Parallel operation of transformer solved problems

There may be a time when the transformer approaches full load. At this point you have two options. Replace the transformer with a larger kVA. Parallel to a new transformer. Sometimes it is more practical from parallel to a new transformer as there is a minimum of downtime to the operation. Three conditions must be met before connecting transformers in parallel.1 Transformers must have the same primary and secondary voltage ratings. If the voltage ratings of transformers are not the same, large circular currents will flow both in the primary and secondary winding. Circulating currents are currents that flow between the two transformers but not through the loads. The smaller transformer will act as a load on the larger transformer. Due to the low resistance of the transformer winding, the currents circulating can end up being large and dangerous enough. Although the voltages induced in the secondary transformers are AC, the same circular currents flow into each of the secondary windings. Any current flowing into the secondary transformer must be combined with a current in the primary so that the correct CEMF is produced in the primary winding. The current in the primary is equal to the secondary current divided by the ratio of turns. This means that the circular currents proportional to those of the secondary ones will flow even in the primary ones.2 When connecting, you must observe the terminal polarity of the transformers. This still allows to parallel a subtractor-polarity transformer with an additive-polarity transformer if it is ensured that the connection terminals have the same instant polarity. Figure 10. Circulating currents It is possible to replace the secondary winding of the transformer with batteries to analyze what would happen if thepolarity were not observed. Figure 11 shows two batteries with equal tensions connected improperly in parallel. The batteries act as if they wereseries with each other and only the resistance of the winding themselves will limit the current. This current will be large enough and will most likely exceed the winding ratings and burn the transformer. Once again, any current flowing into the secondary transformer must be combined with a current in the primary so that the correct CEMF is produced in the primary winding. The current in the primary is equal to the secondary current divided by the ratio of turns. It is necessary to ensure that the instant polarities of all connected terminals together are always the same. 3. All transformers must have the same impedance per cent. This is something we will cover in detail later. Using the same percentage impedance it is important to ensure that transformers share the load according to their capacity. For example, if they have the same impedance per cent, a 100 kVA and 25 kVA transformer can be parallel so that the 100 kVA transformer always carries four times more than the 25 kVA transformer load. As a transformer is loaded, its terminal voltage changes due to the IZ fall (loss line) in the winding. Percentage impedance is simply an expression of the impedance of the transformer as a percentage of the nominal impedance of full load of the transformer. If transformers have the same impedances per cent, then their terminal tensions are equal each time the transformers bring an equal percentage of their full load currents. This ensures that transformers share the load according to their individual capabilities. Consider the transformers 100 kVA and 25 kVA mentioned above. If these two transformers have the same impedance per cent, together they are able to provide a load of 125 kVA without exceeding the rating of both transformers. However, if the twohave different impedances per cent, that with impedance per cent lower will be overloaded before they reach 125 kVA. Figure 11. polarity of the line ObservationPolarity when connecting transformers in parallel You can connect transformers that have different polarities in parallel. You have to remember that it matches the polarities. First we learned that H1 and X1 are always the same polarities, so it is important to pay much attention to the polarity of transformers. There is a sequence to follow when drawings of a transformer are performed: Determines the polarity of the power line. The polarity of the power line determines the primary polarity of the transformer. Primary polarity determines the secondary polarity of the transformer. When you connect, you ensure that the negatives are connected together and the positives are connected together. Video alert! The video below passes through how to correctly connect parallel wrappings. Test closing voltage Before making the final secondary connection, you need to do a simple voltmeter test. This test determines whether or not a proper polarity has been observed. Use winding as batteries again to determine instant polarity. Start on one side of the voltmeter and work the way to the other side. Figure 12. If a correct polarity has been observed, the voltmeter should read zero volts. If the circuit is improperly connected, you will see the two tensions added together. This will cause large circular currents and kablazalflam! In figure 12, two batteries are connected in parallel with the right polarities observed, and with a voltmeter installed instead of the last connection. The closing voltage measured by the voltmeter should be zero volts. If you follow the circuit around, you can see that when the batteries are properly connected, they are in series, opponents. (This is, the two tensions oppose each other.) In Figure 6, the two batteries are connected in parallel with improper polarity, and with the voltmeter installed in placeconnection, as before. Measured timevoltage like twice the battery voltage. If you follow the circuit around, you can see that when the batteries are improperly connected are in series, helping. (This is, the two tensions add together.) Figure 13. good CA closure test Figure 13 shows a voltmeter used to test the closing voltage on two parallel transformers together. The instant polarity of the primary bus is designed as two batteries so that you can better view the relationship between the two windings. Starting from one side of the meter and traveling to the other side, we can calculate that the meter will read zero volts and is safe for connection. Figure 14. Closing test CA kablazalflam Figure 14 shows a voltmeter used to test the closing voltage on two transformers that are improperly connected in parallel. The voltmeter now reads twice the secondary voltage. In this case, do not remove the voltmeter and make final connections or you can experience kablazalflam. Instead, you need to correct improper connection and remake the test. The video below explains how to correctly use the voltage closing test. Attribution Paralleling Transformers (polarity) video of The Electric Academy is under a Creative Commons attribution license. The Electric Academy voltmeter closing test video is under a Creative Commons attribution license. With Testbook Mock Tests Options: Same voltage ratio and same voltage that refers to the primary ratio and the same voltage the transformer to be connected in parallel. The phase shift between primary and secondary must be the same for all transformers connected in parallel. The phase sequence must be the same. All the above download questions with PDF solution ›› Conditions for the parallel operation of transformers: The voltage line ratio of two transformers must be equal Impedanceof each transformer should be equal and should have the same loss ratio equivalent to equal resistance (X/R) (X/R)transformers should have the same secondary polarity winding the transformers should have the same phase sequence (three-phase transformer) the phase shift between primary and secondary must be the same for all connected transformers in parallel download demand with pdf solution ›› problems example 1: a source that can be represented by a voltage source of 8 v rm in series with an internal resistance of 2 kΩ is connected to an ideal load resistance of 50-Ω. calculates the value of the ratio of turns for which the maximum power is supplied to the corresponding load and load power? using matlab, track the power in milliwatt supplied to the load according to the transformer ratio, covering the ratios from 1.0 to 10,0 solution: for maximum power transfer, the load resistance (referred to the primary) must be equal to the source resistance. example 2 transformer at 460-V:2400-V has a series loss reaction of 37.2 Ω as indicated on the high voltage side. a load connected to the low voltage side that absorbs 25 kw, a unit power factor, and the voltage measures 450 v. calculates the corresponding voltage factor and power measured at the high voltage terminals. power factor at the primary terminals: cos(9.5) = 0.9861 delay example 3: the resistances and reaction of losses of a 30-kVA distribution transformer, 60-Hz, 2400-V:240-V are r1 = 0,68 Ω r2 = 0.0068 Ω xl1 = 7,8 Ω xl2 = 0.0780 Ω, where the undersigned 1 denotes winding and the undersigned 24V each quantity is referred to its side of the transformer. a. draw the equivalent circuit of which (i) the high sides and (ii) the low voltage sides. labels numerical impedances. b. consider the transformer to provide its nominal kva to a load on the low voltage side with 230 v through the(i) Find the high level terminal voltagea load power factor of 0.85 lagging. (ii) Find the high part terminal voltage for a load power factor of 0.85 leaders. c. Consider a nominal-kVA load connected to low voltage terminals operating at 240V. Use MATLAB to track high-side terminal voltage as a function of the power-factor angle as the load power factor varies from 0.6 leading through the power factor of drives to 0.6 pf delay. Example 4: a single-phase load is supplied via a 35 kV power supply whose impedance is 95 + j360 Ω and a 35-kV:2400-V transformer whose equivalent impedance is (0.23 + j1.27) Ω reported to its low voltage side. The load is 160 kW at 0.9 leading power factors and 2340 V. a. Compute voltage to the transformer high voltage terminals. b. Understand the voltage at the end of sending the power supply. Experience reactive power and power input at the power supply end. Example 5: The following data were obtained for a 20-kVA, 60-Hz, 2400:240-V distribution transformer tested at 60 Hz: a. Computes current load efficiency and nominal voltage of the power factor terminal 0.8. b. Take that the load power factor is varied while the load voltage and secondary terminal are maintained constant. Use a phasor diagram to determine the load power factor for which the adjustment is larger. What is this regulation? Solution: (a) Nominal current on the HV side = 20 kVA / 2400 = 8.33 A. Therefore, total power loss at total load current: Example 6: A three-phase step-up transformer is rated 26-kV:345-kV, 850 MVA and has a 0.0035 + j0.087 series impedance per unit on this base. It is connected to a generator from 26kV, 800-MVA, which can be represented as a voltage source in series with a reactivity of j1.57 per unit based on the generator. (a)reactivity of the generator per unitthe basis of the step-up transformer. (b) The unit is providing 700 MW to 345 kV and 0.995 power factors late to the system at the high voltage terminals of the transformer. (i) Calculates the voltage of the transformer at the bottom and the internal voltage of the generator behind its reaction in kV. (ii) Find the output power of the generator in MW and the power factor. Solution: Page 2TRANSFORMERS 1. Mention the difference between core and shell transformers. In the core type, the winding surrounds the core considerably and in shell type the core surround the winding. 2. What is the purpose of rolling the nucleus into a transformer? To reduce the loss of eddy current. 3. Give the emf equation of a transformer and define each term Emf induced in the primary coil E1 = 4.44 fΦmN1 volt Emf induced in the secondary coil E2 = 4.44fΦmN2 volt Where f is the input frequency AC Φm is the maximum flow value in the N1 core, N2 are the number of primary and secondary turns. 4. Does the transformer draw any current when the secondary is open? Why? Yes, (primary) will draw the current from the main power to magnetize the core and provide iron and copper leaks on no load. There will be no current in the secondary since the secondary is open. 5. Define the voltage adjustment of a transformer When a transformer is loaded with a constant primary voltage, the secondary voltage decreases due to the load of the power factor in delay, and increases for the leading pf load due to its internal resistance and loss reactivity. The change of secondary terminal voltage from no full load load expressed as a percentage of no full load or load voltage is defined as regulation. %regulation down = (0V2-V2) x 100/0V2 %regulation up = (0V2-V2) x 100/V2 5. The total load copper loss in a transformer isWatt. what will be the half-load loss? if x is the actual load ratio at full load, then the copper loss = x2 (full load copper loss.) here wc = (0.5)2 x 1600 = 400 watts 7. define the efficiency of a transformer all day. is calculated on the basis of energy consumed during a certain period, usually a day of 24 hours. ηall day = power in kwh /input in kwh for 24 hours. 8. why transformers are classified in kva ? the copper loss of a transformer depends on the current and the loss of iron on the voltage. the total losses depend on volt- ampere and not on the power factor. that is why the evaluation of transformers is in kva and not in kw. 9. which are the typical oi of the automatic transformer? (i)To give a small push to a distribution cable to correct the voltage drop. (ii)As induction engines. — as furnace transformers (iv) as interconnected transformers (v) in single-phase and three-phase locomotive control equipment. 10. What are the applications of step-up and step-down transformers? Step-up transformers are used in generation stations. normally the generated voltage will be 11 kv or 22 kv. this voltage is up to 110 kv or 220 kv or 400 kv and transmitted through transmission lines. (in short it can be called as an end of sending.) the downstream transformers are used in reception stations. the voltage is again reduced to 11 kv or 22 kv and transmitted via power supply. (in short it can be called as the end of reception.) Further, these 11 kv or 22k v went down to 3 400 v steps by means of a distribution transformer and made available at the consumption premises. transformers used in power stations and reception stations are called power transformers. 11. How are transformers classified according to their construction? or mention thebetween transformers like “CORE” and “SHELL”. O What are the two types of cores used? Compare them. Transformers are classified according to their construction as, (i)Core type (ii)Type of toll (iii)Spirakore (iii)SpirakoreSpirakore type is a newer transformer and is used in large transformers. In “core” type, the winding (primary and secondary) surrounding the core and in “shell” type, the core surround the winding. 12. Explain about the material used for the construction of the nucleus. The core consists of steel laminations for transformers assembled to provide a continuous magnetic path with a minimum of air space included. The steel used is of high silicon content sometimes heat treated to produce a high permeability and low hysteresis loss to the usual operating flow density. The eddy current loss is reduced to a minimum by rolling the core, the laminations which are isolated from each other by a slight layer of vanished oxide or by a layer of oxide on the surface. the thickness of the laminations varies from 0.35 mm to a frequency of 59 Hz and 0.5 mm for a frequency of 25 Hz. 13. When does a Bucholz relay work in a transformer? Bucholz Confidence is a protective device in a transformer. If the coil temperature exceeds its limit, Bucholz relay operates and gives an alarm. 14. How does the frequency change affect the functioning of a given transformer? With a frequency change, iron loss, copper loss, regulation, efficiency and heating varies and therefore the operation of the transformer is affected 15. What is the angle with which the current without load will flood the ideal applied voltage? In an ideal transformer, there are no copper leaks and no core loss, (i.e. the lost core). The non-load current is only magnetizing current. Therefore, the no-load current moves away from an angle of 90°. However the windings have resistance and reactivity of escape and therefore the current of no load stops slightly less than 90°. 16. Lists the advantages of the core step arrangement into a transformer.To effectively reduce space. (ii) To obtain a reduction in average lengthof the winds. (iii) to reduce the loss of i2r. 17. Why are the traspirators oated in the transformers? The traspirators are used to affect atmospheric moisture and therefore not allowing to switch to transformer oil. also to allow the oil inside the tank to expand and contract as its temperature increases and decreases. also to avoid slipping of oil i.e. decomposition of oil. the addition of 8 water parts in 1000000 reduces the amount of insulating oil. normally silica gel is filled in the respirator with pink color. this color will be changed in white due to a continuous oo, which is an indication of bad silica gel, is normally heated and reused. 18. What is the function of the transformer oil in a transformer? nowadays instead of natural mineral oil, synthetic oils are used as askrels (commercial name).) they are not flammable; under an electric arc do not decompose to produce flammable gases. pyrocolor oil has a high dielectric force. Therefore it can be said that the transformer oil provides, (i) good insulation and (i) cooling. 19. a single-phase transformer 1100/400 v, 50 hz has 100 laps on secondary winding. calculates the number of laps on his primary. we know that v1 / v2 = k = n2 / n1 replacement in the above equation 400/1100 = 100/N1 n1 = 100/400 x 1100 = 275 turns. 20. What are the functions of the current without load in a transformer? the current without load produces flow and provides iron loss and loss of copper without load. 21. How to transfer quantities from one circuit to another circuit into a transformer? 1.According to the first 2.Primary to the secondary symbol value v2 V2/k vl kv1 i2 ki2 i1 /k r2 R2/k2 rl k2r1 x2 X2/k2 XL’ k2x1 ZL/k2 22. the voltage regulation of a transformer can go negative? if it is so under what condition? Yeah. if thehas a leading power factor. 23. They distinguish between power transformer and distribution transformer. Power transformersvery high power ratings in the order of MVA. They are used in the generation and reception stations. Sophisticated checks are required. The voltage ranges will be very high. Distribution transformers are used in the consumer part. The voltage levels will be average. The power plant will be small in order of kVA. No complicated checks are required. 24. What is the purpose of providing ‘tappe’ in transformer and where are they provided? In order to reach the required voltage, “tappe” are provided. Normally it will be provided at low voltage sides 25. Give the method of reducing iron loss in a transformer Iron leaks are minimized using high quality base materials such as silicon steel with very low hysteresis loops and producing the core in the form of laminations. 26. State the condition for maximum efficiency Copper Loss = Iron Loads