

Hv or Iv winding ground fault engineering essay

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Assignment I

HV and LV bushing flashovers (external to the tank)

Detection

Detection of flashovers is approached in different ways. One common way is through the current differential protection relay of the busbar which is connected to the transformer. Hence, there is very little need for a special flashover protection with the presence of busbar protection. Another way is by using an instantaneous overcurrent protection on the secondary side of the transformer, this technique will detect many flashover faults on the surface of the bushings

Protection

The transformer fault statistics show that terminal failures and bushing failures occur frequently. As a result, most transformers old or new contain some form of flashover protection. One common protection consists of metallic rings around the root of each bushing. The rings are insulated from the transformer tank and connected to each other. There is a conductor from the rings to the earthing mat in the substation. A flashover on the surface of the bushing should terminate on the flashover ring. In such cases, a current starts to flow in the earthing conductor. The current is fed through a current transformer and an instantaneous overcurrent protection on the secondary side. Figure 1 Bushing flashover test

HV or LV winding ground fault

Protection

A simple overcurrent and earth fault relay will not provide adequate protection for winding earth faults. Even with a biased differential relay installed, the biasing desensitizes the relay such that it is not effective for certain earth faults within the winding. This is especially so if the transformer is resistance or impedance earthed, where the current available on an internal fault is disproportionately low. In these circumstances, it is often necessary to add some form of separate earth fault protection. The degree of earth fault protection is very much improved by the application of unit differential or restricted earth fault systems as shown in Figure 2. Figure 2 winding to ground fault protection

On the HV side, the residual current of the three line CTs is balanced against the output current of the CT in the neutral conductor, making it stable for all faults outside the zone. For the LV side, earth faults occurring on the delta winding may also result in a level of fault current of less than full load, especially for a mid winding fault which will only have half the line voltage applied. HV overcurrent relays will therefore not provide adequate protection. A relay connected to monitor residual current will inherently provide restricted earth fault protection since the delta winding cannot supply zero sequence current to the system. Both windings of a transformer can thus be protected separately with restricted earth fault, thereby providing high-speed protection against earth faults over virtually the whole of the transformer windings, with relatively simple equipment. The relay used is an instantaneous high-impedance type.

Inter-turn fault

Inter-turn faults may happen when the insulation between turns breaks down causing cracks in the windings and short circuited turns. There are several factors that may lead to insulation break down. Lighting surges several times the rated system voltage may possibly damage the transformer winding insulation leading to a short-circuited turn. Other contributing factors include mechanical forces and ingress of moisture into the insulation oil. A turn-to-turn fault may cause substantial damage not only at the fault location. The heat generated by the fault current will melt part of the winding. The molten copper from the fault location will solidify to small copper particles. The circulating oil in the transformer may transport these copper particles from the fault location. Figure 3 turn to turn fault and fault current

Detection

For oil immersed transformers, the heat generated due to the fault current will decompose the oil into gas. Therefore, Buchholz protection relay serves as a great detector for inter-turn faults. Another approach of monitoring pressure rise may also be used to detect this kind of faults. Turn-to-turn faults are very difficult to detect by protection equipment using electrical input quantities only

Protection

The Buchholz relay unit contains two mercury switches. The production of gas in the tank will eventually bubble up the pipe to be trapped in the top of the relay casing, so displacing and lowering the level of the oil. This causes the upper float to tilt and operate the mercury switch to initiate the alarm circuit. A typical Buchholz relay will have two sets of contacts. One is

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arranged to operate for slow accumulations of gas, the other for bulk displacement of oil in the event of a heavy internal fault. An alarm is generated for the former, but the latter is usually direct-wired to the CB trip relay.

Core fault

A conducting bridge across the laminated structures of the core can permit sufficient eddy-current to flow to cause serious overheating. The bolts that clamp the core together are always insulated to avoid this trouble. If any portion of the core insulation becomes defective, the resultant heating may reach a magnitude sufficient to damage the winding.

Detection

It is nevertheless highly desirable that the condition should be detected before a major fault has been created. In an oil-immersed transformer, core heating sufficient to cause winding insulation damage will also cause breakdown of some of the oil with an accompanying evolution of gas. Hence, The Buchholz relay serve as a good core fault detector.

Protection

The additional core loss cause severe local heating, however it will not produce a noticeable change in input current and hence it cannot be detected by the normal electrical protection. Hence, the Buchholz relay is used as the protection element in oil-immersed transformer as it will detect gas accumulations due to local heating of the core and it will either give an alarm or trip depending on the severity of the fault.

Tank Fault

The oil in a transformer constitutes an electrically insulating medium. It also constitutes a cooling medium. The service reliability of an oil-immersed transformer therefore depends to a large extent on the quality of the oil. The dielectric strength of the oil is the most important property of the oil. A breakdown of the insulation can occur if water and impurities have reduced the dielectric strength of the oil.

Detection

Loss of oil through tank leaks will ultimately produce a dangerous condition. Reduction in winding insulation is one such condition. Overheating on load due to the loss of effective cooling is another such condition. The oil level should be monitored. Oil immersed transformers with an oil conservator should therefore be provided with an oil level monitor.

Protection

The transformer tank is nominally insulated from earth (an insulation resistance of 10 ohms being sufficient) earth fault protection can be provided by connecting a relay to the secondary of a current transformer the primary of which is connected between the tank and earth

Partial discharges

Partial Discharge (PD) phenomena is defined as localized dielectric breakdown of a small portion of a solid or liquid electrical insulation system under high voltage (HV) stress. PD causes the insulation to deteriorate progressively and can lead to electrical breakdown. Therefore, the integrity of the insulation of HV equipment should be confirmed using Partial

Discharge Analysis (PDA) during its manufacturing, its commissioning, and during its life time. Partial Discharge in power transformers can lead to corrosion on solid insulating materials, which may lead to a breakdown of the concerned operating component. PD can also decompose and pollute the insulating oil, so that the insulation properties of the oil can no longer be guaranteed. Partial Discharge Measuring of transformers is therefore essential at the beginning of their life-cycle and at the time of major repairs.

Detection

General Overheating

Overheating may occur due to several reasons such as reduced cooling or sustained overloading. Oil sludge can block cooling ducts and pipes. This may result in overheating when the transformer is loaded. The failure of a forced cooling system can also cause overheating.

Detection

It is necessary to supervise forced cooling systems. An alarm should be given if the cooling system stops. The oil temperature can be monitored and appropriate action taken before the transformer becomes overheated. Similarly, Overloading causes increased copper losses and a consequent temperature rise. Power transformers can be temporarily overloaded. The length of the acceptable overload period depends on the initial temperature and the cooling conditions.

Protection

Thermal protection is usually done by oil and winding temperature devices, or relays that have similar tripping characteristics to the thermal time

constant of the transformer. Winding temperature is normally measured by using a thermal image technique. A sensing element is placed in a small pocket near the top of the main tank. A small heater fed from a current transformer on the LV side is also mounted in this pocket and this produces a temperature rise similar to that of the main winding, above the general oil temperature. Then based on the temperature condition an alarm or trip signal is initiated. In modern systems, cooling fans and pumps are mounted on the transformer and are integrated with a modern digital microprocessor system. The microprocessor reads Oil temperature and current measurements and then process the data to calculate the estimated hottest spot temperature and accordingly take action by activating/deactivating the cooling fans. This method is more favorable than the traditional methods as tripping on high temperature may not be recommended in some applications. In addition, it will extend the life of the unit.