भारत सरकार, GOVERNMENT OF INDIA
रेल मंत्रालय, MINISTRY OF RAILWAYS

TECHNICAL SPECIFICATION FOR

Gas Chromatograph for analysis of dissolved gas in Transformer Oil

Specification No. TI/SPC/PSI/GASCHR/0250

This specification supersedes the specification no. ETI/PSI/105(07/93)

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1.0 Forward

1.1 Gas Chromatography is a method widely used for detection of various types of dissolved gases in the insulating oil of oil filled equipment's, identification of concentration of these gases to interpret the incipient fault and to adopt preventive measures before the transformer fails under energized condition.

1.2 In order to facilitate initial procurement and installation of the instrument, Spec. No. ETI/PSI/105(7/93) for Gas Chromatograph was issued by Traction Installation Directorate of RDSO.

1.3 In view of much technical advancement in the field of dissolved gas analysis, this Specification No. TI/SPC/PSI/GASCHR/0250, which incorporates the latest Data on Gas Chromatograph and its requirements, supersedes earlier specification no. ETI/PSI/105(7/93).

2.0 Scope:

2.1 It is to be noted that "The make in India Policy of government of India shall be applicable."

2.2 This specification applies to constructional and technical requirements of Gas Chromatograph including associated detecting devices and accessories.

2.3 Gas Chromatograph/Transformer Oil Gas Analyser should be suitable to perform the analysis of gases which have been extracted from Transformer oil. The final results shall be printed out.

3.0 Governing Specifications:

3.1 Assistance has been taken from the following standards, code of practices etc. in preparation of this specification;

SN	Standard No.	Description
i.	IS: 9434: 2019	Oil Filled Electrical Equipment — Sampling of Gases and Analysis of Free and Dissolved Gases
ii.	IS: 10593: 2023	Mineral Oil-Filled Electrical Equipment in Service — Guidance on the Interpretation of Dissolved and Free Gases Analysis
iii.	IEC: 60567 (2023-12)	Oil-filled electrical equipment – Sampling of free gases and analysis of free and dissolved gases in mineral oils and other insulating liquids – Guidance
iv.	ASTM D 3612-02 (Reapproved 2009)	Standard Test method for Analysis of Gases Dissolved in Electrical Insulating Oil by Gas Chromatography

4.0 Environmental & Operating Conditions

4.1 The instrument shall be suitable for indoor use and operate satisfactorily in coastal areas under normal and polluted atmospheric conditions and subjected to normal vibrations and shocks encountered in a machine, testing shop. It shall operate satisfactorily up to a temperature of 50^0C and relative humidity of 100%.

5.0 General requirements

5.1 Micro-processor based equipment with self-diagnostic facilities, it shall be provided with a front panel touch screen of at least 7 inch, for the DGA functionality.

5.2 The instrument should have self-diagnostic feature available on the touch screen of the analyser. It should provide an alarm for the same. The manual must be provided for comprehensive fault analysis.

5.3 Alarm on Touch Screen shall be provided in case of failure or incorrect functioning of any of the critical component of the equipment. The alarm can be acknowledged but the same shall remain till alarms conditions are mitigated and faults are addressed.

5.4 Data logging and storage should be possible using a laptop or desktop PC. Suitable laser jet printer (B&W) should be provided with the DGA.

5.5 All faults shall be logged in the system and can be seen on the touch screen.

5.6 Whenever the fuses are being used for protection of the instrument, they should have LED indicators to communicate their status.

6.0 The DGA should be type tested from NABL or ISO 17025 accredited laboratory for at least of the following standards.

a. IEC – 61000-4-2
b. IEC – 61000-4-6
c. IEC – 61000-4-11
d. IEC – 61000-6-4
e. IEC – 60068-2-2
f. IEC – 60068-2-30

7.0 Technical Requirements

7.1 The instrument shall be operated by Single Phase, 50Hz AC supply with 230V that may vary by +10% and -15% of rated voltage. Protection against high voltage shall be provided in the form of appropriate MOV (Metal Oxide Varistors).

7.2 ~~The equipment shall be compact unit with three column Gas Chromatography with Single Flame Ionisation Detector (FID) and two Thermal Conductivity Detectors (TCD).~~ The equipment shall be compact unit with a minimum of two columns connected with single Flame Ionization Detector (FID) & Two Thermal Conductivity Detector (TCD) such that complete analysis is completed in single injection.

7.3 ~~The detector modules, power supply units, all should be in one compact unit~~. The Detector Modules (FID & TCD), Methanizer, Injection Ports, Column Oven, Power supply unit, all Mechanical Gas flow valves and Temperature Controller circuit and Signal receiving and amplifying units should be in a single Compact unit. The unit should be designed so as to analyse the gases like Hydrogen (H2), Oxygen (O2), Nitrogen (N2), Carbon dioxide (CO2), Carbon monoxide (CO), Methane (CH4), Ethane (C2H6), Ethylene (C2H4), Acetylene (C2H2), Propane (C3H8) and Propylene (C3H6) at ambient temperature using Argon/Helium as carrier gas. ~~The Gas Circuit should be so designed as to have four separate inlet connections, for carrier gasses and fuel gases. Only one recorder would be used by inter-charging the connecting leads with the help of selector switch. To ensure sturdy and leak proof operation, stainless steel gas tubing connections are preferred for internal gas circuit.~~ As the complete operation is needed in single injection therefore dual channel data system should be provided to be connected to TCD and FID. The pneumatics must have 3 level of control – Through cylinder regulator, through Pressure Regulating valve in Gas Chromatograph and through Dual Flow Control (DFC) available in Gas Chromatograph. All internal and external tubing's must be Stainless Steel only.

7.4 The sensitivity of the apparatus should be able to detect the following minimum concentration of dissolved gases.

i. Hydrogen : 05 ppm
ii. Hydrocarbon : 01 ppm
iii. Carbon monoxides : 25 ppm
iv. Carbon dioxides : 25 ppm

7.5 The equipment shall be consist of following;

7.5.1 Flame Ionisation Detectors (FID):

Parameters	Requirement
Operating Temperature	Ambient to 250 deg. C
Temp. accuracy	± 0.5 % of set value

7.5.2 Thermal Conductivity Detectors (TCD):

Parameters	Requirement
Operating Temp.	Ambient to 200 ^{o}C Minimum
Temp. accuracy	± 0.5 % of set value

~~**Column Details**~~

~~Column 1~~	~~Porapak N, 3 m length X 3mm diameter~~
~~Column 2~~	~~Moleecular Sieve 5A or 13X 0.5m length X 3mm diameter~~

7.5.3 Methanizer (Methannator)

The specially designed high sensitivity methanizer is required for converting CO, C02 to Methane using Nickel Catalyst for low level CO & C02 analysis.

Parameters	Requirement
Operating Temp.	Ambient to 400 ^{o}C Minimum
Temp. accuracy	± 0.5 % of set value

7.5.4 Injection Ports

Parameters	Requirement
Inlet System Type	Packed Injector
No. of injector installed	02 installed
Temp. range	Ambient to 400 ^{o}C Minimum
Temp. read out	All temperature should be set and viewed from the 7 inch color touch screen. The set point and process value should be visible.
Temp. accuracy	± 0.5 % of set value
Overheat protection	Should be available

7.5.5 Column Oven

Parameters	Requirement
Temp. range	Ambient to 450 ^{o}C Minimum
Temp. read out	All temperature should be set and viewed from the 7 inch color Touch screen. The set point and process value should be variable.
Temp. accuracy	± 0.5 % of set value
Overheat protection	Should be available
Auto cooling	Forced air
Heating rate	50 to 250 ^{0}C in 5min

Cooling rate	250 ^{0}C to 50 ^{0}C in 10 min

7.5.6 Detector

Parameters	Requirement
Detector used	FID/TCD/Methanizer
Detectors Installed	FID/TCD/Methanizer
Temp. read out	All temperature should be set and viewed from the 7 inch color touch screen. The set point and process value should be visible.
Temp. accuracy	± 0.5 % of set value
Overheat protection	Should be available

7.5.7 Mechanical Gas Flow Control Valve:

The Mechanical Mass Flow Control valves should have excellent flow repeatability & precision.

8.0 Data System with Associated Hardware and Software.

~~MS – Windows based program for Data collection, Data handling and generation of report is to be provided. This provides flexibility for the option to shrink or enlarge a graph of interest and creates a quantitative report for percentage Area, & Height.~~

8.1 Dual Channel Data System should be provided for data acquisition, analysis and report generation. The data system should be suitable to work in Windows 11 (64 Bit OS Environment) or latest, along with 22 Bit ADC hardware. The data system software should be supplied with branded i5 (13th Generation or above with minimum 16 GB RAM) Desktop PC with licensed OS. A Suitable B/W laser printer should be supplied along with PC. 22 Bit Analog to Digital Converter used between PC and Gas Chromatograph for data acquisition, should work on Ethernet as well as USB port.

8.2 Along with the data system, suitable licensed DGA Interpretation software should be provided for data interpretation based on Duval Triangle and IEC method & IS method.

9.0 Dissolved Gas Interpretation Software

Dissolved Gas Interpretation software for computation and interpretation of the results of analysis of dissolved gases in transformer oil shall be provided which should be licensed from the OEM. The software shall provide user with option to enter all respective and relevant data related to transformer and method used for analysis and interpretation.

10.0 Constructional Features

Gas chromatograph should have the following features.

10.1 Colour Touch screen (of at least 7 inch) for the control of the system parameters with a 24-bit microcontroller system running at the back end to provide good performance.

10.2 The mainframe should be equipped complete with auto cooling facility. The set point for the auto cooling should be user settable from the touch screen and should be able to disabled if required.

10.3 The control system should be with extensive auto diagnostic features & user friendly system with password protection for factory setup menu.

10.4 Safety features should be provided with few controls like maximum column temperature settable by the user using password protection.

10.5 ~~Dual Channel software & hardware with USB interface is required to be provided for data acquisition, data analysis and report generation.~~

10.6 ~~DGA Calculation and Interpretation software for Head Space Sampling Should be provided. The Interpretation methods supported should be Duvall triangle, IEC Cubic and IEC ratio methods.~~

10.7 ~~The PC should be minimum i5 with 19.5inch Monitor along with SS HDD. The B/W Laser printer also to be provided.~~

11.0 Vial Head Space Auto Sampler with Vial Preparation Kit

i. Vial Preparation kit with necessary regulator, valves and needles x 1 set
ii. Vial Crimping tool x 2
iii. 20 ml Vials x 100 numbers
iv. Perforated Aluminium Cap + TFE-fluorocarbon-faced butyl septum X 400 Numbers
v. Vial Head Space Auto sampler with heating & Agitation and storage to inject samples up to 2.5 ml
vi. Fully automatic with incubation,
vii. Heating zone to be in-built & included.
viii. Rotating head design to ensure injector port is always free for manual injections and maintenance.
ix. Integrity check for Auto sampler.
x. Automatic cleaning & purging system.
xi. Integrated vial Oven temperature up to 150 ^{0}C.
xii. A Manual single vial Head Space Sampler must also be supplied so that in event of failure of automated Head Space Sampler (HSS) the analysis work is not compromised.

12.0 Calibration Gas Mixture (1 No)

Calibration Standard Gas Mixture (0.5 Liter Water capacity) with NABL traceability should have the composition as Methane 500 ppm, Ethane 500 ppm , Ethylene 500 ppm, Acetylene 500ppm, Hydrogen 1000 ppm, Carbon monoxide 1000 ppm, Carbon dioxide 2500 ppm, Oxygen 1 %, Nitrogen 3%, balance Argon/Helium.

13.0 Standard Accessories For GC Installation:

13.1 The manufacturer may separately quote for the following items required for the analysis of dissolved gases in the transformer oil:

i. Two nos. Hydrogen Cylinders 47 ltrs. Water capacity filled at >110 bar with 2 stage SS pressure regulator.
ii. Two nos. Argon/Helium Cylinders 47 ltrs. Water capacity filled at >110 bar with 2 stage SS pressure regulator.
iii. Two nos. Zero Air Cylinders 47 ltrs. Water capacity filled at >110 bar with 2 stage SS pressure regulator.
iv. 5 KVA voltage stabilizers with digital display.

13.2 The following accessories shall be supplied free along with the instrument.

i) Set of fuses - 1 set
ii) Tubing for gases - 12 meter
iii) 2 ml Syringe with side bore needle - 1 Nos.
iv) Brass nut & ferrule - 20 Nos.
v) Soap bubble flow meter -1 No.
vi) Set of Tools -1 set
~~vii) Manual Head Space Sampling kit in case of failure of Automated Head Space Sampler – 1 Set~~
~~viii) The PC Should be supplied with licensed OS.~~

14.0 Tests

14.1 The equipment shall be inspected and tested at the manufacturer's premises before the dispatch as per schedule to the mutually agreed between the supplier and purchaser. The tests shall be witnessed by the purchaser's representative(s).

14.2 The manufacturer shall also furnish complete technical details along with the test certificates for the performance claimed.

15.0 Technical Data: Particulars and Drawings

15.1 The manufacturer shall furnish their compliance or otherwise against each clause/sub clause of the technical specification. If the manufacturer wishes to deviate from the provision of any of the clause/sub-clause, he shall furnish the full details with justification for such deviation.

15.2 The manufacturer shall also furnish descriptive technical literatures, assembly layout drawing, schematic diagrams etc. for scrutiny to the purchaser.

16.0 Commissioning

The equipment shall be supplied and commissioned by the supplier at the purchaser's premises. The offer shall include training on the equipment for one week at purchaser's premises, at the time of commissioning.

17.0 Operation and Maintenance Instructions

The supplier shall supply free of cost two copies of instruction manual for operation and maintenance of the equipment. The manual shall contain full particulars of various components, fully dimensioned drawings, circuit diagrams etc.

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