



FILTERALL Limited

INDUSTRIAL FILTRATION AND ALLIED SERVICES

Technical Specification Number S213 for Compact Transformer Oil Regeneration Plant,
rev Q 2013 www.filterall.com

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1. GENERAL

The Compact Regeneration Plant has been designed specifically for on-site use, to completely regenerate insulating oils in energized or de-energized transformer. The use of the Compact Regeneration Plant is suitable for regular oil purification (degassing, drying and filtration), but its main application is in the removal of acidity, sludge, other soluble oil decay products and discoloration while leaving the oil with an excellent oxidation stability and reduced gassing tendency. The complete Compact Regeneration Plant is mounted on a leak proof base (stationary) and can be installed and operated in a double axel trailer (mobile).

The unique feature which distinguishes FILTERALL's Compact Regeneration Plant from the other oil processing plants, is the ability to "regenerate" the oil continuously using a cyclic programme which reactivates the clay columns after oil processing is completed. Reactivation of Fuller's Earth is fully automated and enables the Compact Regeneration Plant to process oil again and again, using the same Fuller's Earth. Fuller's Earth does not need to be removed from the Compact Regeneration Plant for a period of up to two years. When finally removed (as dry, neutral sand) it can be used for building materials or similar. PLC controlled programme allows continuous oil regeneration in transformers without interrupting power transmission.

2. THE PERMASORB PROCESS

The main philosophy behind the development of the Compact Regeneration Plant was and still is the ability to economically fully regenerate used transformer oil on-site and energized. The concept of regenerating the oil within an energized or de-energized transformer is paramount. The regeneration or reclamation process requires that the deteriorated transformer oil be passed through an adsorbent "bed" such as Fuller's Earth. As the "Fuller's Earth treatment" removes the contaminants from the oil, the Fuller's Earth gradually becomes saturated and its regeneration capability decreases rapidly. At this point, the Fuller's Earth in the conventional plant must be replaced, in the Compact Regeneration Plant it will be reactivated. Since the spent Fuller's Earth retains its own weight of oil, Fuller's Earth replacement is wasteful, requires handling and is environmentally detrimental and costly to dispose of. "Reactivation" is preferable. The Compact Regeneration Plant contains Fuller's Earth in columns and the "Permasorb" process is the mechanism and control system that allows the Fuller's Earth in the columns to be repeatedly reactivated. Permasorb Fuller's Earth reactivation process is environmentally safe and clean.



Notes :-

- “Regeneration”, “Reclamation” or “Recycling” of old (aged), used transformer oil is the physical, not chemical process, usually including “Fuller’s Earth Treatment” that will restore the used oil to its original “as new” state, as defined by the BS 148 or IEC 296 specifications.
- “Sludge”, according to Myers, Kelly and Parrish in , “A Guide to Transformer Maintenance” (publ. S.D. Myers Inc. 2nd edition 1988), occurs as a result of the action of acids on the iron, copper, paints, varnishes etc. The products go into solution in the oil and eventually combine to form a sludge, which precipitates out and manifests itself a hygroscopic, partially conductive, resinous polymeric type substance.
- “Reactivation” of the Fuller’s Earth, is the process whereby the “activity” or “adsorptive properties” of the Fuller’s Earth are restored to their original active state.

3. PROCESS APPLICATIONS

The Compact Regeneration Plant is operationally very cost effective in a number of situations;

On –site Regeneration (Regeneration of Oil in Transformers):- Before undertaking regeneration of transformer oil on site, a sample of the oil will have been fully tested. The results of the test sample will determine to some extent, the regeneration and its parameters, but the gas analysis in particular will determine whether the transformer can be treated in the energized or de-energized state. In both cases however, the oil in the transformer is re-circulated for a period of time through the Compact Regeneration Plant.

a. Energized :- The flow rate with energized transformers is variable depending on transformer size and number of cycles is dependent on degree of contamination (acidity, sludge) etc... However, regeneration on-site will require 8-12 passes through the Compact Regeneration Plant.

b. De-energized :- Turbulence is not such an important factor with de-energized transformers and consequently the oil flow rate through the Compact Regeneration Plant can be increased to the maximum.

De-sludging :- De-sludging takes place at a higher temperature than oil regeneration. The two most important criteria for de-sludging to take place are:

- a) The temperature of the oil in circulation through the transformer must be over its aniline point of about 78°C, in order to re-dissolve the sludge and
- b) Oil supplied to the transformer during circulation must be freshly regenerated to be able to dissolve and absorb sludge.

Note :

- (sludge precipitated out of oil is re-dissolved in the same hot transformer oil. The temperature at which the sludge becomes “Soluble” is indicated by the aniline point of the oil)
- (IFT should be > 40 dynes/cm)



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a. Energized:- The process is very efficient and is aided by the slight mechanical vibration and heat generated by the energized transformer. Between 30-60 passes may be necessary to complete the task.

b. De-energized - Less efficient than a) above and de-sludging takes longer, depending on the size of the transformer.

Tank-to-Tank Regeneration:- To utilize Fuller's Earth to the best efficiency flow should be reduced to 20-25% of the nominal (full) flow.

4. PROCESS DESCRIPTION

The Compact Regeneration Plant is connected by hoses to the transformer in a closed-loop arrangement and the entire system including hoses, is filled with oil before processing is initiated. The oil is pumped from the bottom of the transformer through the Compact Regeneration Plant and returned to the top of the unit being treated.

The Permasorb process combines two separate options; purification and regeneration.

Regeneration is a cyclic two phase processing procedure, a phase, followed by a reactivation phase. Operating temperatures and flow rates are determined by the type of application and the degree of contamination as determined by earlier sampling and testing.

Processing Phase:- Purification and Regeneration constitute the processing phase which lasts for about 8 hours. Flow rate of oil according to the application, is adjustable from 20 to 100% of nominal capacity.

Purification:- Purification as an operation on its own is only limited to moisture extraction, degassing and particulate filtration using: high vacuum, heat and fine filtration (0.5 micron) while maintaining the oil at 65-70°C.

Regeneration :- In the Permasorb process, the oil is regenerated by forced percolation through "activated Fuller's Earth" columns at about 70°C. After regeneration, the oil is further degassed before passing through a 0.5 micron filter back into the transformer.

Note :

"Regeneration" is required when "purification" on its own is unable to upgrade the insulating properties of the oil due to high acidity, sludge and chemical contamination from other oil decay products. During regeneration, degassing and drying also takes place, but the main function is to extract, by adsorption in the "clay columns", acid contaminants and other soluble and colloidal oil decay products.

Adsorption efficiency is maximized at the processing temperature of about 60-70°C.

Reactivation phase:- After having circulated nominal quantity of oil, the Fuller's Earth bed is usually quite saturated and their efficiency drops off sufficiently to justify reactivation. At this point the hot oil circulation through the purification section continues. The Fuller's Earth is reactivated in columns and a small quantity (0.2% of oil processed) sludgy contaminants recovered as oily scum are collected in a holding tank before being drummed for re-sale and re-processing, or for waste disposal. The clean oil trapped in the clay is recovered. After the reactivation phase, which lasts for about 14-16 hours, the processing phase is re-initiated.



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Controls & Instrumentation :- Operation and control of the regeneration plant is by PLC (process logic controller), interfaces with a Data Supervisory management system, based on Windows operating 32 Bit software. This enables the plant to run virtually unattended but where required, the operator interfaces with the plant by means of a standard computer. Plant status such as alarms, flow rate, pressures, litres processed etc... are constantly displayed, as well as logged to a hard disk. Employing the above control system enables Filterall to offer the following optional extra features to improve safety or operation during regeneration.

- a) Accurate oil level monitoring of transformer.
- b) Accurate oil level monitoring of storage tanks.
- c) Oil test data storage facility example (di-electric strength, water content, acidity etc...)

All associated instrumentation and pneumatic controlled equipment is of the highest and proven quality.

Precautions :- In the event of temporary power failure, emergency shut-down procedures are automatic. All motors are overload protected and alarms and interlocks ensure safe and simple operation. Back-up automatic safety systems are included especially connected with oil heating, oil flow, vacuum, oil foaming, air entrapment and discharge oil quality.

Notes:

- The “clay columns” consist of a structure bed of various activated clays and activated alumina. The “structuring” addresses the need to maintain constant repetitive percolation characteristics and residence times through many reactivation cycles.
- Hot oil circulation is maintained during reactivation . This ensures, in the case of de-energized transformers, that there is no layering of the oil due to temperature differences. In any event, for de-sludging a hotter oil temperature is required in order to re-dissolve the sludge which can then be removed during the next processing cycle.

Oil Spillage Contingency :- FILTERALL have developed a unique triple oil spillage contingency for maximum environmental protection.

Supervisor :- Two operators are required for plant set-up. Thereafter one operator is required to monitor plant only. Operators active (manual) work is typically 1-2 hours per 24 hours period. Actual starting and stopping are automatically and reliably executed by the PLC program.

5. TECHNICAL DATA

Plant :- The Compact Regeneration Plant is mounted in a leak proof base equipped with lifting hooks. Access doors supported on gas struts for operation and maintenance are provided.

Inlet Pump :- Oil flow rate is variable between 10% to 100% rated capacity.

Inlet Strainer :- Gross particle removal; porosity 125 micron.

Oil Heating :- Low watt density heaters are supplied (max 1.7 watt/cm heating capacity).

Vacuum Pump :- Direct driven, high efficiency rotary vane (0.5mb).

Clay Treatment :- Mild steel columns are filled with structured activated clay packing.

Polishing Filter :- Porosity 0.5 micron.

Discharge Pump :- High suction, centrifugal.



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Gas Demister :- Closed system, will demist vapours from vacuum pumps before discharging to the OCU unit.

Odour Emission Unit :- Odour converter is fitted to reduce smell and CO emissions from the plant.

Oil Storage Tank :- Steel tank, rectangular configuration, for intermediate storage of oil during reactivation of Fuller's Earth.

Electrical Supply :- (3-ph 50Hz, 380/240V) or (3-ph 60Hz, 480V) or (3-ph 60Hz, 460V)

Affluent :- Air and neutral gases. MRP1/609-D600 - 15m³ /hr.

Plant Efficiency :- Oil loss, max 0.2% of initial volume..

Weight & Dimensions :- See separate Flow Schematic

Hoses:- Inlet hose 10m long nitrile rubber. Outlet hose 10m long nitrile rubber.
Both hoses equipped with kam-lock quick connectors

6. DUTY & PERFORMANCE

Plant Efficiency:- High and consistent efficiency of Compact Regeneration Plant ensures complete treatment of oil (either in a transformer or in a single pass operation) to comply with IEC publication 296 for new oils.

Plant Capacity:- Capacities (See Flow Schematic) is based on initial acidity of 0.2mg KOH/g of oil. At different initial acidity, new capacity will be in inverse proportion to new initial acidity. The plant will regenerate approximately 1200-1500 litres of oil with an acidity of 0,2 mg KOH/gm oil before reactivation of the Fuller's Earth is required.

Test Description	Method	Unit	Initial Oil Condition	Single Pass Quality
Moisture	IEC 733	PPM	<100	5
Breakdown Voltage	IEC156	Kv	<20	>70
Acidity	IEC296	mg KOH/g	0.2	<0.03
Tan Delta 90c	IEC247		<0.01	<0.005
Inter facial tension	ASTM	Dynes/cm	<15	>35
Colour appearance		Visual	Brown/ Cloudy	Clear Light Yellow
Gas content	GC	%v/v	8	0.1
Oxidation stability	IEC74 164 hours		Depleted	Restored



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7. OPTIONAL EQUIPMENT

Transformer Oil Level Monitor (Option L):- During oil processing it is important to monitor the oil level in the transformer. Filterall plant will not alter oil level in the transformer. Therefore if oil level falls below specific level, an oil leakage between transformer and plant is evident. An automatic valve at the bottom of the transformer (suction) will shut down and the non- return valve at the top of the transformer (discharge) will not allow oil drainage from the transformer. Oil level is monitored by level transducer, inserted into any opening in the transformer body. This system is important for environmental protection as well as safety of operation.

Electric Cable (Option E):- Electric cable, flexible 4 core 10m long suitable for full power load of the plant.

Trailer: (Option M):- The Compact Regeneration Plant is mounted on a double-axle trailer. The chassis is steel and the body cover is mild steel with aluminium roof. Access doors supported on gas struts for operation and maintenance are provided. The trailer is equipped with overrun brakes.

8. GUARANTEES

Mechanical Guarantee:- FILTERALL guarantees the machinery supplied under this specification against defects in material and workmanship under normal use and service for a period of 12 months from date of shipment. FILTERALL's obligation under this warranty is limited to repairing or furnishing without charge, F.O.B. Point of manufacture similar part to replace any part, which within warranty period is proven defective. FILTERALL shall not in any event be held responsible for any specials, indirect or consequential damages.

Performance Guarantee:- FILTERALL guarantees that the performance of the equipment will be within limitations as detailed in "Duty and Performance" in this specification.

9. DOCUMENTATION

One copy of the Operating & Maintenance Manual is supplied with each Compact Regeneration Plant in CD format.



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10. TYPICAL PLANT PICTURES



***FILTERALL RESERVES THE RIGHT TO CHANGE ANY PART OF
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