

SECTION 5

OPERATION - FULLERS EARTH

5.1 FULLERS EARTH - GENERAL

This section describes the normal operation of the triple tower hydraulic dump, fuller's earth oil treatment system. Refer to the flow diagram in Section 9 of this manual. Fullers earth oil up-grading and treatment filters are designed to improve the power factor, interfacial tension, dielectric breakdown voltage and to improve the color of transformer and circuit breaker oils.

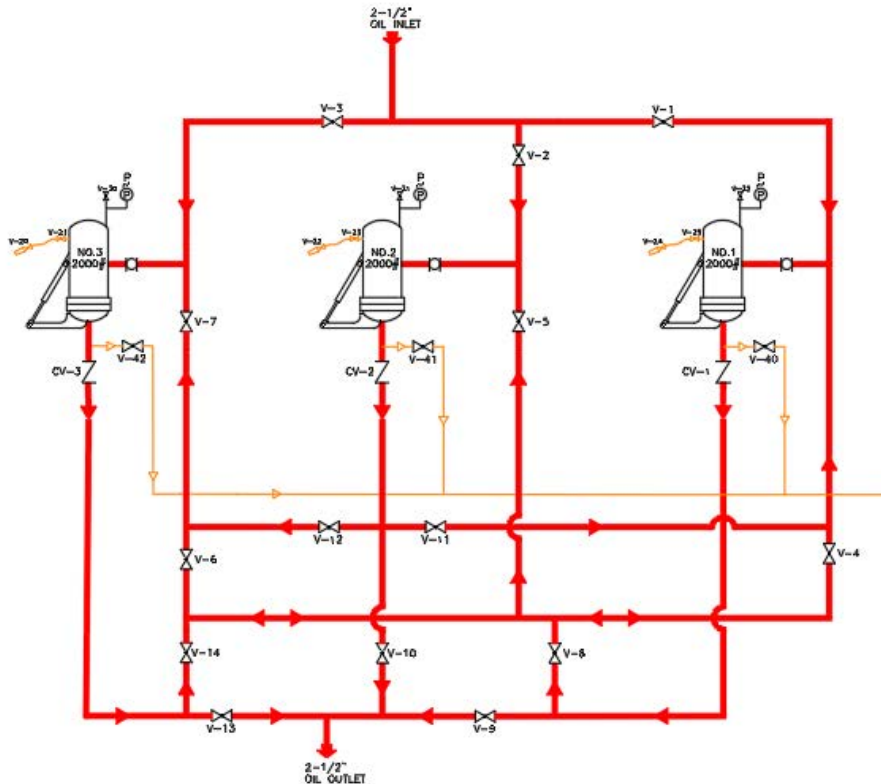
A few applications are as follows: Upgrading new oil when contaminated during shipment, oil that has been in storage tanks for long periods, filling transformers with new oil, desludging of older transformers in service and in repair shops.

When fuller's earth oil treatment is desired, the operator can pump oil through the vessels in either series or parallel. To use the fuller's earth filters, direct flow to the towers and return by connecting oil hoses from the oil source to the fuller's earth module inlet V- and outlet V-.

The oil flows through the fullers earth vessels and then through the trap filter (if the unit is so equipped).

"NOTICE"

IT IS HIGHLY RECOMMENDED TO USE A TRAP FILTER ON THE OUTLET OF THE FULLERS EARTH SYSTEM TO TRAP ANY FULLERS EARTH PARTICLES THAT MAY BE CARRIED OUT OF THE TOWERS BY THE OIL!



Series Flow: 1-2-3

No. 1 as lead (1-2-3):

Open: V-1, V-5, V-7, V-8, V-12, V-13
Close: V-2, V-3, V-4, V-6, V-9, V-10, V-11, V-14

No. 2 as lead (2-3-1):

Open: V-2, V-4, V-7, V-12, V-14,
Close: V-1, V-3, V-5, V-6, V-10, V-11, V-13, V-8

No. 3 as lead (3-2-1):

Open: V-3, V-5, V-9, V-11, V-14
Close: V-1, V-2, V-4, V-6, V-7, V-8, V-10, V-12, V-13

Tower No. 1 removed (2-3):

Open: V-2, V-7, V-12, V-13
Close: V-1, V-3, V-4, V-5, V-6, V-8, V-9, V-10, V-11, V-14

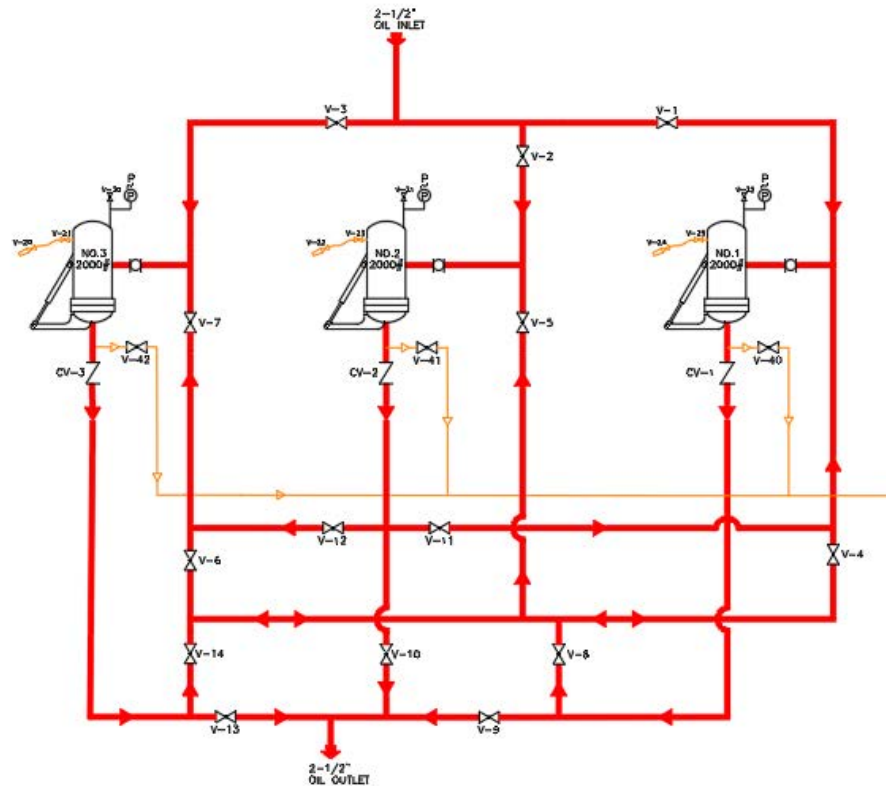
Tower No. 2 removed (1-3):

Open: V-1, V-6, V-7, V-8, V-13
Close: V-2, V-3, V-4, V-5, V-9, V-10, V-11, V-12, V-14

Tower No. 3 removed (3-1):

Open: V-3, V-4, V-9, V-14
Close: V-1, V-2, V-5, V-6, V-7, V-8, V-10, V-11, V-12, V-13

OPERATION – FULLERS EARTH
SECTION 5
PAGE 3



Series Flow: Backwards (3->2->1)

No. 2 as lead (2->3->1):

Open: V-2, V-4, V-7, V-9, V-12, V-14

Close: V-1, V-3, V-5, V-6, V-8, V-10, V-11, V-13

No. 3 as lead (3->2->1):

Open: V-3, V-5, V-9, V-11, V-14

Close: V-1, V-2, V-4, V-6, V-7, V-8, V-10, V-12, V-13

Tower No. 1 removed (3->2):

Open: V-3, V-5, V-10, V-14

Close: V-1, V-2, V-4, V-6, V-7, V-8, V-9, V-11, V-12, V-13

Tower No. 2 removed (3->1):

Open: V-3, V-4, V-9, V-14

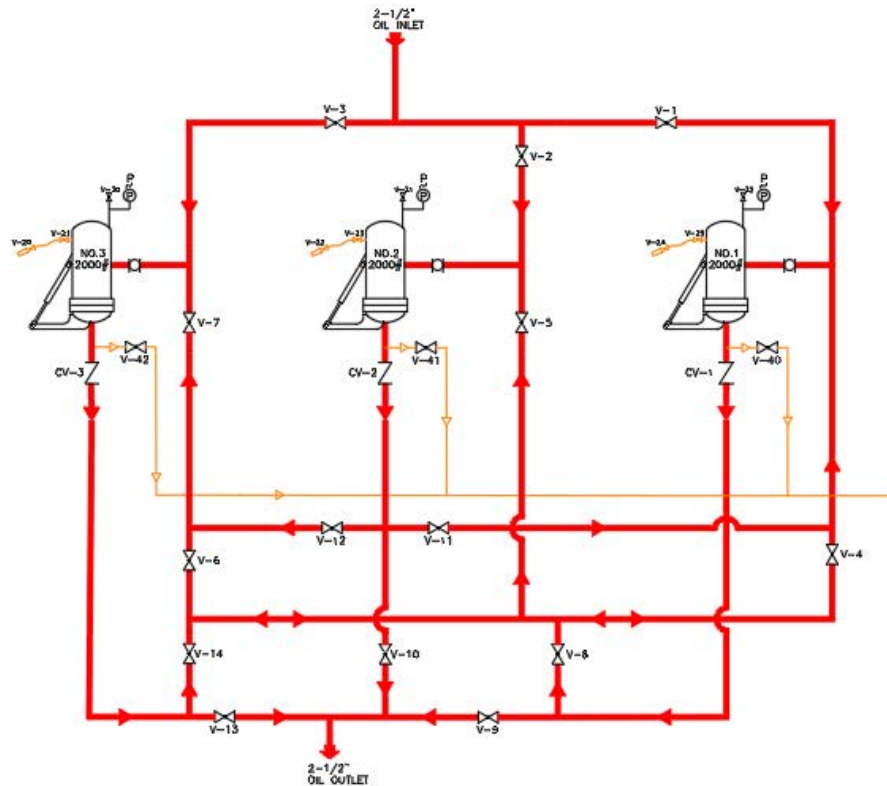
Close: V-1, V-2, V-5, V-6, V-7, V-8, V-10, V-11, V-12, V-13

Tower No. 3 removed (2->1):

Open: V-2, V-9, V-11

Close: V-1, V-3, V-4, V-5, V-6, V-7, V-8, V-10, V-11, V-12, V-13, V-14

OPERATION – FULLERS EARTH
SECTION 5
PAGE 4



Parallel Flow:

All towers in Operation:

Open: V-1, V-2, V-3, V-9, V-10, V-13

Close: V-4, V-5, V-6, V-7, V-8, V-11, V-12, V-14

Tower No. 1 removed:

Open: V-2, V-3, V-10, V-13

Close: V-1, V-4, V-5, V-6, V-7, V-8, V-9, V-11, V-12, V-14

Tower No. 2 removed:

Open: V-1, V-3, V-9, V-13

Close: V-2, V-4, V-5, V-6, V-7, V-8, V-10, V-11, V-12, V-14

Tower No. 3 removed:

Open: V-2, V-3, V-9, V-10

Close: V-1, V-4, V-5, V-6, V-7, V-8, V-11, V-12, V-13, V-14

5.2 FULLERS EARTH FILLING PROCEDURE

Operate the vacuum filling pump and pull a vacuum on the F/E tank to be filled by opening the appropriate isolation valve (*V-40 for tank #1, V-41 for tank #2, V-42 for tank #3*). Ensure that all oil supply and return valves are closed. Open valve V-21 on tank #1, V-23 on tank #2, and V-25 on tank #3. When the tank has reached the appropriate vacuum level (approximately 26 in Hg) as indicated by the compound pressure gauge on top of each tower, open the bag of earth and insert the flexible vacuum filling hose nozzle into the fullers earth bag. Open the fill valve slowly (*V-24 for tank #1, V-22 for tank #2, V-20 for tank #3*). The F/E will be drawn into the tank by vacuum. Each tank is designed to hold LVM 30/60 mesh fullers earth (attapulugus clay) or activated alumina. When the tank is full, let the vacuum pump run until a good vacuum reading is achieved (around 26 or 27 in hg) and then close the vacuum pump isolation valve and then stop the vacuum fill pump.

Open the fuller's earth oil supply valve to the tower that has just been filled **VERY, VERY SLOWLY** and fill the tower with oil **VERY, VERY SLOWLY** while under vacuum. (Never charge two towers with oil at the same time). When a positive pressure begins to show on the pressure gauge located on top of each tower, vent all air from the vessel using the vent valve provided (*V-32 for tank #1, V-31 for tank #2, V-30 for tank #3*). Check for leaks.

"NOTICE"

- 1. THE FIRST TWO BAGS SHOULD ALWAYS BE FILLED SLOWLY TO PREVENT DUST CARRY-OVER AND PREVENT SCREEN DAMAGE.**
- 2. THE DUST FILTER IS FOR VACUUM FILLING ONLY AND MUST BE ISOLATED WITH VALVES V-40, V-41, AND V-42 WHENEVER OIL IS FLOWING.**
- 3. AFTER THE TANK HAS BEEN FILLED WITH FULLERS EARTH, BE SURE TO CLOSE THE TOP FILL HOSE SHUT-OFF VALVES NO. V- AND/OR V-. THE FILL HOSE IS NOT RATED FOR NORMAL OPERATING PRESSURES AND WILL RUPTURE IF PRESSURIZED.**

5.3 FULLERS EARTH DUMPING PROCEDURE

When it becomes necessary to dump the spent clay, the operator should close the oil supply valves. If the towers are connected to a Baron oil purifier, with the purifier discharge pump running, run the oil purifier's vacuum pump to pull oil from the fullers earth filter into the vacuum chamber of the oil purifier. Crack the

vent valve located near the tower's panel mounted pressure gauge slightly. This helps the oil purifier's vacuum pump to remove oil from the tower and into the vacuum chamber.

Another method for draining the oil is to apply compressed air to the filter and force the oil out through the drain valve into a collection device such as a blow-down tank. Vacuum is not required when using this method. The compressed air method is considerably faster than the method using the vacuum pump.

"CAUTION"

***WHEN APPLYING COMPRESSED AIR TO THE FULLERS EARTH FILTERS,
DO NOT APPLY MORE THAN 20 PSI AIR PRESSURE !***

After the remaining oil has been drained from the tank, the operator can loosen the hex nuts on the bottom opening cover and swing the bolts to one side. Start the hydraulic power unit and operate the control valve. As the cover opens, the spent cake will drop from the tower. Should the cake not drop immediately, a gentle prod may be required to loosen it. Be cautious. Once the cake starts moving, the entire tower will empty at once. **BE PREPARED.** After the tower is completely empty, the operator should clean the stainless steel screen in the cover with a soft brush or cloth. Then, the O-ring cover gasket should be cleaned and checked for damage and replaced if necessary.

If the gasket is serviceable, it should be wiped with a clean oily rag, and the groove should also be cleaned to remove any clay that might be lodged in it. Use the hydraulic controls to close the bottom cover. Swing the closure bolts into place and tighten the hex nuts. The fuller's earth filter tower can now be re-filled with new clay. (See filling procedures).

The following is a brief description of the uses of fuller's earth as a filter media and some suggestions in storage and handling procedure:

Fuller's earth can be used to decolorize and neutralize any petroleum oil, especially electrical insulating oils. It excels in neutralizing traces of strong inorganic acid. Thus, it is the adsorbent of choice for finishing acid-treated oils. Due to the relatively large pores in fuller's earth, it is well adapted to the removal of high molecular weight sulfonates, resins, and asphaltines. It is moderately affective in removing odors, but it does not strongly absorb aromatics.

New transformer oil will discolor as oxidation of the oil takes place. Color by itself is not a reliable test in evaluating the condition of the oil for further use, but indicates that something is happening within the transformer that requires investigation. Once transformer oil changes from the light yellow color range into the orange and reddish brown color range, the oil has degraded to the point where the vital parts of the transformer are being seriously affected.

As the color of the oil changes, sludge's form in solution with the oil due to oxidation, which causes a drop in interfacial tension and the acid (Neut) number to increase. When transformer oil deteriorates to the reddish brown color ranges, deposited sludge's continue to oxidize and harden, blocking vents and insulating cooling fins, causing higher operating temperatures. Insulation shrinkage is taking place, and premature failure is a good possibility.

Fuller's earth can be purchased in bulk or in 50 pound vapor insulated bags.

Care must be taken not to expose the fuller's earth to humid air or moisture. This causes clay to loosen its granular structure and turns it to plain mud. Fuller's earth has a specific gravity of approximately 2.45, and the bulk density is 35 pounds per cubic foot.

Each vessel will hold the quantity of LVM 30/60 mesh fuller's earth listed in Section 2 and should be purchased in vapor insulated bags. After the vessel is filled with fresh clay, the filter should be subjected to vacuum in order to evacuate all trapped air. Vacuum fill and vacuum evacuation are always used to remove air prior to flooding with oil.

The decision of when to change the spent clay has been a great problem to utilities for a long time. Field testing with a Gerin test kit has been one means of determining if the clay is still active.

The most efficient use of the clay is obtained by running the towers in series with the lead tower as the roughing filter and the following towers performing the polishing. When the clay in the lead filter is spent, it should be changed and the series flow reversed to make the freshly charged tower the polishing unit and the former polishing unit the roughing filter.

Optimum performance of the clay is achieved at an operating temperature range of between 160° - 180° Fahrenheit. (71° - 82° Celsius)

One thing to always remember when setting up your system, in order to pump dielectric oil through a single 2000 lbs tower or two 2000 lbs towers in parallel flow mode you will need a pump capable of building a minimum of 60 psig. If you

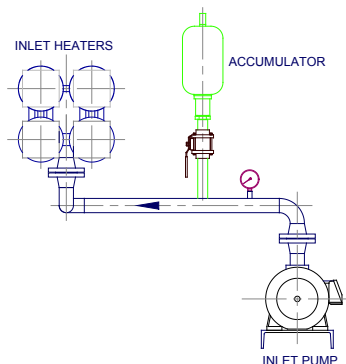
OPERATION – FULLERS EARTH
SECTION 5
PAGE 8

are going to pump dielectric oil through two towers in series flow mode you will need a pump capable of building 80 to 90 psig. **Never** set the inlet pump relief valve pressure above 90 psig.

CAUTION

If this oil treatment system is to be used with an existing Baron oil purifier you will need to increase the inlet pump relief valve setting (usually number RV-1) to between 60 psig to 80 psig as directed above in order to pump oil through the 2000 lbs bed of fullers earth. Sometimes the trial and error method must be used when determining the required relief valve setting for your application.

Also, if you have to set your inlet pump relief valve to 80 or 90 psig in order to pump oil through the towers in series flow mode you will, in all probability pop the inlet filter safety relief valve each time you start the oil purifier inlet pump. Should this happen it is recommended that you install a one gallon capacity, bladder type hydraulic accumulator in the piping just down stream of the inlet pump and before the inlet heaters. This will solve the problem of hydraulic shock (momentary surge in pressure) when the inlet pump starts. You will need an accumulator charging kit in order to charge the accumulator with dry nitrogen as the pressure in nitrogen bottles can be over 2000 psig. We recommend charging the accumulator to a pressure of between 5 and 10 psig above the inlet pump relief valve setting with dry nitrogen. Always use extreme caution and follow the accumulator manufacturer's instructions when charging the accumulator with nitrogen.



Recommended method for installation of the accumulator