SERGI

TRANSFORMER PROTECTOR

TRANSFORMER PROTECTOR vs
OTHER PROTECTION SYSTEMS

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OVERVIEW

SERGI Transformer Protector

TRANSFORMER PROTECTOR vs STANDARD PROTECTIONS

FIREWALLS

HOW IT WORKS

Create a physical barrier between assets. In case of fire, the distance combined with the physical barrier would prevent fire from propagating to nearby assets and installations.

PROS

- It is practical and cost-effective to implement on new projects

CONS

- Needs adequate separation between the transformer's installation and the adjacent buildings, installations, and assets. It is not suitable for narrow spaces and already conceived plans if no space is saved for it.
- Consumes space in width and height.
- Limit of 2 hours fire rating average industry protection minimum requirements.

TRANSFORMER PROTECTOR vs STANDARD PROTECTIONS

DELUGE SYSTEMS

HOW IT WORKS

A deluge system is a fixed fire protection system in which the pipe system is empty of water and kept pressurized with dry air until a fire condition is detected. The deluge valve is operated to distribute pressurized water to the nozzles or sprinklers directing the water onto the protected object(s).

PROS

- It Is practical where quick application of large quantities of water is required to control a fire and protect high-value adjacent assets, such as on generator and unit transformers in power stations, bulks supply transformers at industrial plants, and major transmission or substation transformers in city locations.

CONS

- It does not prevent tank rupture caused by internal arcing from the initiating fault.
- Can cause flashover, or crack and rupture of bushings by thermal shock.
- If used with foam mix will need decontamination of the water used to fight the fire and all other water sources must be contaminated.
- A large amount of water must be 100% available to operate this solution.

TRANSFORMER PROTECTOR VS STANDARD PROTECTIONS

WATER MIST SYSTEMS

HOW IT WORKS

Same as deluge system but requires much less water as they have a smaller droplet. Here the goal is to cover more surface than with the deluge system and to create steam to achieve a cooling effect.

PROS

- Same as the deluge system with the upgrade that the amount of water needed is much less.

CONS

- It does not prevent tank rupture caused by internal arcing from the initiating fault.
- Can cause flashover, or crack and rupture of bushings by thermal shock.
- If used with foam mix will need decontamination of the water used to fight the fire and all other water sources contaminated.

TRANSFORMER PROTECTOR vs STANDARD PROTECTIONS

WATER CURTAIN

HOW IT WORKS

It is a system that sprays water, not all over an asset but to its perimeter. Here the goal is to protect the adjacent assets, installations, and buildings, in the same way it's done by a firewall but with water.

PROS

- If it is well implemented can achieve protection of the adjacent assets, installations, and buildings.

CONS

- Can cause flashover, or crack and rupture of bushings by thermal shock.
- If used with foam mix will need decontamination of the water used to fight the fire and all other water sources contaminated.

TRANSFORMER PROTECTOR vs STANDARD PROTECTIONS

HYPOXIC ENCLOSURE

HOW IT WORKS

Modify the environment to lower the concentration of oxygen in the air below 17% (below this limit is not possible for fire to exist) in the surrounding spaces of the transformer installation.

PROS

- Below 17% oxygen concentration is not possible for fire to exist. Lowering the risk of fire to zero.

CONS

- Not suitable for all installations.
- Potentially harmful for workers and plant operators.
- It does not prevent tank rupture caused by internal arcing from the initiating fault.

TRANSFORMER PROTECTOR VS STANDARD PROTECTIONS

FIRE SUPPRESSION USING INERT GAS FOR OXYGEN DISPLACEMENT

HOW IT WORKS

The same principle of the hypoxic enclosure but injecting inert gas into the ENCLOSURE to displace the oxygen and prevent the fire from existing. The most used gas for this kind of solution is nitrogen. It should be noted that for an Inert Gas for Oxygen Displacement or a Hypoxic enclosure to provide effective fire protection, the enclosure must remain intact. Pressure venting may be required to ensure that the enclosure is not breached by the transformer failure event.

PROS

- No need of great transformations or civil work compared to the “water” systems. And no need of extensive piping or to have water available and secured for the solution to work.

CONS

- Not suitable for all installations.
- It does not prevent tank rupture caused by internal arcing from the initiating fault.

TRANSFORMER PROTECTOR vs STANDARD PROTECTIONS

NITROGEN INJECTION FIRE EXTINGUISHING SYSTEM

HOW IT WORKS

Once the fire is detected, a quantity of the oil within the transformer is drained and filled with nitrogen to extinguish the fire from the transformer. After years of R&D, the SERGI 1000 SYSTEM was the pioneer and still is an example of this kind of solution.

PROS

- Once oxygen is displaced from the enclosure is not possible for fire to exist. And is approved by many regulations around the world.

CONS

- It does not prevent tank rupture caused by internal arcing from the initiating fault.
- It became so popular that you can find in the market many providers of the solution with dissimilar price points and quality.

TRANSFORMER PROTECTOR vs STANDARD PROTECTIONS

System or Solution	TRANSFORMER PROTECTOR	Firewalls	Deluge systems	Water mist systems	Water curtain	Hypoxic enclosure	Inert gas for O2 displacement	Nitrogen injection fire extinguishing system
Protect tank rupture from internal arc fault	✓	✗	✗	✗	✗	✗	✗	IN A FEW CASES
Prevent fire due to tank rupture or internal arc fault	✓	✗	✗	✗	✗	IN SOME CASES	IN SOME CASES	IN SOME CASES
Prevent fire from propagating and limit its consequences	✓	IN SOME CASES	IN SOME CASES	IN SOME CASES	IN SOME CASES	IN SOME CASES	IN SOME CASES	IN SOME CASES
Do not produce hazardous residuals substances	✓	✓	IN SOME CASES	IN SOME CASES	IN SOME CASES	✓	✓	✓
Cannot be remotely altered by a Cyberattack	✓	✓	✗	✗	✗	✓	✓	✓
Suitable to be installed in existing installations	✓	NOT ALWAYS	NOT ALWAYS	NOT ALWAYS	NOT ALWAYS	NOT ALWAYS	NOT ALWAYS	✓

TRANSFORMER PROTECTOR vs ELECTRICAL/MECHANICAL PROTECTIONS

PRESSURE RELIEF VALVE/DEVICE

HOW IT WORKS

A spring-loaded valve with a dual gasket sealing mounted directly on the transformer tank. The valve opens at a pre-determined differential pressure across the valve, and then relief and rupture disc vents are resealed when the pressure differential across the valve has reduced to typically 50-60 % of the opening pressure. This device can be designed with pipes to direct the oil and gases to a safe point at ground level within the bunded oil containment area.

PROS

- It is designed to evacuate dangerous gases and oil. The valve can reseal after protection

CONS

- Can’t act fast enough to prevent explosions.
- The pressure relief valve is also not designed to protect against low-impedance faults.
- This solution cannot prevent tank rupture from an internal arc fault.
- The disadvantage over the rupture disc is that the opening time is longer and its venting path has higher flow resistance.

TRANSFORMER PROTECTOR vs ELECTRICAL/MECHANICAL PROTECTIONS

BUCHHOLZ RELAY

HOW IT WORKS

The Buchholz Relay serves to detect the buildup of gas in the relay due to discharge or overheating in the transformer. This detection triggers an alarm signal. Additionally, the relay identifies an oil surge from the transformer tank to the conservator and a drop in oil level below the relay's mounting height, both of which act as trip signals.

PROS

- It is considered the simplest form of transformer protection. And detects in the early stages the internal faults that can occur on the transformers.

CONS

- The Response time continues to be long. A minimum working time average: of 0.1 to 0.2 seconds.
- The relay is only detecting faults in cases when the level of oil is below normal.
- The Buchholz relay is not designed to protect against low-impedance faults.
- This solution cannot prevent tank rupture from an internal arc fault.

TRANSFORMER PROTECTOR vs ELECTRICAL/MECHANICAL PROTECTIONS

SUDDEN PRESSURE RELAY

HOW IT WORKS

The same as the Buchholz relay. There exist two types of pressure relief valves: pressure sensing and flow sensing. It can be used as an alarm only or as a protection operative device.

PROS

- It is designed as a system to save oil and gas whenever it detects a possible malfunction.

CONS

- Its implementation is technical and requires costly civil works on existing transformers.
- Its operation can damage the transformer in case of activation caused by a seismic event.
- Difficult to maintain, and high level of misoperations.

TRANSFORMER PROTECTOR vs ELECTRICAL/MECHANICAL PROTECTIONS

DIFFERENTIAL PROTECTION

HOW IT WORKS

Connected to current transformers that monitor the ampere-turn current across primary, secondary, and possibly tertiary windings, as well as any additional windings. The relay is triggered when the difference in ampere-turns between input and output surpasses a set bias level. Though this protection proves highly effective in identifying electrical faults within the transformer, its sensitivity is constrained by the necessary bias to account for inrush current and changes in ratio due to tap changer operations.

PROS

- Highly effective in identifying electrical faults within the transformer.

CONS

- Unless saturation is avoided, the difference in CT characteristics due to different ratios being required in circuits of different voltages may cause appreciable differences in the respective secondary currents whenever through-faults occur. This trouble is aggravated in the case of transformers due to unequal ratio CTs being employed on either side of the protected transformer. A source of ratio error that results in circulating currents under through-fault conditions is the unequal burden imposed on the CTs due to unequal lead lengths.
- Tap changing equipment is a common feature of a power transformer which effectively alters the turns ratio. Compensating for this effect by varying the tappings on differential-protection CTs is impracticable. Biased or percentage differential relays ensure stability with the amount of unbalance occurring at the extremities of the tap-change range. Biased relays are better suited to the overall protection of variable-ratio transformers.
- When the transformer is energized, the transient inrush of magnetizing current flowing into the transformer may be as great as ten times full-load current and it decays relatively slowly. This is bound to operate the Differential Protection of Transformers falsely. The magnitude of the magnetizing inrush current is a function of the permanent flux trapped in the transformer core and the instant on the voltage cycle when it is switched on.
- Additionally, it is not effective for protecting the transformer against external faults that do not cause a current imbalance between the primary and secondary terminals. Furthermore, differential protection is not suitable for protecting the transformer against internal faults that involve the core or the tank, such as core saturation, overheating, or oil leakage, as these do not produce a significant current difference.

TRANSFORMER PROTECTOR vs ELECTRICAL/MECHANICAL PROTECTIONS

CIRCUIT BREAKER

HOW IT WORKS

A circuit breaker is an electrical switch that operates automatically to safeguard an electrical circuit from harm resulting from overload or a short circuit. Its primary role is to identify a fault and, by interrupting the circuit's continuity, promptly halt the electrical flow. Unlike a fuse, which operates once and necessitates replacement, a circuit breaker can be reset—either manually or automatically—to restore regular functioning.

PROS

- Space-saving and cost-efficient solution to protect small transformers. It is designed to protect and disconnect the transformer.

CONS

- It can become expensive for transformers over 1,000 amps.
- It can be affected by extreme heat conditions.
- require constant maintenance. And A circuit breaker can wear out if it trips too many times.

TRANSFORMER PROTECTOR vs ELECTRICAL/MECHANICAL PROTECTIONS

Solution	TRANSFORMER PROTECTOR	Pressure relief valve	Buchholz relay	Sudden pressure relay	Differential protection	Circuit breaker
Protect tank rupture from internal arc fault	✓	✗	✗	✗	✗	✗
Protect against low impedance faults	✓	✗	✗	✗	✗	✗
Prevent fire from happening or to propagate and limit its consequences	✓	✓	✓	✓	✓	✓
Cannot be miss triggered by seism	✓	✗	✓	✗	✓	✓
Cannot be remotely altered by a Cyberattack	✓	✗	✗	✗	✗	✗
Fast signal to trip electrical Transformers	✓	✗	✗	✗	✓	NON APPLICABLE

TRANSFORMER PROTECTOR VS MONITORING SYSTEMS

COMPREHENSIVE GAS ANALYSIS SOLUTIONS

HOW IT WORKS

Multi-gas dissolved gas analysis (DGA) devices sense 7 fault gases, oxygen, and moisture. Options include load sensors, inputs/outputs, configurable alarms, and extensive communication protocols. Single-gas dissolved analysis (DGA) devices provide gas level alarms and real-time gas and moisture monitoring. They are easy to install and can communicate data back.

PROS

- As it is an alarm system, if the system is not compromised, they are good for delivering real-time information about the transformers which is useful for maintenance analysis and planning of the lifecycle of the asset. It is useful to monitor assets that are placed in remote settings from a single control room.

CONS

- It does not prevent tank rupture caused by internal arcing from the initiating fault.
- Can’t act fast enough to prevent explosions.

TRANSFORMER PROTECTOR vs MONITORING SYSTEMS

ENHANCED MONITORING SYSTEMS

HOW IT WORKS

- Bushing monitoring and partial discharge system continuously monitors transformer bushings and detects Partial Discharge (PD) activity in the main tank, providing early fault alerts and vital health information on bushings and the transformer.
- Tap gas dissolved analysis (DGA) allows monitoring of gas conditions within the tap changer, considering OLTC specificities.
- Transformer monitoring system collects real-time data from an array of sensors and delivers information based on IEEE/IEC standards transformer mathematical models.

PROS

- As it is an alarm system, if the system is not compromised, they are good for delivering real-time information about the transformers which is useful for maintenance analysis and planning of the lifecycle of the asset. It is useful to monitor assets that are placed in remote settings from a single control room.

CONS

- It does not prevent tank rupture caused by internal arcing from the initiating fault.
- Can’t act fast enough to prevent explosions.

TRANSFORMER PROTECTOR VS MONITORING SYSTEMS

EFFICIENT ANALYSIS AND REPORTING TOOLS

HOW IT WORKS

- Compact Portable Dissolved Gas Analysis (DGA) System performs laboratory-quality DGA on-site in 30 minutes, avoiding the need to send oil samples to a lab and wait for results. It expedites data communication to the operation and maintenance team.
- Software assists users in focusing their attention by visualizing and evaluating asset data, monitoring the entire fleet, setting alarms, analyzing issues using IEEE/IEC diagnostics, and monitoring critical situations.

PROS

- As most of them are alarm systems, if the system is not compromised, they are good for delivering real-time information about the transformers which is useful for maintenance analysis and planning of the lifecycle of the asset. It is useful to monitor assets that are placed in remote settings from a single control room.

CONS

- It does not prevent tank rupture caused by internal arcing from the initiating fault.
- Can’t act fast enough to prevent explosions.

TRANSFORMER PROTECTOR vs MONITORING SYSTEMS

System or Solution	TRANSFORMER PROTECTOR	Gas Analysis Systems	Enhanced Monitoring Systems	Analysis and Reporting Tools
Protect tank rupture from internal arc fault	✓	✗	✗	✗
Prevent fire due to tank rupture or internal arc fault	✓	✗	✗	✗
Prevent fire to propagate and limit its consequences	✓	✗	✗	✗
Detect and/or react to abnormal levels of gas caused by internal tank failure	✓	✓	✓	IN SOME CASES
Cannot be remotely altered by a Cyberattack	✓	✗	✗	✗

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