



FILTERALL Limited

INDUSTRIAL FILTRATION AND ALLIED SERVICES

Technical Specification Number S214 for Compact Transformer Oil Regeneration Plant Type
RPA rev Q 2013 www.filterall.com

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1. GENERAL

The Regeneration Plant Attachment has been designed specifically for on-site use, to completely regenerate insulating oils in energized or de-energized transformers. The use of the Regeneration Plant Attachment is in the removal of acidity, sludge, and other soluble oil decay products and discoloration while leaving the oil with an excellent oxidation stability and reduced gassing tendency. The complete Regeneration Plant Attachment is mounted on a leak proof base (stationary) and can be installed and operated in a double axle trailer (mobile).

The unique feature which distinguishes FILTERALL's RPA from conventional oil regeneration 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 Regeneration Plant Attachment to process oil again and again, using the same Fuller's Earth. Fuller's Earth does not need to be removed from the Regeneration Plant Attachment 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 Regeneration Plant Attachment was and still is the ability to economically fully regenerate used transformer oil on-site. 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 Reactivation Plant Attachment 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 Reactivation Plant Attachment 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 Regeneration Plant Attachment (RPA) cannot work independently. This plant was specifically developed to work in conjunction with existing oil purifiers (mobile and stationary) in the market place. Investigation has revealed that most makes of purification plants, not only Filterall type, can be adapted to work in conjunction with the Regeneration Plant Attachment unit.

Before operation can commence, the existing purification plant needs to be modified slightly to enable the Regeneration Plant Attachment to work in conjunction with it. These modifications normally entail the addition of 3 valves in to the plant. Once modifications are completed the operation can start.

Operations:- The oil inlet to the existing oil purifier is connected to the used transformer oil tank or to a transformer. The oil is then drawn in by the purification plant inlet pump and passed through a heater where it is heated at 60 deg C. Thereafter the oil through a selection of diverting valves is sent to the RPA unit for regeneration. Once the oil leaves the fullers earth columns of the RPA , it returns to the purification plant. Entry to the purification plant is before the fine filter. Once regenerated, the oil is filtered by the existing purification unit where after it then passes through the vacuum chamber and is eventually discharged back to the transformer or storage tank.

Note:- Free water should be drained from the used transformer oil tank and transformer prior to commencement of regeneration. Inlet connection on used transformer oil tank should be at least 200mm above the drain connection.

The RPA process contains two operations, namely oil regeneration and clay reactivation.

Oil Regeneration:- The oil is pumped from the existing oil purifier into fullers earth percolating columns. Oil percolates through fullers earth columns. Correct oil treatment temperature and optimum contact time with the fullers earth is controlled automatically by the purifier. Solid and liquid contaminants are removed from the oil and retained in the fullers earth. In the process of regeneration, oil is also dehydrated down to 5ppm. Oil is not degassed in the Process of regeneration. Oil degassing will be carried out by the existing oil purifier. Regenerated oil is then discharged to the purifier. After having processed an amount of oil corresponding to the capacity of the RPA , the fullers earth in columns will be reaching saturation point and its regeneration capacity will be reduced.



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Reactivation:- At this point an operator will decide to discontinue oil regeneration and to commence the reactivation cycle. The fullers earth is reactivated (cleaned in situ) in the columns and the contaminants trapped by the fullers earth are collected in a form of an oily sludge, representing less than 0,2% of processed oil. After the reactivation phase, which last for 14 - 16 hours depending on the contamination of the oil being regenerated, the processing phase is re-instated by the purification plant valve selection.

Controls and Instrumentation:- Operation and control of the regeneration plant is by PLC, programmable logic control system. This enables the plant to run virtually unattended but where required, the operator interfaces with the plant by means of switches installed on the plants control panel mimic. All associated instrumentation and pneumatic controlled equipment is of the highest and proven quality.

Precautions:- In the event of temporary power failure, emergency shutdown procedures are automatic, and restart is done by the operator once power is restored. All motors are overload protected and alarms and interlocks ensure safe and simple operation.

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

Note:

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.

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 degree the regeneration required, 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 Regeneration Plant Attachment.

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

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

Desludging :- 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.
- b) Oil supplied to the transformer during circulation must be freshly regenerated to be able to dissolve and absorb sludge.

Desludging of the transformer can be carried out in the energized and de-energized state.



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Notes:

- (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)
- a. Energized:-** The process is very efficient and is aided by the slight mechanical vibration and heat generated by the energized transformer. Between 30-6-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 nominal (full) flow.

Note:-

When working on energized transformers it is imperative that the existing purification plant is designed to work on energized transformers. All responsibility for this operation rests on the owner of the purifier and not FILTERALL.

4. TECHNICAL DATA

Leak proof skid:- The RPA is mounted on a steel leak proof base.

Gas Demister:- Closed system, will condense vapours from the reactivation pump before discharging to the OCU unit.

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

Electrical Supply:- 3-ph 50Hz, 380/420V , 3-ph 60Hz, 600V OR 3-ph 60Hz, 460V

Effluent:- Air and neutral gases:

Plant Efficiency:- Oil loss, max 0,3% of initial volume.

Environment:- RPA should operate inside the building with minimum temperature of +5 C. IF operations are outside plant should be installed in a suitable enclosure. These enclosures can be mobile trailers, sea freight containers or installed on the back of a box covered truck.

5. DUTY & PERFORMANCE

Plant Efficiency:- High and consistent efficiency of RPA ensures complete treatment of oil to comply with IEC publication 296 for new oils.

* Continuous operation 30 days per month

* Initial oil acidity of 0,2 mg KOH/g of oil.

Plant Capacity:- At different initial acidity, new capacity will be in inverse proportion to new initial acidity.



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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

Notes:

1. Single pass quality performance can vary due to old oil contamination levels.
2. Performance of moisture, breakdown voltage, solid particle removal and gas content will be determined by the oil purification plant of the client.

6. OPTIONAL EQUIPMENT

Twenty Foot Container (Option 20):- Installation in a 20 foot dry sea freight container with doors, windows and operators space.

Fourty Foot Container (Option 40):- Installation in a forty foot sea freight container with space for laboratory and accommodation.

Cold and Hot Weatherproofing (Option W2):- Cold and hot weatherproofing for operation above 30 C or below 0 C. Heat insulation, and ventilation is included with this option in the laboratory area.

Electric Cable (Option E):- Electric cable, flexible 40m long suitable for full power load of the plant.

Semi – Trailer (Option S):- The RPA is mounted on a single or double-axle, super single or double wheeled semi- trailer. The chassis is steel and the body cover is composite material. The trailer is equipped with twin line air-brakes.



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Note:

A lowering of interfacial tension indicates contamination by POLAR contaminants. There is a great deal of data that would seem to link increased acidity with a lowering IFT."A Guide to Transformer Maintenance", S.D. Myers, J.J. Kelly, R.H. Parrish (Publ. S.D. Myers Inc. 2nd ed. 1988)

Mobile Installation: (Option M):- Is on a roadworthy trailer, for RPA 1/609 on a compensating double axel trailer, is of steel weatherproof construction. The trailer is equipped with a 2" ball tow hitch and an Over- ride brake as standard. Access to the machinery is through two double doors at the rear end of the trailer and side doors are fitted where required. Internal illumination is provided for lighting up the working area. On mobile units, an extra precaution is taken to prevent incorrect rotation of equipment by means of a Phase Sequence Relay and automatic interlock.

Portable Installation (Option P):- Similar to mobile installation two swivel and two fixed castors are used to move the RPA around the factory floor. (Only for plant RPA 1/609).

7. COMMISSIONING

A Commissioning Engineer will be available for start-up service and training for client's operators at an extra cost. Since Filterall regeneration plants are very easy to operate, commissioning is not usually required.

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 and Maintenance Manual is supplied with each Compact Regeneration Plant in CD format.



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TYPICAL PLANT PICTURE



FILTERALL RESERVES THE RIGHT TO CHANGE ANY PART OF THIS SPECIFICATION WITHOUT NOTIFICATION.