changing. In a simplified from this scheme require regulating winding in power transformers, the tapping of which are changed over under load by mean of on load tap changer.
In certain situation, it is necessary to provide both OFTC and OLTC. Example, to change the terminal voltage from 33 to 11 or 66 to 33KV, it is necessary to change the terminal voltage by OFTC 's and for voltage regulation of +5 to -15% (in the ranges of 1.25,1,1.5%) the OLTC's are used.

Basic operation condition of OLTC

 ISSN: 2278-4632
Vol-10 Issue-5 No. 3 May 2020

1.The load current in the transformer winding must not be interrupted during a tap changer.
2.The tap change must be carried out without short circuiting a tapped section of the winding.

Design consideration of tapping winding

1.The tap changer of transformer has to be capable of meeting the rating conditions of transformer (normal,peak-rating, over loading)
2.The maximum system voltage on which the transformer has to work.
3.Step voltage and the number of steps.
4.The maximum RMS test voltage to earth and across the tapping range.
5.The maximum surge voltage to earth and across the tapping range.
6.The maximum power frequency and surge test voltage between phase where applicable.
7.Current rating both for normal full load and peak rating condition

Design of on load tap changer

Apart from tap selection, the most important task of an OLTC is the break function or current (load) transferring action (see fig. 2). After transferring the current, the contact which "breaks" must be capable of withstanding the recovery voltage. The required switching capacity (the product of switched current and recovery voltage) for a specific contact in an OLTC is based on the relevant step voltage and current but is also determined by the design and circuit of the OLTC. The switching capacity itself is primarily a function of the contact design, contacts peed and arc-quenching agent. Historically, most power transformers use mineral oil as a cooling and insulation medium. The development of OLTCs toward the present "state of the art" designs also focused on transformer oil. Apart from the insulation properties of the transformer oil, the arc quenching behavior of the switching contacts determined the design and size of "oil-type" OLTC 'S.

Various approaches with solid state technology, such as static OLTCs and hybrid OLTCs as resistor or commutating types, have been discussed since the 1980s, but only a few applications have been implemented. The first application of vacuum interrupters in reactor-type OLTCs in the USA, which started at the same time, was more successful. The size of the vacuum interrupters at this time, particularly for the range of high currents, was not a limiting factor because of the compartment-type design, but not so for the in tank resistor-type OLTCs.

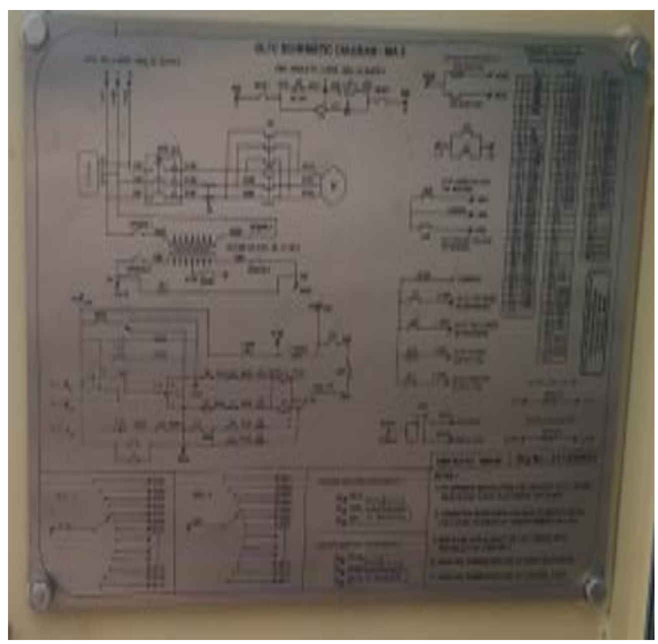

Fig.3.oltc schematicdiagram

Fig.4.design of on load tap change

Looking at the overall profile of

● Reliability ● Economy ● OLTC lifespan ● Range of ratings At the present time and in the foreseeable future, vacuum switching technology in OLTCs provides the best solution for today's expectations. All new OLTC designs (resistor and reactor-type) of the machine fabrication are based on vacuum switching technology.

OLTC Position Number	**High voltage across 1U1 1V1 1W1**		**Intermediate voltage**			**Low voltage Volts**	**Impedence volts at 75°C on 100MVA baseHV/IV**
			Each phase	**Across2U1 2V1 2W1**			
	Volts	Amps	OLTCconnector	Volts	Amps		
1			2.1-3	165000	349.9		5.28%
2			2.1-4	161700	357		
3			2.1-5	158400	364.5		
4			2.1-6	155100	372.2		
5			2.1-7	151800	380.3		
6			2.1-8	149820	385.4		
7			2.1-9	147840	390.5		
8			2.1-10	145860	395.8		
9			2.1-11	143880	401.3		
1 0			2.1-12	141900	406.9		
1			2.1-13	139920	412.6		

ISSN: 2278-4632
Vol-10 Issue-5 No. 3 May 2020

1							
12			2.1-14	137940	418.6		
13			2.1-15	135960	424.6		
14			2.1-16	133980	430.9		
15	220000	262.4	2.1-17	132000	437.4	11000	9.69%
16			2.1-18	130020	444	Unloaded	
17			2.1-19	128040	450.9		
18			2.1-20	126080	458		
19			2.1-21	125080	462		

Table.1.OLTC Positions for 230kV Side of 100MVA Power Transformer

Conclusion

For the time being, no alternative to regulating transformers is expected. The tap-changer will therefore continue to play an essential part in the optimum operation of electrical networks and industrial processes in the foreseeable future. Conventional tap-changer technology has reached a very high level and is capable of meeting most requirements of transformer manufacturers. This applies to all the voltage and power fields of today, which will probably remain unchanged in the foreseeable future. It is very unlikelythat, as aresult of newimpulses to development, greater power and higher voltages will be required. Today, the main concern focuses on service behavior as well as the reliability of tap-changers and how to retain this reliability at a consistently high level during the regulating transformer's life cycle.

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