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TRANSFORMER OIL FILTERING, DEGASSING AND DRYING UNIT

MODEL S1000



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MODEL S1000

SPECIFICATION

Maximal oil flow rate	1000 l/h
Heating capacity	2 x 7.5 kW
Adjustable oil temperature range	45 °C – 100 °C
Differential temperature (inlet/outlet)	approx. 28 °C
Minimal oil inlet temperature	5 °C
Vacuum pump capacity	25 m ³ /h
Filter fineness	3 - 5 microns
Total power	17 kW
Final oil qualities, after three passes:	
- water content	2 - 5 ppm
- gas content	0.05 % Vol
Operating pressure in degassing tank	2 - 9 mbar
Unit, size	1350 x 700 mm
Trailer, size	1500 x 1000 mm
Unit, weight	approx. 550 kg

The Unit is delivered ready for operation, together with: control panel, wiring and two connecting hoses for oil (each 5 m long).

BRIEFLY ABOUT THE UNIT

The Unit **S1000** is designed for filtering, drying and degassing of transformer oil.

The model and the example that were kept in mind during development and construction of this Unit were the machines, which proved to be most efficient in operation, built by leading European manufacturers.

All essential parts of the Unit (vacuum pump, gear pump, electromagnetic valve and floater) are produced by leading German manufacturers. Some of the components (such as fine and coarse filters, temperature control, construction of the heaters, gear pump) had to be modified to improve the operation of the Unit and to eliminate shortcomings noticed in the operation of some other machines of this kind.

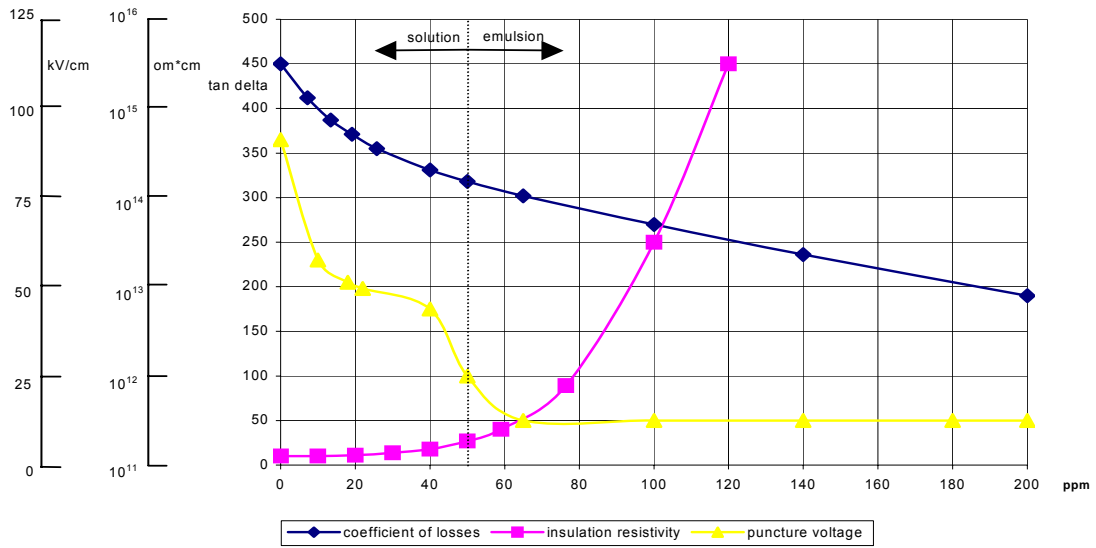
BRIEFLY ABOUT THE PROCESS

The electrical properties of insulating oil (such as puncture voltage and coefficient of losses) can be considerably improved by its filtering, degassing and dehydration. Only properly and sufficiently filtered and dried oil is suitable for filling up of the transformer. Even brand-new oil is rarely clean enough to be used in high-voltage installations, as it is often already polluted in the transporting barrels and it may absorb too much moisture in contact with air. During its operation, transformer-insulating oil is absorbing moisture over its free surface in the expansion vessel and it becomes polluted by absorbing dirty particles, fibers, soot and aging products. Therefore, oil conditioning has to eliminate the following:

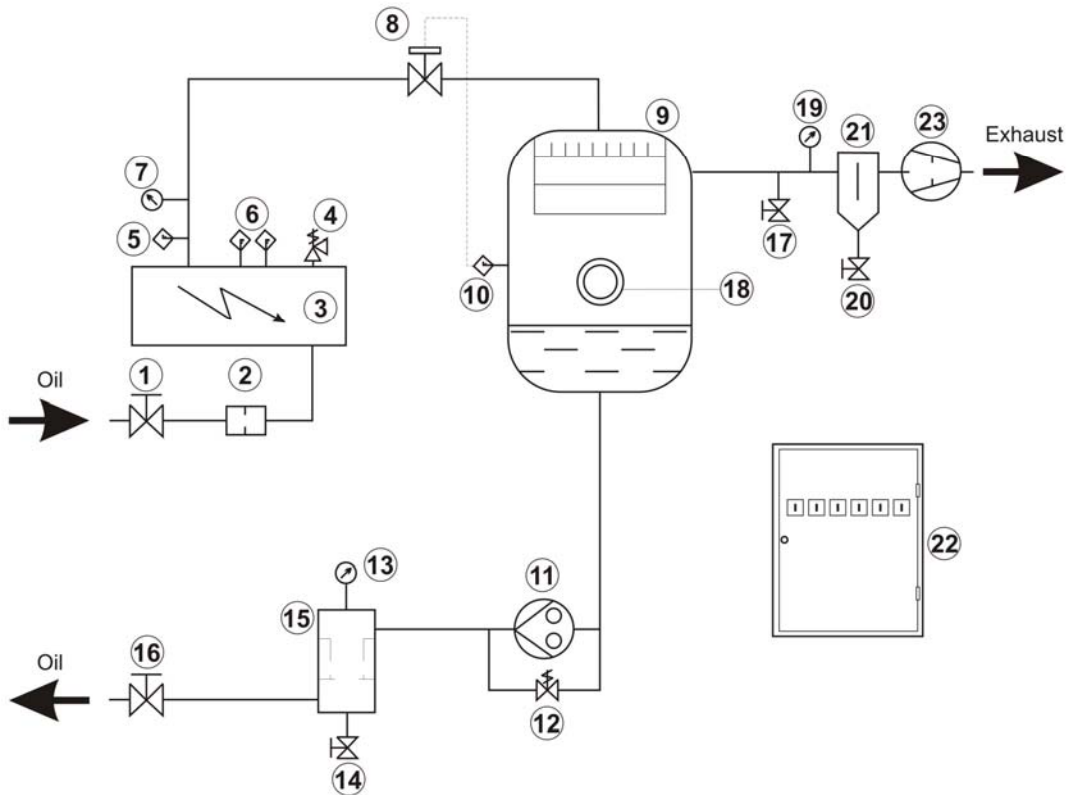
- solid particles
- free and dissolved water
- dissolved gasses

The puncture voltage can be considerably increased and the coefficient of losses $\tan\delta$ improved by filtering, degassing and dehydration of insulating oil to the extent depending on moisture content. The following graph shows insulating oil characteristics in relation to moisture content:

OIL DIELECTRIC STRENGTH VS. MOISTURE CONTENT



Schematic construction of the **S1000** Unit is presented in the following drawing:



The details on the particular stages of operation are given with each part of the Unit in the following text.

THE UNIT CONSISTS OF:

1. Inlet valve a spherical valve with special “Teflon” gaskets

2. Coarse filter as oil is often very polluted, the Unit is fitted with a large sized, easy to open and clean, coarse filter. Oil is conveyed at a reduced flow rate around a strong permanent magnet which retains steel particles and protects the gear pump from damages

3. Oil heater 15 kW power of the heater is divided into two stages, each of 7.5 kW. Oil is heated indirectly by means of electric heating elements insulated from oil by pipes and air. The heating process is thereby gradually accomplished and, with the sufficiently large heating surface, any damage of oil is excluded. In addition, for each heating stage there is one 2.5 kW heater in each of the six heating pipes. Together with the thermal control (details of which are given in the following text) this allows heating of oil in individual stages, e.g. at higher temperatures quite “tenderly”

4. Safety valve prevents increase of pressure in case oil is overheated

5. Safety thermostat the Unit is equipped with a precise thermostat, acting as a safety thermostat. By means of other two thermostats, both heating stages can be controlled. This safety thermostat is designed to allow max. temperature of 100⁰C, with a construction that allows it both safety and control role.

6. Control thermostats fitted with an external button for the temperature range from 40⁰C up to 100⁰C; the button maximum position is 100⁰C, thus these control thermostats act as another safety device to prevent oil overheating

7. Thermometer measures the temperature at the outlet of the oil heater
8. Electromagnetic valve a special magnetic valve capable of operating in vacuum, resistant to transformer oil and high temperatures. It controls the oil level in degassing tank
9. Degassing tank of a welded construction, with specially shaped separating sheets for equal distribution of oil. Oil is conveyed over the "RASIG" rings, where oil surface is significantly increased and gas fractions can be efficiently separated. In addition, the resting time of oil is increased to the maximum. The degassing tank is equipped with a sight-glass for the visual control of the process, as well as with a special lamp for illumination if the tank interior. The power supply of the lamp is 24 V for safety reasons
10. Floater this floater, as essential control equipment, is procured from well-known European manufacturer. It protects the degassing tank from overflowing and, together with electromagnetic valve, prevents the insulating oil to penetrate into the vacuum pump
11. Gear pump with 1000 l/h capacity. This pump is specially designed to operate under vacuum conditions.
12. Overflow valve protects the Unit from an excessive rise of pressure in case outlet valve is negligently closed or because of some other reason
13. Manometer for reading of fine filter dirtiness, through oil pressure rise
14. Valve a spherical, closing valve for insulating oil sampling

- | | |
|-------------------------------------|---|
| 15. Fine filter container | the fine filter container is of a size that allows it to accept a standard filter separating particles of 3-5 microns |
| 16. Outlet valve | a spherical valve with special "Teflon" gaskets |
| 17. Air valve | a spherical valve for aeration of the degassing tank in case of an excessive foaming of oil |
| 18. Sight-glass for process control | equipped with search-light fitted on its right side to illuminate the interior of the degassing tank |
| 19. Vacuum meter | measures vacuum in the degassing tank |
| 20. Discharge valve | a spherical valve discharging condensate from the separator |
| 21. Separator | of a special construction for separation of liquid fractions from gasses which are extracted out of degassing tank |
| 22. Control panel | consisting of fuses, contactors, electric motor electrical protection, relays, transformer, main switch, internal wiring etc., for an automatic operation of the Unit |
| 23. Vacuum pump | of 25 m ³ /h capacity, provides vacuum for operation of the Unit, equipped with a so-called "gas-ballast" valve |
| 24. Framework | a welded, sectional steel construction, which represents foundation for all described components of the Unit |
| 25. Electric equipment | consisting of driving motors for the gear and vacuum pump and of internal wiring of the Unit. Suitable for three-phase, 50 Hz power supply |

THE UNIT IS SUPPLIED WITH THE FOLLOWING ACCESSORIES:

- 26. Two flexible hoses specially designed, suitable for operation in vacuum and oil, both equipped with hose connections for 1" tread; each hose 5 m long

- 27. Connecting cables four-stranded cable complete with a electrical plug for connection of the Unit to the power supply; the cable is approx. 6 m long

INSTRUCTIONS FOR OPERATION

PREPARATION OF THE UNIT FOR OPERATION

1. Plug the Unit into the power supply source;
2. Connect oil hoses as short as possible;
3. Adjust the thermostats;
4. Close all valves;
5. Turn-on the main power switch;
6. Check the rotation direction by turning on of the pumps, several times in short intervals;
7. Turn-on the vacuum pump and open the "gas ballast" valve;
8. Turn-on the floater, which will automatically turn on the oil level control.

TURNING-ON OF THE UNIT (COMMENCEMENT OF FILTERING, DEGASSING AND DRYING PROCESS)

9. Close the "gas-ballast" valve on the vacuum pump;
10. When vacuum reaches 95 %, open the valve No. 1;
11. Open the valve No. 16 and turn-on the gear pump when oil level reaches the sight-glass level;
12. Adjust the oil flow with valve No. 1 and frequency converter;
13. When oil flow becomes constant, turn on the heaters;
14. If oil foams too much, lower the vacuum by easily opening of the valve No. 17.

UNIT SHUT DOWN

15. Turn-off the heaters. The gear pump shall continue operating for at least another 10 minutes;
16. Turn-off the gear pump;
17. Close the valve No. 1;
18. Leave the vacuum pump in operation for at least another 30 minutes with the "gas ballast" valve open;
19. Turn-off the main power switch;
20. Disconnect the power supply.

TECHNICAL CHARACTERISTICS OF THE UNITS PRODUCED BY „KONDIC DOO“

Unit type	S500	S1000	S2000	S4000	S6000	S10000	S12000
Maximal oil flow (l/h)	500	1000	2000	4000	6000	10000	12000
Heating power (kW) (No. of stages)	7 (1x7)	15 (2x7.5)	30 (2x15)	60 (2x30)	75 (3x25)	150 (3x50)	180 (3x60)
Vacuum pump capacity (m ³ /h)	16	25	63	100	160	250	300
Fine filter (μm)	3 – 5	3 – 5	3 – 5	3 – 5	3 – 5	3 – 5	3 – 5
Inlet moisture content (ppm)	50	50	50	50	50	50	50
Outlet moisture content (ppm)	2 – 5	2 – 5	2 – 5	2 – 5	2 – 5	2 – 5	2 – 5
Inlet gas content (%vol.)	10	10	10	10	10	10	10
Outlet gas content (%vol.)	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Min. Inlet temperature (t °C)	5	5	5	5	5	5	5
Differential temperature (inlet/outlet) (Δt °C)	28	28	28	28	28	28	28
Dimensions of the Unit (mm) (L/W/H)	1200 500 1600	1350 700 1600	1500 900 1750	1900 1100 2000	2100 1200 2300	2200 1400 2500	2400 1600 2500
Weight of the Unit (kg)	400	550	700	1300	2300	3000	4500

Unit can be produced in accordance with specific requests of the Client (additional vacuum pump, additional heater, etc.)

Temperature load of the heaters is 1 W/cm².

TROUBLESHOOTING

If malfunction occurs, the Unit should be checked in accordance with the following Table:

Problem	Cause of the problem	Remedy
1. Poor oil throughput (characteristic ringing sound coming from the gear pump indicating that there is not enough oil in degassing tank)	1.1. Dirty coarse filter	1.1. Clean the coarse filter
	1.2. The transformer is placed too low in relation to Unit	1.2. Place the Unit in a better position in relation to the transformer
	1.3. Pressure is too low and the pump operates in foam	1.3. Increase the pressure by adjusting valve No. 17
	1.4. The magnetic valve is closed	1.4. Open the magnetic valve
2. Oil level in the degassing tank is too high	2.1. The gear pump is not turned on	2.1. Turn-on the gear pump
	2.2. Pressure is too low	2.2. Increase the pressure by opening valve No. 7 easily
	2.3. Outlet valve is closed	2.3. Open the outlet valve
3. There is constantly too much foam in the degassing tank	3.1. Inlet oil contains water and air b) a rip in the feed hose or on some other joints c) flow back of oil to the transformer is not good	3.1. a) Repair or replace the hose, or repair the rip in the hose joint b) Ensure that the hose for oil flow-back is immersed in oil

Problem	Cause of the problem	Remedy
4. The vacuum pump is overfilled with oil	4.1. Evaporation in the degassing tank is too high	4.1. Drain the oil from the vacuum pump and refill the pump with new oil
	4.2. The condensate separator is over-filled	4.2 Empty the condensate separator (open the valve No. 20 and rise pressure in the degassing tank to reach atmospheric level)

SPECIAL NOTE:

Whenever the Unit is re-installed and re-energized, the rotation direction of the gear and vacuum pump should be necessary checked, paying special attention to the arrow indicating direction. If the direction is opposite, the two phases in the electrical plug should be reversed (no phases reversion is allowed in the motors, as they are adjusted to the Unit).

PROTOCOL

Made on 15th March 1986 on testing of the Transformer oil filtering, degassing and drying Unit, Model **S1000**

The tests attended by:

Aleksandar Kondić, Eng. (the designer and the manufacturer of the Unit)

Vinka Jovanić, Eng., of RO ŽTO (the Railway Transport Organization of Belgrade)

Ljubiša Knežević, Eng., of RO ŽTO of Belgrade

The Unit tested at RO "MINEL" OOUR "DINAMO" in Belgrade

The transformer oil characteristics before drying:

- Dielectric strength of fresh oil before drying 50 kV/cm
- Oil amount taken before drying 190 l
- Capacity of the Unit 1000 l/h

The drying process completed in four (4) passes of oil through the Unit and the following results obtained:

	Dielectric strength (KV/cm)	Oil amount (l)
Initial condition	50	190
First pass	132	190
Second pass	224	190
Third pass	232	190
Fourth pass	240	190

The transformer oil tested in the RO "MINEL" and the chemical laboratory of RO ŽTO of Belgrade (Makiš).

Made in Belgrade
On 15th March 1986

Signed by:
Aleksandar Kondić, Eng.
Vinka Jovanić, Eng.
Ljubiša Knežević, Eng.

LIST OF REFERENCES

SOLD UNITS:

1. State Railway Company - Beograd (Serbia and Montenegro)
2. Electrodistribution – Subotica (Serbia and Montenegro)
3. Thessalonica (Greece)
4. Baghdad (Iraq)
5. Electrodistribution – Mostar (Bosnia and Herzegovina)
6. Electrodistribution – Banja Luka (Bosnia and Herzegovina)
7. Mašinoinženjering – Beograd (Serbia and Montenegro)
8. Electrodistribution – Knin (Croatia)
9. Petar Drapšin-Mladenovac (specific impregnation Unit)
10. Electrodistribution –Knin (Croatia) – Unit for drying of transformer coils
11. Yugoslav crude oil pipeline - Zagreb (Croatia)
12. Šinvoz – Zrenjanin (Serbia and Montenegro)
13. Electrodistribution – Slovengradec (Slovenia)
14. Electrodistribution – Vranje (Serbia and Montenegro)
15. Electrodistribution – Prijedor (Bosnia and Herzegovina)
16. Electrodistribution – Užice (Serbia and Montenegro)
17. Electrodistribution – Požarevac (Serbia and Montenegro)
18. Electrodistribution – Sarajevo (Bosnia and Herzegovina)
19. SANU - specific Unit
20. Skopski leguri – Skopje (Macedonia)
21. Faculty of Technology and Metallurgy – Unit for transformer oil regeneration

PROVIDED SERVICES - FILTERING, DRYING AND DEGASSING OF TRANSFORMER OIL:

1. "Vlasinske" hydropower plants: VRLA 1,2,3,4
2. Stadium "FC Red Star" – Beograd
3. TRAYAL – Kruševac
4. JAT – Beograd
5. TIGAR - Pirot
6. Elektrovod - Beograd
7. FAM -Kruševac
8. Electrodistribution - Kragujevac
9. Kluz - Beograd
10. Electrodistribution - Pančevo
11. ŽUPA - Kruševac
12. Prva Iskra – Barič

13. Rekord – Beograd
14. 14. Septembar, Elektremont – Užice
15. American embassy – Beograd
16. TEP – Zagreb
17. Zorka-zaštita bilja – Šabac
18. ŽTP - Makiš
19. Coca - Cola – Beograd
20. ZMAJ – Zemun
21. State Government
22. Mostogradnja – Beograd
23. State parliament
24. Hipol - Odžaci (hidraulično ulje)
25. National security – Bgd
26. GSP – Beograd
27. Minel ELIP
28. Elektroprivreda – Beograd
29. Vrenje – Beograd
30. Minel Dinamo – Beograd
31. DUGA – Beograd
32. IMT - Beograd
33. Zavod za mere i dragocenosti
34. Galenika – Beograd
35. Tipoplastika - G.Milanovac
36. Elektrodistribucija - Banja Luka
37. BIP - Sladara – Čačak
38. Elektromontaža – Beograd
39. Pekara "KLAS" - Beograd
40. Sartid 1913 (beli limovi) – Šabac
41. "POLITIKA" AD - Beograd
42. GP " Ratko Mitrović " – Beograd
43. Institut "VINČA" – Beograd
44. Stari arhiv Jugoslavije – Beograd
45. "KNJAZ MILOŠ" – Aranđelovac
46. Napredak – Ratkovo
47. "JUGOPETROL" – Smederevo
48. Beogradski sajam – Beograd
49. Stadion "JNA" – Beograd
50. PC Ušće - CK Beograd
51. "Politika" - pogon Krnjača
52. Šećerana – Crvenka
53. Rafinerija – Beograd

54. Vazduhoplovni zavod " Moma Stanojlovic" – Batajnica
55. Tehnoauto – Požarevac
56. Minel ELVO - N.Beograd
57. CER – Čačak
58. Filip Kljajić – Kragujevac
59. Naftna polja – Tenje
60. MKS – Smederevo
61. SFS - Paraćin
62. BIP – Beograd
63. Elind Teur – Valjevo
64. "JUGOPETROL" – Smederevo
65. Stadion "JNA" – Beograd
66. "Politika" - Krnjača
67. Rafinerija – Beograd
68. Hotel " SLAVIJA"
69. "IPOK" – Zrenjanin
70. "SUNOKO" - Fabrika šećera Pećinci (turbinsko ulje)
71. "SUNOKO" - Fabrika šećera Bač (turbinsko ulje)
72. Vojvodinaput - Zrenjanin
73. „ANODA“ - Valjevo
74. „TIZ“ – Zemun
75. „NAPREDAK“ – Stara Pazova
76. "INSTITUT ZA KUKURUZ" – Zemun Polje