

## **REVISED TECHNICAL SPECIFICATION FOR BET SURFACE AREA ANALYZER**

### **Purpose**

The equipment is intended for performing physisorption and chemisorption analyses. The instrument has to perform the following functions, analyze the specific surface area of the materials in various physical shapes and forms, determine other information such as gas uptake, micropore volume and pore size distribution.

### **Detailed Specifications of BET SURFACE AREA ANALYZER**

#### **A.1. Main Features**

- **Specific surface area:** Minimum surface area of 0.01 m<sup>2</sup>/g or better to 'No known upper limit'
- **Gas volume range:** 1 x 10<sup>-3</sup> cc to > 1 x 10<sup>2</sup> cc or better
- **Reproducibility:** 0.5% or better
- **Operating environment:** 20-80% RH, 15° - 35° C or better
- **Pore Diameter Range:** 4 to 300 nm or better
- **Micropore Volume:** Detectable within 0.0001 cc/gm or better
- **Vacuum system:** The vacuum system should be capable of degassing the samples upto a vacuum level of 1 x 10<sup>-3</sup> Torr or better. Preferably there should be separate vacuum pump systems for degassing and for analysis so the vacuum pump system meant for degassing is not shared by analysis manifold.
- **Furnace controller:** PID, featuring auto-tuning
- The system should have minimum 12 gas inlets with 6 gas inlets for physisorption allowing connections to multiple gases thus eliminating the need to change gas lines. Another 6 gas inlets for chemisorption for simplifying the pre-programming of chemisorption studies.
- Analysis system along with appropriate high sensitivity pressure transducers should be provided.
- **Sample tubes/ holders:** Variable IDs (inner diameter) of the sample tubes/holders **compatible** with the **BET SURFACE AREA ANALYZER** to be supplied so that samples with various geometries with irregular dimension/s could be accommodated for the measurements & analysis (total thirty numbers; ten numbers each in three different types of holders with suitable capacity). Samples holder for fine powders should have the provision to vacuum seal
- **Standard Reference Materials:** Surface area reference material and Chemisorption reference material with details to be provided
- **Electronic weighing balance** capable of measuring weight with an accuracy upto 0.1 mg level (10<sup>-4</sup> g or better) having maximum weighing capacity of ~ 200 gm (one number) to be supplied from reputed manufactures with comparable performance to Sartorius makes

#### **B. Computer and Software**

- **Computer:** Compatible latest high performance computer dedicated to the equipment with high RAM (2GB and above) for faster data acquisition and processing. The computer should be
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guaranteed for a period of 2 years from the date of BET SURFACE AREA ANALYZER commissioning. It is preferred that the computer is procured in India, integrated with the equipment and the required software's are to be installed.

- **Printer:** Suitable compatible laser black and white printer
- The equipment should be fully automated with built-in micro-processors & control systems for the entire operation and analysis.
- **Software:** Suitable software and other interfacing & integration for carrying out the measurement and analysis with high levels of reliability and accuracy. Software should be capable of performing the following tasks
  - Generate both 'Single- and Multi- point BET specific surface area'
  - Generate all the measured 'Adsorption and Desorption Isotherms'
  - Langmuir surface area with slope, intercept, constant and correlation co-efficient
  - Mesopore volume and Mesopore area distribution by BJH, HK and other models
  - T-plot for micropore area & volume
  - Density functional theory to generate various parameters, e.g.,:
    - Micropore and mesopore distributions
    - Porevolume distribution of Poresize
    - Surface energy distribution of poresize
    - Surface area distribution of poresize
  - Summary report
- The software should allow the user to enter any Isotherm into the system by way of a data file or table for calculating thickness curves for T-plots;  $\alpha$ 's plots and BJH pore size distribution. There should be capability to overlay the reference isotherm with other plotted data for comparisons.

### **C. Power Requirements**

- Power 220-240 V AC, 50 Hz
- Suitable UPS(APC/ SOCOMEC) with backup power of upto 30 minutes with details of maintenance schedule and warranty to be quoted

### **D. Qualification Criteria & Other Aspects**

- The vendor should have supplied minimum two **BET SURFACE AREA ANALYZERS** in India and details should be furnished. A certificate from the users should be furnished for, the satisfactory operation of the instrument
  - Should have agents in India to provide after sales service, support and maintenance
  - The machine should be guaranteed for a period of 2 years from the date of commissioning. During warranty period, if there is any repair to be carried out at the supplier's works, transportation cost of equipment/component besides repair / replacement charges, if any, should be borne by the supplier. All the related formalities should be borne by the supplier.
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- AMC charges for 3 years beyond the warranty period of 2 years with details of maintenance schedule, item wise checking should be quoted
- Photographs and catalogues related to every item of should be enclosed
- **Training:** All the expenses related to training by OEM engineers at BHEL R & D should be specified.
- Dimensions of equipment, weight and space requirements should be submitted in technical offer.
- Installation & Commissioning should be carried out at BHEL R&D. Pre-installation requirements should be furnished
- Commissioning charges, if any, to be indicated
- Compliance statement of specification to be submitted along with the offer. Failure to give compliance statement, the offer is liable to be rejected. All tender specifications to be compared with machine offered line by line and documentary evidence must be enclosed by the supplier along with quotation
- Two hard copies of all the operational manuals related to the BET SURFACE AREA ANALYZER system have to be provided after procurement of the equipment
- Supplier must be ISO 9001: 2001 certified

#### **E. Options**

- Suitable & recommended gas cylinders with regulators and gauges for regulating different gases (Nitrogen & Helium or other gases depending on the equipment configuration) to the main equipment (total two numbers, one cylinder for each gas). Further cylinder connectors, isolation valves, suitable gas line connectors & appropriate fittings for different gases required for the measurements in the desired pore size ranges should also be quoted
- Cryo can details with various capacities for storage of liquid nitrogen etc should be quoted with suitable safety trolley along with its recommended safety thermals (two pairs) and safety goggles (two numbers) for safe handling the liquid nitrogen etc should also be quoted
- **TCD (Thermal conductivity detector) filament : Preferably tungsten-rhenium, diffusion-type, oxidation resistant or better and the sample thermocouple should be preferably positioned alongside sample for accurate temperature measurements**

#### **F. Spares and Accessories**

- Recommended spares and consumables that should be required for a period of two years for the equipment to be supplied. The supplier should also ensure that the spares are available for at-least ten years from the date of commissioning for trouble free operation

#### **G. Technical & Commercial bid submission**

**G.1.** Technical offer with all catalogues should be provided

**G.2.** Compliance statement meeting the specification line by line should be provided (Failure to give compliance statement, the offer is liable to be rejected)

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**G.3.** Commercial bid with terms and conditions to be submitted in a separate Sealed Cover

**H.** After the BET SURFACE AREA ANALYZER delivery to BHEL R & D, if the equipment is installed in existing R & D building and later if it has to be shifted to the new building (Center for Nanotechnology and Applications) this has to be done by the supplier and related expenses should be specified. The shifting will be within 9 months of initial installation

**I. Delivery:** The equipment should be delivered within 3-4 months from the date of placement of purchase order

**Note:** All covers should be clearly marked indicating the contents and should be SEALED.

**Note:** Service centers should be preferably in India.

**For any Technical Clarification, please contact :**

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