

- ▶ GAS REMOVAL
- ▶ WATER REMOVAL
- ▶ ACID & SLUDGE REMOVAL
- ▶ COLOUR RESTORATION
- ▶ PARTICULATE MATTER REMOVAL
- ▶ CORROSIVE SULFUR REMOVAL

- DEGASSIFICATION
- DEHYDRATION
- DEACIDIFY
- DESLUDGE
- FILTRATION
- COLOR IMPROVMENT

November 2019

ECOIL Transformer Oil Regeneration System

ADDRESSING THE NEEDS OF ELECTRICAL TRANSFORMERS AND ADDING "VALUE" TO SUCCESSFUL OPERATION.

The ECOIL Mobile Regeneration System (Model RS-M and RS-S) has been specifically designed for onsite use to completely regenerate insulating oils in energized or de-energized transformers.

Proven technology with best track record in industry

*The ECOIL system provides regular oil purification such as degassing, drying and particulate removal **but its main application** is in the removal of acidity, sludge, other soluble oil decay products and corrosive sulfur as well as bring the oil back to its original colour.*

This is accomplished by the use of high vacuum de-gasification technology and particulate filters combined with our special blend of Absorbent Media.

The Ecoil System is mounted on a spill containment basin and can be installed and operated on a semi-trailer or sea freight container.



TECHNICAL SPECIFICATION

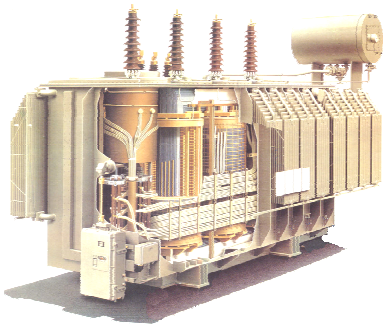


Address: 5111 Fountain St. N., Breslau, ON, N0B 1M0 Canada

Phone No.: 1 (519) 653 6464

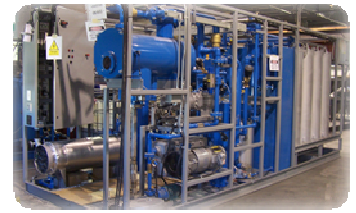
Fax No.: 1 (519) 648 2323 E-Mail: sales@filtervac.com

www.filtervac.com



Scope of Supply

The scope of supply of this specification shall include the design, fabrication and factory testing of a Transformer Oil Regeneration System Model Ecoil.



1. GENERAL DESCRIPTION

The unique feature, which distinguishes the ECOIL System (Model RS-M and RS-S) from other mobile or stationary oil processing plants, is the ability to **reactivate** the used Fullers Earth. The ECOIL's reactivation process is fully automated and enables the system to process oil again and again using the same clay. With the use of this process the clay need not be removed from the ECOIL System for a period of up to two years or 300 + reactivations. When finally removed as dry neutral sand, it can be disposed of as non-hazardous substance and be used for building materials. Computer-controlled program allows for continuous oil regeneration in transformers without interrupting power transmission.

The transformer regeneration system is used to treat the following parameters:

- Reduce oil acidity
- Improve oil color
- Improve oil Interfacial tension
- Remove corrosive sulfur from oil
- Improve the Power Factor
- Optional corrosive sulfur treatment

DURASORB PROCESS:

The driving force behind the Development of the **ECOIL System** was and is still the ability to economically fully regenerate used transformer oil within an energized or de-energized transformer.

Regeneration of transformer oils is needed when the transformer oil has deteriorated to a level whereby regular oil purification (degasification & filtration) is no longer adequate. The regeneration or reclamation process requires passing the deteriorated transformer oil through an adsorbent media such as Fuller's Earth or activated clay.

Filtervac offers a variety of options to meet the customer's specific requirements.

Filtervac's team of Sales Personnel, Engineers and Designers work together with customers with focus on:

- *High safety standards*
- *Accessibility and serviceability*
- *Cost effective design*

Using the most up to date mechanical design Software packages (3D & 2D) to create a real life image of the system before it is built.

As the adsorbent media removes the contaminants from the oil, the clay gradually becomes saturated and its filtration efficiency is steadily reduced until its adsorptive capabilities have been maximized.

The **ECOIL System** allows for the reactivation of the special blend of media and avoids all the complications and costs associated with typical oil processing units. It has been recognized that after initial reactivation, the media's adsorptive capability is enhanced and provide better results than virgin Fullers Earth type media. The ECOIL System contains media in the columns and the Durasorb Process is the mechanism and control system that allows the media in the columns to be repeatedly reactivated.



2. PROCESS APPLICATIONS

The **ECOIL**

System was designed to be operationally cost effective in a number of situations.

INSITU REGENERATION:

Before undertaking regeneration of transformer oil insitu, sample (Regeneration of oil in transformer) of oil will have to be taken and tested. The results of the test sample will provide an estimate on the duration of the regeneration and its parameters, but the gas analysis in particular will determine whether the transformer can be tested in the energized (invivo) or de-energized state. Regardless of which method is utilized, the oil in the transformer is re-circulated for a period of time through the ECOIL Mobile System.

- I. **Invivo-Energized:** The flow rate with energized transformers is variable from 2000 l/hr (depending on transformer size) to 5000 l/hr and number of cycles is dependent on degree of contamination (acidity, sludge, color) etc. However, regeneration invivo will require 2 to 12 passes through the ECOIL Mobile System depending on the level of oil contamination.
- II. **De-energized:** Turbulence is such an important factor with de-energized transformers and consequently the oil flow rate through the system can be increased to a maximum of 5000 l/hr.

DESLUDGING:

Desludging takes place at a higher temperature than oil regeneration. The two most important criteria for desludging 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 dissolve sludge.

Transformer Solid Insulation

- *Life of transformer is highly effected by the life of insulation*
- *Insulation represents the weakest point in the transformer*
- *It is critical to maintain the insulation system in any transformer*
- *Damage to insulating paper is irreversible*

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

- I. **Invivo:** The process is very efficient and is aided by the slight mechanical vibration and heat generated by the energized transformer. Between 2 - 20 passes may be necessary to complete the task depending on level of oil contamination.
- II. **De-energized:** Less efficient than Invivo method and desludging takes longer, depending on the size of the transformer.
- III. **Tank-to-Tank Regeneration:** To utilize Fuller Earth to the best efficiency flow should be reduced to 20-25% of the nominal (full) flow.



3. PERFORMANCE

Plant Efficiency High and consistent efficiency of the system ensures complete treatment of transformer oil to comply with IEC publication 296 for new oils. In most cases it is possible to reach better parameters than offered by brand new oil. **Plant capacity:** is based on initial acidity of 0.2mg KOH/g of oil.

TABLE 1: PERFORMANCE ANALYSIS



TEST DESCRIPTION	METHOD	UNIT	INITIAL OIL CONDITION	RS-M 5000 SINGLE PASS QUALITY
ACIDITY	IEC 296	mg KOH/g	0.25	<0.03
COLOR APPEARANCE	--	Visual	 Brown/Cloudy	 Clear Light Yellow
BREAKDOWN VOLT	IEC 156	KV	<30	>70
MOISTURE	IEC 733	ppm	<2000	5
TAN DELTA (90 C)	IEC 247		<0.01	<0.005
IFT	ASTM	Dynes/cm	<15	>35
GAS CONTENT	GC	% v/v	8	0.01
OXIDATION STABILITY	IEC74 164 hrs	--	Depleted	Restored

TABLE 2: COMPARISON OF IEEE RECOMMENDED OIL QUALITY STANDARDS VS.

RS-M TYPICAL PERFORMANCE

TEST DESCRIPTION	ASTM METHOD	IEEE STANDARDS	RS-M PERFORMANCE
DIELECTRIC STRENGTH (kV)	D 877	30	40
WATER CONTENT (mg/kg)	D 1533	35	5
NEUTRALIZATION VALUE; mg KHOH/g	D 974	0.05	0.03
POWER FACTOR @ 100 C	D 924	1	0.4
INTERFACIAL TENSION (mN/M)	D 971	35	40
OXIDATION STABILITY 164	D 2440	0.5	0.4
Neutralization value mg KOH/g		0.25	0.10
Sludge (% by mass)			

The typical system consists of the following components:

1. Inlet Basket Strainer
2. Inlet Oil Gear Pump
3. Inlet Filter
4. Electrical Heater
5. Flow Meter
6. Clay Treatment Columns
7. Column Blower
8. Clean Oil Storage Tank
9. Dirty Oil Tank
10. Emission Control Purifier
11. Processing Vacuum Chamber c/w Oil Level Controller
12. Vacuum Pump
13. Vacuum Booster
14. Oil Trap
15. Oil Discharge Pump
16. Fine Filter (Aft-Filter)
17. Flow Meter
18. Inlet & Outlet Sampling Ports
19. Inlet and Discharge Valves and Connections
20. Auto In-Plant Recirculation Valve
21. Piping and Process Valves
22. Control Panel Instrumentation and Controls
23. Semi-Trailer

4. PROCESS DESCRIPTION

The ECOIL Mobile System 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. Once the System is filled, the oil is automatically **re-circulated** for a minimum of 10 minutes through the inlet and outlet hoses to ensure that all air is eliminated from the system. A set of manual air eliminators and several automatic valves are located near the transformer to provide safe and reliable re-circulation of oil within the system whilst providing the up most assurance that air will not be entering to the transformer. After sufficient re-circulation, the oil in the transformer is ready to be processed.

An operator has the choice of two (2) separate operating conditions in which he may treat the oil, **purification** or complete **regeneration**. This decision is based on oil analysis done prior to the processing of the oil. Operating temperatures and flow rates must also be determined and these decisions are determined by the type of application and the degree of contamination as determined by earlier oil analysis. Regardless of which process is chosen, the oil is pumped from the bottom of the transformer through the ECOIL System and returned to the top of the unit after being treated.

PURIFICATION:

Purification as an operation on its own and is only limited to moisture extraction, degassing and particulate filtration. The oil enters the system whereby it is heated by a set of electric heaters (designed to bring and maintain oil at (65-70°C) before pumping through a pre-filter (rated at 5 microns) and a fine filter (rated at 0.5 microns). From filters it is entering to the Vacuum Chamber. In the Vacuum Chamber the oil passes through fibreglass coalescing elements where it is exposed to high vacuum and is degassed and dehydrated before it is pumped out as processed oil.

REGENERATION:

Regeneration operating condition consists of two phases:

- a) Processing Phase: In the Durabsorb process, the oil is regenerated by forced percolation through “adsorptive media” columns at about 65°C. After regeneration, the oil is pumped through a 0.5 micron rated filter before it is degassed. After degasification of oil within the vacuum chamber, the oil is discharged through a flow meter before being returned back to the transformer. The processing phase lasts approximately 4-12 hours depending on the quality of the oil being treated and the number of columns selected within the system.
- b) Reactivation Phase: After having circulated nominal quantity of oil, the clay beds are usually quite saturated with contaminates absorbed from the oil and their efficiency drops off sufficiently to justify reactivation.

The clay is reactivated in the columns and a small quantity (0.1% of oil processed) of oily scum is collected in a waste oil tank before being drained. The clean oil trapped in the clay is recovered. The reactivation phase takes approximately 10 to 14 hours and upon its completion, the re-circulation of oil is re-initiated by pressing a single function key on keyboard. After sufficient re-circulation, the system is ready to automatically engage back into a Regeneration operating condition.

The insulation oil has one of the main factors in improving the useful life of electrical equipment. Each quality parameter of insulation oil is significant; therefore maintaining the insulating oil parameters within specific range should be controlled during electrical equipment maintenance.

Deterioration and aging process of oil has direct effect on the useful life of the electrical transformer. The insulation oil, like any insulation material, is comparatively expensive and this is one of the main reasons not to buy new oils, but rather adopt oil regeneration program.

The insulation oil quality parameters will be restored to comply within the industry standards applicable for electrical transformer insulating oils.

The majority of electrical equipment in operation today is filled with insulating (mineral) oil. The primary function of the oil is to provide a high dielectric insulating material and an efficient coolant. The effectiveness of the oil as insulating material is reduced as the moisture level increases, while cooling is reduced as the oil oxidizes. Paper insulation will also absorb moisture from oil, thus increasing power factor readings.

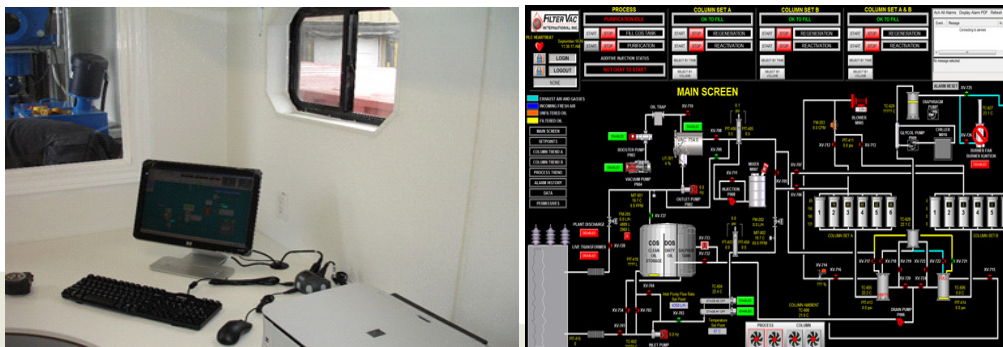
5. CONTROLS & INSTRUMENTATION

An Allen Bradley Programmable Logic Controller (P.L.C.) interfaced with a Supervisory Control and Data Acquisition (SCADA) computer system controls the regeneration system. The P.L.C. monitors and controls all aspects of the operation of the system. Allen Bradley's Programmable Logic Controllers are world renowned for their durability and functionality. A fully modular design aids in problem troubleshooting and offers easy replacement in the case of a modular failure.

The Window 7 based SCADA software system allows the operator to interface with the P.L.C. in a graphical, easy to use and easy to understand format. The SCADA software is well recognized as one of the world market leaders in their field. From the custom designed application, the operator can monitor and control all aspects of the operation. All pertinent operational data and events are displayed in real-time as well as logged for future viewing and analysis. The application offers an extensive alarm system to alert the operator to critical events as well as context sensitive Help functions to assist in the normal operation of the system as well as troubleshooting.

The control system has been designed and extensively tested to provide virtually fully automatic operation. In addition, the system offers important features including:

- Fully developed report generation with facilities for operator entered test data such as dielectric strength, moisture content, acidity etc.
- Data analysis tools to allow the operator and the supervisor to analyze the system performance and then fully optimize the system.
- Accurate Oil level monitoring of transformer or tank (Optional but recommended)
- Fail-safe design ensures proper system shutdown in the case of loss of power with fully automatic restart after power is restored.
- Safety systems included ensuring safe operation of all systems and ensuring successful oil regeneration.



The oxidation of insulation oil begins as soon as the equipment is energized. A chemical reaction occurs when the oil is exposed to a combination of heat, oxygen, core and coil components.

As the process of oxidation progresses, acids and polar compounds are formed and in turn become sludge.

As the process of oxidation progresses, acids and polar compounds are formed and in turn become sludge.

This sludge will then coat heat transfer surfaces on the core/coil and the tank/radiators, in case of transformer, reducing the heat transfer capacity of the system.

The operational temperatures are increased, thus accelerating the degradation of the oil. When the properties of oil have changed – the oil can no longer perform. Under such circumstances oil has to be changed or treated. Treatment methods are: oil filtering, purification and oil regeneration. In the process of purification water, dirt, and gasses are removed from power transformer oil. Regular purification will increase breakdown voltage to required level. Oil purification is an effective preventive maintenance method. When oil is in a transformer, due to deterioration, it reaches a stage where purification is no longer efficient, oil has to be changed or regenerated.

The control system has been specially designed to both assist and protect the operator. All functions initiated by the operator are routed through P.L.C. where the programming is set to ensure that the proper operation occurs. Flow diagram and general operating conditions such as alarms, flow rate, pressures and liters processed are continually displayed on the screen and logged on a disk. A series of alarms and interlocks are incorporated and should a vital alarm be triggered, the system would automatically and safely shut down. This enables the plant to run virtually unattended but where required, the operator interfaces with the plant by means of a keyboard. Although the operation of the system is automated, provisions are provided for manual override of certain functions. A security function requires the operator to log on the system with a unique operator password that sets the level of control available to the logged individual. Higher-level supervisory and engineering passwords increase the level of control available.

6. OPERATOR REQUIREMENTS

Two operators are required for system set-up. Once the system is engaged only one operator is required to monitor the system. The system is so user friendly that the operator typically only requires 1 to 2 hours per 24-hour period of manual labour.

OPERATOR:

Operator's main role is to enter global commands (via key board). Although the system is sophisticated, the commands are kept simple (i.e. start, stop & process) and do not require an advanced level of computer background. Actual starting and stopping is then automatically and reliably executed by P.L.C. program. The system can only be accessed when the operator has logged himself or herself on via his own password as a current operator.

SUPERVISOR:

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

Adsorption clay is the material most frequently used for regenerating of oil. This is specially activated clay with specific properties that allow the processing and regenerating of insulating oils.

Regeneration is the complete treatment of oil to like new condition. Regeneration of oil in transformer is far more efficient than simple oil changing. The total volume of oil is recirculated a number of times thorough Filtervac's regeneration plant and "flushing effect" of transformer is achieved.

It is obvious that regeneration as complete oil treatment method is the best technical solution to aged transformer oil. Apart from this it is also highly cost effective in comparison to an old procedure of oil replacing.

7. MAIN COMPONENTS

A. INLET STRAINER:

A 40-mesh clean able basket strainer is provided to remove large particles from the oil before entering the inlet pump. The strainer vessel is constructed of cast iron steel while the strainer basket is constructed of stainless steel. The strainer vessel comes complete with a quick disconnect cover that allows for quick and easy cleaning of strainer basket.

B. INLET PUMP:

Positive displacement gear type pump or equivalent, complete with mechanical seal, is utilized to draw oil into the ECoil System. The pump is direct driven by TEFC motor

C. ELECTRIC HEATER:

A low watt density heater is used to prevent the heat degradation of oil. Heater elements are encapsulated in steel tubes thus completely insulated from oil to prevent a fire hazard. The Heater is controlled by heavy-duty contractors and an electronic temperature controller. The oil temperature is thermostatically controlled from 20 to 90 °C

D. INLET FILTER

A filter vessel is provided and the vessel comes complete with a 22micron Absolute rated pleated filter cartridge. The vessel comes equipped with Automatic air eliminator to ensure that all entrapped air in the piping system and vessel is removed within the first Couple of passes of oil. The differential pressure of the filter cartridge is continuously monitored and the operator is notified when the filter is to be changed out.

E. FLOW METER:

Flow Indicator/Switch is used to signal low flow conditions interlocked with the heater and shall require proper flow to engage the heater. Should a low flow condition exist while the heater is engaged, a signal is sent to the P.L.C., which then safely shuts down the heater and the system and illuminates an alarm signal located on the panel to notify the operator of a low flow condition.

F. CLAY TREATMENT COLUMNS

A set of mild steel columns are filled with a special blend of structured Activated Fuller's Earth Clay packing. The number of columns is dependent on the flow rate of the system and on the length of oil processing time (ie. before reactivation of clay is required) desired by the operator.

INLET STRAINER



INLET PUMP



ELECTRIC HEATER



INLET FILTER (F1)



CLAY TREATMENT COLUMNS



H. PROCESSING/VACUUM CHAMBER CONSTRUCTION:

Shell and all internal parts are made of carbon steel and come complete with view port. Vacuum chamber features heavy-duty design, suitable for mobile installation. Suitable flexible connections shall be provided to the discharge pump and vacuum pump shall be provided to minimize vibration.

Located inside the vacuum chamber will be a series of coalescer filters (Number of coalescers directly related to flow rate) Also located inside the vacuum chamber will be a series of level switches, one (1) optical probe and one (1) float actuated level controller which are explained in further details in other sections of this specification.

I. OIL LEVEL CONTROLLER:

Inside the Vacuum Chamber, a level transducer is utilized to monitor the oil level and provides feedback to the oil discharge pump to speed up or down to maintain a constant level in the vacuum chamber.

J. VACUUM PUMP:

Direct drive, high efficiency rotary vane vacuum pump (0.05 mb) is supplied to provide for the degasification of the oil. Each vacuum pump comes complete with an exhaust filter to ensure that no noxious fumes are sent to the atmosphere.

K. VACUUM BOOSTER PUMP:

Direct drive roots type vacuum booster to achieve an ultimate vacuum 0.5 mbar For transformer evacuation and dry-out, vacuum booster (Roots Rotary Blower) is recommended dry-out applications. Vacuum Booster and pump combination is less sensitive in pumping large amounts of water vapor which is the case in transformer dry outs. An oil overflow device is incorporated to prevent the oil from transformer entering into booster. Recommended for flow rates greater than 900GPH.

L. OIL TRAP:

A Secondary Chamber, termed the "Oil Trap", located between the vacuum chamber and the vacuum pump is provided to ensure that no oil is pulled into the vacuum pump. The fool proof Oil Trap design employed by Filtrvac system utilizes a set of baffles and comes complete with a High Level Switch implemented to immediately shut down the system upon the sensing of oil accumulation at the bottom section of the Oil Trap. The Oil Trap is provided as a backup safety feature should all necessary level switches and optical probes located in the vacuum chamber fail.

PROCESSING/VACUUM CHAMBER CONSTRUCTION



VACUUM PUMP



VACUUM BOOSTER PUMP



OIL TRAP



M. DISCHARGE PUMP:

A Screw Pump featuring high suction capabilities removes oil from the processing chamber and directs the oil through the fine filter and the flow meter before the oil is either re-circulated or discharged back to the transformer/tank. TEFC Motor directly drives the discharge pump.

N. FINE FILTER:

A filter vessel is provided and the vessel comes complete with a 3-micron absolute rated pleated filter cartridge. The vessel comes equipped with automatic or manual air eliminator to ensure that all entrapped air in the piping system and vessel is removed within the first couple of passes of oil. The differential pressure of the filter cartridge is continuously monitored and the operator is notified when the filter is to be changed out.

O. FLOW METER:

A digital flow sensor is supplied to provide the operator with ability to totalize (Batch and Cumulative amounts) the amount of oil delivered on the outlet side of the system. The flow sensor also provides the operator with instantaneous monitoring of system's flow rate. All data is provided on the computer screen.

P. SAMPLING PORTS:

One (1) inlet and one (1) outlet sampling ports are provided to allow for easy oil sampling.

Q. SIGHT GLASS:

Filtervac provides a side by side Double Window Sight Glass on the inlet and outlet side of the Fuller's Earth Columns. These sight glasses provide the operator with the ability to gauge the efficiency of the Fuller's Earth Regeneration Process by allowing the operator to compare the oil colour prior to the Fuller's Earth Regeneration Process vs. the colour of the oil after the Fuller's Earth Regeneration Process.

R. OIL HOSES:

Optional Inlet and outlet hoses: As per customer specific requirements, rubber or stainless steel (flexible and braided) hose is provided for both inlet and outlet connection with multiple lengths options. Hoses are equipped with quick connectors and stored in protective plastic pipes inside the trailer.

S. SKID WITH SPILL CONTAINMENT:

The ECOIL System is equipped with a unique oil spill containment base for maximum environmental protection. This consists of full system skid with a 2" lip and oil level switch to shut system upon detection of oil spill.

OIL DISCHARGE PUMP



FINE FILTER



Flow Meter



SAMPLING PORTS



CORROSIVE SULFURE VALVES



SIGHT GLASS



OIL HOSES



SKID WITH SPILL CONTAINMENT



T. CONTROL PANEL INSTRUMENTATION, ALARMS & INTERLOCKS

In conjunction with the Allen Bradley PLC, a 15" color HMI touch screen panel (brand and models are subject to change) (Noted as Option HMI/1) is mounted on the main control panel. The HMI is linked to laptop or desk top computer to have control and monitoring of the system operations from either the process or control room. The HMI provides for a very detailed flow diagram to be shown and allows for maximum feedback and interface for the operator. All operating controls shall be located on the flow diagram with appropriate identification and major function are controlled and adjusted by the touch of the screen/mouse. Data logging is provided on the HMI and also via CSV files for downloading to a laptop.

Standard Instrumentation and Control Components:

Temperature Controller (1) Electronic temperature controller featuring fail safe operation.

Indicator Gauges

- Differential Pressure Gauges/Switches for Polishing Filter is provided to monitor the status of the polishing or prefilter cartridges
- Compound Gauge is provided to monitor the status of the dispersion coalescing filters.
- Vacuum Indicator Gauge is provided to determine level of vacuum within the chamber.

Foam Control (1) Occasional foaming oil can develop under certain circumstances. If the Photo Eye Sensor, located in the Vacuum Chamber, detects high foam, a Solenoid Operated Valve will be actuated to break vacuum and thus the foaming will be reduced to acceptable levels. Plant operation is not affected, unless severe foaming conditions persist. If they persist, the system will safely shut down.

Up to date monitoring of plant's vital parameters including

- High oil level in the degasifying unit alarm
- Low level in the degasifying unit alarm
- Flow rate monitor includes No Flow and Reverse Flow
- And other alarms

Description: Filtrvac has accounted for all potential scenarios that may be encountered out in the field and has provisions for automatic shutdown of plant in the case of any alarm situation. The following alarms and interlocks ensure simple and safe automatic operation of purifier:

- **Heater:** Heater is activated only when flow of oil is detected by a flow switch. Pre-set oil temperature is maintained within 2° F.
- **Optical Probe/Vacuum Break:** Foam or oil overflow to vacuum pump is positively prevented by optical probe.
- **Low Level Alarms:** One Low Level Switch is installed and is interlocked with the discharge pump to prevent it from operating unless sufficient oil head is present.
- **High Foam/Level Alarms:** Should high-level condition occur in the vacuum chamber, the system will be stopped to prevent flooding of chamber.
- **Skid High Oil Level Alarm:** A level switch is provided within the skid's 2" spill containment lip.
- **No Flow Alarm:** A vane type flow switch is provided on the discharge side of the heater.

REGEN ON SITE



REGEN PROCESSING LARGE TRANSFORMER



ON SITE OIL PROCESSING WITH REGEN



8. OPTIONAL EQUIPMENT

Option MT	5th WHEEL TRAILER
<p>System is placed in a roadworthy, weatherproof double axel 5TH Wheel Trailer. The system is designed to be operated from the inside of the trailer. To access and monitor components on the ECoil System, the trailer is equipped with rear barn doors (Qty 2) and one (1) side door. The side doors access an office area or storage area of the trailer, where by the operator can either store equipment or monitor the status of the system. The outer walls of the trailer/doors are constructed of Aluminum type material. The braking system consists of electric /hydraulic braking system. Standard Length of Trailer is 25-30FT depending on customer's requirements & options chosen. An office area can be provided at the front section of the trailer as per customer preference.</p>	

Option MT1	SEMI TRAILER
<p>The ECoil System is mounted on a double-axle, super single or double wheeled semi-trailer. Trailer comes complete with two (2) side door entrances and one (1) aluminum staircase (c/w rail) that is easily safely stored and removed from under the trailer. Built in furniture is provided in this option to house the computer system and the operator. Length Ranges from 25-40FT depending on customers' requirements & options chosen.</p>	

Option 20	20FT CONTAINER
<p>Installation in a 20 foot dry sea freight container with doors, windows, ventilation fans and louvers. Operator space for this option is confined due to the physical size limitations of the 20 Ft container. This option can accommodate a maximum of 12 columns.</p> <p>Optionally the container can be provided on a container chassis providing flexible mobility option.</p>	

Option 40	40FT CONTAINER
<p>Installation in a 40 foot dry sea freight container with doors, windows, ventilation fans and louvers. Operator space for this option is provided with optional office area containing furniture and air conditioning. This option can accommodate a maximum of 36 columns with small office.</p> <p>Optionally the container can be provided on a container chassis providing flexible mobility option.</p>	

Option MCT/3



Option MT1



Option 20



Option 40



Trailer Chassis



Option AI**DBPC ADDITIVE INJECTOR**

Additive Injector package is supplied to replace additives removed in the Fuller's Earth filtration process. This package is located inside the plant and includes the following components:

- 100 or 200 Liter Tank (26 or 53 USGPH; Depending on the size of the system) complete with low and high level switches and sight glass assembly.
- One (1) positive displacement gear pump.
- One (1) mixer assembly with a stainless steel propeller and a TEFC Motor.

U. VACUUM BOOSTER PUMP:

Direct drive roots type vacuum booster to achieve an ultimate vacuum 0.5 mbar. For transformer evacuation and dry-out, vacuum booster (Roots Rotary Blower) is recommended dry-out applications. Vacuum Booster and pump combination is less sensitive in pumping large amounts of water vapor which is the case in transformer dry outs. An oil overflow device is incorporated to prevent the oil from transformer entering into booster. Recommended for flow rates greater than 900GPH.

Option LM**LEVEL MONITOR & RE-CIRCULATION ASSEMBLY
(Required for Oil Treatment on Energized Transformer)**Level Monitor:

The Ecoil Transformer Oil Regeneration System does not alter oil level in transformer but it is important to monitor the oil level in the transformer to avoid any potential oil drainage from the transformer while it is energized.

Filtovac supplies a Valve Assembly Box that contains a set of automatic valves and manual and automatic air eliminators. This Portable Valve Box Assembly is located adjacent to the transformer is connected to the inlet and outlet of the transformer as well as to the System's inlet and outlet hoses.

To monitor the oil level in the transformer, a level transducer is provided by Filtovac and is to be inserted by the customer into any opening in the transformer. If a low level occurrence should occur, a signal will be sent to the System's P.L.C. and this signal will be relayed to an automatic valve located on the Valve Assembly Box (suction side) which will close the discharge valve and will not allow oil drainage from transformer to occur. Simultaneously the system will safely shut down and will notify the customer of the alarm.

Automatic Re-Circulation:

One important requirement that is required when treating oil in an Energized Transformer is that all air and gases entrapped in the System's piping and hoses must be removed prior to exposing the transformer to the initial surge of oil in the system. To accomplish this, the Filtovac Oil Purification System 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. Once the oil is filled, the oil is automatically re-circulated for a minimum of 10 minutes through the inlet and outlet hoses via the use of the automatic valves located on the Portable Valve Assembly Box.

To ensure all air is eliminated from the system, the Valve Assembly Box also comes complete with a set of manual and automatic air eliminators.

After ten (10) minutes of automatic re-circulation of the oil in the system, the oil in the transformer is ready to be processed and with the use of the automatic valves located on the Valve Box Assembly, the processing begins automatically. This procedure occurs after any start-up including a provision for automatic re-circulation after a temporary power loss.

Note: This option is only available in conjunction with Option MMI

Option AI**Option LM**

Level Monitor Assembly & Required
Hose Reels (For Pneumatic and
Electrical Connection of Remote Level
Monitor Assembly)



Option PG**POWER GENERATOR**

Power diesel generator (Indoor Generator Set) is provided to allow for plant operation without requirement for external power source. This option would include a Fuel tank designed to allow for 24 hour usage of the generator and would include a panel which includes feature as, but not limited to, a voltmeter and amp meter. In addition this option includes stainless steel flexible exhaust connector, critical grade exhaust muffler & rain cap.

Option TH**THERMIC BOILER HEATER**

Instead of utilizing an electric heater to heat the oil, Filtrvac substitutes the use of a Thermic Boiler Heater (Hot water heating medium) and high efficiency heat exchanger assembly to provide precise and cost efficient heating of the oil. The Thermic Heater is supplied with modulating burner and can operate between LO-33% and HIGH –100%.

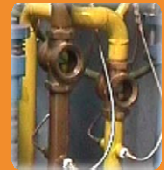
Option FM**FLOW METER**

Burkert totalizing flow meter with a capacity of 9,999 liters is installed to register only the oil delivered at the outlet.

Option PG**Option TH**

REM	REGENERATION EFFICIENCY MONITORING
<p>Whilst the Oil Regeneration Phase is in progress, this option will allow automatic detection of when the Fuller's Earth Clay has fully maximized its adsorptive capacity. Once this condition has been detected, the system will engage in a brief closed loop re-circulation (for cooling purposes) of the oil before automatically stopping the oil regeneration phase. The operator will be made aware of this condition and will be prompted to engage the reactivation cycle. For added automation, it is also possible to pre-set the system to automatically start (without prompting the operator) the reactivation cycle.</p>	

Option REM



H1 and H2	HYGROMETER
<p>H1: Provides installation of one (1) Doble Domino Moisture Analyzer on the discharge side of the ECoil System. H2: Provides installation of two (2) Doble Domino Moisture Analyzers on the inlet and discharge side of the ECoil System. In addition the Domino System is able to provide an output that can be displayed on the Touch or Computer Screen (Option MMI/1 or MMI/2). The Doble Analyzer is the most accurate moisture analyzer on the market ($\pm 1\%$) and provides accurate readouts for a complete range of oil temperatures up to 160° C.</p>	

Option H1 & H2



Option X1/S	HOSE REEL AND HOSES
<p>Two flexible hoses of 10M in length, with couplings and Spring Return winding storage reels. Filtervac can provide other length subject to customer preference and technical feasibility specific to hose size limitations.</p>	

Option X1/M



Option X1/ME	MOTORIZED REEL AND HOSES
<p>Two hoses of 10M in length, with couplings and motorized storage reels. Filtervac can provide other length subject to customer preference and technical feasibility specific to hose size limitations.</p>	

Option X1/ME



Note: If a reel is required to store a longer length of hose, please speak with our inside sales person and we can provide a solution to suit your needs.

POWER SOURCE OPTIONS:

Option XC	POWER SOURCE CABLE
<p>Filtervac provides a spring loaded cable reel that would be capable of handling 15M (50ft) of power source cable Note: Option includes 15M of power source cable with open end for customer to connect with appropriate plug.</p>	

Option XC



Option XCR1	POWER SOURCE MOTORIZED CABLE REEL & REEL
--------------------	---

Cable would be stored on a motorized cable reel and is designed to hold 15M (50ft) in length. Filtervac is able to provide optional upgrade to a cable that is capable of storing up to 100M of power source cable.

Note: Lengths of cable and hoses supplied loosely or with the hose/cable reel assemblies can be offered in longer lengths but must be specified by the customer and is subject to an adder price. If a certain length is specified and the Filtervac issued quotation refers to that length, the quotation overrides the technical specification in terms of the length of oil hose or power source cable supplied.

WEATHERPROOFING OPTIONS:

W	COLD WEATHERPROOFING
----------	-----------------------------

Weather proofing for applications to operate in locations with ambient temperature under 0 °C; this includes providing heat insulation for the trailer or container, heating in office area and ventilation fans in the process area.

W1	COLD & HOT WEATHERPROOFING
-----------	---------------------------------------

Weather proofing for applications to operate in locations with ambient temperature above 40 °C and under 0 °C; this includes providing heat insulation for the trailer or container, heating/air conditioning in office area and ventilation fans in the process area.

Option XCR1



Option W



Option W1



OTHER SPECIAL FEATURE OPTIONS:

Option CB	CIRCUIT BREAKERS
All fuses are replaced by circuit breakers within the control panel.	

Option CST	CORROSIVE SULFUR TREATMENT
Filtervac provides the option to treat corrosive sulfur. Provided with this option a set of valves (automated) to allow treating corrosive sulfur and depending on the end customer preference and type of system arrangement; either an on board or off system dirty oil holding tank is used to contain the corrosive sulfur.	

Many other options available upon request such as:

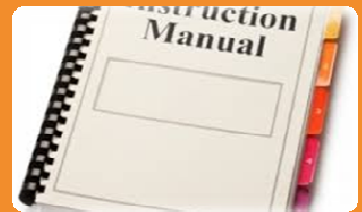
- Air Dryer Package with compressor.
- Enhanced Vacuum Package for faster transformer evacuation
- 4 way valve connected between inlet and discharge oil line allowing the draining of oil lines.
- Installation of variable speed drives on the booster pump to increase transformer evacuations.
- Split Skid Vacuum/Booster Pump Skid (Removable Skid allowing for use near transformer during evacuation)
- Hot/Cold Weatherproofing & Extreme Hot/Cold Weatherproofing of Trailers.
- On-Board Holding Tanks
- 20 or 40ft Customized Sea Freight Container Installations
- On-Line Gas Analyzer
- Full Oil Testing Equipment available.

Option CB



9. GUARANTEES & DOCUMENTATION

- Filtervac warrants the plant supplied under this specification against defects in material and workmanship under normal use and service for a period of sixteen (16) months from date of shipment or twelve (12) months after the start-up of the system. FILTERVAC's obligation under this warranty is limited to repairing or furnishing, without charge F.O.B. point of manufacture, a similar part to replace any part, which was proven to be defective within warranty period. Filtervac shall not in any event be held responsible for any indirect or consequential damages. The Performance Guarantee will be within limitations as detailed in Duty & Performance paragraph of this specification.
- Two (2) copies of Operating & Maintenance Manual are supplied with each system. These systems are designed to operate with the utmost simplicity and therefore typically they do not require any prior training to operate. If any training is required, please contact Filtervac for additional charges.



10. MODEL NOMENCLATURE CHART (REGENERATION)

Please tick (✓) in the appropriate box for required options. Contact Sales department for additional accessories.

RS - - \ - - - - - - - - - 'X'

CODE	✓	Mobility Options
S		Stationary (please select one of the following options)
20		20 FT Customized ISO Container
40		40 FT Customized ISO Container
M/		Mobile (please select one of the following options)
MCT/3		Cargo Trailer with triple axles
MT		5 th Wheel Trailer
MT1		Semi-Trailer

Max Nominal Flow			✓	No. Of Columns
CODE	✓	Liters/Hr		
1000		1000	→	4 or 6
2000		2000	→	6 or 10
3000		3000	↘	10 or 12
5000		5000	→	12, 14, 16 or 24
6000		6000	→	16 or 24
7500		7500	→	24 or 30

CODE	✓	Set of Columns
1		Single Set Columns
2		Double Set Columns

CODE	✓	Power Options
223		220V/3PH/60Hz or 50 Hz
383		380V to 415V /3PH/60Hz or 50 Hz
463		460V to 480V /3PH/60Hz
573		575V to 600V /3PH/60Hz

CODE	✓	Instrumentation Options
H1		Single Domino Hygrometer
H2		Double Domino Hygrometer
DM		Dew Point Monitor
V/2		Secondary Vacuum Transmitter

CODE	✓	Heater
EH		Standard (Electric Heater)
TH		Thermic Boiler Heater
EH/TH		Combination of Electric & Boiler

CODE	✓	Miscellaneous Options
AI		DBPC Additive Injector
LM		Level Monitor(for Energized Transformer)
CB		Circuit Breakers
4WV		Four Way Valve for Hose Draining
REM		Regeneration Efficiency Monitoring
CST		Corrosive Sulfur Treatment
W		Cold Weather Protection
W1		Cold and Hot Weather Protection
D		Desludging (c/w larger heaters)
SPL		Specific Engineering
ADP		Air Dryer Package
BSV		Baby Sitter Valve
CODE	✓	Vacuum Pump (Standard is Rotary vane)
RVVP		Single rotary Piston VP
SVP		Single screw VP
CODE	✓	Cold Traps
XCT45		Condense moisture@ - 45 c
XCT65		Condense moisture @ - 65 c
XCTN		Nitrogen cold trap on mobile cart
XVDO		Enhanced Vacuum Pump Package For Transformer Dry Out

CODE	✓	Power Source Options
XC		Power Source Cable
XCR1		Power Source Motorized Cable Reel
XCR		Spring loaded cable reel
PG		Power Generator

CODE	✓	Hose Options
X1/S		Spring Rewind Reel & Hose
X1/ME		Motorized Electrical Hose Reel & Hoses
XOH		Oil Hoses
XVH		Vacuum Hose c/w camlock
XHS		Hose Storage (In PVC Tubes)

11. FLOW DIAGRAM

FLOW DIAGRAM

