

EXPRESSION OF INTEREST FOR CARBON FIBER FACILITY

PACKAGE # 2:

**SETTING UP COMPLETE FACILITY
FOR
FIBER SPINNING & DMAC RECOVERY PROCESS LINE**



MISHRA DHATU NIGAM LIMITED

A Govt of India Enterprise

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Corporate Identity Number : U14292AP1973GOI001660

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1. OBJECTIVE

Mishra Dhatu Nigam Limited (MIDHANI), a public sector company under Ministry of Defence has been playing a very active role in development and manufacture of strategic materials for various sectors like Space, Energy, Aero, Defence, etc. MIDHANI is a unique integrated metallurgical plant located in Hyderabad, Telangana, India and presently setting up a facility for Armour business at Rohtak, Haryana and Aluminium Alloy Rolled Product facility at Nellore, Andhra Pradesh.

MIDHANI has wide manufacturing facilities for manufacture of low alloy steels, high alloy steels, special steels, stainless steels, super alloys, titanium and titanium alloys in various forms and sizes. More information can be found on www.midhani-india.in

MIDHANI desires to augment its manufacturing facility by setting up a carbon fiber plant for strategic applications under "Make in India" initiative program of the Government of India. MIDHANI is considering for establishing production facilities for carbon fiber of capacity 60 TPA of various grades of carbon fiber utilizing the technology developed by CSIR-NAL. The facility shall be located in the present premises of MIDHANI at Kanchanbagh, Hyderabad. Hence Midhani is desirous of identifying established equipment manufacturers for carrying out the detailed design, manufacture, supply, erection and commissioning of associated line equipment for the carbon fiber facility. The brief of the Project and scope of the package pertaining to this EOI is described below.

2. BASIC INFORMATION OF THE FACILITY TO BE ESTABLISHED

Polyacrylonitrile (PAN) based Carbon Fiber Manufacturing facility is planned to be established at MIDHANI. PAN copolymer is prepared by processing a mixture of Acrylonitrile (AN) and Comonomer (CM) in a Continuous Stirred Tank Reactor (CSTR) along with water and other reagents. Reaction is carried out at a constant temperature and pH. The polymer slurry is passed through a monomer stripper column to recover the unreacted monomer followed by filtration in a centrifuge / drum filter to produce wet polymer cake. The wet cake is dried, granulated and stored at appropriate condition for use.

PAN polymer is subsequently dissolved in Dimethylacetamide (DMAc) solvent in a high shear mixer at 80-85 deg C temperature. The polymer solution (spin dope) is passed through agitated thin film evaporator under vacuum for removal of trapped air bubble. The spin dope is further passed through multistage filtration to remove any foreign/gel particles. The filtered spin dope is extruded through spinneret dipped in coagulation bath. The bunch of freshly formed filaments (fiber yarn) in the coagulation bath is forwarded to subsequent hot water (40-90 deg C) baths through the fiber forwarding rollers for washing and stretching. These wet drawn fibers are taken through a spin finish bath consist of emulsion of water and modified silicon oil. These fibers are then dried and densified on hot rollers. The required diameter of fiber is obtained by stretching them finally at 140 deg C. The fiber yarn (termed as special acrylic fiber) is collected as spool using precision winders.

DMAc solvent used for dissolution and coagulation gets diluted with water in the process. This DMAc-water mixture is collected in tank. The pure DMAc is recovered by distillation and recycled in subsequent batches.

The special acrylic fibers (SAF) are converted to carbon fibers by continuously forwarding into a sequence of heat treatment processes at various temperatures and processing conditions which includes Pre-treatment with steam, thermo-oxidative

stabilization (200-280 °C) in air, followed by Pre-Carbonization (400-850 °C) and Carbonization (900-1500 °C) under nitrogen environment. These fibers are passed through a bath containing electrolyte solution for surface treatment followed by washing in water bath and drying in air. These fibers are taken through a sizing bath and then dried at 140-160 deg C. The dried carbon fibers are collected in the form of long continuous tows wound on suitable core using precision winders.

The establishment of an integrated facility to run the above processes includes following work packages:

- Package #1: Setting up a complete facility for synthesis of Polyacrylonitrile (PAN)
- Package #2: Setting up a complete facility for fiber Spinning and DMAc Recovery
- Package #3: Setting up a complete facility for Heat Treatment

In order to provide required utilities to run the above processes and to manage the waste and effluents generated from different process, a separate work package is required, as mentioned below

- Package #4 : Setting up a Effluent Treatment Plant
- Package #5 : Setting up complete Utility Systems

3. THE PROJECT SCOPE

The scope of work covers basic and detail engineering design, manufacture, assembly, testing at manufacturer's works, painting, delivery F.O.R. site, erection as per approved layout drawings, testing and commissioning of Equipment inclusive of associated control, electrical and all accessories required for this package of Carbon Fiber Plant for safe and successful operation & maintenance. The equipment shall meet the specified performance to the satisfaction of the Purchaser.

The supplier shall include in its scope all accessories and auxiliaries, interconnecting piping, measuring and control instruments, all internal and interconnecting cables and wires, safety devices, compressor and materials which are not specifically mentioned here but are otherwise required to complete functioning of the equipment package offered in every respect for its satisfactory performance and safe operation.

The erection & commissioning of equipment including supervision shall be carried out by equipment supplier. Successful bidder shall arrange themselves necessary unskilled and semi-skilled labours, tools, tackles for erection. The successful Bidder of equipment shall provide procedure for erection, skilled manpower for supervision for timely completion of erection & commissioning.

The supplier shall arrange necessary material handling equipment at his own cost (for handling, storage and erection of equipment).

The Purchaser shall provide all the civil works such as Building for the shop, civil foundations for equipment, drains, pipe & cable trenches, conduits, etc. based on the detailed civil assignment drawing including information of loads from package supplier/successful bidder. After handover of site, the successful bidder shall erect / install equipment in the building / foundation provided by the Purchaser. The foundation

base and pockets for foundation bolts shall be cast as per the foundation assignment drawing furnished by the successful Bidder.

The required foundation material & embedded steel/inserts (viz. foundation bolt / leveling wedge / anchor system) shall be included as essential part of package supply. The foundation bolts/anchoring system shall be supplied by the bidder prior to execution of civil work by the purchaser. Intimation in this regard shall be sent to the bidder well in advance for supply of these items.

Minor civil works such as chipping and chiseling, alignment and grouting of foundation bolts, etc. for the erection / installation of Plant and Equipment is included in the scope of successful bidder.

All the engineering drawing / data and details e.g. foundation dimensions, foundation load data, foundation profile and levels of concreting, drawing/ catalogue of machine anchorage system, working instruction for mounting / grouting bolt / anchor / wedge etc. for carrying out the required Civil foundation work by the Purchaser shall be provided by the successful bidder.

The successful bidder shall provide two years spares for operation and maintenance including commissioning spares if required. The first fill of hydraulic oil, grease, coolant, lubricant etc. if required for startup and commissioning the machine shall form essential part of supply. Similarly, for demonstrating operational test on the machine, clamping unit, dowel pins & bush, consumables shall be supplied with the equipment (as applicable). Supply of oil, grease etc. shall be the responsibility of the bidder till the commissioning of the machine.

Purchaser shall provide two number of Power feeders at 415V, 50 Hz. within 20m radius from the equipment foundation. Further Power distribution and conversion / generation of any other voltage level, as required, shall be in bidder's scope of supply. All necessary supplies of Power and control cables, cable termination kits, laying and termination of all associated power and control cables from the outgoing terminals of Purchaser PCC (415 V) to the main PDB (being supplied by the Bidder) shall be in Bidders scope. Internal power distribution for various drives / accessories etc. of the machine shall be through machine control panel which shall be built in part of the machine.

The supplier shall provide required electrical earthing for his supplied equipment/ items and furnish the relevant drawing / data to the purchaser/buyer.

All accessories including electrics, instrumentation, etc., shall also be considered in the scope of supply along with equipment. The interconnecting piping along with fittings and any specific filter/instrumentation/valve (if required) for connecting the machine to the media shall form essential part of supply.

Bidder shall indicate the requirement (Quantity) of utilities for the package like water, compressed air, nitrogen, steam, fuel gas (if required), etc.& and any other services requirement for the offered package. Purchaser will provide the utility at a building column one meter above the ground level. The necessary isolation valve along with interconnecting piping & fittings as required for above utilities shall be in the scope of supply.

The erection, commissioning, testing including supervision of erection and demonstration of performance test of machine / equipment shall be undertaken by successful bidder.

The successful bidder will have to undertake comprehensive insurance policy and maintain its validity till commissioning and handing over of the equipment to Purchaser.

All the equipment supplied shall comply with the requirements of all recognized design and manufacturers standards applicable to that type of equipment, including American Petroleum Institute (API), American National Institute (ANSI), Tubular Exchangers Manufacturers Associations (TEMA), National Association of Corrosion Engineers (NACE), Occupational Safety and Health Agency (OSHA), National Electrical Code, Institute of Electrical Electronics Engineers (IEEE), American Society of Mechanical Engineers (ASME), Indian Boiler Regulations (IBR), Indian Standards (IS), European Industrial Gases Associations (EIGA) and MSIHC (Manufacture, Storage and Import of Hazardous Chemicals) Rules.

All vents supplied shall be of Flame arrestors where pure Acrylonitrile (AN) and Dimethylacetamide (DMAc) are being used.

All material used in the supplied equipment shall be compatible with all conditions of the processes using Acrylonitrile (AN) and Dimethylacetamide (DMAc)

4. BATTERY LIMIT & EXCLUSION

Particularly and unless otherwise stated in the Scope of Supply and Services, the following list of items are not included in scope of supplier:

- Civil foundation work
- Dismantling of any existing equipment
- 11 KV Switchboard
- FDA & Fire Fighting System
- Illumination System
- Cranes, hoists & other material handling system with its electrics, control & power feed system
- Primary Earthing System.
- Intercommunication systems (telephone, loud speaking communication system, CCTV system etc.).
- Water Supply system
- Air conditioning and ventilation facility
- All utilities piping and cabling till the agreed TOP
- Supply of utilities - compressed air, water, steam, nitrogen, etc.

Takeover point for Utility fluids (Water, compressed air, etc.) supply is considered at the nearest building column (max. 20m away from the equipment). The column nos. will be discussed and mutually agreed during layout finalization. All interconnecting piping from the TOP and upto the consuming point of supplied equipment will be in the scope of supplier. TOP for Electrical part is defined separately in Electrical Section.

5. BASIC INFORMATION OF THE PACKAGE #2

Fiber Spinning and DMAc recovery process line is described in **ANNEXURE - I**

6. ELIGIBILITY CRITERIA PACKAGE #2

Only those organizations that meet the following criteria are eligible to participate.

Sl. No.	Criteria	Documents for confirmation
1	Should have a minimum average annual turnover of INR 14 Crore (INR Fourteen Crore) in previous three financial years (FY 2015-16, 2016-17,2017-18)	Certified copies of annual account statements to be submitted.
2	Should have carried out *similar work of 50% of proposed Package capacity including design, manufacturing, supply & commissioning in last 10 years solely or in consortium.	Contract reference & other documentary evidence to be submitted.
3	Should have positive net worth in each of the previous three financial years (FY 2015-16, 2016-17,2017-18) OR Submission of solvency certificate for Rs.5.6 crores issued not earlier than 6 months from the date of EOI	Certified copies of annual account statements to be submitted. OR Issued by nationalized or scheduled bank.
4	Should have been established and operating since at least 5 years before the date of this advertisement	Certificate of Incorporation issued by the Registrars of Companies clearly stating the year of establishment.
5	Should have PAN, TAN, TIN & GST numbers with Income tax in case of Indian Companies. In case of Foreign parties, Relevant Tax Registration and PAN No. shall be submitted after placement of Order	a) Copy of registration certificates for Indian parties. b) In case of foreign parties, relevant tax registration certificate from the countries where the company is registered. Undertaking for obtaining PAN shall be submitted.
7	Should not be a trading company	Self-certified document to be submitted
8	Acceptance of all Commercial Terms & Conditions	Self-certified document to be submitted

***Similar work means work of Storage Tanks, Jacketed (water/steam) Tanks with agitator, Liquid Recirculation system, Fiber forwarding system, Fiber drying unit, , Solvent Recovery Plant; Material of Construction for all supply shall be of Stainless steel material**

7. SELECTION OF BIDDER

Bidders who fulfil **all** the eligibility criteria and accept **all** the commercial terms and conditions as outlined in this EOI shall be considered as eligible bidders.

Selection of bidder shall be as per the following process-

- a. Based on information provided in response to Eligibility Criteria, bidder will be evaluated by Midhani and eligible bidders will be informed within 15 days from last date of EOI submission.
- b. MIDHANI may organize a bidder's meet within fifteen days from date of declaration of eligible bidders for answering any clarifications on Technical Specification.
- c. All eligible bidders will be provided with a Technical Specification containing more information of the package requirement along with price bid format and detail commercial terms & conditions.
- d. Bidders have to submit their technical offer with detailed technical specifications and price bid as per price bid format within 28 days from issue date of documents as indicated under the clause 7(c).
- e. L1 bidder will be decided for each package after technical evaluation of submitted bids

8. PROJECT TIME SCHEDULE

It is expected that the following schedule will be maintained by both, bidder and Midhani

A. Tentative time line for the Carbon Fiber Project is 12 months from the effective date of contract.

B. Sequence of Evaluation of EOI response with tentative time line is as under:

Sequence. No.	Activity	Description	Response by Date
1	Release of EOI	EOI is released in newspapers within India & MIDHANI web site. The date of release shall be considered as the zero date for response.	Zero date
2	Response to EOI	Bidders to recognize the eligibility requirements and understand the project needs. Any clarifications required at this stage may be communicated by mail to purchase department	15 days from Release of EOI
3	Evaluation of EOI	Submitted documents towards eligibility and bidders acceptance of commercial terms as given in EOI will be scrutinized.	Midhani will declare eligible bidders within 15 days after Response to EOI
4	Site visit & Bidders conference	Bidders are encouraged to visit site and attend bidders conference for seeking any clarification on the Project. Discussions will be recorded and will	To be completed within 15 days after issue of Technical specification &

		become part of the technical specifications.	commercial document.
5	Issue of Technical Specification containing more information about the requirement , price bid format & Commercial conditions	Technical Specification containing more information about the requirement and Commercial terms & Conditions will be given to all declared eligible bidders.	Within 15 days after eligible bidders meet.
6	Detailed Technical Specification & Price Bid Submission	Bidders to submit the acceptance of Technical specification as discussed during the bidders conference along with detailed Techno-commercial offer of the Package & firm price bid and other document as per tender	To be submitted within 28 days after issue of technical specification & Price Bid Format.
7	Selection of Successful bidder	The Package wise L1 eligible bidder will be declared as the successful bidder.	Within 21 days after submission of price bid.

9. COMMERCIAL CONDITIONS

A	Payment Terms A1. For Plant, Machinery and Equipment including Design, Engineering and Training
a.	10 % of contract price after signing of contract agreement /release of P.O against BG along with 14% interest having validity till dispatch of FOR stage of last consignment.
b.	10% of contract price after submission of specified documents & Drawings against BG along with 14% interest valid till dispatch of FOR stage of last consignment and acceptance of the same by Midhani
c.	60 % of the value of each and every part dispatch of Equipment payable against the presentation of necessary negotiable documents proving that the goods are dispatched FOR site. In case of part delivery, BG of equal mount with validity till last delivery is to be submitted
d.	10 % of the contract price after completion of erection-commissioning and issue of Provisional Acceptance Certificate by Midhani
e.	10 % of the contract price on issue of Final Acceptance Certificate or 10 % after PAC against BG for the same amount having validity till defect liability period.
	A2 Complete Erection, Start and Putting into Commissioning including supervision:

a.	Ninety (90) per cent of the Contract Price for installation and commissioning along with 100% Service Tax shall be paid on issue of Provisional Acceptance certificate (PAC).
b.	10 % of the contract price for installation and commissioning on issue of Final Acceptance Certificate or 10 % after PAC against BG for the same amount having validity till defect liability period.
B	Security Deposit
a.	10 % of contract value shall be deposited within 30 (thirty) days of Agreement signing.
b.	The Security Deposit shall be in relation to the scope of work till the completion of installation and commissioning of the plant, machinery and equipment and issuance of PAC upon successful completion of the PG Test.
c.	Security Deposit shall be given in the form of Demand Draft or Bank Guarantee from a nationalized Bank or Scheduled Bank encashable in India
C	Delivery Schedule
a.	The delivery schedule should match with overall project schedule
D	Liquidated Damage
a.	Liquidated Damages be levied against Joint Developer in case of unsatisfactory supply/ execution of contract or delay in supply of materials/ execution of agreement beyond the date of delivery/ completion of job specified in the Agreement. LD is leviable @ 1% per week or part thereof subject to a maximum of 10% of Contract price with Taxes, Duties, levies, cess etc including Erection & Commissioning charges.
E	Performance Guarantee Tests and Provisional Acceptance
a.	The supplier shall be responsible for carrying out performance guarantee tests as per the Agreement / Specification in the presence of Midhani representative on Package facility plant, machinery and equipment supplied by him. This responsibility shall rest with the supplier regardless of whether the erection has been carried out by him or any other agency.
b.	The date of completion of performance guarantee test shall be considered to be the date of the PAC, and the plant, machinery & equipment is ready for commencement of commercial production.
F	Defect Liability Period and Final Acceptance
a.	The supplier shall warrant that the Package facilities or any part thereof shall be free from defects in the design, engineering, materials and workmanship of the plant, machinery and equipment and structures and refractory's supplied and of the work executed for twelve (12) months from the date of issue of Provisional Acceptance Certificate.
b.	After satisfactory completion of guarantee period (i.e 12 months) Midhani will issue the Final Acceptance Certificate (FAC) to supplier.

10. DISCLAIMER

Bidders shall study carefully eligibility requirements and Project Package scope given in the EOI and understand himself of the requirements sought. Claims and objections due to unawareness on the subject shall not be considered.

Eligible bidders to study carefully all documents, Technical Specification & Commercial conditions referred to herein before accepting the same. He shall fully satisfy himself of the appropriateness of the equipment and layout as indicated in this EOI considering the conditions of working at and around the construction Site. Further he shall take full responsibility for development in design, manufacturing and supply and safe and efficient operation and guarantee quality of the plant, machinery and equipment supplied and specified output. Claims and objections due to ignorance on the subject shall not be considered after submission of the response to EOI.

MIDHANI reserve the right to cancel the EOI either wholly or in part, without any entitlement or compensation to the bidders and without assigning any reason there off.

11. INTEGRITY PACT

All eligible bidders shall sign the Integrity Pact along with submission of his acceptance of technical specification & commercial terms & conditions. Non signatory of Integrity Pact shall disqualify the bidder.

12. CONTACT DETAIL

For Commercial queries-
AGM-Purchase Department: Mr. Anand Kumar,
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For Technical Queries-
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Cell +919177387087
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ANNEXURE – I

SETTING UP COMPLETE FACILITY FOR FIBER SPINNING AND DMAc RECOVERY

1. Process Description

This section deals with following two processes area-

- a. Wet spinning of precursor fiber using Polyacrylonitrile (PAN)
- b. Recovery of DiMethylAcetamide

a. Wet spinning of precursor fiber using Polyacrylonitrile (PAN)

The precursor fiber is made through the wet spinning technology, where the PAN polymer is dissolved in the DMAc solvent along with additives. The dissolution process starts with high shear mixing of PAN, DMAc and additives. The mixture is then heated and agitated under vacuum to complete the dissolution process. To remove the trapped air bubble in the spin dope, it is passed through the mechanically agitated thin film evaporator under vacuum. The spin dope is maintained always at high temperature till the extrusion point because the spin dope has tendency to make gel particle at low temperature. The spin dope is further passed through multistage filtration to remove any foreign/gel particles. The filtered dope is extruded through a spinneret dipped in coagulation bath. Coagulation bath consist of a mixture of solvent Dimethylacetamide (DMAc) and non-solvent Demineralized (DM) water. The bunch of freshly formed filaments (fiber yarn) in the coagulation is taken to subsequent baths through the fiber forwarding rollers for washing and stretching. These fibers are stretched while washing in wash/stretch baths with gradual increase in temperature and water concentration. These wet drawn fibers are taken through a spin finish bath consist of emulsion of water and modified silicon oil. Spin finish is applied onto the fibers to keep them intact and to avoid fusion during subsequent operations. These fibers are finally densified and stretched on the hot rollers to get the precursor of required denier. These precursor fibers are wound on bobbins.

b. Dimethylacetamide (DMAc) solvent recovery Area

The concentration of coagulation and wash baths during spinning are maintained by continuous addition of water. The overflows from these baths (solvent + non-solvent mixture) are sent for DMAc recovery in distillation column. The pure fraction of distilled DMAc is collected for reuse while intermediate fractions are again charged for distillation.

Note:

- i. System capacity design should have flexibility for $\pm 10\%$ variance.
- ii. During design bidder may offer superior technology if known/available after reviewing with client for safe and efficient operation

2. Input Materials

This process facilities to be established under package # 2 is capable of producing poly acrylic precursor fibers and DMAc (solvent) recovery shall use the following material grades and for manufacturing carbon fibers:

<i>Sl No</i>	<i>Material</i>	<i>Grade</i>
1	DimethylAcetamide (DMAc)	Industrial
2	Polyacrylonitrile (PAN)	-
3	Additives	Analytical grade
4	Spin finish	industrial


3. Output – Products & Effluents

a. Products 1: Polyacrylonitrile fiber

<i>Polyacrylonitrile fiber property</i>	<i>Specification range</i>
Filament diameter	~10 micron
Filament count	6000
Mass per unit of the yarn	0.47 g/meter
Moisture	< 2%
Spin finish content	< 3.0 %

The fibers collected on the bobbin at winder. The winder should have capacity of 30 kgs spool winding.

b. Product 2: Recovered DMAc

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Purity of recovered DMAc : > 99 %
 Colour : colourless

c. Effluents:

i. Liquid Effluents:

SL no	Effluent	Quantity	Treatment
1	Overflow from WB 4	~9 KL/day	In ETP
2	Overflow from WB 5,6,7,8	~18 KL /day	
3	Spin finish solution	~9 kg/day	
4	NVI from DMAc distillation	-	
5	DMAc distillation First Cut	~1.9 KL/day	
6	Soft water from Vacuum pumps	~1.2 KL/day	

ii. Solid Effluents:

SL no	Effluent	Quantity	Treatment
1	PAN thick fibers from dope bleed tank	~10.0 kg/day	In solid incinerator
2	Waste fiber during lacing/ start up	~10.0 kg/day	

iii. Gaseous Effluents:

SL no	Effluent	Quantity	Treatment
1	Solvent vapor from exhaust hood of fiber spinning area	-	In scrubber

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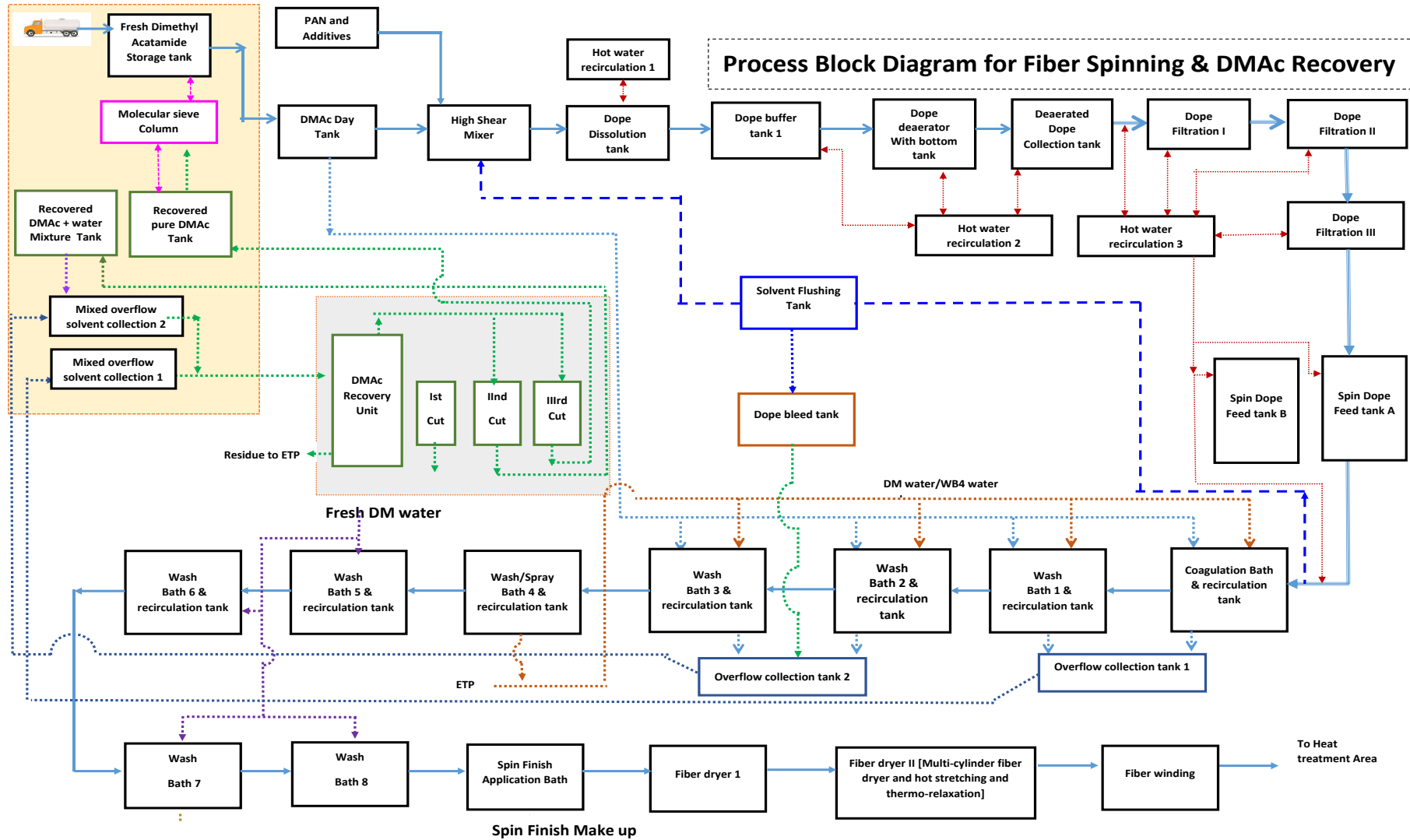
TECHNICAL SPECIFICATION FOR FIBER SPINNING AND DMAc RECOVERY FOR
CARBON FIBER PLANT (PACKAGE #02)



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 TECHNICAL SPECIFICATION FOR FIBER SPINNING AND DMAc RECOVERY FOR
 CARBON FIBER PLANT (PACKAGE #02)



4. Process Block Diagram



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TECHNICAL SPECIFICATION FOR FIBER SPINNING AND DMAc RECOVERY FOR
CARBON FIBER PLANT (PACKAGE #02)



5. General Scheme

- Number of extrusion positions : 12 No's
- Spin dope flow rate per position : 10-15 LPH
- Dope Concentration : 14-18 %w/w polymer
- Mass per unit length of fiber : 0.47g/meter

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 TECHNICAL SPECIFICATION FOR FIBER SPINNING AND DMAc RECOVERY FOR
 CARBON FIBER PLANT (PACKAGE #02)



6. Broad Technical details of the Equipment

<i>Sl. No.</i>	<i>Process Equipment</i>	<i>Qty.</i>	<i>Operating Conditions</i>	<i>Capacity</i>
1	Fresh DMAc Storage Tank	1	Temperature: Ambient (20 – 50 deg C) Pressure: Atmospheric Level: 0 – 100 % LT (Level Transmitter) Flow rate: ~ 2000 LPH (Transfer to Day Tank)	*25000 L
2	Recovered DMAc + Water mixture Tank	5	Temperature: Ambient (20 – 50 deg C) Pressure: Atmosphere Level: 0 – 100 % LT (Level Transmitter) Flow rate: ~ 2000 LPH	10000 L
3	Molecular sieve column	1	Temperature: 100 deg C (Steam in Jacket) Vaccum	500 L (To remove 70 – 80 Kg of water)
4	DMAc Day Tank	1	Temperature: Ambient (20 – 50 deg C) Pressure: Atmosphere Level: 0 – 100 % LT (Level Transmitter) Flow rate: by Gravity transfer to High Shear Mixer	5000 L
5	High Shear Mixer	1	Temperature: upto 70 deg C Revolution: upto 1000 RPM (variable through VFD) Vaccum & Nitrogen Flow rate: by Gravity transfer to Dope Dissolution Tank	4000 L
6	Dope Dissolution Tank	4	Temperature: 80 deg C Agitation in the tank: mild rpm (helical blade) Vaccum & Nitrogen Level: 0 – 100 % LT (Level Transmitter) Flow rate: ~ 2000 LPH	5000 L
7	Agitated Thin Film Deaerator	1	Temperature: upto 80 deg C Vaccum & Nitrogen Flow rate: Gravity Fall to Deaerated Dope Collection Tank)	800 LPH with 4000 L bottom tank
8	Dope filtration unit	3	Temperature: upto 80 deg C	To be calculated (by

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	(3 – 10 Micron size)		Pressure: upto 30 bars Flow rate: ~ 500 LPH	equipment supplier) for 200LPH dope flow rate with viscosity 200 poise at 50 deg C
9	Coagulation Bath and Recirculation Tank (CB & RT)	1	Bath section: 12 No's (individual for each fiber tow) Temperature: Minus (-) 10 deg C to plus (+) 50 deg C Circulation flow rate: upto 1500 LPH per section Over flow of all sections are combined to flow back into recirculation tank Level: 0 – 100 % LT (Level Transmitter in Tank) Forwarding drive speed: extrusion velocity 10- 20 meter/min	10000 L(Tank) Each section of coagulation bath dimension–[1.8L x 0.4W x 0.3H] in meters
10	Wash Baths and Recirculation Tank	8	Single bath section for 12 tows Temperature: 30 deg C to 35 deg C Circulation flow rate: 2000 LPH Level: 0 – 100 % LT (Level Transmitter in Tank) Forwarding drive speed: 10 – 75 meter/min (max)	2000 L(Tank) Wash bath dimension – [1.5L x 1.8W x 0.25H] in meters
11	Spin Finish Application bath & Recirculation Tank	1	Single bath section for 12 tows Temperature: 30 deg C Circulation flow rate: 500 LPH Level: 0 – 100 % LT (Level Transmitter in Tank) Composition: Silicone Oil 5% and water 95% Forwarding drive speed IN: 75 meter/min (max) Forwarding drive Speed OUT: 75 meter/min (max)	1000 L (Tank) Wash bath dimension – [1.5L x 1.8W x 0.25H] in meters
12	Fiber Dryer I: Hot air circulation dryer with multipass rollers driven by single drive	1	Single dryer for 12 tows Temperature: upto 100 deg C Residence time and Hot air flow for Circulation Forwarding drive speed IN: 75 meter/min (max) Forwarding drive Speed OUT: 75 meter/min (max)	Heater (for hot air flow) Capacity to be calculated (by equipment supplier) for 40kg water removal per hour
13	Fiber Dryer II: Hot air circulation dryer with steam	1	Single dryer for 12 tows Temperature: up to 140 deg C; drum heating by steam	Heater (for hot air flow) Capacity to be

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 TECHNICAL SPECIFICATION FOR FIBER SPINNING AND DMAc RECOVERY FOR
 CARBON FIBER PLANT (PACKAGE #02)



	heated roller with multi pass roller driven by individual drivers		Residence time, Hot air flow for Circulation, steam pressure Forwarding drive speed IN: 75 meter/min (max) Forwarding drive Speed OUT: 75 meter/min (max) (Fiber Feed to Fiber hot stretching unit)	calculated (by equipment supplier) for 10kg water removal per hour
14	Fiber hot stretching unit: Hot air duct – electrically heated	1	Single duct for 12 tows Temperature: upto 140 deg C; Length: 5 meter Max. Hot air flow for Circulation Forwarding drive speed IN: 75 meter/min (max) Forwarding drive Speed OUT: 200 meter/min (max) (Fiber Feed to Fiber winder)	Heater Capacity (for hot air flow to heat fiber upto 140 deg C) to be calculated by the equipment supplier
15	Fiber Winder	15	Fiber spool total mass (Max): 30 Kgs Automatic changeover: YES Tension control: YES	-
16	Overflow collection Tank	2	Temperature: Ambient (20 – 50 deg C) Pressure: Atmosphere Level: 0 – 100 % LT (Level Transmitter) Flow rate: ~ 1000 LPH	2000 L
17	DMAc Distillation Unit with 3 No's distillate collection vessels, reflux drum, packed column for fractionation and Vacuum system	1	Batch distillation under vacuum to recover DMAc fraction with > 99% purity Temperature: 180 Deg C max. Input details: batch size – 12000Kg with DMAc water ratio is 50 : 50	Batch Still 12000 L
18	Dope Bleed Tank	1	The dope bleed tank with perforated partition at the bottom of tank and DM water recirculation pump with spray nozzle. Addition vessel (200 L capacity) with a extrusion pump (~ 100 LPH) and die (1000 No's hole with 300 – 400 micron hole diameter	3000 L

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19	Solvent Flushing Tank	1	Temperature: Ambient (20 – 50 deg C) Pressure: Atmosphere Level: 0 – 100 % LT (Level Transmitter) Flow rate: ~ 1000 LPH (Recirculation through dope line (High Shear Mixer to extrusion point) and back to the tank)	5000 L
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7. General Description of the process at the respective Equipment

<i>Sl. No.</i>	<i>Process Equipment</i>	<i>General description</i>
1	DMAc Storage Tank	SS Tank for storing Fresh / recovered/mixed DMAc solvent in tank farm area.
2	Molecular sieve column	Packed bed column with molecular sieve for removing of moisture from DMAc solvent
3	DMAc Day Tank	SS tank for storing daily needs of DMAc inside spinning plant area
4	High Shear Mixer	A high shear mixture with jacket for mixing of polymer powder and solvent.
5	Dope Dissolution Tank	A jacketed tank with anchor type agitator blade. The steam/hot water supplied through jacket to heat the dope.
6	Agitated Thin Film Deaerator	A column with thin film applicator blade to spread the dope inside. By applying vacuum on the top, air bubble removed from film.
7	Dope filtration unit (3 -10 micron size)	A large area stainless steel filter medium which filter the dope at low pressure drop. A jacketed housing ensures the heating of dope throughout the filtration.
8	Coagulation Bath and Recirculation Tank (CB & RT)	The coagulant is recirculated through Coagulation bath through a recirculation tank. The temperature, flow and concentration of coagulant is to be controlled here for uniform coagulation. The dope is extruded through a spinneret which is dipped inside coagulant in the bath. The filament formation occurs as the dope comes out of spinneret which is taken up over a fiber forwarding roller drive.
9	Wash Baths and Recirculation Tank	The fiber is passed through the baths using with help of fiber forwarding rollers & drive. The bath solution is recirculated in wash bath and recirculation tank. The temperature, flow and concentration of bath solution is controlled.
10	Spin Finish Application bath & Recirculation Tank	The fiber is coated with spin finish solution to keep the yarn intact. Spin finish solution is recirculated.
11	Fiber Dryer I: Hot air circulation dryer with multi-pass	Fiber is dried with recirculated hot air to remove moisture from it. Fiber passes over multiple roller system to ensure sufficient residence time to remove moisture.

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	rollers driven by single drive	
12	Fiber Dryer II: Hot air circulation dryer with steam heated roller with multi pass roller driven by individual drivers	Fiber is dried over steam heated multi-cylinder drum drives. The fiber passes several time over these cylinder to ensure the desired moisture level is attained.
13	Fiber hot stretching unit: Hot air duct – electrically heated	The stretching unit is electrically heated rectangular duct.
14	Fiber Winder	The fiber winder is capable up to 30 kgs of winding of yarn which can change the spools automatically. The software controlled winding in winder has a HMI over which one can set desired spool, length, weight, winding pattern (pitch) etc. Once the desired length of winding completes on a spool, the other empty spool takes its position without wasting of any fibers.
15	Overflow collection Tank	A stainless steel tank for collecting overflow from coagulation and wash bath and send it to tank farm area for storage.
16	DMAc Distillation Unit with 3 No's distillate collection vessels, reflux drum, packed column for fractionation and Vacuum system	Mixed solvent is heated in still, the vapour are enriched in column and low volatile product is collected from top which condenses and collected in three different tanks. These tanks will be a water rich fraction, mixed fraction and pure DMAc fraction.
17	Dope Bleed Tank	This is used to extract the solvent from bled/waste dope.
18	Solvent Flushing Tank	A stainless steel tank with recirculation provision. The pure DMAc is recirculated in the fiber spinning line (from high shear mixer to the spinneret point) for flushing in case of plant safe shut down or start up.