

1. (PACKAGE - F) - Pyrolysis Plant (Continuous Non - Catalytic Thermal Depolymerization Plant)

A	<p>Scope of Supply: Design, Procurement, Engineering, and Supply of fully Continuous Non- Catalytic Thermal Depolymerization Plant that can handle 1000 Kg of Waste Plastics on a continuous feed in 24 hours and convert them into Oil, Gas, and Char. The char shall be continuously removed and cooled near to atmospheric temperature. The non-condensable gas should be supplied to gas engine to produce electricity. The tentative specifications are provided in subsequent sections. However, it is vendor's responsibility to supply a safe and sustainable system by including all other component and necessary spare parts for smooth running of the plant. The vendor must provide complete technical details of each component quoted under this unit.</p>	
B	<p>Standards to be Followed: ATEX (Explosion protection) certificate approved by TUV shall be provided. External HAZOP shall be conducted for each plant as part of the engineering. Safety Integrity Level for safety-relevant loops, Control philosophy with a safety focus implemented by control logic, automated safety routines, interlocks, and set points for alarm and warning triggers shall be provided. The plant automatically reaches safe mode if required, independent of operator action.</p>	
C	<p>Safety standards to be followed: IEC 61508: Functional Safety of Electrical / Electronic / programmable electronic safety related system IEC 61511: Functional safety - Safety instrumented systems for the process industry sector IEC 62061: Safety of machinery: Functional safety of electrical, electronic and programmable electronic control systems</p>	
Sl. No.	Parameters of the Unit	Specification
1	Waste plastics Thermal Depolymerization unit with set of accessories for recovery of Fuel Oil, Produced gases and Solid materials	Thermal Depolymerization with the environmentally friendly closed-loop thermal breaking reaction of the high molecular weight plastics in an oxygen- free environment, producing low molecular weight molecules. (a) Quantity: 01 (b) Capacity of 1000 kg per day on continuous Basis (c) Non-Catalytic Process (d) Electrically Heated

2	Applications	<p>(a) Production of quality Fuel Oil</p> <p>(b) Unit should be capable of handling Multi- Layer Waste Plastics with aluminum, carry bags, mixed plastic scrap, laminates, packing material waste, multilayered plastic etc.</p> <p>(c) Recover produced gases and solid residue i.e., charcoal of high quality</p>
3	Output	The plant should have system to separate liquids with two different boiling points. Char must be cooled and removed continuously. Producer Gas
4	Waste Plastic Shredder	Shredder should reduce the size of the waste plastics and make it uniform for proper feeding with a capacity of 150 kg per hour.
5	Buffer Silo	The uniform feedstock should be stored in a silo size 1.5 m ³ . MOC: IS2062 Gr. A with agitator connected to a drive and motor
6	Transport conveyor	The transport conveyor transfers the feedstock from Silo to the feeding unit. The conveyor should be a screw conveyor, “U” trough with a transparent lid to view the material movement.
7	Feed Stuffing screw	The feed screw with a electric heater to partially melt and feed into reactor in an airtight manner. MOC: Special alloy Material A335 or better.
8	Core Reactor	In the reactor, Polymer waste is heated up to 500 deg C to crack the polymer chains to short chain and char. MOC: SS304
9	Reactor heating system	<p>a) Electrically heated furnace Temperature: Working temperature up to 500 °C</p> <p>b) Temperature should be uniform throughout the reactor and Temperature accuracy: + 5 °C.</p> <p>c) The reactor should be fitted with external heaters and a pocket heater should be installed to provide uniform heating.</p>

10	Char Removal Screw	Water jacketed screw conveyor, which removes the char from the reactor, cools down and transported to a collection bin
11	Stepped Condensation	Several boiling points of the condensable vapour are collected as wax, Petrol Range of Hydrocarbons and Diesel Range of Hydrocarbons. The system should have re-boilers, distillation columns and tube and shell heat exchangers and oil receivers.
12	Cooling system	In order to successfully separate low- boiling components, low cooling water flow temperatures can be provided by an active cooling system (compression chiller) at ambient temperature.
13	Emergency torch	Very short chain products (permanent gases should be burnt without damage in an emergency torch if they can't be used on site to generate electricity or heat
14	Monitoring	<ul style="list-style-type: none"> a. Level Monitoring in Input Material storage, Output Material Storage b. Temperature Monitoring in Complete Process c. Flow Measurement of Produced Oil & Gas d. Input Feed status
15	Control System	Web-based SCADA for Monitoring & Control of Total Unit with Multiple Alert with DAQ system
16	Communication	Data Communication standards meet DLMS Protocol with IEC 61850 Facility
17	Housing	The entire system should be skid-mounted and can fit into a 20 feet container
18	Operating Power	415 VAC 3 Phase, 50hz
19	Diesel Generator	25kva Generator attached with the Unit

20	Pre-installation requirements	<p>a) Bidder should provide all technical drawings related to the plant and prefabricated shed design required for plant installation.</p> <p>(b) Plant installation requirements (electricity, water, construction structure etc.) should be provided accurately.</p> <p>(c) The bidder shall have one R&D consultant from any CFTIs for technological input and pre-installation test whose credentials shall be provided during quotation.</p> <p>(d) The product characterization results must be verified from any CFTIs lab.</p>
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2. UV Weather –O- Meter (Accelerated UV Test Chamber)		
Sl. No.	Items	Specification
1	Applications	To simulate, accelerate and correlate the artificial sunlight/weathering atmosphere for polymers, coatings, textiles, woven sacks, film/sheets, etc.
2	Conforms to standards	ASTM G151, ASTM G 154, ASTM D 5208, ISO 4892 (1 & 3), SAE J2020
3	Components surface temperature	<p>45°C to 80°C for UV Cycle</p> <p>45°C to 60°C for Condensation</p>
4	Temperature accuracy	± 0.1°C or better
5	Temperature resolution	1°C or better
6	Temperature controller	Black Panel Temperature
7	Centre distance of lamp	5 cm or better
8	Humidity	upto 100%
9	Light source	UV Fluorescent Lamp
10	Wavelength	UVA (340 nm) & UVB (313 nm)
11	Minimum sample holder plates	Aluminum Plates 24 sample holders or more
12	Conditioning cycle	Light cycle and Condensation cycle

13	Water spray system	Water spray system consisting of spray nozzle, piping control & drain
14	Irradiation Control	Irradiation control (solar eye automatically maintain light intensity through feedback loop this controller monitor UV intensity and compensate lamp aging or any other variability by adjusting power to the lamp) with NIST traceability
15	Irradiance Calibration	Irradiance calibration (calibration radiometers for periodical calibration) with NIST traceability (UVA & UVB)
16	Installation requirements	Bidder to specify the pre-installation requirements
17	Other built –in features	Easy programming of cycles, temperature checking and status performance with proper safety controls
		Self-diagnostic system for complete error checking and performance status should be displayed
		The built-in calibration includes lamp calibration service or maintenance
		Data Acquisition Program via Ethernet
		De-ionized water unit
18	Training	Onsite training for system operation and maintenance as well as application support should be provided
19	Other Mandatory Items	An appropriate toolbox/kit for routine maintenance should be provided with the
		Hard copies of Operational & Service Manual- 01 Set.
		01 additional set of UVA & UVB (12nos. each)
		Valid calibration certificates
		Radiometer for calibration
		Power backup: Suitable UPS for UV system for 30 minutes
		Power and receptacle/socket as per Indian Standards should be provided

		The vendor shall have a local service and application office and infrastructure to attend by visit within 48 hours of need
		Machine should come with all other essential accessories & spares required for installation, commissioning & Operation
		The vendor should have technical support in the area of application and service available within the country
20	Warranty	Minimum 2 years of warranty to be provided
21	Scope of supply	Complete list of items quoted are to be provided
22	Intallation & Commissioning	The Machine should come with all other essential accessories & spares (as per ASTM & ISO standards) required for installation, commissioning & operation

3. FT-IR Spectrometer		
Sl. No.	Items	Specification
1	Application	Analysis of functional groups in solid, liquid, semi-solid, gel, powder, etc.
2	Wave number	4000 - 400 cm ⁻¹ or better
3	Spectral resolution	0.4 cm ⁻¹ ; or better
4	Signal to Noise ratio	40000 : 1 or better (peak to peak)
5	Detector	Temperature controlled DLaTGS detector
6	Beam splitter	ZnSe beam splitter with ZnSe window
7	Light source	Solid state laser
8	Sample Interference	ATR – Attenuated Total Reflection (Monolithic diamond) to meet the range
9	Internal Validation	Performance validation through inbuilt calibration with NIST traceability standards

10	Library	Library consisting of minimum of 10000 spectra which includes Polymeric materials, blends, Petrochemicals, chemical compounds, inorganic materials (oxide, sulfides etc), Fuels and oils shall be provided. There should be an option to create open library
11	Warranty	Interferometer, Source and laser warranty of 3 years.
12	Other items	Diamond ATR
		Liquid cell holder
		Replacement dessicant
		Liquid Cell Window
		Mirror should be gold coated
		Provision to upgrade with FT microscope in future.
13	Accessories	Pellet Maker, Hydraulic press with required accessories. KBR powder- 25 gm
		CRM with NIST traceable/NABL accredited calibration certificates to be supplied
14	Personal Computer (PC)	A Personal Computer having latest configuration: i7 processor 10th generation, 16GB RAM, DVD - RW, 500 GBSSD, Windows 11 with lifetime licence, Latest microsoft Office professional, 27 " LCD display, Wifi enabled or with better specifications along with a suitable colour laser printer
		All software shall be loaded into the hard disk with appropriate partitions. All original CDs/DVDs must be provided
		UPS (5 KVA) for 1 hour or higher power backup (2 years warranty on UPS and 2 years warranty on batteries)
		Spectral comparison feature to be available

15	Software	Software shall be capable to carry out various blend analysis and Peak Integration functions suitable for Petrochemical/Polymer Identification
		Mixture analysis
		Peak labelling
		Peak integration functions(Area, height)
		Quantification feature to be available
		Easy export of data in excel
16	Terms & Conditions	Manufacture/Supplier should have sizable installations of same or better model worldwide and at least five in India which is education institutions/Research Testing centrally funded institution
		A Satisfactory Performance certificate from at least one Customer to be provided for eligibility. Bidder should submit complete contact details
		Service Support: reporting time within 48 hours after officially request for service
		Hard copies of operational & Service manual -01 set
17	Scope of supply	Complete list of items quoted are to be provided
18	Training	Training on operation & maintainance of the equipment should be provided onsite
19	Intallation & Commissioning	The Machine should come with all other essential accessories & spares required for installation, commissioning & operation

4. Melt Flow Rate Tester

Sl. No.	Items	Specification
1	Scope	Determination of flow properties of polymer powders & granules

2	Purpose	For automatic Measurement of Flow behaviour of Polymeric materials as per ASTM & ISO methods
3	Standard	ISO 1133 and ASTM D1238, Method A, B & C, and other equivalent International standards
4	Temperature range	30 to 400 °C
5	Temperature display resolution:	+/- 0.1 °C
6	Temperature controller	Electrically heated with microprocessor based PID Digital Temperature Controller
7	Timer	Digital timer with a range of 999.9 sec or better, accuracy +/- 0.001 sec with buzzer indication facility
8	Display	On-board LCD Display with alphanumeric keypad for methods setting and visualization of results
9	Thermal stability:	+/- 0.2 °C from 30 to 400 °C with thermal fuse protection
10	Data acquisition	MVR with up to 10 data points acquisition for a single test (with encoder)
11	General requirement	Corrosion resistant pistons and barrel inert to the test materials confirming to ISO 1133 & ASTM D1238 with dimensional conformity traceable certificate
12	Die	Standard die as per ISO 1133/ASTM D1238 Diameter 2.095 mm, Length 8 mm, tungsten carbide; should be supplied with dimensional conformity certificate
13	Die and cylinder dimension	Confirming to ASTM D1238 & ISO 1133
14	Calibrated Go/No-Go Gauge	Go-Gauge shall not be <2.090 mm.
		No-go gauge shall not be >2.100 mm.
15	Barrel Cylinder	Hardened Nitride Steel

16	Motorized Lifting	Should be equipped with high accuracy encoder and motorized lifting device to allow precise and exact positioning of the lifting device for the masses
17	Cutting device	Automatic cutting device
18	Calibration certificates	A calibration certificate from NABL accredited lab with traceability to NIST/International standards for load, timer, temperature controller & mass measurement to be provided
19	Special Features	High Precision digital encoder for automatic measurement of MVR
		Auto weight loader and lifter for automatic and accurate test mass application
		Integrated load system for material compacting, purging and final expulsion with a controlled and programmable force
		High-temperature accuracy and stability
		On-board interface for method setting and visualization of results
		Fully automatic mass selector system to carry out tests with single weight or multiple weights in increasing, decreasing or free sequence
		Built in timer with buzzer alarm
		Temperature accuracy and stability according to standards on whole working range
		Quick release die slide
Corrosion-resistant material for barrel, piston, and dies		
20	Masses	0.325, 1.0, 1.2, 2.16, 3.8, 5, 10, 15, 21.6 kg
		CRM with NIST traceable certificate

21 Accessories

Windows-based software
A Personal Computer having latest configuration: i7 processor 10th generation, 16GB RAM, DVD - RW, 500 GBSSD, Windows 10 or higher with lifetime licence, Latest microsoft Office professional, 27 ” LCD display, Wifi enabled or with better specifications along with a suitable laser printer
Spare Standard Die/Nozzle and Piston
Fuses and Thermal Probe
UPS (5 KVA) for 1 hour or higher power backup (2 years warranty on UPS and 2 years warranty on batteries)
Hard copies of Operational & Service Manual- 01 set
The Machines should come with all other essential accessories & spares (as per ASTM & ISO standards) required for installation, commissioning & operation
Standard Tool Kit containing cleaning tool for barrel and die, compression tool, die removing tool, die plug, cut-off knife, laboratory funnel or spoon for sample loading into barrel, levelling device, die retaining plate, tilt mirror, cleaning patches & cleaning cream
Should be supplied with suitable external thermometers to calibrate the barrel temperature at 190 ° C, 230 ° C & 300 ° C with traceable calibration certificate (188 ° C to 192 ° C with readability 0.1 ° C), (228 ° C to 232 ° C with readability 0.1 ° C) & (298 ° C to 302 ° C with readability 0.1°C)
01 No. of extra standard die set and guages as per standard
Safety gloves & goggles required for day to day activities during operation of Machine-01 set

		<p>Necessary Hoses & Nipples & pressure controller sytem required to connect the air line & Switches & adaptors for electrical connection-01 set</p>
		<p>The equipment should be supplied with all the essential accessories to meet the standard methods mentioned above. The Basic start-up kit including material for calibration shall be provided by the supplier</p>
22	Software	<p>Software for set up of parameters, automatic control of operations like automatic weight lifter, storage of various test parameters & measurement points & Standard functions like auto calibration , calculation& data collection</p>
		<p>PC control and advanced data analysis</p>
		<p>For Graphs and numerical data for the whole test, Basic statistical analysis of data</p>
		<p>Shear Rate, shear stress, and viscosity (flow curve from multi-weight tests), MVR, Intrinsic Viscosity (I.V.) estimated through correlation with MFR data/MVR Data</p>
		<p>Operating console with LCD display</p>
23	Standard Reference Materials	<p>Standard Reference Materials of low MFI & with NIST traceable certificate as per ASTM 1238 requirements to be supplied</p>
24	Warranty	<p>Minimum 2 years warranty must be provided</p>
25	Scope of supply	<p>Complete list of items quoted are to be provided</p>

26	Training	Training on operation & maintenance of the equipment should be provided onsite
27	Installation & Commissioning	The Machine should come with all other essential accessories & spares (as per ASTM & ISO standards) required for installation, commissioning & operation.

5. Modulated Differential Scanning Calorimetry (MDSC)		
Sl. No.	Items	Specification
1	Purpose	Measures heat absorbed or released by a sample as a function of time, temperature, and environment
		Measurement of the following properties of polymers, rubbers, elastomers, etc.
		1. Glass transition temperature (T_g)
		2. Melting temperature (T_m)
		3. Crystallization temperature (T_c)
		4. % of crystallinity
		5. Curing temperature
		6. Degree of cure
		7. Purity
		8. Activation energy
		9. Heat of enthalpy
		10. Heat of fusion
		11. Kinetic studies (isothermal/non-isothermal)
		12. Thermal stability
		13. Oxidation/decomposition
14. Oxidative-Induction Time (OIT)		
15. Specific Heat		

2	Principle/Definition	MDSC is a thermo-analytical technique to investigate the response of polymers to heating cycle
3	Reference Standard	ASTM D 3417-99, ASTM D 3418-15, ASTM E 1356-08(2014), ISO 11357-1:2016, ASTM-D 3895-14, IS-4984, ASTM E-1269
4	System	System shall be capable of running in conventional DSC mode as well as Sine wave modulated DSC mode
5	Temperature Range	-120 °C to 700 °C or better
6	Temperature Accuracy	± 0.1 °C or better
7	Temperature Precision	± 0.05 °C or better
8	Heating Rate	0.1 °C/min to 200°C/ min or higher
9	Cooling Rate	0.1 °C/min to 100°C/ min or higher
10	Oscillating (modulated) heating rate	± 1.0 °C/min. Or better
11	Furnace	To be constructed of corrosion-resistant material suitable for rapid heating/cooling and should have a long lifetime
12	Calorimeter Sensor	Thermopile or constantan or platinum Thermocouple
13	Calorimeter Baseline Repeatability / Stability/ Flatness	<30 µW or better
14	Maximum Calorimetric Sensitivity	0.2 µW or better
15	Calorimetric Precision (based on metal standard)	± 0.10% or better
16	Dynamic Range	± 200 mw to 500 µW
17	Temperature Calibration	5 points calibration over the full temperature range

18	Baseline Noise (max. peak to peak)	0.1 μ W or better
19	Software	Operating software and analysis software shall be user friendly and shall be running on windows 10 or higher version
		Analysis software shall have the provision to smoothen to evaluate peak temperature, onset temperature, glass transition temperature, melting temperature, crystallization temperature, % of crystallinity, purity, curing temperature, activation energy, heat of enthalpy, heat of fusion, kinetic studies, Oxidative-Induction Time (OIT), X-scaling w.r.t time, temperature, etc.
		The software shall have the provision to view total heat flow, modulated heat flow, total heat capacity signals in real time during experiment
		Software for kinetic studies (to be supplied with one license as the same can be used with TGA) for single and multiple steps through non-linear regression
		The data analysis software should be unkeyed or multi-user licensed to allow installation at a minimum of 3 PCs Calibrations shall include baseline, cell constant, and temperature. Scheduling capabilities must be present, such that these calibrations and/or verifications can be programmed to perform during normal quiescent periods, such as overnight or on weekends
The data file format should easily allow sharing/transfer of data files as individual electronic documents, which are readable by the same data analysis package		

		<p>The operating software should also be capable of periodically and automatically checking for updates via an Internet connection, and downloading/installing those updates if desired</p>
		Library
		Compatible to Windows 10 or higher OS (32 and 64 bit) and should have the capabilities to heating rate, temperature setting, etc. and capable of collecting data on heat flow, heat capacity enthalpy change, C_p , T_g , T_m , T_c , peak area, peak onset, etc
20	Measurement Atmosphere	N_2 or O_2 or air
21	Provision for cooling	Fully automatic Inbuilt liquid nitrogen cooling system & accessories with variable cooling rates as specified above
22	Control system	Built-in Gas mass flow control system with auto-gas switching option within the test run
23	Accessories	MDSC must include:
		02 no. of the Platinum pan with lid
		02 no. of Graphite pan with lid
		100 nos. of Copper pans for the OIT test
		800 nos. of Aluminium pans with lid
		Standard samples such as Indium, Cobalt, Tin, Adamantane, Sapphire with Traceable calibration Certificate for calibration purpose
		Reference standard for sub-ambient temperature
		Crimper and die set to be supplied along with the Instrument for sample preparation of both dry powder and liquid samples
		Suitable controlled cooling system for maintaining -120 to 700 °C range
		Gas Tubing & fittings-01Set
Moisture dryer-01Set		

		<p>PC of required configuration with the original software</p> <p>01 No. of filled N₂ gas cylinder with two-stage SS Gas regulator of the best quality with tubing fittings</p> <p>01 No. of filled O₂ gas cylinder with a two-stage SS Gas regulator of the best quality with tubing fittings</p> <p>01 No. Five Digit High Precision Digital Weighing Balance (1µg readability)</p> <p>UPS (5 KVA) for 1 hour or higher power backup</p> <p>Basic tool Kit-01 set</p> <p>Hard copies of Operational & Service Manual- 01 set</p> <p>Necessary Hoses & Nipples required -01 set</p>
24	Calibration Certificate	Calibration certificates for supplied reference material traceable to NIST and internal calibration report to be provided
25	Personal Computer (PC)	<p>A Personal Computer having latest configuration: i7 processor 10th generation, 16GB RAM, DVD - RW, 500 GBSSD, Windows 11 with lifetime licence, Latest microsoft Office professional, 27 ” LCD display, Wifi enabled or with better specifications along with a suitable laser color printer</p> <p>All software shall be loaded into the hard disk with appropriate partitions. All original CDs/DVDs must be provided</p>
		<p>Modulated DSC shall have the ability to apply sinusoidal temperature wave to sample by amplitude and frequency</p> <p>Modulated DSC shall include the ability to perform quasi-isothermal experiments i.e. holding isothermal with a small temperature modulation</p>

26	Others	Modulated DSC should be able to show the following signals in real-time during the experiment: Total Heat Flow, Total Heat Capacity, Reversing Heat Capacity, Reversing Heat Flow, Non-Reversing (Kinetic) Heat Flow, Modulated Temperature, Modulated Heat Flow, Heat Flow Phase, Reference Sine Angle, Temperature Amplitude, and Heat Flow Amplitude
		DSC shall allow for the direct measurement of specific heat CP i.e. in one single scan
27	Scope of supply	Complete list of items quoted are to be provided
28	Training	Training on operation & maintainance of the equipment should be provided onsite
29	Intallation & Commissioning	The Machine should come with all other essential accessories & spares (as per ASTM & ISO standards) required for installation, commissioning & operation

6. Thermal Evaporator System		
Sl. No.	Items	Specification
1	Thermal Evaporator System	
1.1	<u>VACUUM CHAMBER:</u>	
	Ø Material of Construction (MOC): SS 304 grade /Better;	
	Ø Chamber size : Approximately 400 mm (W) X 400 mm (D) X 450 to 500 mm (H) [minimum requirement]	
		Ø Necessary ports required for Pumping, evaporation sources, Gas Inlet, Vent, gauge, feedthrough, view port, mechanism etc.
<u>THERMAL EVAPORATION SOURCE:</u>		

	<p>Ø 2 sets of LT evaporation electrical feed through.</p>
	<p>Ø Evaporation source holder: made of electrolytic pure copper, with 200 A current carrying capacity (Filament, Basket and Boat as evaporation source).</p>
1.2	<p>Ø 2 nos of 200 Amps power supply capable of delivering 200 A at 10 V, 100 A at 20 V</p>
	<p>Ø Thyristor Controller in the input circuit of LT selector to be provide for the output power variation.</p>
	<p>Ø Digital panel meters to be provided for secondary current through current transformers.</p>
	<p>Ø Electromagnetic shutter with control panel for Thermal source</p>
	<p><u>ION BEAM CLEANING:</u></p>
	<p>Ø One HT electrical feed through to carry power for ion cleaning should be provided.</p>
1.3	<p>Ø A bar-type ion bombardment gadget should be fixed on the feedthrough to provide a uniform glow discharge.</p>
	<p>Ø A 5000V DC open circuit, 3500 Volts at 50mA high reactance tyepel transformer and solid state bridge rectifier should be provided.</p>
	<p>Ø Thyristor based IB current controller with display should be provided</p>
	<p><u>Rotary Work Holder:</u></p>
1.4	<p>Ø The rotary substrate work holder and associated fixtures are designed to hold 4” wafer (100 mm) substrates.</p>
	<p>Ø The rotary drive mechanism to be provided for the continuous rotation of the substrate with adjustable speed 5 rpm to 20 rpm.</p>
	<p><u>FILM THICKNESS MONITOR:</u></p>
	<p>Ø A Digital Thickness monitor with a water-cooled Crystal holder, and Oscillator to be provided to measure the in situ rate of deposition and Thickness. The DTM should have the following specification:</p>
1.5	<p>Ø Rate Display: 3 digits LED auto ranging from 0.000 to 999 A°/sec.</p>
	<p>Ø Thickness display: 4 digits LED auto ranging from 0.000 to 999.9 kA°.</p>

	<p>Ø Static Thickness resolution: 1 A° at min. update rate.</p>
2	Vacuum Pumping System
	<u>High vacuum pump:</u>
2.1	<p>Ø A Turbo Molecular pump having a suitable pumping speed (minimum 400 lit/sec) to achieve a chamber vacuum level of at least 1×10^{-6} mbar.</p> <p>Ø Detachable liquid nitrogen trap to be provided for fitting below the high vacuum valve and for use when needed.</p> <p>Ø Ultimate Pressure: $\leq 1 \times 10^{-6}$ mbar to be achieved</p>
2.2	<u>Rotary Pump:</u>
	<p>Ø Dual-stage rotary pump (20 m³ /hr or Higher) for roughing and backing operations.</p>
	<u>HIGH VACUUM VALVE:</u>
2.3	<p>Ø Motorized high vacuum valve with built-in facility to automatically throttle the pumping system.</p> <p>Ø Drawing of the valve should be provided along with the bid.</p>
	<u>VACUUM VALVES:</u>
2.4	<p>Ø Electromagnetically operated right angle bellow sealed valves for roughing, backing and high vacuum applications</p> <p>Ø Electromagnetically operated vent valve</p> <p>Ø Fine control needle valves to be provided</p>
2.5	<u>SS Plumbing line & Collar</u>

4.5	<p>Ø SS Plumbing line with flexible hoses & KF connections wherever required with necessary interlocks to be provided</p>
2.6	<p><u>VACUUM GAUGES:</u></p> <p>Ø Digital Pirani and Penning Gauges with display to be provided.</p>
3	<p>Mounting Frame /Support Stand</p>
	<p>Ø Necessary pumping systems can be accommodated below the stand</p> <p>Ø Must have castor wheels for mobility with arresting pads.</p>
4	<p>Spares & Consumables</p>
	<p>Ø Set of O rings and gaskets – 1 set</p>
	<p>Ø Quartz crystals- 10 No's</p>
	<p>Ø Tungsten helical- 6 No's</p>
	<p>Ø Tungsten baskets – 6 No's</p>
	<p>Ø Molybdenum Boats – 5 No's</p>
	<p>Ø Rotary Pump Oil – 5 litres</p>
	<p>Ø Al metals (wire/granules) (99.99%) 100 gm,</p>
	<p>Ø Ag metal (wire/granules) (99.99%), 100 -gm</p>
	<p>Ø Vacuum clamps with metal O-rings</p>

	<p>Ø Vacuum grease</p>
	<p>Ø Penning gauge (1 No.)</p>
	<p>Ø Pirani gauge (1 No.)</p>
	<p>Ø Set of Maintenance kit</p>
5	Water Chiller
	<p>Ø Reputed Make water chiller unit of capacity of 0.5 TR to be provided with re-circulating pumps, storage tank, valves, gauges, hoses, etc. for closed loop water cooling</p>
6	Warranty
	<p>Ø 2 Years from the date of commissioning and acceptance of equipment</p>
7	Special Criteria
	<p>Ø The thickness uniformity should be $\pm 5\%$ over 50mm (2 inch) diameter substrate. A measurement certificate of thickness uniformity of any metal (for example Al/Cu/Ag) on substrate of appropriate size should be provided with Technical Bid.</p>
	<p>Ø The committee reserves the right to verify the certificate and thickness uniformity at the customer site/manufacturer site. If it is done at Manufacturer site, then Manufacturer has to arrange the necessary facilities for assessing uniformity.</p>
8	Eligibility Criteria
	<p>Ø Supplier or its Authorized Agent should have ISO or equivalent international standard certificate.</p>
	<p>Ø Supplier or its Authorized Agent should have Export Experience of Similar products</p>
	<p>Ø Original Invoice, Original Warranty Certificate, Original Test Reports should be produced for all imported items from OEM (Original Equipment Manufacturer) at the time of supply of the equipments</p>

	Ø System Catalogue & Accessories catalogues like Turbo Pump, Rotary Pump, digital thickness monitor should be provided along with Technical Bid
9	Utilities
	Ø Pre-installation requirements should be provided to run the instrument.
10	Manuals
	Ø Operation Manual to be given after installation and acceptance of equipment
11	User Training
	Ø Training for 1-2 users should be provided to make them well familiar with the operation of various components and successful growth of the thin films using the given deposition unit.
12	Scope of Supply: Complete list of items quoted are to be provided
13	Intallation & Commissioning: The Machine should come with all other essential accessories & spares required for installation, commissioning & operation.

7. Binder Jetting 3D Printer		
Sl. No.	Items	Specification
1	Technology	Binder Jetting Technology.
		Industrial print head able to selectively deposit a liquid binding agent onto a thin layer of powder particles — either metal, ceramics, oxides, carbon, or composites
		The machine should be able to run non-reactive, oxide and ceramics materials
		The machine should meet the requirements of international Binder Jetting safety standards
		Build method: The process should be repeatable layer by layer, using a map from a digital design file, until the object is complete. 3D CAD files through metallic, oxide, carbon and ceramic powder with binder jetting should be usable
		The machine should be able to operate without operator's interference unattended for the entire duration of the build

		It should use open source materials (including our research materials) to print and their parameter editing in software and hardware
2	Build Volume	A minimum builds volume of (150-200) x (50-100) x (50-100) mm in XYZ or better Build substrates capable of handling various alloys and ceramics should be specified
3	Part Density	The vendor should exhibit the capability of the machine to have part density to be equal to or more than 95% (depending on the material) Part density variability across the build area not more than 1.0 %.
4	Layer thickness	~ 30-100 μm
5	Build Rate	50cc/hr or better
6	Print Resolution	30 μm or better
7	Min. Powder Size	3 μm (d50) or better
8	Binder Systems	3D printer should compatible with following binders Inorganic, Organic binder, Water Based and Suspended Nanoparticle Based, Solvent based, Phenolic-based binder, etc. Binders for high-temperature materials, etc.
9	Re-coater System	The Re-Coater unit should Dispense powders accurately and uniformly Reduce the amount of waste powder Potentially decrease layer time with controlled dispensing

		Minimize pluming of fine powders
		Be simple to load powder
		Be easy-to-move boxes
10	Recoated heater temperature (°C)	40 °C to 50 °C
11	Part build parameter	Parameter modules including modules for material development to enable the user to modify the system parameters according to the user's choice of material
		Editable parameter module should be made available for the required materials developed by our laboratory
		Provide the parameter set availability chart with slice size and inert gas details for all the materials offered, if applicable
12	Print head system	Machine should be equipped with print head that selectively deposits a liquid binding agent onto a thin layer of powder particles — either metal, oxides, carbon, ceramics, or composites
		Machine should have different print heads for ceramic, metal, oxide & composites
		Printing directions should be mentioned without pause
		MS-Windows based STL Editing Software with the following features to be provided
		Indications and warnings for system malfunctioning.
		Indicator for material required (for a job), utilization and remaining
		Automatic generation of different types of supports (angle, gap, volume etc.) is preferred
		Edit feature to fix bad STL or sliced files, including those from 3D scanning systems with automatic and manual correction modes is also

13	Latest Version Software	<p>Viewing, orienting, slicing, layout (3D nesting) of multiple CAD (STL) files</p> <p>Should be capable to accept neutral CAD formats as input</p> <p>Editable and Multiple build strategies</p> <p>Build time and power requirement calculations</p> <p>Additionally, upgrades in the software should be made available to the user free during warranty period</p> <p>Software license must be perpetual</p>
14	Computer	<p>Bidder should supply suitable latest model OEM workstation with complete accessories and UPS for handling large size stl data (128 GB RAM, 12th generation i9 processor, 5TB HDD, 6GB dedicated Graphics card)</p>
15	Process Parameters	<p>All the parameters governing the additive manufacturing Binder Jetting process should be open and freely editable to the users for Research & Development (R&D) purpose</p> <p>A complete list of editable process parameters with configured materials to be provided by the manufacturer</p> <p>To control the performance of each powder layer, the system should detect the powder preparation and performance after every distribution cycle. If a layer defect is detected, the system should automatically attempt to correct the spread of powder layer uniformity</p> <p>A closed-loop monitoring feedback system with high-precision positioning of build platform should be integrated</p>
16	Drying System	<p>Bidder should quote and supply suitable manual sieving system</p>

16	Powder Sieving Kit	It should be capable of sieving both reactive and non-reactive materials
17	Materials	<p>Below materials should be compatible with the quoted machine</p> <p>Copper</p> <p>Silver</p> <p>Aluminium</p> <p>Alumina or other ceramics</p> <p>Carbon-based materials</p> <p>Li based materials such as LiCo_2O_4, LiFePO_4, LiMn_2O_4, $\text{Li}_4\text{Ti}_5\text{O}_{12}$</p> <p>Also, it should permit to use third-party materials and their parameter editing in software and hardware both. Usage of third- party material options in the system should not void warranty of machine, a certificate to be provided by the manufacturer in their technical bid</p> <p>Material Data Sheets- Specify the qualified materials and its material properties with material technical data sheets. All the specified material should be approved with respective ASTM standards. Respective AMS / UNS or DIN standards to be mentioned in the data sheets to meet DIN OR equivalent standards for reference. The material data sheets should contain generic mechanical, physical and chemical properties. The datasheets to include all the material properties</p>
18	Other Item	<p>The bidder should also provide the following items with the system</p> <p>Powder removing container</p> <p>Powder Process Container</p> <p>Finishing tools</p> <p>Handling Device</p>

		Vacuum cleaner
		Suitable Compressor
		High Temperature Laboratory Furnace >1600 °C
		Suitable UPS for the whole system with one hour backup
19	Documentation & Manuals	Documentation as below to be provided with the machine
		Operation Manual
		Software Instruction Manual
		Maintenance and troubleshooting manual and safety guidelines
20	Supplier Requirement	Accessory handling guidelines
		The bidder should also provide the name and contact details of the users where a machine with a similar specification has been supplied in India
21	Delivery Period	The bidder must be an Original Equipment Manufacturer (OEM) or re-presentative of the foreign concern in India
		10-15 weeks from the date of placement of purchase order
		Installation & commissioning to be done free of cost at user site
		All necessary trainings pertaining to the machine, software and accessories need to be given free of cost at user site
22	Installation, commissioning, and training	Vendor should supply the required build materials and binders to demonstrate and develop prototype

		Supplied should demonstrate building the minimum layer thickness of 30 to 100 microns at the time installation
		Vendor service technicians and/or subcontractors engaged should work closely with the user to perform the following tasks
		Customer pre-installation site assessment checklist via email
		Development of schedule for machine installation
23	Packaging	Details of site preparation conditions are to be provided in the technical bid
24	Warranty	The appropriate packaging should be made to withstand the conditions of air, water, and truck transport
		The machine with standard parts and accessories / attachments must be guaranteed for free repairs and replacements for a period of 24 months from the date of installation and commissioning
25	Consumable	For initial operations, supplier should supply minimum 15 kgs each of the following powders compatible with the machine as a start-up package: 316L, 304L, Copper, SiC, Aluminium, etc.
		Supplier should supply minimum of 15 L binders such as inorganic, Organic binder, water based, Phenolic-based binder
		Supplier should supply the necessary tool kits
26	Scope of supply	Complete list of items quoted are to be provided
27	Training	Training on operation & maintenance of the equipment should be provided onsite
28	Intallation & Commissioning	The Machine should come with all other essential accessories & spares (as per ASTM & ISO standards) required for installation, commissioning & operation.

8. Benchtop NMR Spectrometer

Sl. No.	Items	Specification
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1	InstrumentType	It should be PulsedFourierTransform NMR Spectrometer
2	SamplePresentation	Standard5mmmod,178mm(7'')longNMRtubes
3	MagnetType	Permanent,Cryogen-Free, should provide frequency to entire sample without tube movement
4	Operating frequency	80 MHz or more
5	Probe	It should have Probe for 1H, 13C and 19F
6	1H 50% Linewidth	0.3Hz or better (Instrument software Shim test report along with 10% H2O in D2O or shim standard sample peak with resolution at 1H 50% Linewidth should be submitted)
7	1H 0.55% Linewidth	10Hz or better (Instrument software Shim test report along with 10% H2O in D2O or shim standard sample peak with resolution at 1H 0.55% Linewidth should be submitted)
8	1H 0.11% Linewidth	20Hz or better (Instrument software Shim test report along with 10% H2O in D2O or shim standard sample peak with resolution at 1H 0.11% Linewidth should be submitted)
9	Sensitivity (Signal:Noise)	It should offer 200:1 or better for 1% Ethyl Benzene, Measured in a single scan on the quartet of the CH2 group. (Spectra of standard sample with sensitivity >120:1 should be submitted as a proof)
10	Anomer Study option	Should have carbon 2D variant with NOE, APT for anomer configurations
11	Stray Field	Should be <2 G all around the system
12	LockType	External Hardware Lock should be Independent of the sample and No Deuterated solvent should be required
13	Solvent suppression	It should have Solvent Suppression Pulse Sequence
14	ProbeTuneandMatch	Should be Preset,nouserinterventionrequired
15	Shimming	Shimming should be fully automated. Shimming for each sample should not be required

16	Experimental Protocols	It should perform following protocols with ease for all nuclei H, F and Carbon 1- D (H, F, and C), 1-D Paramagnetic, 2-D COSY (Correlation Spectroscopy), 2-D TCOZY (Total Correlation Spectroscopy), 2-D JRES (Homonuclear J-Resolved Spectroscopy), 2D F – COSY (Correlation Spectroscopy), 2D F – JRES (J-Resolved Spectroscopy), 2D FH – COSY (Correlation Spectroscopy), Relaxation T1 and T2, Proton Pulse-Decoupled, DEPT (Distortionless Enhancement byPolarization Transfer), APT (Attached Proton Test), HETCOR (Heteronuclear Correlation Spectroscopy), HMBC (Heteronuclear Multiple Bond Correlation), HMQC (Heteronuclear Multiple-Quantum Correlation), HSQC (heteronuclear single quantum correlation) HSQC-ME (multiplicity-edited HSQC)
17	Operating temperature	20°C to 26°C
18	Software and Computer	An appropriate (e.g MNOVA) Software with permanent license should be offered along with the system
		i7 processor 10th generation, 16GB RAM, DVD - RW, 500 GB SSD, Windows 11 with lifetime licence, Latest microsoft Office professional, 27” LCD display, Wifi enabled or with better specifications along with a suitable laser colour printer
19	Accessories to be quoted and supplied along with machine / equipments:	1. Online reaction monitoring Kit- 01 No.
		2. NMR tube- 100 nos.
		3. Maintenamce kit-01 no.
20	Warranty	02 years warranty should be provided with continued software upgradationas and when released
		The duly authorized representative(s)/scientists of the CIPET shall have the right, before payment, to inspect the Goods either at the OEM stores/during manufacture, or at the Place(s) of Delivery. The Supplier shall provide all facilities for such inspection

21	Inspection and acceptance	Any inspection carried out by representative(s) of the CIPET or any waiver thereof shall be without prejudice to other provisions of the Contract concerning obligations assumed by the Supplier, including specifications of the Goods
		Upon delivery and inspection of the Goods, the CIPET shall inspect the goods as soon as possible and complete the Goods Receiving Document. Should any Goods fail to conform to the technical specifications, codes and standards under the Contract, the CIPET may reject the Goods. The supplier shall, at no cost to the CIPET, replace the rejected Goods or, alternatively, rectify the non-conformity
		In the case of Goods ordered on the basis of specifications or samples, the CIPET shall have the right to reject the Goods or any part thereof and terminate the Contract if the Goods do not conform to the specifications and/or samples. Nothing in this clause shall in any way release the Supplier from any warranty or other obligations under the Contract
22	Training	Onsite training (03 days) should be provided to the staff after installation. The Supplier shall provide all facilities for such training programme
		Complete set of manuals for the operation of equipment should be given
23	Scope of supply	Complete list of items quoted are to be provided
24	Intallation & Commissioning	The Machine should come with all other essential accessories & spares required for installation, commissioning & operation

9. Oxygen Transmission Rate

Sl. No.	Items	Specification
1	TYPES OF TESTS TO BE PERFORMED	Oxygen transmission rate (OTR) is the measurement of the amount of gas that passes through a substance over a given period
2	APPLICABLE STANDARD	ASTM D3985, ASTM F1307, ASTM F1927, DIN 53380-3 ISO 15105-2, JIS K7126 films

3	Measuring range for film and sheet	Test Range, Single Cell Mode, Unmasked - 0.05 to 200 cc/(m ² -day) or equivalent
		Test Range, Single Cell Mode, Masked - 0.1 to 2,000 cc/(m ² -day) or equivalent
		Test Range, Dual Cell Mode, Unmasked - 0.006 to 100 cc/(m ² -day) or equivalent
		Test Range, Dual Cell Mode, Masked - 0.01 to 1,000 cc/(m ² -day) or equivalent
4	Resolution	Resolution, Single Cell Mode- 0.01 cc/(m ² -day)
		Resolution, Dual Cell Mode - 0.005 cc/(m ² -day)
5	Measuring range package	0.0005 to 1.0 cc/(m ² -day)
6	Resolution	0.00005 cc/(m ² -day)
7	Measuring chambers	2 Chambers (with independent sensors)
8	OTR Repeatability (50 cm ²)	±0.002 cc/(m ² · day) or ± 1% of relative whichever is greater
9	Test Method	Coulometric (sensor in cell)
10	Sample size	10.2cmx 10.2cm (50cm ² Test area), small size samples should also be tested with the help of 5 cm ² aluminum masking foil
11	Film Test Cell per module	2X50cm ² (pneumatic clamping cell)
12	Thickness of sample	Upto 3mm
13	Carrier Gas Requirement	One Gas Cylinder with gas mixture of 98%N ₂ & 2%Hydrogen as per ASTM requirement to be supplied
14	Test Gas Requirement	One Gas Cylinder of 99.99% dry O ₂ as per ASTM requirement to be supplied
15	Humidity Range	0%RH & 35%RH to 90% RH, 100% RH for films” and packages RH sensor directly at sample site

16	Humidity control accuracy	±3%RH
17	Temperature Requirement	10-40 °C
18	Temperature control accuracy	±0.5 °C or better
19	Gas Pressure Range	30 – 35 psig
20	Cell Clamping	Pneumatic
21	Barometer	Barometric pressure compensator
22	Special Features	Fully Automatic Testing
		Automatic RH control & Built-in software
		Faster Speed to test
		Improved results
		Easy film replacement
		No calibration Required
		Advisory screen prompts operator input
		Customize and store up to 99 test methods
		System protects against over or under pressure
		System protects against thermal runaway
		Status-screens display real-time information
		Pneumatic clamping
“No-flow” adjustment required		
Repeated calibration not required before each testing		

23	Accessories to be supplied	Necessary two precision, two stage SS diaphragm Regulator for Carrier gas & test Gases of best quality with all necessary tubing fittings & Moisture tap filters for accurate pressure adjustment
		Standard Reference/Certified Films
		Rings for sample cell of necessary quantities
		Kit consisting Brass Nut, Brass Ferrule, O ring for cell, Copper tubing, cutting kit, Grease, syringe & certified film as mentioned above
		Aluminium Foil Mask for 5cm ² film sample Operating Software
		Basic tool Kit-01 set
		Hard copies of Operational & Service Manual- 01 set
		Necessary Hoses & Nipples required for gas connections-01 set
24	Calibration	Calibration certificate traceable to NIST for the certified Films and instrument to be supplied
25	Installation and Commissioning	The Machines should come with all other essential accessories & spares (as per ASTM & ISO standards) required for installation, commissioning & operation

26	Scope of supply	Complete list of items quoted are to be provided
27	Training	Training on operation & maintainance of the equipment should be provided onsite