



FILTERALL Limited

INDUSTRIAL FILTRATION AND ALLIED SERVICES

Technical Specification Number S211 for Mobile Oil Regeneration Plant (For recycling of Transformer oil on site) Type MRP rev Q 2013 www.filterall.com

CONTENTS

1. GENERAL
2. THE PERMASORB PROCESS
3. PROCESS APPLICATIONS
4. PROCESS DESCRIPTION
5. TECHNICAL DATA
6. DUTY & PERFORMANCE
7. OPTIONAL EQUIPMENT
8. GUARANTEES
9. DOCUMENTATION



FILTERALL Limited

INDUSTRIAL FILTRATION AND ALLIED SERVICES

Technical Specification Number S211 for Mobile Oil Regeneration Plant (For recycling of Transformer oil on site) Type MRP rev Q 2013 www.filterall.com

1. GENERAL

The MRP (Mobile Regeneration Plant) has been designed specifically for on-site use, to completely regenerate insulating oils in energised or de-energised transformer. Although use of a MRP is not a substitute for regular oil purification (degassing, drying and filtration), it does carry out the same functions; but its main application is in the removal of acidity, sludge, other soluble oil decay products and discolouration while leaving the oil with an excellent oxidation stability and reduced gassing tendency. The complete MRP is mounted on a leak proof base and can be installed and operated in a semi-trailer, truck or sea freight container.

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

2. THE PERMASORB PROCESS

The main philosophy behind the development of the MRP 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 Fullers 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 FILTERALL's MRP 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 MRP 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:-

1 “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.

2 “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.

3 “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 MRP is operationally very cost effective in a number of situations. Although the unit was designed so that it could be moved from one transformer site to another, the unit’s versatility and efficiency has not been compromised by its mobility :

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 MRP.

a. 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 MRP.

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

De-sludging :-

De-sludging takes place at a higher temperature than oil regeneration. The 2 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 redissolve the sludge and

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

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

Notes :-

1. Sludge precipitated out of oil is re-dissolved in the same hot transformer oil. The temperature at which the sludge becomes “Soluble” is indicated bythe aniline point of the oil.

2. IFT should be > 40 dynes/cm)



FILTERALL Limited

INDUSTRIAL FILTRATION AND ALLIED SERVICES

Technical Specification Number S211 for Mobile Oil Regeneration Plant (For recycling of Transformer oil on site) Type MRP rev Q 2013 www.filterall.com

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.

De-energized :-

Less efficient than Energized 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 MRP 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 MRP 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 procedure, a processing 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.



FILTERALL Limited

INDUSTRIAL FILTRATION AND ALLIED SERVICES

Technical Specification Number S211 for Mobile Oil Regeneration Plant (For recycling of Transformer oil on site) Type MRP rev Q 2013 www.filterall.com

Reactivation Phase:-

After having circulated nominal quantity of oil, the Fuller's Earth beds are 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 16 hours, the processing phase is re-initiated by pressing a single function key on the keyboard.

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.

Notes :-

1. 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.
2. 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.

Precautions:-

In the event of temporary power failure, emergency shut down procedures are automatic and restart is done by the operator, once power is restored. No automatic starts are permissible due to the safety concerns on energized transformers. 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 quantity.

Oil Spillage Contingency:-

FILTERALL have developed a unique triple oil spillage contingency for maximum environmental protection.



FILTERALL Limited

INDUSTRIAL FILTRATION AND ALLIED SERVICES

Technical Specification Number S211 for Mobile Oil Regeneration Plant (For recycling of Transformer oil on site) Type MRP rev Q 2013 www.filterall.com

Operator:-

Operator enters global commands only via keyboard, or computer mouse, such as start and stop processing etc. Actual starting and stopping then automatically and reliably executed by PLC programme. Operator can access plant only after he has logged himself via his own password as a current operator.

Supervisor:-

Supervisor can use stored data to analyse performance of the plant as well as the operator. Management has a powerful tool to optimize oil processing operation.

5. TECHNICAL DATA

Trailer:- The MRP is mounted on a single or double axel, super single or doubled wheel semi-trailer. The chassis is steel and the body cover is composite material. The trailer is equipped with twin line air brakes.

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

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

Inlet Filter:- Porosity 30 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).

Vacuum Booster:- Direct driven, roots type vacuum booster ultimate vacuum (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.

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

Effluent :- Air and neutral gases.

Electric cable :- Electric cable suitable for full power load of the plant.

Plant efficiency :- Oil loss, max 0.3% of initial volume.

Hoses :- Inlet, nitrile single wire. Outlet, nitrile single wire. Lengths dependant on Trailer length or Client's requirements. Both hoses are equipped with quick connectors and stored in protective pipes below the floor of the trailer.

Table tops :- Built in table top mounted on anti-vibration pads. A drawer for storage of documents is also supplied.



FILTERALL Limited

INDUSTRIAL FILTRATION AND ALLIED SERVICES

Technical Specification Number S211 for Mobile Oil Regeneration Plant (For recycling of Transformer oil on site) Type MRP rev Q 2013 www.filterall.com

6. DUTY & PERFORMANCE

Plant Efficiency:- High and consistent efficiency of MRP Ensures complete treatment of oil (being it 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.

Test Description	Method	Unit	Initial Oil Condition	Single Pass Quality
Moisture	IEC 733	PPM	<200	5
Breakdown Voltage	IEC156	Kv	<30	>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

CONTINUOUS OPERATION (OPTIONAL):- To maintain continuous processing, the Fuller's Earth on the plant can be supplied with dual recycling columns. This will enable the operator to still process through Fuller's Earth (1st module), while reactivating (cleaning) second module.



Technical Specification Number S211 for Mobile Oil Regeneration Plant (For recycling of Transformer oil on site) Type MRP rev Q 2013 www.filterall.com

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.

Power Generator (Option G):- Power generator provides sufficient power for proper plant operation. If power supply is available, generator need not be used.

Cable Reel (Option C):- Spring return reel suitable for flexible electric cable facilitates easier handling of cable on site.

Semi-Trailer: (Option S)- The MRP 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.

Trailer Body Specifications:-

External Body Dimensions - To be advised once size of plant to be purchased is known.

Front, Side Walls and Rear - 23mm thick panels consisting of inner and outer fibreglass skins with 18mm phenol bonded ply between skins.

Roof - 50mm thick roof insulated with 45mm polyurethane foam and inner and outer G.R.P. skins.

Panel Finish - Our internal and external panel finish will be white high gloss G.R.P. Sheeting joint free.

Double Rear Doors - Fully opening double rear doors fitted into a rear door frame (frame opening 2520mm x2420mm).

Floor - 3mm steel deck.

Trailer Specifications:- Dimensions - See body dimensions above.

Suspension and Axles - "GO" or "Henred" mechanical suspension with 127mm diameter axles.

Braking - To SABS (South African Bureau of Standards) specifications.

Tyres and Rims - 5 off 12R22, 5 Continental Super single tyres and rims fitted in single wheel formation

Spare Wheel and Carrier - One spare wheel with basket type spare wheel carrier fitted.

Landing Legs - "Jost" A420G leg gear.

Toolbox - Lockable toolbox fitted.

Additional:

- a. Two sliding windows
- b. Small doors on sides
- c. Front door
- d. Cable box
- e. Aluminium checker plate on floor
- f. 6mm ply under internal skin in roof
- g. marker lights



FILTERALL Limited

INDUSTRIAL FILTRATION AND ALLIED SERVICES

Technical Specification Number S211 for Mobile Oil Regeneration Plant (For recycling of Transformer oil on site) Type MRP rev Q 2013 www.filterall.com

Safety Bars - Safety bars are included on both sides of the trailer.

Lights and Wiring - DIN 7 pin socket, 24V system, dual combination stop, tail and separate indicator lights.

Trailer Heating - The trailer will be equipped with 3 electrical heaters (one in the column section, one in the plant section and one in the operator section). There will be a separate electrical connection for these heaters when the plant is stored on site. This is important to keep the plant in the trailer warm when in storage and prior to starting the plant.

Once the plant operates the heaters can be turned off.

The following are also included in the trailer:

- a. Two sliding windows
- b. Small doors on sides
- c. Front door
- d. Cable box
- e. Aluminium checker plate on floor
- f. 6mm ply under internal skin in roof
- g. Partition with door and window.
- h. Two off double side doors complete with access steps and grab handles.

The above trailer specification is a general specification outlining the design parameters and materials of construction which could change from plant to plant. Please make sure you check your local road ordinances to confirm if the above trailer conforms to their requirements. If not, please come back to us with requirements and we can re-quote you on any other requirements your local ordinances would require.

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

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

Cold Weatherproofing(Option W1):- Weatherproofing for operation below 0°C, including heat insulation, heating and ventilation.

Cold & Hot Weatherproofing (Option W2):- Weatherproofing for operation above 35°C or below 0°C. Heat insulation and ventilation is included with this option in the laboratory area.



FILTERALL Limited

INDUSTRIAL FILTRATION AND ALLIED SERVICES

Technical Specification Number S211 for Mobile Oil Regeneration Plant (For recycling of Transformer oil on site) Type MRP rev Q 2013 www.filterall.com

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.

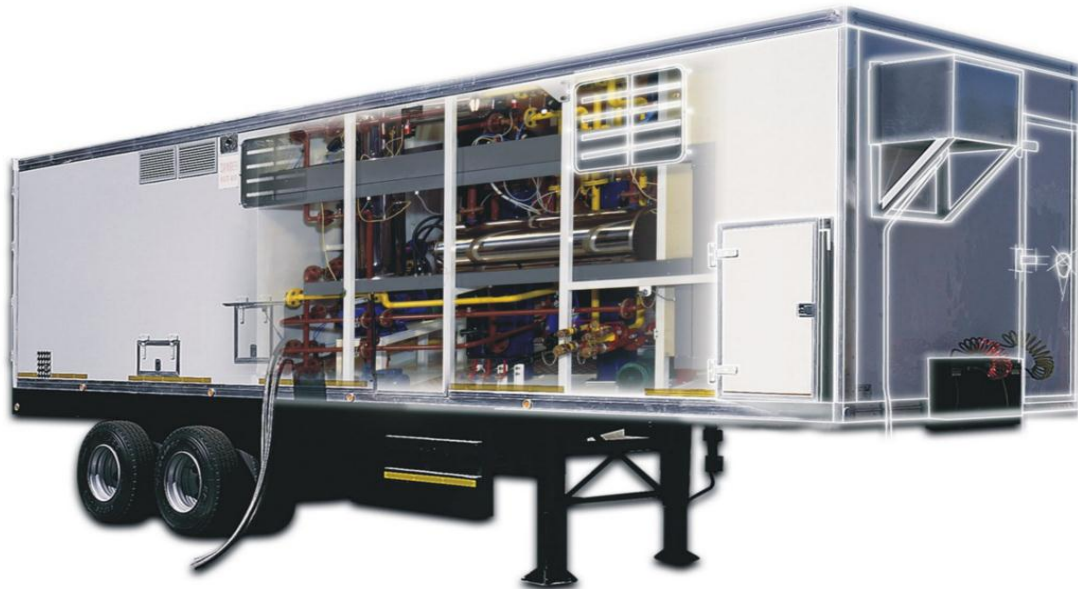
Performance Guarantee:-

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 MRP in CD format.

Mobile Regeneration Plant



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