

Specifications of Rotational Rheometer

1. Scope of the tender

The scope of the tender includes supply, installation and demonstration of the performance of the instrument as per the specifications given, on-site user training and commissioning of a computer controlled rotational rheometer at VSSC, Trivandrum.

2. Description

The computer controlled rotational rheometer shall be capable of evaluating the rheological characteristics of thermoplastics, thermosets, resins, rubbers, low and high viscous fluids and nanofluids in both controlled stress and controlled strain modes.

- The geometries should include parallel plate, cone and plate, serrated plates and concentric cylinder.
- The rheometer should be capable of performing experiments such as determination of flow properties, creep, stress relaxation and oscillation experiments.
- The instrument should have the capability to generate the output values viz., elastic modulus, viscous modulus, complex modulus, and viscosity through modes of operation such as viscometry, oscillation, temperature ramp/step, strain sweep, frequency sweep, creep and stress relaxation.
- The equipment should have in-built temperature sensor for monitoring and controlling torque variations due to temperature.
- It should have high resolution optical encoder for accurate measurement of angular displacement. It should have both Peltier temperature control as well as high temperature furnace.
- It should have auto gap adjustments, be able to measure raw phase angle & real time wave form monitoring throughout the data points.

3. Technical requirements and specifications

Sl. No.	Parameter	
1	Rheometer Main Unit	<ul style="list-style-type: none">○ Main rheometer electronics and power supply must be housed in a separate unit to minimize the effects of vibration and heat.○ It should have motor and transducer with both air bearing and magnetic thrust bearing units.○ The normal force transducer of the rheometer should be separated from the optical encoder.○ Automatic recognition of different geometries and all information specific to the geometry should be automatically configured into the software with appropriate parameters (type, dimension, material etc).
		<ul style="list-style-type: none">○ The rheometer should have the provision for

		<p>automatically correcting the residual bearing friction.</p> <ul style="list-style-type: none"> ○ The rheometer should have the provision for motor and geometry inertia correction in both flow and oscillation mode, with the actual inertia measured by the instrument. ○ The rheometer should have the option to zero the gap automatically. The speed of gap closure should be continuously variable. ○ The rheometer should have the capability of running the available tests in one fixed procedure. It should also have manual override capability to change any of the steps or add a new step. ○ During any test, the normal force on the sample [compression or tension] to be kept within defined limits. ○ During temperature sweeps or ramps, the gap should automatically adjust for thermal expansion/contraction of the measurement plates by actual movement of the geometry as long as the normal force is within the limits. ○ Software gap correction for parallel plates should be invoked if the limits have been reached. ○ The bearing lock mechanism, its capabilities and advantages are to be specified. ○ A purge gas cover should be supplied for purging inert gas. ○ Safety features in the main and sub-systems for safe functioning of the equipment to be highlighted.
2	Rheological measurements	<ul style="list-style-type: none"> ○ Controlled stress and controlled strain mode in all plate geometries ○ Scan multiple frequencies (frequency sweep) and step and/or ramp heating (temperature sweep)
3	Materials	<ul style="list-style-type: none"> ○ Viscoelastic materials from extremely low viscosity fluids (viscosity min 1 mPa.s or better) ○ Thermoplastics, thermosets, resins, rubbers, low and high viscous fluids and nanofluids
4	Temperature control	<p>Furnace (suitable cooling arrangements via LN2 or other means to be provided):</p> <ul style="list-style-type: none"> ● Operating temperature range: -150°C to 600°C ● Heating rates: 0.1 to 10°C/min or better
		<p>Peltier plate:</p> <ul style="list-style-type: none"> ● Operating temperature range: -20°C to 150°C ● Heating rates: 0.1 to 10°C/min or better
		<p>The equipment shall be capable of automatic recognition of different temperature systems, i.e., peltier and furnace</p>
		<p>Suitable temperature controller(s) to be provided for all the given geometries</p>

		Separate geometries suitable for furnace and peltier to be provided.
		The temperature control system should employ radiant heating. Entire temperature range must be achieved using water circulation. The heating rate and temperature of upper and lower plates should match by proper calibration. The upper plate should provide cooling using either air cooler or using a temperature-controlled circulator plate.
5	Minimum torque in oscillation	0.005 μ N.m or better
6	Minimum torque in steady shear	0.005 μ N.m or better
7	Maximum torque	200 mN.m or better
8	Torque resolution	0.1 nN.m or better
9	Angular frequency, minimum	10^{-7} rad/s or better
10	Angular frequency, maximum	600 rad/s or better
11	Angular velocity range	0 to 300 rad/s or better
12	Step change in angular velocity	≤ 10 ms
13	Step change in strain	≤ 20 ms
14	Normal force range	0.01 to 50 N or better
15	Displacement resolution	10 nrad
16	Modes of analysis	<p><u>Oscillation Mode</u></p> <ul style="list-style-type: none"> ○ Torque/Stress sweep (linear or log) at single frequency ○ Frequency sweep (linear or log) at single torque ○ Frequency sweep (linear or log) at single strain ○ Strain/angular displacement sweep (linear or log) at single frequency ○ Temperature sweep at single frequency/torque <p><u>Flow Mode</u></p> <ul style="list-style-type: none"> ○ Controlled stress or torque sweeps. ○ Controlled rate (1/s) or speed (rad/s) sweeps. ○ Stress stepped flow. ○ Temperature sweep at constant stress or rate. <p><u>Creep Mode</u></p> <ul style="list-style-type: none"> ○ Constant stress creep and recovery. ○ Automatic sensing of steady state during creep test. <p>Stress relaxation</p>
17	Plate Geometries (with and without solvent trap)	<p>Parallel plates</p> <ul style="list-style-type: none"> ● 40-50 mm dia. (SS – 1 no.) ● 20-25 mm dia. (SS – 1 no.) <p>Cone and plate ($\leq 2.0^\circ$ cone angles)</p> <ul style="list-style-type: none"> ● 20-25 mm dia. (SS – 1 no.) ● 40-50 mm dia. (SS – 1 no.) <p>Serrated plate</p> <ul style="list-style-type: none"> ● 40 mm dia. – 1 no.
18	Disposable parallel plates made	20-25 mm – 100 sets

	of aluminum	
19	Calibration standards	Suitable Low Viscosity, High Viscosity and PDMS Standards shall be supplied along with the equipment along with the calibration certificates, wherever applicable.
20	Air compressor (oil-free)	<ul style="list-style-type: none"> ○ A high-quality air drier should be supplied to ensure clean, dry and oil free air to the rheometer. ○ The air filter should have a regulator and pressure gauge to regulate the air supply to the rheometer. ○ High quality air filter assembly should be supplied along with the air compressor and the air filter should be capable of filtering any oil, moisture or particulates from the air supplied to the air bearing. ○ The air filter should have an electronic timer for automatically draining out any accumulated water or oil from the air. ○ Electrical requirements: 220±10 V, AC, 50 Hz ○ Noise-free functioning (65-70 dB) ○ Necessary tubes and valves, required for connecting the air filter to the air compressor and to the rheometer should be provided as standard supply.
21	Accessories for the rheometer	<ul style="list-style-type: none"> ○ Accessory for rheological study of pressure sensitive adhesives ○ Torsion clamp accessory ○ Dewar of suitable capacity & necessary connections & adaptors and other mechanisms for connecting dewar to the equipment to be provided for low temperature measurements using LN2 ○ Dewar capacity & details of all accessories to be provided along with the offer ○ A computer with the latest version of the processor, Windows based operating system as well as MS Office Suite available at the time of supply should be provided along with a colour duplex laser printer. ○ The computer should facilitate the control of the instrument and accessories through the supplied software.
22	Optional accessories	<ul style="list-style-type: none"> ○ Concentric cylinder measuring systems (with and without solvent trap): Single and double gap – 1 no. each (price to be quoted separately).

23	Software requirements	<ul style="list-style-type: none"> ○ All the operations of the rheometer should be controlled through software installed in a Windows based PC. Data analysis software should be provided. ○ Analysis of data as well as operation of rheometer should be possible concurrently through the software. ○ Full-fledged software for the operation of rheometer and data analysis ○ Real-time display and storage of oscillation waveforms for each data unit. The waveform should be viewable in either a graphical or tabular form in the analysis package in order to provide an indication of the reliability of the data. ○ Report raw phase angle in oscillation experiment to quantify the amount of instrument inertial correction applied during the measurement. ○ Image capture and video streaming capability ○ Free software upgradation for lifetime. Software update both on-line and offline should be possible. ○ Software should allow off-line data analysis in another PC (preferably in excel format). ○ Help videos should be provided for experimental set-up, experimental parameters and various types of rheological measurements
24	Ability to predict models for material behavior	<ul style="list-style-type: none"> ○ Flow: Newtonian, Casson, Bingham, Herschel-Bufkley, Power Law, Sisko, Cross, Williamson, Ellis, Carreau, Best fit polynomial. ○ Models related to creep and stress relaxation. ○ Models related to oscillation – Time temperature superposition with WLF and Arrhenius models, Coz-Merz. ○ User-defined models ○ Time-Temperature Superposition capability must be built into the software package and should be part of the standard software supply.
25	Warranty	<ul style="list-style-type: none"> ○ The main and auxiliary equipment (air compressor, dewar etc.) shall be provided with a minimum warranty of 1 year.
26	Annual Maintenance Contract	<ul style="list-style-type: none"> ○ Non-comprehensive AMC for 3 years after the expiry of warranty shall be provided (2 regular AMC visits + Emergency visits as applicable). The AMC cost with a detailed split up for the charges incurred for visit/spares/ repair etc., are to be submitted separately.
27	Supply Duration	<ul style="list-style-type: none"> ○ The equipment shall be supplied to VSSC within 16-20 weeks from the release of PO.
28	Installation and demonstration	<ul style="list-style-type: none"> ○ The equipment shall be installed and demonstrated at VSSC free of cost.

29	PDI	<ul style="list-style-type: none"> ○ PDI will be undertaken (online or offline mode). The readiness for PDI shall be communicated to VSSC.
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4. Other Terms & Conditions

- Pre-qualification criteria
 - Party shall submit brochure/catalogue of the proposed make/model of the equipment mandatorily during bid submission.
 - Party shall provide the details of organizations (Govt./PSU/key industrial players) where same or equivalent model has been supplied.
 - Party shall provide service support for minimum 10 years regardless of any administrative / technological constraints from the supplier's end.
 - Party shall provide support not only for the main equipment (hardware and software) but also for the allied accessories viz., air compressor, computer, printer etc.
- Installation & demonstration of the performance of the instrument as per the above specifications, on-site user training and commissioning of the instrument are to be provided by the party free-of-cost.
- List of recommended spare parts and consumables for two years of operation should be supplied during bid submission with item-wise price.
- Guarantee/warranty: The complete supply must be guaranteed for free repair/replacement for 12 months at no extra cost from the date of installation, commissioning and acceptance by VSSC. AMC from 2nd year onwards should be provided as per the standard AMC conditions of VSSC for 3 years after the warranty period. The AMC cost is to be provided separately. The cost for non-comprehensive AMC will be considered during price bid comparison.
- Full technical details in English (both hard and soft copies) should be provided supported by well-documented catalogues/leaflets of the version supplied.
- Operation/maintenance manual, trouble-shooting flowchart, detailed wiring diagrams/circuit, and maintenance tool kits are to be provided.
- Detailed description of the control system is to be provided.
- Party should provide all utility requirements from VSSC for the complete installation and demonstration of the operation of the instrument.
- The cost of the PC, air compressor and related peripherals can be quoted separately. Party should take the responsibility of the service of the computer and printer.
- Two numbers of high quality (CONCOA or equivalent brand of international repute) nitrogen regulator with pressure gauges should be supplied for N₂ gas supply. 50 metres of silicone tubing and necessary fittings also should be supplied.

- Pre-delivery inspection (online or offline) shall be done prior to the delivery.
- Party has to give a compliance matrix for each specification along with the offer. Otherwise, the offer will not be accepted. Compliance matrix should contain the actual specifications of the product the party is offering in writing against each specification of VSSC. Writing “complies” or “non-complies” alone is not acceptable.
- Name and contact details (including phone and fax numbers, email addresses) of the users of the instrument quoted, both in India and abroad, should be provided.
- Full certifications (including ISO, calibration certificate and traceability certificate for calibration standards), wherever applicable, should be provided for all the items.
- All sub-systems, accessories and optional accessories mentioned in the specification should be quoted separately.
