DAKSHIN TRANSFORMER OIL

MULTI STAGE GAS EXTRACTOR

D-TOMGET, Model:1207

(As per ASTM 3612-02 Method A)

For

Dissolved Gas Analysis of Transformer Oil

Designed by

Central Power Research Institute, Bangalore

&

Developed by

Dakshin Lab Agencies, Bangalore

(Comprehensive Catalogue)

CERTIFICATE

केन्द्रीय विद्युत अनुसंधान संस्थान

(भारत सरकार की सोसाइटी, विद्युत मंत्रालय)

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TO WHOMSOEVER IT MAY CONCERN

Date : 07.07.2006.

THIS IS TO CERTIFY THAT WE HAVE TRANSFERRED TECHNOLOGY OF MULTIPLE GAS EXTRACTION APPARATUS TO M/S. DAKSHIN LAB AGENCIES, BANGALORE. MULTIPLE GAS EXTRACTION APPARATUS PROCURED FROM M/S. DAKSHIN LAB AGENCIES, BANGALORE IS WORKING SATISFACTORILY.

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Additional Director

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INSTALLATIONS OF D-TOMGET

Research Institutions

1. Central Power Research Institute (CPRI), Bangalore
2-5.CPRI Regional Testing Laboratory at Guwahati, Kolkatta,Ghaziabad and Bhopal
6. Electrical Research & Development Association(ERDA), Vadodara
7. Indian Institute of Science (IISc), Bangalore
8. Maulana Azad National Institute of Technology (NIT), Bhopal

Electricity Boards

9-11. Tamil Nadu Electricity Board (TNEB), Chennai, Coimbaore and Trichy
12. Karnataka Power Transmission Corporation Ltd (KPTCL), Bangalore

Hydro Power Plants

13. National Hydroelectric Power Corporation Ltd., Chamba, Himachal Pradesh
14. Drug Green Power Corporation Ltd. Chhukha, Bhutan

Thermal Power Plants

15. APGENCO Thermal Power Station, Vijayawada, Andhra Pradesh
16. Neyveli Lignite Corporation (NLC) Thermal Power II, Tamil Nadu
17. NTPC Energy Technology Research Alliance, NETRA, Noida
18. NTPC, Singrauli Super Thermal Power Station, Shaktinagar, Uttar Pradesh

Industries

19. Hindalco Industries Ltd. Taloja, Navi Mumbai
20. Areva T & D India Ltd , Bangalore
21. Alstom Project India Ltd., Mumbai
22. Essar Steel Ltd, Hazira, Gujarat
23. Raj Petro Specialties Ltd, Manali, Chennai
24. Tovya Automation Pvt. Ltd, Bangalore
25. Dani Instruments India Pvt Ltd , Mumbai
26. Prama Instruments Pvt. Ltd. Mumbai

Oil Testing Laboratories

27. Abirami Engineering Works, Chennai
28. Power Electronical, Nashik
29. Excel Equipments, Kochi
30. Universal Welding and Engineering Works, Mumbai

Railways

31. EMU Car shed Avadi
32. Electric Loco Shed, Erode

Overseas Installations

33. Tenaga Nasional Berhad, Kuala Lumpur, Malaysia
34. Druk Green Power Corporation Ltd, Chhukha, Bhutan

DISSOLVED GAS ANALYSIS OF TRANSFORMER OIL (DGA)

DGA is the most sensitive and reliable loss prevention technique.

It gives an early indication of abnormal behavior of the transformer.

It helps to evaluate the health of transformer and is a guide to monitor the trends of developing faults.

Transformer Oil:

Transformer oil is used as a coolant and an insulator in transformers.

It bathes every internal component and contains lot of diagnostic information.

It can be called as 'blood' of transformer and contains the 'fault gases', which are formed due to natural ageing and as result of faults inside the transformer.

Formation of Fault Gases includes oxidation, vaporization, insulation decomposition, oil breakdown and electrolytic action.

Periodic analysis of oil samples for the amount and composition of dissolved fault gases forms a means of detecting faults.

Steps of DGA:

Dissolved Gas Analysis (DGA) contains three important steps

1. Transformer Oil Sampling using Oil Sampling Tube without exposure of sample to atmosphere.

2. Extraction of all dissolved gases from oil sample using Transformer Oil Multi-stage Gas Extractor.

3. Quantitative determination of fault gases using Gas Chromatograph and diagnosis of faults.

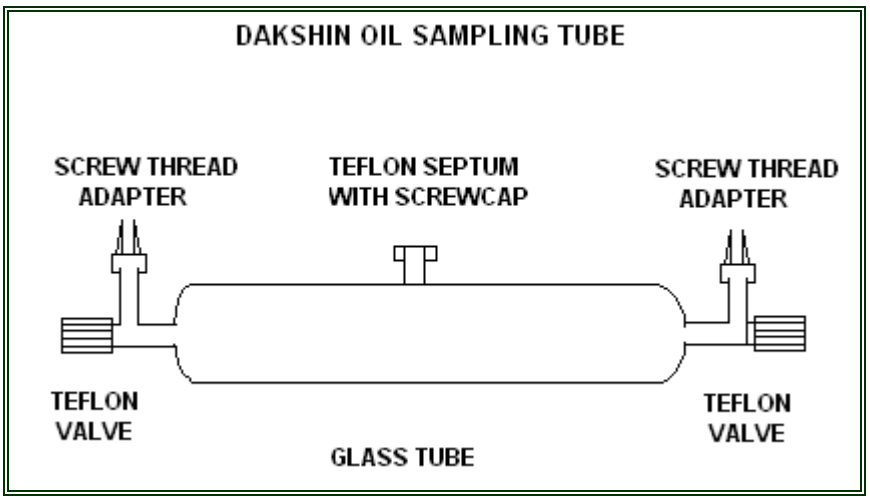
SAMPLING OF TRANSFORMER OIL

Dakshin Oil Sampling Tube:

The results of DGA shall be as good as the sample obtained.

Always ensure that the drain valve is flushed. This is an area of stagnant oil that will not be part of the oil circulation flow within the transformer.

If this valve is on the bottom of the transformer there could be a lot of sediment or free water present. Make sure that a sufficient amount of oil is allowed to flow through the valve to remove the stagnant oil.



Accessories required for oil sampling:

1. Impermeable oil resistant silicon tubing with inner diameter of 8 mm.

2. A gas tight 'Dakshin Oil Sampling Tube' in the form of a glass tube with a capacity of 250 ml, having two airtight Teflon valves at both ends.

   At the center of sampling tube a septum holder is provided with airtight screw cap.

   Both ends of the sample tube have detachable screw type adapters to attach the connecting tubes conveniently.

3. Thermo foam box is given for transportation of sampling tubes. This box protects the sampling tube from sunlight during transportation and storage.

Procedure for Sampling of Transformer Oil:

One end of the Dakshin Oil Sampling Tube is connected to the sampling point of the transformer by silicon tubing using the metallic adapter and the other end by tubing to waste vessel.

The oil sampling tube is held vertically and the screw cocks on the sampling tube are opened. Now, sampling valve on the equipment is opened carefully, so that oil flows through the sample tube to waste.

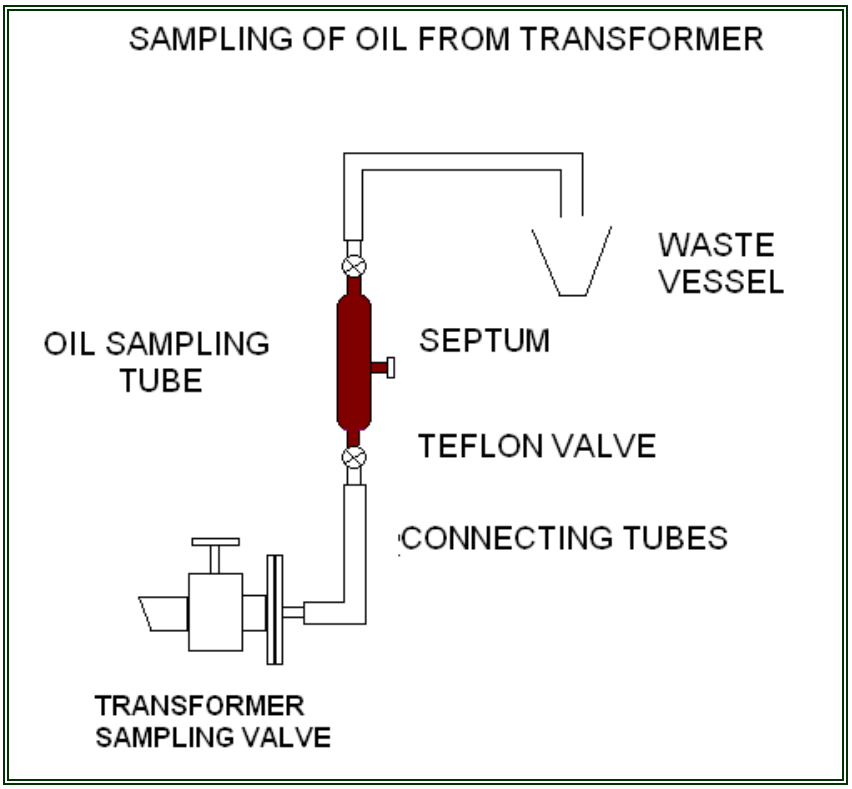
The sample tube is completely filled and about two liters of oil is allowed to flow waste. The oil flow is then closed by shutting off first the outer screw cock, then the inner screw cock and finally oil sample valve.

After detaching the tubing from both the ends of sample tube, it is wrapped by aluminium foil to prevent oxidation by light and kept inside the special thermo foam boxes.

The sample is to be analyzed within seven days. Two samples, instead of one, drawn at a time will serve to check the consistency of results and help improve reproducibility.

Dakshin Oil Sampling Tube should be full and completely closed.

It is used for both Dissolved Gas Analysis and Moisture Content Test.



Trends:

The best information is obtained by viewing trends. So it is useful to take a benchmark sample when a transformer is first energised, or when an oil treatment is performed, and to take further samples at regular intervals so that any variation in quality can be identified to indicate developing faults

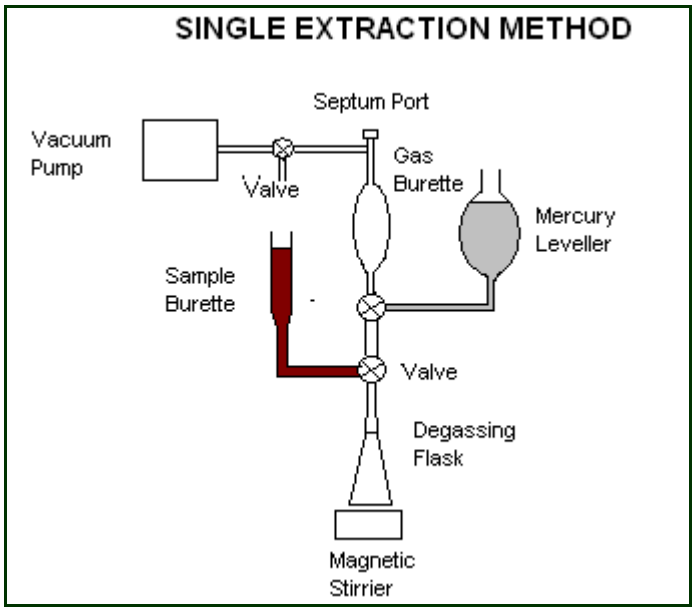
EXTRACTION OF DISSOLVED GASES

Next important step in DGA is Gas Extraction where many errors may occur. It is essentially subjecting oil sample to high vacuum and isolating the evolved gases without any air contamination.

This can be achieved by using appropriate apparatus and technique introduced by Central Power Research Institute, Bangalore.

Unless complete and accurate extraction of gases is achieved, the results obtained in DGA shall be erroneous.

Single Extraction Method : (Obsolete now & dealt here for comparison purposes)
Until 2004, Gas extraction was carried out by adopting single extraction method which had many limitations as detailed below.



Limitations of Single Extraction Method:

1. This method does not have provision to expose the same sample oil, more than once to vacuum and hence extraction efficiency was less than 50%.

2. Measurement of extracted gases was not accurate since some part of the extracted gases was trapped in de-gassing vessel and in vacuum line also.

3. Mercury was contained in an open moving vessel for trapping the isolated gases and needed manual lifting, thereby, exposing the operator to risk

4. The oil sample was stored in SS containers or glass bottles and transferred to beakers before pouring into oil burette through a funnel. Thus some quantity of dissolved fault gases escaped into atmosphere.

5. Glass valves were used with possible grease contamination.

6. Hot plate was used, making the sample to ageing, resulting in wrong results

MULTI STAGE EXTRACTION METHOD

During 2004, Central Power Research Institute, Bangalore introduced a novel method in which the same sample oil could be exposed to vacuum many times, until there is no further increase in the volume of gases extracted.

This method was further developed by Dakshin Lab Agencies, to provide….

DAKSHIN TRANSFORMER OIL MULTI STAGE GAS EXTRACTOR (D-TOMGET) Model:1207

This advanced system is a patented apparatus and unique in its design.

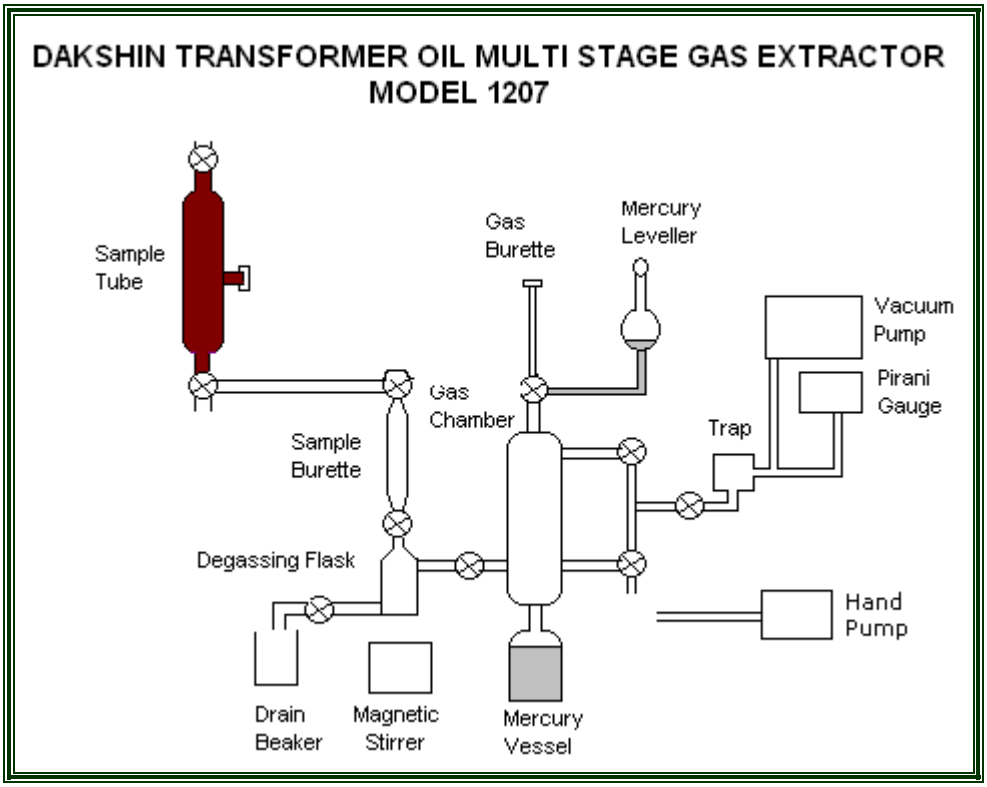
It is designed to extract even small traces of fault gases in transformer oil which are to be detected at an early stage, to identify a developing fault in transformer.

A fixed volume (30 ml) of sample oil is directly drawn from sampling tube into de-gassing vessel under vacuum, and the evolved gases are isolated in Gas Chamber.

The mercury stored in a stationary vessel, compresses the gases of Gas Chamber (under differential pressure) into Gas Burette.

In Gas Burette, the gas mixture is measured at atmospheric pressure using Mercury Leveler.

Gas mixture is injected into a gas chromatograph either using a gastight syringe or auto sampler.



MERITS OF (D-TOMGET) Model - 1207

1. The same sample oil is exposed to vacuum many times, until complete extraction of gases is achieved
2. Efficiency is more than 98%
3. Extraction is done at a very high vacuum of 0.02 mbar surpassing BIS specifications
4. Movement of mercury is from a stationary vessel is under atmospheric pressure and does not involve manual lifting.
5. Direct transfer of sample oil, into vacuum without exposure to atmosphere, thereby retaining all dissolved fault gases.
6. The gas extractor is vacuum tight as per IS:9434:1992. If subjected to a vacuum of 0.1 mbar and left, the vacuum remains unchanged.
7. Direct measurement of extracted gases to the nearest 0.05 ml at atmospheric pressure.
8. The Gas expansion chamber is ten times the volume of sample oil for complete extraction as per ASTM D- 3612
9. Whenever vacuum pump is switched on, Mercury vapours are exhausted, thereby protecting the operator.
10. Rinsing of apparatus with new sample is done without dismantling the apparatus.

We reserve the right to make any modifications, for improvements in performance of the system offered, which we consider useful in view of our continued R & D efforts.

SPECIFICATION OF D-TOMGET, Model – 1207

(As per ASTM 3612-02 Method A)

1. **Vacuum Pump:** Direct Drive Rotary Vacuum Pump (air-cooled) with single phase motor of displacement capacity 200 lit/min. Ultimate partial pressure with Gas ballast closed 5×10^{-4} mbar.

2. **Vacuum Gauge:** Digital Pirani Gauge with pressure range of 1000 mbar to 0.001 mbar in numeric LED display along with Calibration Certificate.

3. **Gas Extractor (Patented):** Designed for exposing same sample oil to multiple extractions. To hold vacuum of 0.1 mbar with minimum efficiency of 97% gas extraction, as per IS:9434:1992. The components are,

    a. Oil Sample tube of 350 ml capacity with two Teflon valves, side tube with Teflon lined septum and two machined adapters for connections.

    b. Sample Burette to draw fixed volume of transformer oil directly from oil sample tube, retaining all dissolved gases.

    c. De-gassing vessel with impinging and magnetic stirring. Sample oil exposed to high vacuum of 0.02 mbar.

    d. Draining valve with PTFE plunger for quick draining and rinsing with new sample.

    e. High vacuum gas expansion chamber with heavy duty PTFE control valves, mercury trap, PTFE high precision air inlet valve and gas tight threaded joint as a single unit.

    f. Mercury reservoir with gas tight threaded union joint and excess removal valve.

    g. Gas burette to measure and transfer extracted gases with gastight septum arrangement along with Calibration Certificate of NABL accredited laboratory.

    h. Mercury leveler to measure extracted gases at atmospheric pressure.

    i. Open type oil burette

    j. Vacuum trap

4. **Stand:** Vibration free heavy-duty stand with suitable clamps to hold gas extractor.

5. **Mercury :** Sufficient to operate

6. **Magnetic Stirrer**

7. **Power Distribution Board** with vacuum gauge fixed on it.

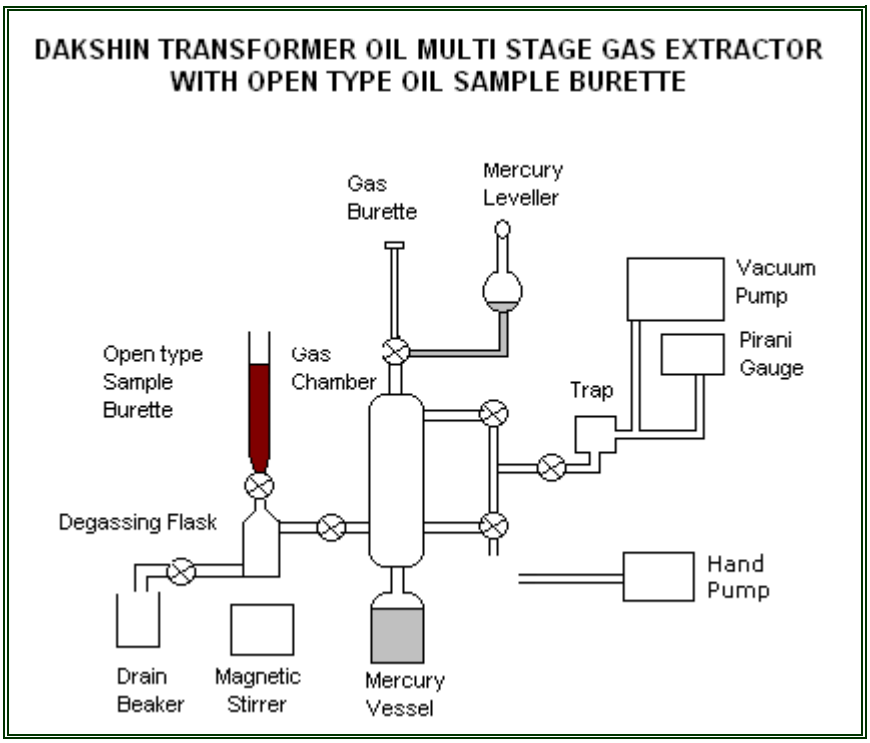
8. **Accessories:** Hand pump, vacuum tubes, vacuum grease and spares like septum, magnetic bar and screw caps.

It is a patented product and available only with M/s.Dakshin Lab Agencies, Bangalore 560 075

OPEN TYPE OIL SAMPLE BURETTE

Until the glass tubes for oil sampling is introduced in your organization, to facilitate immediate usage of Transformer Oil Multi stage Gas Extractor with the available sample oil containers, we provide open type oil burette additionally along with the above apparatus.

The diagram to use open type oil burette is given below.



COMPARISON

SAMPLE OIL HANDLING

	Transformer Oil Multistage Gas Extractor	Single Extraction Method
1	Oil sample is collected in airtight glass Sampling Tubes.	Oil is collected in SS containers or glass bottles-Sample contamination, lose of fault gases
2	Sampling tubes are stored and transported in thermoform boxes, protecting sample oil from heat and light	Oxidation due to sunlight takes place in sample oil
3	Oil from Sampling tube is directly transferred into Oil Burette under vacuum, thereby retaining all gas contents.	Sample oil is poured into beaker and then to open type oil burette – Sample loses some of its gas contents.
4	For every sample, the same fixed volume of sample oil is drawn and sent for de-gassing.	Every time, the sample oil is to be measured before de-gassing – Increase in operating time

RINSING

5	In de-gassing vessel, for effective rinsing, new sample oil impinges the same surface through a small inner sealed tube.	No such facility.
6	Quick rinsing of Oil Burette and De-gassing vessel with new sample oil, using vacuum, without dismantling.	Oil Burette and De-gassing vessel are to be detached every time for rinsing – More rinsing time

EXTRACTION OF FAULT GASES

	Transformer Oil Multistage Gas Extractor	Single Extraction Method
7	De-gassing of gases at a very high vacuum of 0.02 mbar and complete extraction.	De-gassing at simple vacuum of about 100 mbar and extraction is incomplete.
8	Evolved gases are exposed to high vacuum at ten times the volume of sample oil and hence efficient extraction	Gases are exposed to only twice the volume of sample oil- De-gassing is inefficient.
9	Efficiency of extraction is more than 98%.	Efficiency of extraction is less than 50%

ACCURACY

10	Precision valves with Teflon plungers are used to retain high vacuum and they are totally leak proof.	Glass valves are used and the vacuum grease contaminates the sample oil.
11	Mercury leveler can be moved closer to gas burette for accurate readings of gas volume to the nearest 0.05 ml	No such provision
12	Air trapped in mercury piston and mercury vapours are removed under high vacuum, in every stage of de-gassing.	Trapped air and vapours not removed from mercury piston and results are erroneous.
13	Oil sampling tube is used from drawing oil sample through gas tight syringe for Moisture Content Test.	Sample oil is exposed to atmosphere before Moisture Content Test and results are not accurate.
14	Digital Vacuum Gauge with higher sensitivity, to read 0.001 mbar is used	Analog gauges are used

SAFETY FEATURES

	Transformer Oil Multistage Gas Extractor	Single Extraction Method
15	The sample oil is stirred in a round bottom vessel for total gas evolution under room temperature – Safety is taken care	Sample oil is stirred in a flat surface with heating which ages the sample oil giving erroneous results – Not a safe procedure
16	Evolved gases are compressed by mercury stored in a stationary vessel, under a closed system. Hence the operator is not exposed to risk of mercury spilling or vapours.	Evolved gases are pushed by manual lifting of mercury vessel – Exposes operator more to mercury spilling and vapours
17	Integrated Gas Chamber is unique in its design and consists of Gas Valve, Vacuum Valve, Air admittance Valve, Mercury Trap, Mercury flow tube and Vacuum/Pressure Control valve, all in a single piece.	No such facility and safety features – No protection to the operator
18	An additional External Vacuum trap is provided to protect the vacuum pump from accidental mercury entry.	No such facility

DURATION OF EXTRACTION AND REPEATABILITY

19	High performance vacuum pump is used for quick vacuum creation – within 2 minutes	Ordinary vacuum pump is used – takes more than 15 minutes
20	The same sample oil is de-gassed in multi stage, till complete extraction is ensured.	The sample can be de-gassed once only which does not ensure complete extraction – Incomplete extraction
21	Repeated tests reveal the same 'Total Gas Content'	'Total Gas Content' varies in repeated tests and erroneous.

DRAINING OF SAMPLE OIL

	Transformer Oil Multistage Gas Extractor	Single Extraction Method
22	De-gassed oil can be drained with ease without dismantling the apparatus.	De-gassing vessel is to be detached for every sample – Increase in operating time

DESIGN ADVANTAGES

23	Gas Valve prevents oil froth contaminating the mercury.	No such facility
24	Vacuum Valve when closed, retains very high vacuum in Gas Chamber to hold mercury piston up, whereas on opening, it allows air to push down mercury piston.	No such facility
25	Air admittance valve permits atmospheric air to push mercury piston up and also functions as a drain valve for Mercury Trap.	No such facility
26	Mercury Trap is an in built safety feature that prevents mercury from entering into vacuum pump line.	No such provision and safety feature
27	Mercury flow tube minimizes the turbulence when mercury piston moves up or down.	No such facility
28	Vacuum/Pressure Control Valve is used for Connecting Gas Chamber either into Vacuum mode or Pressure mode.	No such facility
29	Gas Burette, Gas Chamber and Mercury Vessel are connected using threaded socket with unions. This withstands the jerks when mercury moves into high vacuum zone.	No such safety features
30	At higher altitudes, for mercury piston to overcome the backpressure of evolved gases, a hand pump is provided.	No provision of pressure mode

UNIQUE ADVANTAGES

OF D-TOMGET, Model:1207

1. Teflon valves eliminate usage of vacuum grease, thus protecting sample oil from possible contamination.

2. These valves hold very high vacuum of 5 microns (0.005 mbar) for longer duration, ensuring total extraction of dissolved gases at ambient temperature.

3. Oil sample tube (which is totally gas tight) is provided to retain hydrogen and carbon monoxide (gases of low solubility) in the same condition as it was inside the transformer without escape into atmosphere.

4. The above oil sampling tube is provided with screw thread septum holder to draw sample oil for Moisture Content Test.

5. During extraction of fault gases, fixed volume of sample oil is transferred under a closed system (from sample oil tube into De-gassing flask through oil burette). This procedure retains all the dissolved gases of sample oil, without any exposure or escape into atmosphere.

6. Drain valves are provided in de-gassing flask so that there is no need for dismantling the system for rinsing purposes with subsequent samples.

7. You could detect your acetylene at a very early stage itself.

8. D-TOMGET fulfills the requirements of ASTM 3612 -02 -A and IS 9434.

   It also surpasses these standards, in its accuracy and efficiency.

   It remains a unique apparatus.

FAQs

1. How is DGA (Dissolved Gas Analysis) related to health of transformer?

Transformer oil is the 'blood' of transformer.

It bathes every component of transformer and contains lot of diagnostic information to evaluate (under Dissolved Gas Analysis) the health of transformer.

2. What are 'fault gases'?

'Fault Gases' are formed in transformer oil due to natural ageing and as result of faults inside transformer.

Gas formation includes oxidation, vaporization, insulation decomposition, oil breakdown and electrolytic action.

The gases of interest are Hydrogen, Methane, Acetylene, Ethylene, Ethane, Carbon monoxide and Carbon-di-oxide.

3. What are the important steps of DGA?

The three important steps are,

a. Sampling of Transformer Oil using Oil sampling tube.
b. Complete extraction of fault gases using Multistage Gas Extractor with efficiency of more than 98%, since the results are interpretation of concentration of fault gases in sample oil.
c. Analysis of fault gases for its contents and quantity in ppm (parts per million)

4. How are the DGA results interpreted?

Fault gases are completely extracted from a known volume of transformer oil and the Volume of fault gases are measured at Standard Temperature and Pressure.

The **Total Gas Content (TGC)** of fault gases in sample oil is observed in

'millilitre (ml) of gases per millilitre (ml) of oil'

Then converted into

'microlitre of gases per litre of oil'

OR

parts per million (ppm)

The quantity of individual fault gases is measured in ppm using a Gas Chromatograph.

Hence to get accurate results **'complete extraction'** is important.

5. What are the different types of DGA?

a. Vacuum Extraction Method (ASTM D-3612- 02)

Sample Oil is exposed to vacuum and evolved gases are compressed using mercury. This method has two types.

Single Extraction method: Oil sample is exposed to simple vacuum, once only and the evolved gases are compressed for volume measurement.

This type has an extraction efficiency of about 45% only and hence obsolete now.

Multistage Extraction method: In this latest novel method, the same sample oil could be subjected to high vacuum, repeatedly many times.

And the efficiency achieved is more than 98% in three extractions itself.

This patented Multistage Extraction method reveals all the dissolved gases in their actual concentrations.

D-TOMGET, Model:1207 is designed for Multistage Extraction.

D- TOMGET, Model:1207 is simple, very accurate and cost effective.

b. The Stripping Method:

Nitrogen is allowed to flow through the sample oil as a carrier gas. Efficiency of the method is very much limited and the system is more complicated.

c. Head space analysis:

Argon is used as blanket in a vial of sample oil and agitated. Accuracy of results depends on various factors like precise volume of oil and blanket gas, apart from temperature and pressure.

5. What are the important specifications of IS:9434:1992, ASTM D -3612 – 02 and CPRI which are followed in D-TOMGET?

a. D-TOMGET, if subjected to a vacuum of 0.1 mbar and left, the vacuum remains unchanged.
b. Gas Expansion Chamber is ten times the volume of sample oil.
c. Extraction is done at a very high vacuum of 0.02 mbar
d. Sample oil is exposed to vacuum many times, until complete extraction of fault gases is achieved.
e. Measurement of extracted gases is to the nearest 0.05 ml at atmospheric pressure.

COMPARISON OF D-TOMGET WITH STANDARDS

Parameters	IS:9434-1992	ASTM D3612-02	D-TOMGET	OBSERVATION
Vaccum Pump	Capable of evacuating glass apparatus to below 0.1 mbar	Capable of evacuating glass apparatus to 0.001 mbar or lower	Capable of evacuating glass apparatus to 0.001 mbar or lower	Better than IS Satisfies ASTM
Vaccum Gauge	Capable to measure the vacuum of below 0.1 mbar	Capable to measure the vacuum of 0.001 mbar or lower	Capable to measure vacuum of 0.001 mbar	Better than IS Satisfies ASTM
Vaccum Holding Capacity	Capable to hold vacuum of 0.1 mbar	No specification	Capable to hold vacuum of 0.005 mbar	Better than IS
Extraction Efficiency	Capable of extracting 97% of dissolved gases	No specification	Extraction Efficiency more than 98%	Better than IS
Gas Sampling Burette	No specification	Sub division 0.01ml Capacity 5 ml	Sub division 0.05 ml Capacity 5 ml	Satisfies ASTM partially
Gas Chamber	Ten times of sample	Ten times of sample	Ten times of sample	Satisfies IS Satisfies ASTM
Degassing Flask	Capacity 50ml	Capacity 50ml	More than 50 ml for Better extraction	Better than IS Better than ASTM
High Vacuum Valves	Glass valves	Glass valves	Teflon valves without grease	Better than IS Better than ASTM
Permanent Joints	No specification	No Specification	Joints with coupling for extra safety	Better than IS Better than ASTM
Magnetic Stirrer	With hot plate	Without hot plate	Without hot plate	Satisfies ASTM

Dakshin Lab……. does it better