

An Analytical Research For Power Quality Improvement With On-Load Tap Changer Distribution Transformer For Automatic Voltage Regulation

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Abstract- The principle reason for existing of the programmed voltage controller (AVR) to control transformers for on-load-tap-changer (OLTC) will be will keep those voltage for low voltage (LV) side for control transformer inside a preset deadband. Initially AVR might have been outlined should adjust to those voltage drop over power transformer impedance brought on stream of the load current. Subsequently an AVR should respond a transform position about OLTC done understanding for lv side load varieties. However, the AVR will too respond around abnormal voltage varieties on the high voltage (HV) side of the energy transformer. Here and there such AVR conduct is not alluring on it only further expands those downright load on the HV framework (i. E. Transmission system). Especially, such conduct ought be kept Throughout basic operation states of the transmission system, for example, such that An moderate energy framework voltage breakdown. Utilizing transformers Furthermore tap changers to view how those voltage meets expectations Previously, an electric framework Furthermore examine those associations with other viewpoints of the system's performance, in control misfortunes or tap changer operation. The principle reason for existing of the (AVR) for force transformers with on-load tap- changer (OLTC) may be should stay with the voltage ahead low voltage side about control transformer inside An preset dead band.

Keywords- Control Transformer, On-load tap Changer, AVR, low Voltage Variation, transform Positions, OLTC control.

I. BACKGROUND

When the load Previously, a force organize is expanded the voltage will diminishing Also vice-versa. Will maintain the system voltage In An steady level, force transformers would Typically provided with an onload tap changer (OLTC). Those OLTC alters the force transformer turns proportion in An amount of predefined steps in that best

approach transforms the auxiliary side voltage. Every step as a rule speaks to a change for lv side no-load voltage for give or take 0.5-1.7%. Standard tap changers offer between ± 9 will ± 17 steps (i. E. 19 will 35 positions). The programmed voltage controller (AVR) is outlined should control a force transformer with a engine driven on-load tap-changer. Regularly those AVR manages voltage toward those optional side of the power transformer.

Those control technique is In view of An orderly guideline which implies that a control pulse, person toward a time, will make issued of the on-load tap-changer component should move it up alternately down by one position. The pulse is created those AVR At whatever point the measured voltage, for An provided for time, deviates from the set reference quality Toward more than the preset deadband (i. E. Degree from claiming insensitivity). Time delay is used to stay away from unnecessary operation Throughout short voltage deviations starting with those pre-set worth. When those load clinched alongside An energy organize progressions it therefore influences voltage profile In load limit. With uphold the load voltage inside admissibility limits, energy transformers are provided with tap evolving framework. Those tap changer alters transformer turns proportion over An number of predefined steps which outcomes transform clinched alongside optional side voltage (Load end). Looking into load tap evolving force transformers need aid a fundamental piece from claiming whatever advanced control framework ,since they permit voltages with be administered during fancied levels in spite of load progressions. The issue for traditional tap changer will be its mechanical structure for muddled rigging instruments for selectors, diverters Furthermore switches. The on-load tap changer (OLTC) need An noteworthy impact looking into voltage soundness.

Voltage Strength may be the capacity of a force framework should keep up unflinching satisfactory voltages in the least Busses in the framework under ordinary states than

afterward being subjected on An disturbance, expand done load demand, or change in framework state reasons An progressive wild decrease clinched alongside voltage. The fundamental Components creating precariousness need aid the powerlessness of the control framework on meet interest to sensitive force. An expansive amount from claiming conveyance frameworks need run into issues for example, poor voltage regulation, poor energy factor, secondary misfortunes and poor efficiency, overloading Furthermore unwavering quality to coherence about supply.

Those principle capacity of the AVR (automatic voltage regulation) framework may be to guarantee those security Furthermore soundness operation of the energy system, guarantee that those voltage Also energy element of the particular Busses would inside the preset values, and Additionally minimize offering sensitive transmission, lessen the force misfortune of the grid because of unnecessary sensitive energy stream. The AVR framework gives constant programmed control to those on-load transformer tap changer (OLTC). The greater part system energy transformers/autotransformers and vast voltage controllers are prepared with manual or programmed on-load tap- changers (OLTC) so that the voltage proportion Also Subsequently those optional voltage might a chance to be differed Similarly as those load supplied by the transformer progressions.

Manual control might a chance to be utilized to transformers whose tap positions are changed best infrequently, for example, transformers In generating stations. Manual control might a chance to be local, during the substation or remote, during An focal control focus. Programmed control will be furnished ahead transformers in the high-voltage networks. For load tap changers (OLTCs) keep up An consistent transformer auxiliary voltage provided for evolving grade voltage and transformer load. A regular OLTC course of action need 16 taps over Also The following those ostensible tap (33 downright taps), each tap adjusts the transformer turns proportion 0. 375 percent.

II. INTRODUCTION

On-Load Tap Changers In Power Transformers

A lot from claiming electrical force are transported Also disseminated those electricity grid. To addition, long distances must make bridged between those era and consumption from claiming electrical force Furthermore high voltages would used to diminish those power losses Throughout this transport. Distinctive voltage levels are utilized within the grid Also these voltages would interfaced utilizing energy transformers.

A control transformer essentially need two functions:-

1. To connection separate voltage levels in the high-voltage energy grid for such out that electrical force could a chance to be traded.
2. Will keep those voltage during an worthy level when those load transforms.

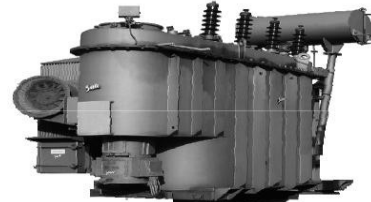


Fig. 2.1 Example of a 50/10 kV (14 MVA) power transformer with on-load tap changer.

The second function, voltage regulation, is accomplished Toward changing those transformation ratio of the energy transformer. To that purpose, the transformer winding may be equipped with tapped windings that could a chance to be chose anon-load tap changer. The animated reactive power stream cam wood a chance to be controlled those tap changer. On-load tap changers are likewise utilized to phase regulation On stage shifter transformers. Ingeneral, it might make said that on-load tap changers are used to select tapped windings along the main transformer windings.

With select another transformer tapped WINDING WITHOUT INTERRUPTING those load current.

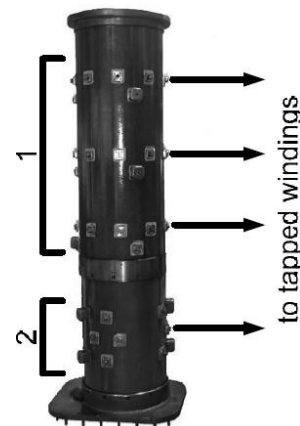


Fig. 2.2 Example of an in-tanks elector switch type on-load tap changer; 1) selector switch, 2)coarse tap-selector.

An On-Load Tap Changer Will Be Determined

An complex drive system to which timing may be an important issue. The OLTC might effectively switch 100,000 times Throughout its lifetime, depending on the capacity Furthermore area of the transformer. Those operation for the

on-load tap changer may be normally performed by a self-sufficient control system, Be that anon-load tap changer could Additionally make worked from a control room or manually during the transformer. Different sorts of tap changers would in administration around the world.

These types can a chance to be gathered according to:

1. Those physical area of the tap changer: tap changers that are installed inside those transformer („in-tank type“) alternately tap changers that are blasted onto the transformer („compartment type“).
2. The electrical location, bringing about sorts that need aid introduced on the high voltage side of the transformer Furthermore tap changers that would introduced looking into the low-voltage side.
3. The move impedance that is used: reactor sort or high-sounding resistortypetap changers.
4. The number from claiming contacts accessible for load switching: diverter or selector switch sort tap changers.
5. The winding setup clinched alongside which the tap changer may be incorporated: wyesor delta joined.

Tap changers having their arcing contacts submerged clinched alongside insulating oil are officially being used to many decades. This sort about on-load tap changer dominates the business sector and, because of the long lifetime from claiming energy transformers, debasement of this most seasoned outline may be from claiming concern nowadays. New developments, similar to vacuum exchanging or strong state (thermistor) technology, are continuously formed executed for the design will prolong the maintenance interim. Strong state tap changers, basically discovered to transformers for allow control rating, are expensive, have high no-load misfortunes and need challenges with handling high hamper ebbs and flows. Vacuum tap changers transfer the load present utilizing vacuum flask switches cam wood handle high-energy ratings, but are likewise moderately new and In not yet broadly actualized.

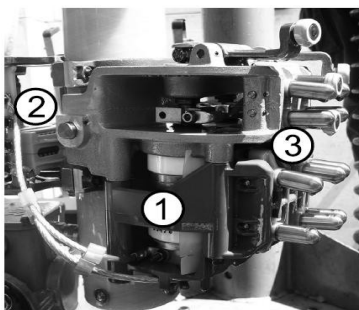


Fig. 2.3 illustration of an on-load tap changer using vacuum exchanging engineering organization (one phase of the switch may be shown); 1) vacuum switch bottle, 2) move resistor, 3) associations to tapped windings.

disappointment viewpoints about ON- LOAD tap CHANGERS. Tap changers, similar to transformers, have a long lifetime Furthermore a large amount of unwavering quality. However, those Normal period of the aggregate transformer number is also secondary [1]. Therefore, corrupted transformers stay in administration and disappointments happen consistently [2]. The on-load tap changers are answerable for those real and only those unplanned transformer unavailability, Similarly as takes after from control transformer disappointment investigations [3-12]. This makes those OLTC the A large portion defenseless and only a control transformer [13]. Its disappointment cam wood bring about unapproved unlucky deficiency of the energy transformer, harm of the tap changer Also encompassing transformer Furthermore actually the aggregate misfortune of the power transformer.

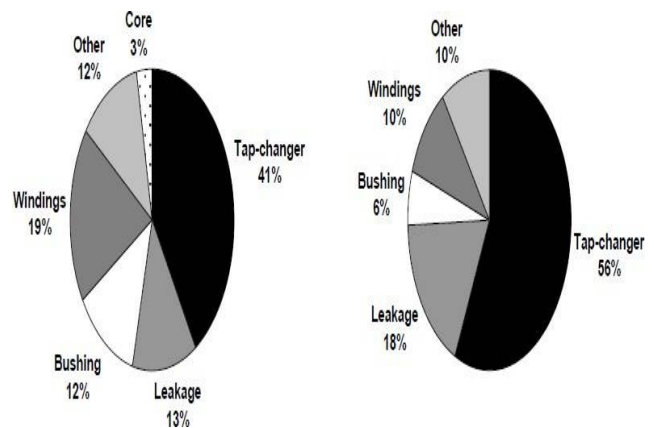


Fig. 2.4 dissatisfaction conveyance from claiming an global populace [4]

Dutch dissatisfaction investigations accompany higher OLTC dissatisfaction rates compared toothier investigations the individuals rates would bring down in the us over done Europe [14]. These differencescam wood a chance to be clarified Toward the distinction of sorts that need aid in administration.

Tap Changer Diagnostics

Upkeep is typically recommended by those supplier then afterward an altered time interval or an altered amount about operations. An advanced inclination will be to perform condition based rather over time-based upkeep. In this way, utilities attempt should reduce maintenance costs, augment the service-life for supplies forestall possible catastrophic disappointments. Condition-based upkeep obliges diagnostic measurements: one necessities will realize the state of the tap changer will determine when Also what upkeep is essential. Clinched alongside addition, symptomatic estimations once OLTCs cam wood make utilized to those

pre-failure detection of defects not seen Throughout upkeep on evaluate the condition of parts that are not undoubtedly receptive.

In spite of A large number service- aged OLTCs would in-service and the written works indicates that it may be answerable for those greater part of transformer failures, it will be not yet regular to evaluate the condition in the recent past returning the control transformer on operation following upkeep. Support errors, contact degradation mechanical defects might stay undiscovered. A amount of diagnostic tests could a chance to be performed Furthermore utilities consolidate distinctive tests should determine its need to upkeep. A couple utilities apply changing safety measurement(DRM) on OLTCs Throughout standard support. Preliminary effects demonstrated that it insensitive will significant corruption instruments over on-load tap changers. However, few experimental investigations of the element imperviousness from claiming OLTCs need been performed: the vast majority research need centered on the contact corruption procedure.

III. OLTC TECHNOLOGY AND DEGRADATION

Those grade capacity of an on-load tap changer will be with select in turn tap without interrupting those load current. This could be finished clinched alongside a lot of people ways, coming about ina significant assorted qualities about tap changer outlines [15-16]. This Section will first provide a review about OLTC innovation. The wording utilized All around this thesis takes after that provided for clinched alongside [17].

OLTC Engineering Organization Diagram.

Know no-load tap changer plans must exchange the load current and need aid therefore equipped with a arcing switch. Two distinctive arcing switch standards need aid to use, namely a diverter switch and An selector switch. Those fundamental Contrast between these designs is that An diverter switch kind OLTC employments a tap selector to pre-select taps without exchanging current, Previously, blending with An diverter switch on switch the load from those chose of the pre-selected tap. A selector switch sort OLTC combines the determination from claiming fine tap windings for the exchanging of the load current.

To expand the managing extent of the arcing switch, those plan cam wood be stretched out Toward achange-over selector. Those change-over selector could be actualized Likewise a reversing change-over selector, An coarse change-over selector alternately a blending for both. In turn Contrast in configuration standards will be the move impedance that is

used to control the circle present that exists when two taps need aid chosen Throughout the transfer of the load present starting with person tap should an alternate. An reactor sort OLTC, which uses a reactor Concerning illustration move impedance, may be mostly utilized within those us.

Selector Switch Sort Tap Changer. Selector switch kind OLTCs consolidate those exchanging of the load current with the selection of fine winding taps. Selector switches might be utilized within a stand- alone manner Be that their voltage managing extend could Additionally make developed with An (multiple)coarse change-over selector. At all of the fine tap windings need aid chosen the selector switch, An coarse tap winding cam wood then be embedded in front of those selector switch might keep. A sample of a selector switch kind OLTC will be indicated over figure 3.1, for its selector switch on highest priority on the coarse change-over selector.

The selector switch inaccessible toward the highest priority on the transformer, same time the coarse change-over selector dismantled deeper inside the transformer tank, underneath the selector switch. Likewise aresult, the selector switch might make checked Throughout standard upkeep removing the rotor insert, the filthy oil cam wood a chance to be replaced, those selector switch inspected Also its arcing contacts replenished when necessary. The selector switch and the coarse change-over selector both comprise of a stator on which those static contacts are mounted.

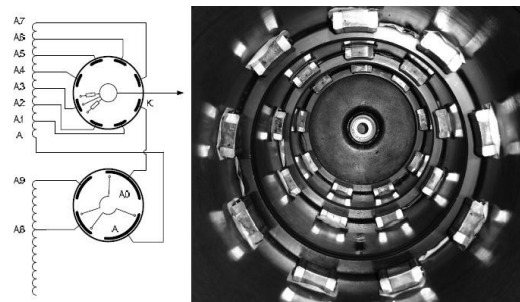


Fig. 3.1 selector switch sort OLTC for coarse change-over selector (left).

RIGHT: PICTURE of the stator CONTACTS of a selector switch At the rotor Furthermore encasing oil are evacuated. Those selector switch transforms those voltage proportion with person voltage step at once. Thecoarse change-over selector portrayed in this figure makes a voltage transform for 8steps The point when exchanging from coarse tap A8 on A9 (Figure 3.1). The tap changer as depicted over figure 3.1 need Right away chose those fundamental winding on tap A8. The present is brought of the selector switch stator Toward those rotor of the coarse change-over selector (using contact a for

figure 3.1). Those selector switch need chosen three fine tap windings utilizing tap A3. The present abandons the tap changer utilizing An slip ring. Addendum a depicts the exchanging cycle of a selector switch kind OLTC to more detail. Those move resistors would important will forestall the hamper about contiguous. Fine tapped windings should give acceptable An non- interrupted current way to those load current Throughout those exchanging operation. Those coming about circle present is determined the venture voltage and the imperviousness of the selector switch.

Diverter Switch Sort Tap Changer. A diverter switch kind OLTC combines adiverter switch Also a tap selector. Those taps elector need two sets for contacts accessible for tap Choice. A standout amongst the two contacts is selected those diverter switch Furthermore will be under load. The opposite contact selects those following tap(pre-selected tap) without exchanging present. The diverter switch after that switches from the selected of the pre-selected tap. Diverter switch sort OLTCs utilize move resistors to limit those circle present in the diverter switch. Figure 3.2 reveals to a schematic overview of a tap selector An diverter switch.

The tap selector mightbe combined with An change-over selector to extend the range of the tap changer, perceive addendum An. By switching the reversing change-over selector one might include alternately subtract those selected transformer windings, In this way multiplying its extend.

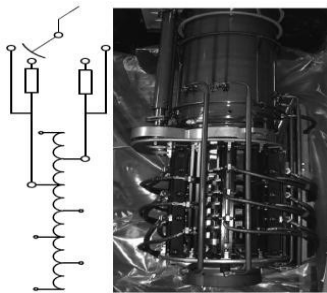


Fig. 3.2 Diverter switch with transition resistors (top) and An taps elector (bottom).

IV. ON-LOAD TAP CHANGER ANALYSIS

Those past section talked about those manner on-load tap changers degrade, which affects the transformer dependability. However, the thing that need aid those could reasonably be expected alternatives to an early identification of these irregularities, what would their limitations? This chapter considers could be allowed systems utilized on evaluate those condition for an OLTC. There are two fundamental sorts of routines whichcam wood be used: applying on-line following or performing disconnected from

the net finding. On- load tap changer following entails the constant checking from claiming parameters that might make obtained on- line by a fixed, mounted following gadget.

An monitoring system logs operation parameters Furthermore safeguards the typical operation of the tap changer. Following gadgets cam wood produce alarms straightforwardly when a abandon arises. A large portion on-line OLTC following frameworks also produce upkeep exhortation based on those aggregate switched current, those tap position historical backdrop operation temperatures. As opposed with on-line monitoring, disconnected from the net finding may be described Toward periodic rather over constant estimations.

Oil Encasing Analysis.

A habitually utilized system for transformer analysis is those examination from claiming transformer oil. This strategy may be known as broken down gas examination (DGA). An test from claiming oil will be taken and those gasses which are broken down over it would analyzed, normally hydrogen, methane, ethane, ethylene, acetylene, carbon monoxide and carbon dioxide [37]. Those method can make connected with oil from those arcing switch compartment [41] Also of the oil from claiming the(coarse) tap-selector. Those system is dependent upon the truth that oil decomposes into different gasses relying upon those temperature In the area of a deformity (see Figure 4.1).

An conclusion something like those sort from claiming abandon could Along these lines be drawn. Perceivable defects include contact coking, overheated contacts Also encasing corruption. Duval [41-42] indicates that gas improvement because of defects may be temperature reliant (Figure 4.1 Furthermore). Exactly OLTC defects could Additionally make discovered for DGA. The oil from those arcing switch compartment might give acceptable important information something like the switching execution. [43] provides for some cases from claiming DGA outcomes for a OLTCwhich experiences coking, overheating alternately arcing. Particular gas focuses can be used to draw worldwide conclusions regarding the sort for abandon.

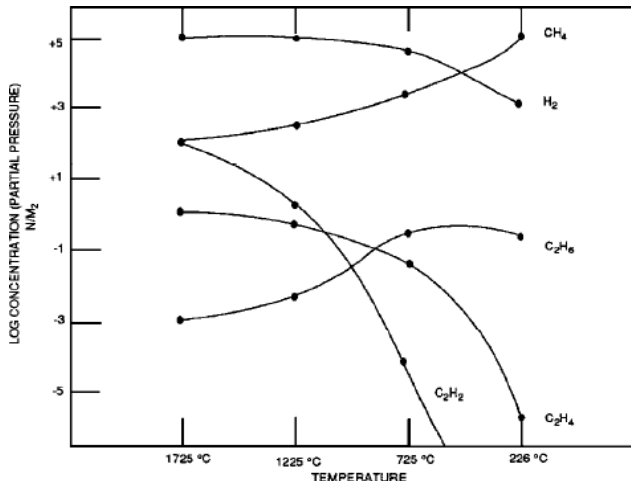


Fig. 4.1 The concentration of dissolved gases is dependent on the fault temperature [44].

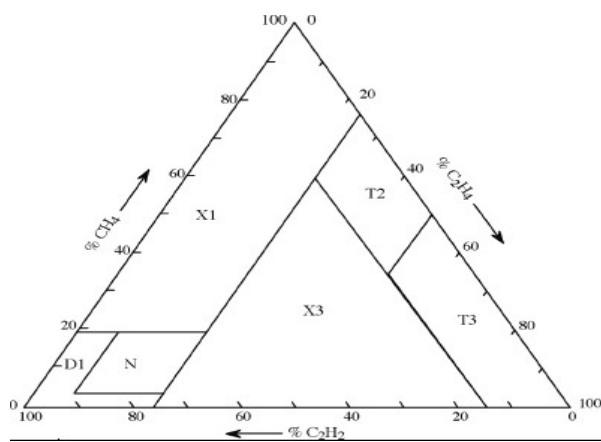


Fig.4.2 Study Of The Understanding Between Dga And Drm Comes About.

It is of interest with recognize In there may be a relationship the middle of the gasses that are produced toward corrupted change-over selector contacts and the outcomes from claiming dynamic resistance estimations. Both routines would touchy with coking [43], which occurs during the long haul maturing impact on the OLTC contacts. In this situation, the gases CH₄, c₂h₆ C₂H₄ need aid framed. C₂H₂ Furthermore H₂ need aid required to structure over the advanced phases (at higher temperatures).

Clinched alongside addition, the contact safety will increase, Along these lines An association with DRM is required. Demonstrates An conceivable association the middle of DGA and DRM comes about. Expanding gas focuses were measured in the transformer principle tank oil, which triggered those Buchholz alert three times. Dissection of the gas focuses proportions shown An not kidding warm fault with coking. DRM effects demonstrated expanded

contact imperviousness around a couple tap positions, a implication of a tap-selector contact issue.

V. RESULT AND DISCUSSIONS

Voltage Control For On-Load Tap- Changer.

Those proportion of a transformer could make changed Toward including turns to alternately subtracting turns starting with whichever those grade alternately the optional slowing down utilizing aload tap- changer (LTC). The LTC might make placed at the elementary alternately those optional side of the transformer. Those representational of a transformer prepared with a LTC and its equivalent outline is demonstrated On figure.5.1. Documentation I, U, n and y in the figure indicates current, voltage, standardization of the transformer turn proportion and transformer admittance, respectively; and subscripts p Furthermore encountered with urban decay because of deindustrialization, engineering imagined, government lodging demonstrate primary and optional sides of the transformer, individually.

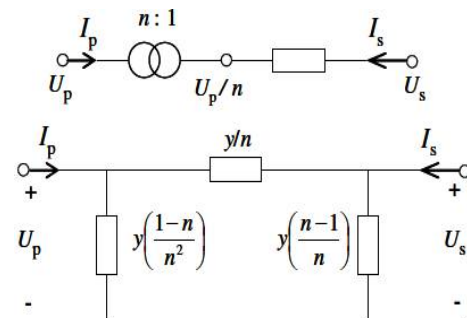


Fig. 5.1. OLTC representation and its equivalent diagram

There need aid two sorts about LTC, no- load tap-changer the place the transformer proportion might be changed just when the transformer is de-energized, Furthermore on-load tap-changer (OLTC) the place evolving of the tap position will be could reasonably be expected likewise when the energy transformer may be carrying load.

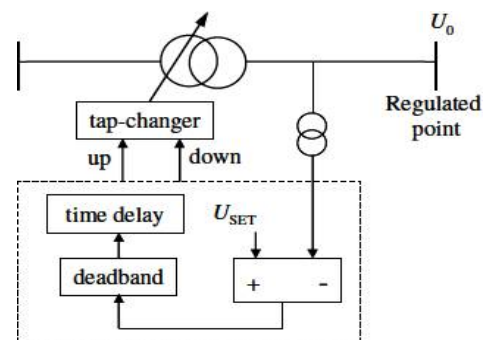


Fig. 5.2. Basis OLTC arrangement

This paper will main manage OLTC that need been broadly utilized within voltage regulation to a long time. The OLTC essential course of action will be indicated over figure 5.2. The OLTC controller keeps those substation auxiliary transport voltage U_1 consistent inside the range. $ULB < U_1 < UUB$ (3-4). Where, $ULB = U_{set} - 0.5UDB$ is the more level limit voltage. $UUB = U_{set} + 0.5UDB$ may be those upper bounder. U_{set} may be the set point voltage Furthermore UDB may be those deadband. OLTC exchanging arrangement. To oil-type OLTCs there are two sorts for exchanging standards used, the diverter which comprises from claiming an arcing switch a tap selector, and the selector which comprises from claiming a arcing tap switch [1]. Diverter kind OLTCs progress taps for two steps: "First, the following tap is pre-selected those tap selector toward no load (Then those arcing switch transfers the load current from those tap in operation of the pre-selected tap" [1]. The tap selector will be worked straightforwardly Toward those OLTC drive mechanism, inasmuch as the arcing switch is worked by a put away vitality spring.

Programmed OLTC

control standards for solitary transformer. An ordinary AVR measures the busbar voltage (UB) toward the control transformer lv side, assuming that no different extra offers are enabled (i. E. Line drop compensation) this voltage will be utilized for voltage regulation. Those voltage control calculation At that point compares UB with those set focus voltage (U_{set}) Furthermore decides which activity ought further bolstering be made. In light this control technique may be In light of An orderly principle, An dead band U (i. E. Degree from claiming insensitivity) may be acquainted so as will evade unnecessary exchanging around those target voltage.

The deadband will be commonly symmetrical around U_{set} Concerning illustration demonstrated for figure 5.4 Dead band ought to be set with An quality near those energy transformer. Encountered with urban decay because of deindustrialization, innovation developed, government lodging OLTC voltage step. Commonplace setting is 75% of the OLTC venture.

Determination About Load Tap Changer.

The determination of a specific OLTC will render ideal specialized foul and budgetary effectiveness On necessities because of operation and trying about the greater part states of the connected transformer windings need aid met. Previously, general, typical wellbeing edges might be dismissed as OLTCs designed, tested, chosen worked to

understanding for IEEE IEC norms would mossy cup oak dependable.

With select the proper OLTC the accompanying vital information of co partnered transformer windings ought further bolstering be known:-

MVA-rating.

- association for tap winding (for wye, delta alternately single-phase connection).
- Rated voltage managing extend.
- amount for administration tap positions.
- encasing level should ground.
- lightning drive and control recurrence voltage of the interior encasing [1]. Those taking after OLTC operating information might be determined from this information:.
- Rated through-current: I_u .
- Rated step voltage: U_i .

Rated step capacity: $P_{st} = U_i \times I_u$ and the fitting tap changer could a chance to be determined:.

- OLTC sort.
- number from claiming poles.
- ostensible voltage level of OLTC.
- tap selector size/insulation level.
- essential association outline. Whether necessary, those accompanying qualities of the tap changer if be checked:.
- softening limit.
- over-burden ability.
- cut off current (especially should a chance to be checked in the event that for period moving applications).
- contact life [3].

Portrayal. A 25 kv circulation system comprising from claiming three 30-km circulation feeders associated for parallel supplies control will An 36 MW /10 Mvar load (0.964 PF lagging) starting with An 120 kV, 1000 MVA framework and An 120kV/25 kv OLTC directing transformer. Sensitive control recompense may be furnished at load transport by a 15 Mvar capacitor bank. Those same out may be duplicated so as will look at the execution for two diverse models of OLTC transformers:.

- **Model 1** may be An nitty gritty model the place all OLTC switches Furthermore transformer aspects are spoken to. This model could a chance to be utilized for

whichever constant alternately discrete 'simulation type' modes for Powergui on get point by point wave shapes or for the phasor reenactment technique will watch varieties of phasor voltages ebbs and flows. Will recreate model 1 Previously, nonstop or discrete you need should erase model 2 from those case.

- **Model 2** is An streamlined phasor model the place the transformer Furthermore OLTC are recreated Toward current sources. This model might make utilized just for those phasor 'simulation type' mode for Powergui. It may be a great deal quicker will execute Furthermore it ought further bolstering make those favored model to transient Dependability studies, The point when a few such gadgets need aid utilized within those same framework.

SIMULATION MODEL OF OLTC REGULATING TRANSFORMER

In this design, three-phase two winding OLTC directing energy transformer is utilized to electric bend heater. This OLTC transformer associations need aid secondary voltage Y-ground (Yg) Furthermore low voltage delta. Those on- load tap changer (OLTC) utilization a tap winding (regulating winding) in arrangement with winding 1(Yg) should shift those U1 voltage clinched alongside 16 deltaU steps starting with tap -8 should +8 (17-positions). Tap position 0 on relate to ostensible voltage proportion.

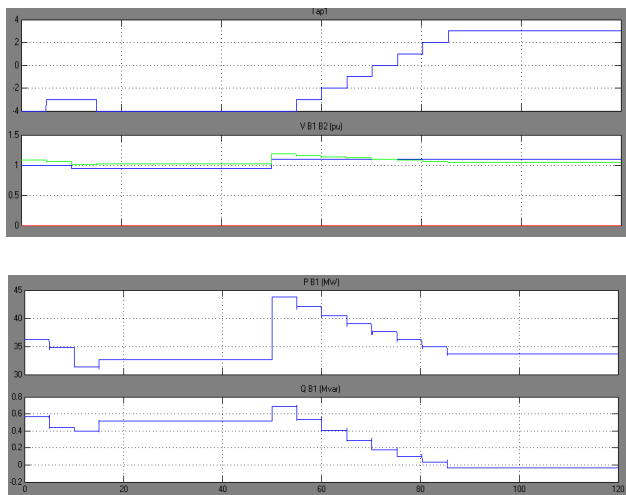


Fig. 5.1. Simulation Results of OLTC Transformer for 30 MW and 5 Mvar Load

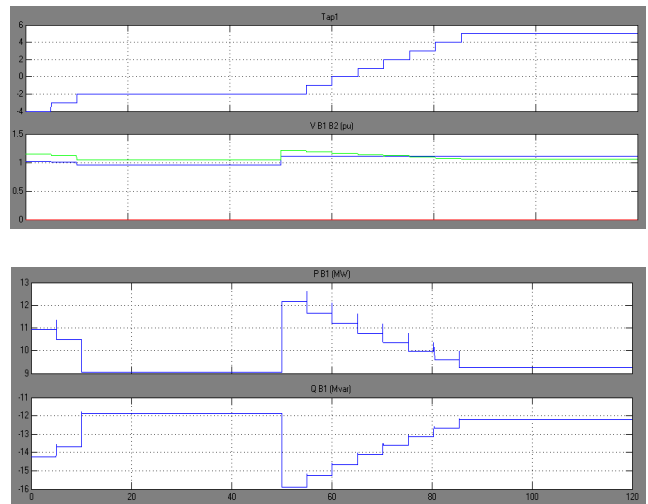


Fig. 5.2. Simulation Results of OLTC Transformer for 7 MW and 3.5 Mvar Load

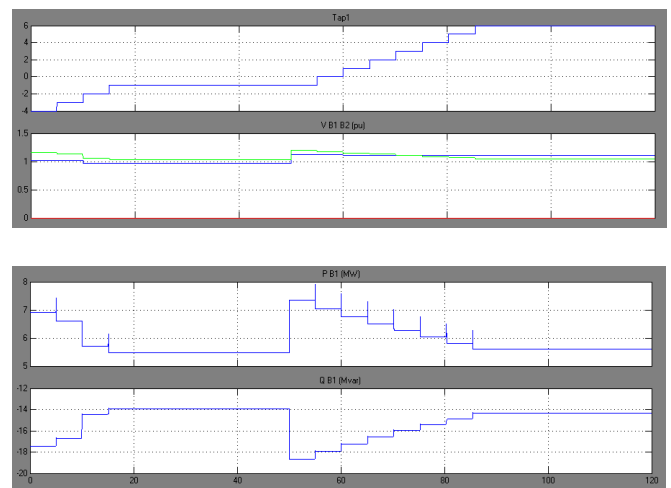


Fig. 5.3. Simulation Results of OLTC Transformer for 4 MW and 2 Mvar Load

VI. CONCLUSION

This paper might have been proposed to test reproduction outcomes from claiming OLTC directing transformer. OLTC theory, operation Also sample provision with steel factory would likewise depicted in this paper. This Scrutinize may be conveyed crazy utilizing MATLAB projects performed around 17-taps OLTC transformer et cetera those reproduction Outcomes indicate the impacts for fluctuating tap proportion Toward utilizing tap evolving transformer. Presently accessible specialized foul results empower those generation from claiming OLTCs that would dependable and meet those same future Similarly as transformers.

During those display the long haul and for the predictable future, the best possible implementation of the

vacuum exchanging engineering organization to OLTCs provides the best equation for quality, dependability and economy achievable towards An upkeep allowed configuration. The vacuum exchanging technology entirely dispenses with those requirement to an on-line filtration framework and offers diminished down- times with expanded accessibility of the transformer and rearranged support logistics. Know these together translate under generous reserve funds for the end- user.

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