

Annexure-10

For 500MVA, 765/400/33kV, 1-Ph, Interconnection Autotransformer reimpregnation, following procedure is adopted:

- (i) After filling the oil in the main tank (ICT), HOC for 48hrs needs to be completed.
- (ii) Then, drain the oil from ICT to the storage tank.
- (iii) Then, again circulation in the storage tank till we achieve the desired parameters of insulating oil like PPM and BDV, simultaneously vacuuming in the ICT tank for 48/72hours needs to be done
- (iv) Then, pushing the oil in the storage tank to ICT tank under vacuum, completes the reimpregnation.
- (v) Refer enclosed OEM document.

List Consumables and Test Instruments for erection & commissioning of large EHV 765KV transformers/Reactor of Recommended Tools, Plant, Facilities,

A) List of Tools & Plant

1. Set of spanners (6 to 46) open ,double ended & Ring type -	2 sets each
2. Set of tubular spanners , 6mm to 32 mm - 1 set	
3. Set of 12 mm square box spanners with standard handles & ratchet handle	1 set
4. Electrically operated impact wrench (preferably cordless) , 12 sq, upto M 16	1 set
5. Pipe wrenches 300 & 450mm -1 no each	
6. Set of heavy duty screw driver flat & star tipped (6" , 10" , 12" & 18")	2 no each
7. Hammer (1 Kg), Nose plier (8"), Cutting Plier (8") & Adjustable wrench (12")	1 no each
8. Circlip plier (Internal / External)	1 no each
9. Centre punch & Chisel (150 & 300mm)	1 no each
10. Crow bar (1 meter long)	2 nos
11. Budger / poker 300 & 400 long , 10, 15 dia with pointed end for hole matching of flanges	2 nos each
12. Steel wire rope slings various sizes (6,12,20mm) and available in pairs / twin pairs for handling accessories.	
13. Endless Nylon slings, rated SWL 5TON - 3,6 & 15 metres long	4 nos each
Nylon Belt(slings) - 5Ton - 4 nos & 3 metres long Nylon Belt(slings)	
14. Nylon / Manila rope, 25mm dia, 25M long -	8 nos
15mm dia ,8 M long -	6 nos
6mm dia ,18 Mlong -	3 nos
15. "D" shackles , 12mm , 25mm & 35mm or nearest standard sizes -	4 each
16. Single sheave pulley ,75 or 100 mm dia -	2 nos
17. Electricians knife , control cable crimping tool 1.5-10 sq mm -	3 nos each.
18. Explosion proof safety hand lamps with double enclosure (24v / 110 V)	3 nos
19. Bourdon type pressure gauge ,100-150 mm dial, 0 to 1kg (0-15psi) -	2nos ,
(all to suit 15Nb threaded socket 0 to 2kg) -	1
0-100milli bar -	2 nos
20. Vacuum Gauges :	
McLeod vacuum gauge with mercury , hose , container etc -1no	
or	
1nos Digital PIRANI Gauge with suitable hose pipe and adopter flange	
Vacuum gauge, 100mm dial , 0 to 760mm Hg-	2nos .
Edward gauge , 100mm dial , 0-25 milli bar (15 NB) thread	1 no
21. Gasket hole punch set for sizes from 6 mm to 36mm in standard sizes.	1 set

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| 22. Portable vacuum cleaner with vacuum hoses and standard suction nozzles | 1 no. |
| 23. 4" angle grinder with grinding and cutting discs | 1 no |
| 24. Electric / Pneumatic pencil grinder with grinding tips of standard profiles | 1 set |
| 25. Portable electric drilling machine upto 15 mm with drill bits of various sizes | 1 set |
| 26. Inclinator / 600mm spirit level of good quality | |
| 27. Straight edge 600-900mm long | 1 no |
| 28. Bushing lifting tool / tackle for 800kV & larger bushings -- type | 1 of each |
| 29. Automotive tyre tube air filling valve adaptor with attachments for connecting compressed air pipe & 0-2kg pressure gauge. | |
| 30. Needle file set | 1 set |
| 31. Metric thread tap sets for 6,8,10,12,16,24 mm and larger sizes if required | 1 set |
| 32. Adjustable free standing Aluminium ladder 6 Metre | 2 nos |
| Folding aluminium platform ladder , 1.5 M height | 2 nos |
| 33. FHP (0.5 HP) pump set with cable and oil resistant vinyl hoses& fittings | 1 no |
| 34. Barrel / Hand pump for oil | 1 no |
| 35. Steel framed cradle , SWL 500 kg to lift & carry 3-4 persons for working at heights on bushings. Cradle to have all necessary protective features for ensuring safety of workmen. | |
| 36. Mobile crane , telescopic, swivelling boom type, with 18-20 Metre hook lift , capacity 30-50 tonnes depending on site layout and conditions, along with trained,licensed operators and riggers. | |
| 37. Electric arc welding transformer, 80-100v OCV , 400 amps with cables, holder , screens/ shield , electrode heater with approved electrodes. | |
| 38. Oxy-acetylene gas cutting set with gas regulators, flashback arrestors, hose pipes , cutting / welding torches and consumables | |
| 39. Dry Air Plant : Dry air plant of capacity 2 M ³ / minute (50 cfm) free air delivery at dew point better than -60° C at pressures of approx 1-1.5 kg/ cm ² . Plant should have a reservoir tank of 1 KL volume with a pressure withstand capability of 8kg/cm ² for holding reserve capacity of air. | |
| Reservoir should be provided with timer controlled auto drain valve for draining condensate water . Dryer unit should be a combination of refrigerated drying and twin dessicant towers with provision for auto re-generation and fitted with an online digital Dew point & temperature indicator. | |
| 40. Vacuum pumps : Transformer evacuation system comprising of suitable positive displacement or rotary vane pumps , roots pump, vacuum gauge & solenoid valve at suction ports of pumps. Pumps should be capable of developing 0.02 mm vacuum with inlet blanked . Provision of single phasing & reverse sequence blocking must be available to prevent reversal of pump direction. Vacuum hoses must be of minimum 50 dia , preferably 80-100mm dia with suitable end flanges . | |
| It would be preferable to provide a vapour condensing unit at outlet to enhance the evacuation capability. | |
| Recommended pump capacity for vacuum pump is 3.5 to 5.0 M ³ /minute & 25 to 30 M ³ /minute for roots pump. System should be complete with 100mm dial vacuum gauge , Edwards Gauge and Mcleod / Pirani gauge for fine vacuum measurement . | |
| 15 & 25 mm dia , wire reinforced, vacuum proof, non collapsible , transparent vinyl hoses of adequate lengths along with matching end fittings for oil level indication in tank and for admitting dry air in transformer | |

41. Oil Treatment plant / Filter machine : High vacuum (< 0.2 mm) filter machine, 10-12 kL / hour capacity, with digital temperature control for control ($50-80^{\circ}\text{C} \pm 2^{\circ}$). Plant must have provision for internal by-pass & with piping to facilitate interchange of inlet/ outlet connections by operating valves on the machine.

Fine filters on the machine should be 0.5 micron size , of bonded cellulose construction that are migration free . Plant should be capable of moisture removal from 30ppm to ≤ 3 ppm and improve BDV from 30kV to ≥ 80 kV in a single pass.& should have facility for oil flow measurement.

Filter machines should be equipped with

a) 2 nos each of aluminium trays of size 1m x 0.5M x 150mm height and 0.5m x 0.5M x 150mm , provided with suitable handles and frame.

b) 4 nos 10 liter capacity steel buckets , duly painted with hot oil resistant paint

c) 2 nos 150-200mm dia s.s funnels

42. Oil storage cum filtration tank : Minimum of 2nos each with capacity of 40 KL , 2- 3 tanks, each with capacity of 20-25kL per transformer is recommended. Tank should be provided with ::

1 nos bolted inspection manhole on top ,

4 nos 50 or 80 NB gate valves fitted at top & bottom of the 2 opposite end plates of the tank,

2 nos 15 NB sampling valves at top & bottom of end plate , 80 NB drain valve at bottom and 2 x 6 kg silica-gel breathers on end plates and 25 NB drain plugs at bottom on either ends of the tank.

Tanks must be painted internally with hot oil resistant paint and suitable paint externally.

Partition plates in the tank must have adequately sized , evenly placed openings to facilitate intermixing and circulation of oil between sections during filtration process.

Thermal insulation of tank with ceramic fibre or suitable eco-friendly materials to conserve heat.

43. (Particle NAS filter) Stand alone filter unit of 10-12kL/ hour capacity, fitted with 0.5 micron filter elements for expediting achievement of particle count parameters during final oil filtration. Filter unit must be equipped with it's own filter chamber/s , pressure gauges at inlet & outlet of each chamber, gear pump with motor & starter, pressure release valves and by-pass valves

Particle count measurement will be done on line with the instrument connected to bottom sampling valve of transformer. Particle count must be less than 780/100mL as per ISO 11171, class 0.

44. Single core, multi-strand , insulated copper wires of sizes 6 & 10 sq mm for earthing of bushings, tank body etc during the course of erection work

45. Aluminium Trays - 2 nos trays ,each of size 1m x 0.5M x 150mm height and 0.5m x 0.5M x 150mm , provided with suitable handles and frame.

b) 4 nos 10 litre capacity steel buckets , duly painted with hot oil resistant paint

c) 2 nos 150-200mm dia s.s funnels

46. Eye bolts of sizes 6,8,10,12 & 16 mm . 4 each

47. Needle file set 1 set

48. Forceps / pincers for handling small components . 2 nos

49. Chain pulley block – 1T & 3 T with lift of 8-10 metres & suitable operating Chain 1 each

50. Tirfor – Pull lift machine , 2T with rope length of 10-12 metres 1 no.

51. Ready to assemble rectangular scaffold frames

a) 1 M x 1 M frame with couplers 20 nos

b) 1 M x 0.5 M frames with couplers	10 nos
52. Hammer drill machine with bits , 13mm , cordless or with cord	1 set
53. Hack saw frames with saw blades	1 set
54. Wood saw	1 no.
55. Mallets – Wooden / PVC	2 nos
56. Hole cutting saw / tool , standard sizes upto 30mm	1 set
57. Portable, hand held cold & hot air blower	1 no
58. Electric heat gun	1 no
59. Lockable almirah 1000mm wide x 600 deep x 1500mm height for storage of tools & consumables located close to work area	1 no.
60. JLG Manlifter (for bushing erection and auxiliary bus erection)-	1no

B) ELECTRIC POWER SUPPLY

Temporary power supply board with dedicated incoming feeder , 300-400 amps incomer fused switch / MCCB , 200 amps TPN fuse switch- MCCB for 10-12kL filter plant , 63 Amps TPN feeder for Vacuum pumping system , 63 amps / 32 amps TPN for Dry air plant , 32 amps TPN feeder for additional fine filter unit , 32 amps TPN for welding machine and 4 nos each of 5 amps and 15 amps industrial switch sockets for various tools / appliances like Nut drivers , Angle grinders and Test instruments.

If erection of 2 or more transformers are carried out in parallel , number of tools , plant , equipments and power supply boards employed needs to be increased appropriately.

C) TEST FACILITIES / INSTRUMENTS :

All instruments used must carry valid calibration certificate

1. Capacitance & Tan delta test set , preferably trolley mounted	1 no
2. CT testing set/ Analyser, preferably trolley mounted	1 no
3. Phase sequence indicator	1 no
4. Transformer turns ratio meter	1 no
5. Transformer Winding resistance meter (10-20 amps)	1 no
6. Motorised / Electronic Insulation Tester,500-1000-2000-5000 Volts Insulation Range - 5Mega Ohm to 10Giga Ohm @ 5KV	2 nos
7. Digital multimeters Fluke or equivalent with facility for AC & DC mA	4 nos
8. Motorised Oil BDV test kit- 0- 100kV	1 no
9. Online Moisture PPM measurement instrument (Vaisala)	1 no
10. Clamp on meter for measuring DC & AC mA.	1 no
11. Clamp on meter for AC amps measurement , 0-600 amps	1 no
12. Frequency Response analyser (SFRA kit)- Haefely or Doble make	1 no
13. PAMAS make particle count measurement instrument	1 no
14. Dew point meter for measurement of dew point with T adaptors	2 nos
15. Ducter /Micro-ohm meter	1 no

16. Coulometer (Carl Fischer) for moisture content measurement	1 no.
17. 1 phase variac 220/400 V input , output 0-120% , 10 amps	3 nos
18. Analogue multimeter for AC/DC with facility for AC /DC current & Voltage measurement in ranges of mA ,0-10 Amps , voltages in different scales up to 2kV and resistances	2 nos
19. Adequate quantity of 1 core , 600v grade , multi-strand copper wire for testing purposes – 300 metres approx	1 lot
19. Test leads of different lengths fitted with good quality crocodile clips / Plug in type jacks to facilitate ease of testing control wiring	1 lot

D) CONSUMABLES:

1. Sand & emery paper etc as required for external cleaning purposes
2. Adequate quantity of unused fluff free cotton cloth for cleaning purposes
3. Anabond -666T / Silastic Silicon sealant-200g pack , Paint brushes (12,25 & 50mm) , NC thinner suitable for PU & epoxy paints, & zinc chromate primer for touchup work
4. Adhesive for rubber cord joint – Locktite / Fevikwik - 20 mL x 10nos
5. Steel wire brushes for cleaning surfaces
6. Nylon brushes
7. Cleaning agents such as Isopropyl alcohol / Benzene , MDC (Methyl di chloride/ acetone etc for cleaning of bushing porcelain, copper, paper etc
8. Molycote thread anti seize paste.
9. Rubbing polish / fine grinding paste
10. GI paint in spray container
11. Approved make of welding electrodes
12. Oxy-acetylene gas in cylinders
13. Dry nitrogen in cylinders – 4 cylinders as stand-by
14. Mercury for Mcleod gauge
15. Silica-gel for replacement in breathers on oil storage tanks.
16. Servogem 3 grease for lubrication of bearings of fans etc if found required
17. Vacuum oil for vacuum pumps
18. Hydraulic oil & fuel oil for cranes.
19. Cable multi strand -30meters for each reactor- for earthing of HV bushing.—30meters x 20nos Reactors.

E) Safety related :

EHS safety instructions for construction sites must be followed in all respect.

All lifting equipments like mobile crane ,Fork lift, tools, tackles , jacks ,slings ,wire ropes, eye bolts, D shackles etc & material handling accessories must have been tested as per requirements of factory act / other appropriate act and valid fitness/acceptance certificates must be available for inspection

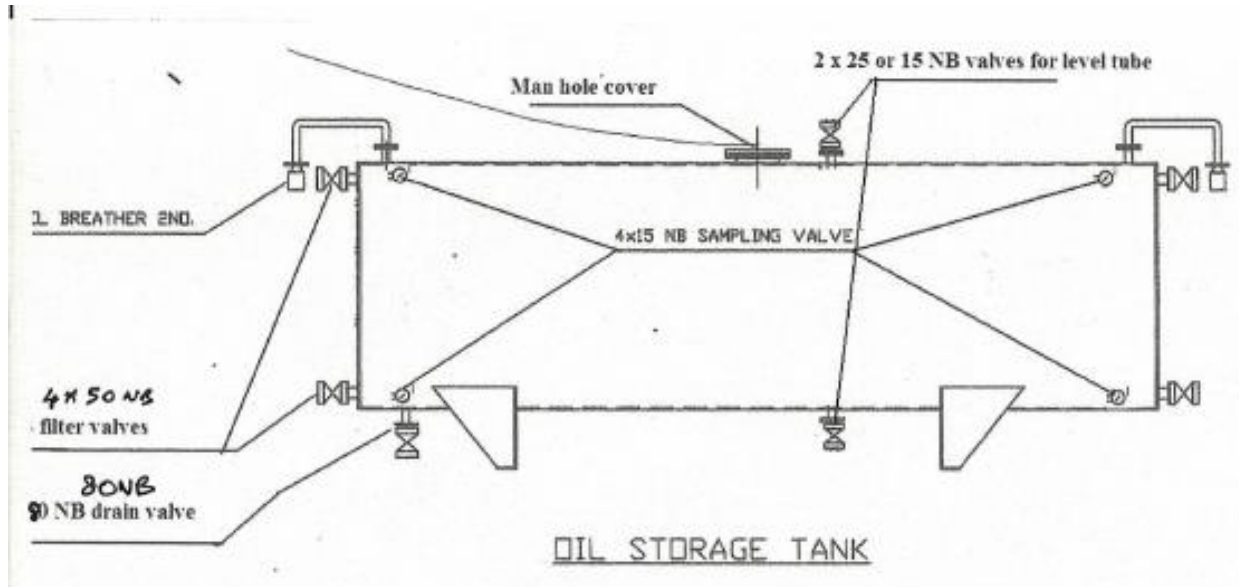
Adequate quantity of fire extinguishers Foam and CO2 type, sand buckets, Safety belts , Fibre glass ladder / Height adjustable Platforms fitted with safety railings , Scaffolds etc.

Adequate quantity of PPE like Safety belts / Harnesses , Safety Shoes, Helmets , Goggles , Ear Muffs , hand gloves, welding shields etc must be made available for work.

Annexture 3 – Figure 1

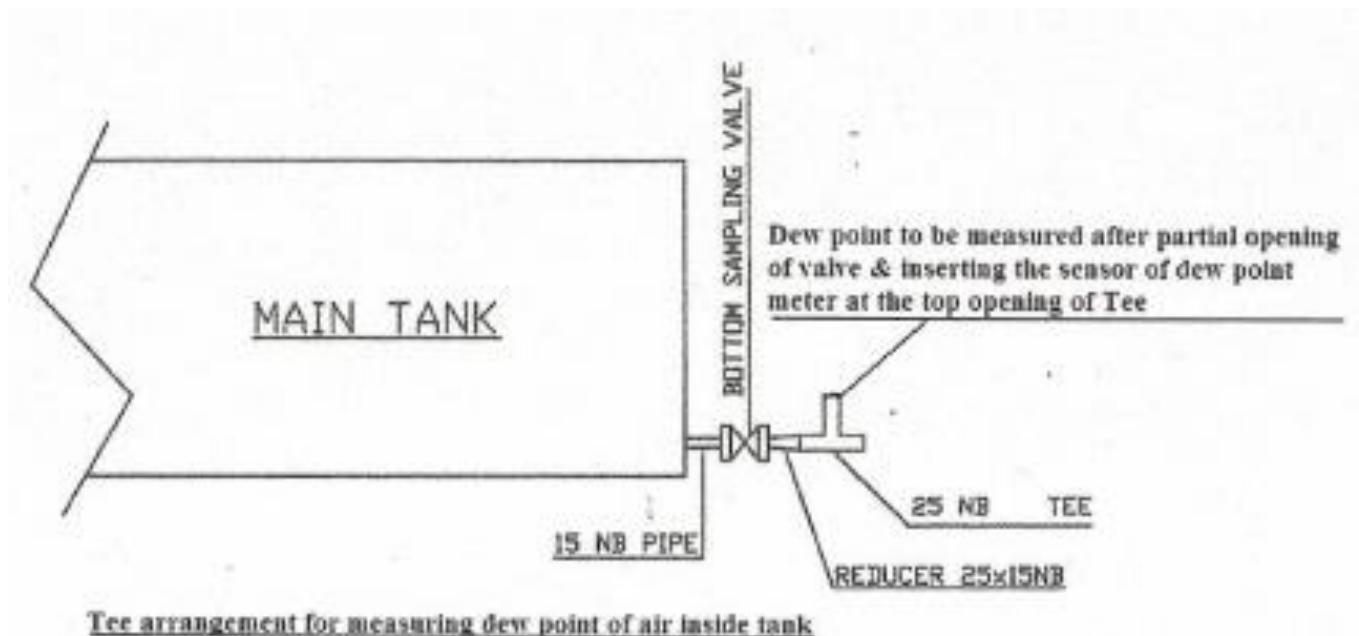
Sketch of oil storage tank with fittings

Refer point no. 42 above:



Annexture – 3 , Figure 2

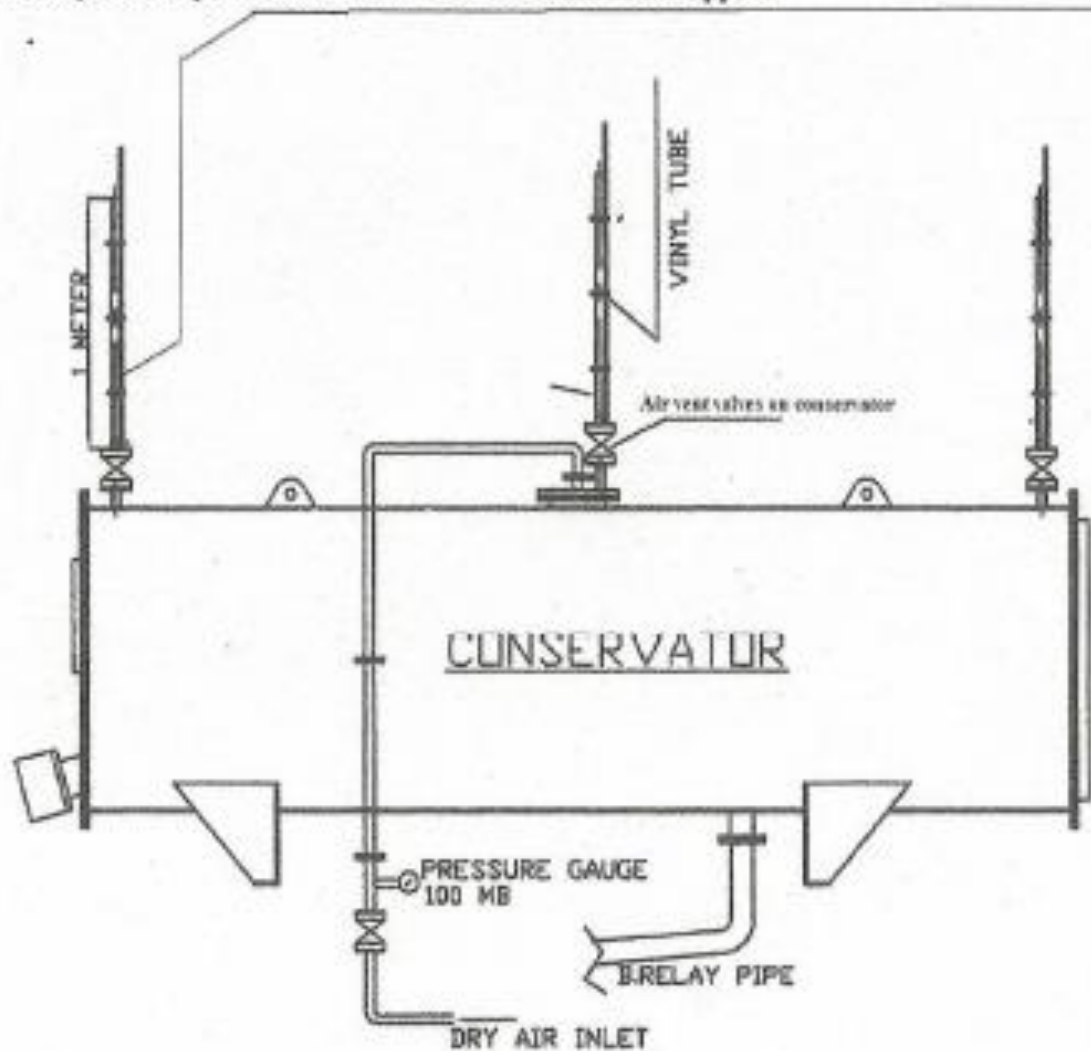
Tee arrangement for measuring dew point inside tank



Annexture – 3 , Figure 3

Arrangements for checking of air cell & commissioning air cell in conservator

3 nos 3/4" transparent vinyl pipe fitted with 25 or 15 NB adaptor flange or threaded nipple to mate on valve body & clamped to 20 x 10 mm wooden batten for support



Annexture 3 – Figure 4

Additional special Filter with separate pump for achieving particle count parameter.
This is additional filter and required in addition to 10KL Filter machine.

Photo of Stand Alone Filter: Refer point no. 43 above for Achieving the Particle Count Requirement:



VPI make– Add on filter unit with Cuno Zeta + filters.

Process Final Parameters to be Achieved:

Minimum process requirements: There can be further stringent process requirements as may be advised from our Engineering from time to time.

1. Before vacuum application, dew point of dry air inside main tank should be: $< -40^{\circ}\text{C}$ (dry air plant should have dew point of less than -60°C . it should be two stage twin tower with molecular sieve desiccant, heatless dryer type, capacity of above 50CFM (100-120m³/hr) and reservoir capacity of 1KL.
2. Vacuum : Maintain less than 0.2 Torr for 72 hours - 96 hours
3. a).Oil Preparation in Storage Tank before filling into Transformer/Reactor: BDV >80KV and moisture content $< 5\text{ppm}$.

b).Oil circulation in transformer/Reactor :

Clause No. 7.3 Hot Oil Circulation:

7.3.1 Hot oil circulation shall be carried out to remove moisture from surface of active insulated part.

7.3.2 Connect the inlet and outlet of the vacuum oil filter to the DN100 valve at the lower part of the tank and connect diagonally the $\Phi 80$ butterfly valve to DN100 valve respectively at the top of the tank. Hot oil circulation shall be made through vacuum oil filter, close the lower part outlet valve of all of the radiators after 12 hours and continue hot oil circulation for the main body as shown in Figure 7.2.

7.3.3 The circulation time should meet the following two provisions :

- a) Maintain the circulation time $\geq 96\text{ h}$ when the temperature of oil from the outlet of the oil filter reached $(60\sim 70)^{\circ}\text{C}$;
- b) 3~5 times of the total oil / oil quantity per hour quantity of the reactor flow through oil filter (h).

7.3.4 The circulation time and procedure shall comply with clause 7.3.3 of sampling and inspecting. It shall reach standard specified in clause 7.1.1.

If it does not reach the standard specified in clause 7.1.1, then continue the circulation until they are achieved.

Oil parameter to meet the end condition ppm & particle count: moisture content $< 5\text{ppm}$, BDV $> 80\text{KV}$, Particle count must be less than 780/100ml as per ISO 11171, class 0. NAS 0. When particle count measured, filtration in Transformer/Reactor must be in progress with radiator and conservator valve open, with oil pushed inside main tank from bottom valve and oil drawn into filter machine from top filter valve.

Note:

- a. Filtration will be considered completed only after achievement of desired oil parameters, particle count and tan delta.