

# **EXPRESSION OF INTEREST FOR CARBON FIBER FACILITY**

**PACKAGE -1:**

**SETTING UP A COMPLETE FACILITY  
FOR  
SYNTHESIS OF POLY-ACRYLONITRILE(PAN)**



**MISHRA DHATU NIGAM LIMITED**

**A Govt of India Enterprise**

**P. O Kanchanbagh, Hyderabad – 500058, Telangana, India.**

**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](http://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 #1:**

Synthesis of Polyacrylonitrile (PAN) Process is described in **ANNEXURE - I**

## 6. ELIGIBILITY CRITERIA PACKAGE#1

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 5 Crore (INR Five 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 <b>*similar work</b> 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.3.6 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, Continuous Stirred Tank Reactor (CSTR), SS Column, Centrifuge/drum filter and dryer for wet cakes/solids; 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 news papers 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 become part of the technical specifications.	To be completed within 15 days after issue of Technical specification & 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

<b>A</b>	<b>Payment Terms</b> <b>A1. For Plant, Machinery and Equipment including Design, Engineering and Training</b>
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.
	<b>A2 Complete Erection, Start and Putting into Commissioning including supervision:</b>
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>B</b>	<b>Security Deposit</b>

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
<b>C</b>	<b>Delivery Schedule</b>
a.	The delivery schedule should match with overall project schedule
<b>D</b>	<b>Liquidated Damage</b>
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.
<b>E</b>	<b>Performance Guarantee Tests and Provisional Acceptance</b>
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.
<b>F</b>	<b>Defect Liability Period and Final Acceptance</b>
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,  
Cell +919177304306  
[anandakumar@midhani-india.in](mailto:anandakumar@midhani-india.in)

For Technical Queries-  
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Complete Address  
Mishra Dhatu Nigam Limited (MIDHANI),  
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**ANNEXURE - I**

**SYNTHESIS OF POLYACRYLONITRILE (PAN) PROCESS LINE**

**(Capacity: 140 TPA of PAN)**

**1. Process Description**

Polyacrylonitrile (PAN) copolymer is prepared by free radical redox aqueous slurry polymerisation in a Continuous Stirred Tank Reactor (CSTR). Water is the dispersion medium and water soluble persulphate and bisulphite are the radical initiators. A mixture of Acrylonitrile (AN) and Comonomer (CM) is fed into the CSTR along with water and other reagents. Reaction is carried out at a constant temperature between 50-60 deg C and pH 2.0-3.0. The polymer slurry overflow from CSTR is collected in a tank and fed to a monomer stripper to recover the unreacted monomer. The polymer slurry is then centrifuged and the wet polymer cake is dried in a dryer. The dried polymer is granulated and stored at appropriate condition until further use.

*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**

The synthesis of Polyacrylonitrile process facilities is capable of producing Polyacrylonitrile (PAN) powder using the following material grades and for manufacturing carbon fibers:

<i>Sl No</i>	<i>Material</i>	<i>Grade</i>
1	DM water	Demineralised water
2	Acrylonitrile (AN)	LR
3	Comonomers	AR
4	Persulfate salt	AR
5	Bisulfite salt	AR
6	Sulphuric acid (H <sub>2</sub> SO <sub>4</sub> )	AR
7	Mercaptans or thiols	AR
8	Weak alkaline solution of oxalates	AR

## MISHRA DHATU NIGAM LIMITED(MIDHANI)

TECHNICAL SPECIFICATION FOR SYNTHESIS OF POLYACRYLONITRILE (PAN) FOR  
CARBON FIBER PLANT (PACKAGE #01)



### 3. Output - Products & Effluents

- a. Products: Polyacrylonitrile(PAN) powder specifications & broad range of quality

<i>PAN copolymer property</i>	<i>Specification range</i>
Moisture Content	0.5-2.0%
Inherent Viscosity	1.5-2.5dl/g

- b. Effluents:

- i. Tentative composition of discharge water from polymer area is as follows.

pH of water: 3-8.

PAN :0.01%

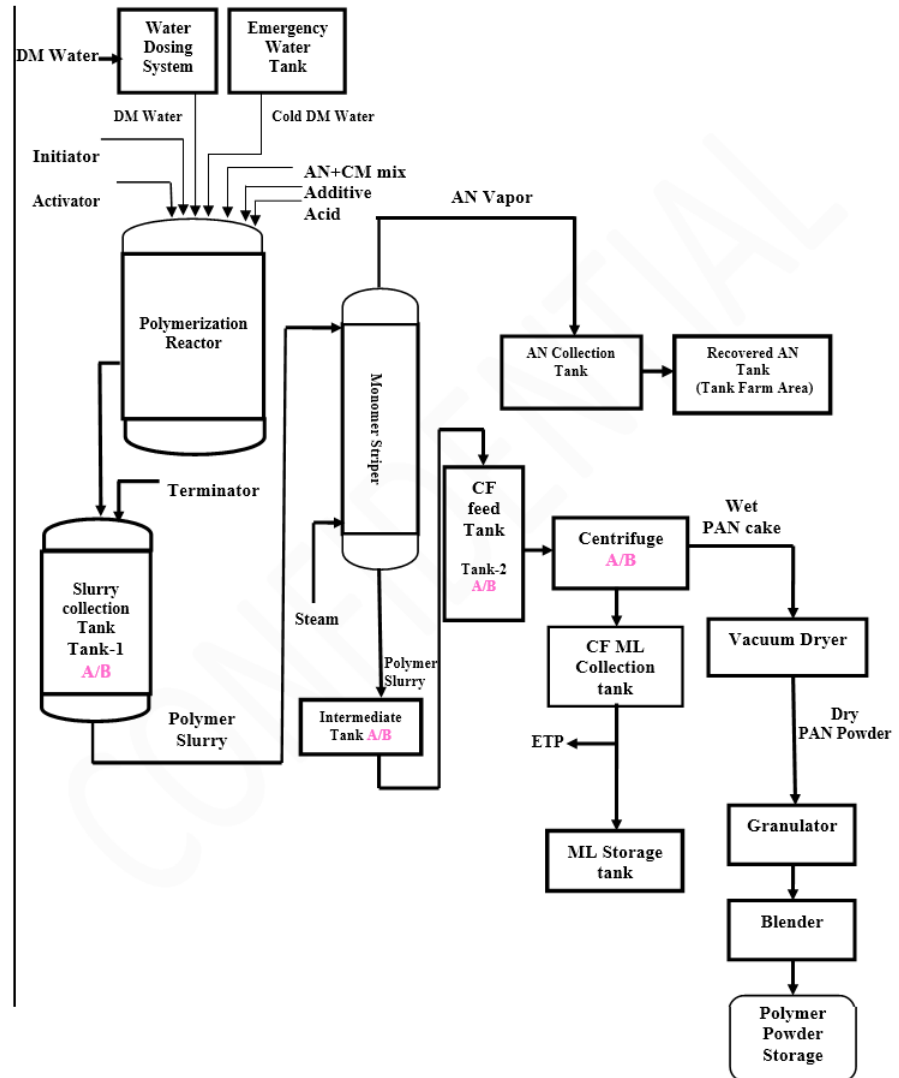
H<sub>2</sub>O : 99.87%

NVI : 0.08%

AN+CM :0.04%

- ii. **Solid:** Polymer dust, scraped from equipment etc.

#### 4. Process Block Diagram



#### 5. General Scheme

- Feed Details in Reactor:
  - Monomer dosing rate : 68kgs/hr
  - Water dosing rate : 210kgs/hr
- Conversion to polymer : 75%
- Slurry Flow rate in downstream process : 400 LPH  
(Slurry storage tank to Centrifuge)
- Batch duration : 24hrs
- Batch frequency : 72hrs

**MISHRA DHATU NIGAM LIMITED(MIDHANI)**  
 TECHNICAL SPECIFICATION FOR SYNTHESIS OF POLYACRYLONITRILE (PAN) FOR  
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**6. Broad Technical details of the equipment**

<i>Equipment name</i>	<i>Quantity</i>	<i>MOC</i>	<i>Operating Conditions</i>	<i>Equipment Size (kL)</i>	<i>Parameter Control</i>
Fresh Acrylonitrile(AN) storage Tank (Tank Farm Area)	1	SS 316	Temperature: 10-15Deg C Pressure:Atm./ Nitrogen blanketing Flow rate: 2000 LPH approx. (For transferring to Process area)	20	<ul style="list-style-type: none"> <li>• Flow rate controlled by pump RPM using VFD for metering pumps</li> <li>• Flow rate controlled by flow control valve for centrifugal pumps</li> <li>• Temperature controlled by supply of cooling/chilled water or steam/hot water as per requirement</li> <li>• Vacuum controlled by control valve</li> <li>• Liquid level controlled by interlocking level transmitter and</li> </ul>
Recovered Acrylonitrile Storage Tank (Tank Farm Area)	1	SS 316	Temperature: 10-15Deg C Pressure: atmospheric / Nitrogen blanketing Flow rate: 2000 LPH approx. (For transferring to Process area)	6.0	
AN distillate Collection Tank	1	SS 316	Temperature: Room Temperature Vacuum Flow rate: 1000 LPH approx. (For transferring to Process area)	1	
Mother Liquor Storage Tank (Tank Farm Area)	1	SS 316	Temperature: Room Temperature Pressure: Atmospheric Flow rate: 1000 LPH approx.	10	
AN day tank	1	SS 316	Temperature: 20-25 Deg C Pressure: Atmospheric / Nitrogen blanketing Flow rate: by gravity / Pumping. (For transferring to Process area)	2.5	
Water dosing system	1	SS 316	Temperature: 70 - 80 Deg C Pressure: Atmospheric / Nitrogen blanketing Flow rate: by gravity / Pumping. (For transferring to reactor and wet cake wash)	2.5	
Preparation tank/Dosing Tank	4	SS 316	Temperature: Room Temperature Pressure: Atmospheric Agitation for dissolution Flow rate: by gravity / Pumping.	0.50	
Preparation/dosing	2	SS 316	Temperature: Room Temperature	1.0	

**MISHRA DHATU NIGAM LIMITED(MIDHANI)**  
 TECHNICAL SPECIFICATION FOR SYNTHESIS OF POLYACRYLONITRILE (PAN) FOR  
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Tank for terminator			Pressure: Atmospheric Agitation for dissolution Flow rate: by gravity / Pumping.		feed/transferring pump • pH controlled using online pH indicator • RPM using VFD motors
Dosing system for chain transfer agent	1	SS 316	Temperature: Room Temperature Pressure: Atmospheric Flow rate: 150 ml per hr (For transferring to reactor)	0.01	
Sulphuric acid preparation & dosing system	2	Suitable for acid	Temperature: Room Temperature Pressure: Atmospheric Flow rate: 1 LPH (For transferring to reactor)	0.10	
Monomer preparation & dosing Tank	2	SS 316	Temperature: Room Temperature Pressure: Atmospheric / Nitrogen blanketing Agitation for dissolution Flow rate: 50 -100 LPH (For dosing to the reactor)	2.4	
Emergency water Tank	1	SS 316	Temperature: 15 deg C Pressure: Atmospheric Flow rate: by gravity; dumping to the reactor	1.0	
CSTR Polymer reactor	1	SS 316	Agitation/stirring: 100 – 500 rpm (variable) Temperature: 50 – 60 Deg C Pressure: Atmospheric / Nitrogen blanketing Over flow rate: by gravity pH: 2 to 3 (Over flow to slurry collection tank)	1.0	
Slurry collection Tank	1	SS 316	Temperature: Room Temperature Pressure: Atmospheric Agitation to avoid settling Flow rate: up to 400 LPH (Transferring to Monomer stripper)	6.0	
Monomer stripper	1	SS 316	Temperature: 60 – 80Deg C Vacuum Flow rate: by gravity	To be calculated by bidder	



**MISHRA DHATU NIGAM LIMITED(MIDHANI)**  
 TECHNICAL SPECIFICATION FOR SYNTHESIS OF POLYACRYLONITRILE (PAN) FOR  
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Intermediate Tank	2	SS 316	(free fall to Intermediate tank) Temperature: 60 - 80Deg C Vaccum Agitation for dissolution Flow rate: 2000 LPH approx. (Transferring to CF feed Tank)	2.0
Centrifuge Feed Tank	1	SS 316	Temperature: Room Temperature Pressure: Atmospheric Agitation for dissolution Flow rate: 2000 LPH approx. (Transferring to Centrifuge/drum filter)	6.0
Drum filter / Centrifuge (to be decided by equipment supplier)	1	SS 316	Temperature: Room Temp Pressure: Atmospheric for centrifuge (Vacuum for drum filter)	Suitable size for 400Lph slurry with ~15% polymer
CF- ML collection tank	1	SS 316	Temperature: Room Temp Pressure: Atmospheric Flow rate: 2000 LPH approx. (Transfer to Mother Liquor storage tank farm)	4.0
Polymer Dryer (Batch – rotary vacuum dryer / Continuous drying; to be decided by equipment supplier)	to be decided by equipment supplier	SS 316	Temperature: 70 Deg C max. Hot air flow for continuous drying / vacuum for batch drying	Batch/Continuous drying for 3000kg wet cake with 40% polymer
Granulator	2	SS 316	Temperature: Room Temperature Pressure: Atmospheric	1250kg dry polymer per day
Polymer Blender	1	SS 316	Temperature: Room Temperature Pressure: Atmospheric	1250kg dry polymer (bulk density 0.33 g/cc)
Polymer Storage (Silo)	2	SS 316	Temperature: Room Temperature Pressure: Atmospheric	10.0



## **7. General Description of the process at the respective equipment**

General description of the respective equipment with possible technical details of the equipment and all the important parameters required for the process needs to be described.

A detailed description of processes involved in the above is as follows,

### **a. Fresh Acrylonitrile & Recovered acrylonitrile storage tank:**

Fresh acrylonitrile & recovered AN are stored in separate tanks in tank farm area at a temperature of 10-15C. These tanks are fitted with recirculation line, level indicator, heat exchanger, pump, motor, flow meter, flame arrestor, temperature indicator, moisture trap, drain etc

### **b. Mother liquor storage tank & intermediate tank**

Acrylonitrile/water mixture from polymer slurry dewatering system is stored in these tanks for offline monomer recovery. These tanks are fitted with recirculation line, level indicator, pump, motor, flame arrestor, temperature indicator, flow meter, drain etc

### **c. Water Dosing System:**

Water dosing system is consist of a still with column equipped with a motor, pumps for water circulation/addition, steam heating coil and heat exchanger to control the water temperature, and valves for controlling the flow and temperature. The demineralised water is used in reactor for polymerisation reaction, preparation of aqueous reagents and washing the polymer cake while centrifuging the slurry.

### **d. Reagents preparation & dosing tanks:**

The required quantity of pure reagents are weighed accurately and dissolved in demineralised water in the respective preparation tanks at room temperature. The solutions are then transferred into their respective feed/dosing vessels to use in polymerization or slurry short stopping. The preparation and dosing vessel units consists of a tank, inlet & outlet line, motor, pump, flow meter, level indicator, dosing pipe, drain etc

### **e. Monomer Comonomer mixture preparation and feed tank**

The monomer mixture is prepared in monomer preparation tank at room temperature. The



mixture is taken in circulation for several hours for complete dissolution of monomer and then transferred to feed tank. The system consists of a tank, motor with variable frequency drive, pump, agitator, recirculation line, level indicator, flow meter, inlet pipe, hopper, dosing pipe, drain etc.

**f. Polymerisation reactor:**

This is a continuous stirred tank reactor (CSTR) to conduct the Acrylonitrile copolymerization in continuous mode of operation in aqueous medium. The water from the water dosing system and other reagents from respective feed tanks are dosed in to reactor at constant flow rate. The polymer slurry formed overflows into a slurry collection tank. The reactor is equipped with an agitator assembly with variable frequency drive, jacket for cooling water circulation, valve to control the temperature, nozzles for adding reagents, emergency water inlet, an overflow nozzle for slurry overflow, online pH meter, RTD, drain etc .

**g. Emergency water tank:**

Polymerization is an exothermic reaction. Any runaway reaction can lead to fire. An emergency water tank is provided for cooling the reactor mass immediately in case of temperature overshoot. This tank consist of DM water at 10-15 C, chilled water is circulated in coils inside the water tank, tank is fitted with water inlet, water out let, level & temperature indicator, drain etc and water outlet valve is interlocked with reaction temperature.

**h. Slurry collection tank:**

The over flown polymer slurry from the reactor is collected in slurry collection tank and kept under stirring. The terminator solution is also dosed throughout the reaction period in to slurry collection tank to short stop or quenches the reaction. The polymer slurry is then transferred from this tank for down-stream processes. It is equipped with an agitator assembly, motor pump, pipelines and valves.

**i. Monomer stripper:**

The unreacted monomer from the polymer slurry is removed using monomer stripper. The monomer stripper unit consists of a long column with baffle and a condenser. The column is heated with steam or hot water to 70 to 80°C under vacuum and the polymer slurry is passed through the top of the column from the slurry collection tank and steam is passed



from down of the column. The unreacted monomer vapor evaporates and condenses at the top of the column and it is collected in AN collection tank. The polymer slurry from the monomer stripper is then fed to centrifuge for dewatering the slurry. It is a jacketed and insulated column equipped with condenser, heat exchanger, inlet pipeline for slurry and steam, outlet pipe line for distilled AN/water mixture & polymer slurry and valves, bottom out let to intermediate tank.

**j. Intermediate tank& Centrifuge feed tank:**

Polymer slurry from the monomer stripper is collected in intermediate tank and then transferred to centrifuge feed tank & slurry is kept under stirring. The polymer slurry is then transferred from this tank for down-stream processes. It is equipped with an agitator assembly, slurry inlet & outlet, level indicator, motor pump, pipelines, valves, drain, etc

**k. Centrifuge:**

Centrifuge is used for dewatering and isolation of polymer from polymer slurry. The polymer slurry from the monomer stripper is fed into centrifuge to remove the water. Filter bags are fixed in the inner side of rotating drum in centrifuge. If the polymer slurry is centrifuged without monomer stripping, the mother liquor is collected in mother liquor storage tank for offline recovery of unreacted monomer by stripping in monomer stripper. The polymer cake is washed repeatedly with the hot water to remove traces of inorganic impurities and monomer mixture if any. Wet polymer cake is scrapped and unloaded from centrifuge. Centrifuge is equipped with a motor, valve, drain, and emergency break. It has nozzles for inflow of slurry and DM water. Batch or continuous slurry dewatering can be done using any other type of dewatering process.

**l. Drying:**

The wet polymer wet cake from centrifuge is dried under vacuum to reduce the moisture content <1%. Rotary vacuum paddle dryer or rotacone or any other continuous drying process is used for drying of polymer. It is equipped with a stainless steel cylinder with limpet for heating utility, charging and discharging port, motor and agitator, dust filter, heat exchanger for cooling, a vacuum pump, distillate collection tank. Wet polymer is charged through charging port and dried under vacuum using steam in limpet. Dried polymer is unloaded from discharging port.

**m. Granulation:**

**MISHRA DHATU NIGAM LIMITED(MIDHANI)**

TECHNICAL SPECIFICATION FOR SYNTHESIS OF POLYACRYLONITRILE (PAN) FOR  
CARBON FIBER PLANT (PACKAGE #01)



The dried polyacrylonitrile (PAN) copolymer is in the form of lump. Polymer is powdered into fine particles using granulator. It is equipped with motor, stainless steel blades and sieves, charging and discharging port. Polymer is fed into the charging port and blade break the polymer lump which are passed through sieves and collected from discharging port.

**n. Blending and Polymer storage:**

Granulated PAN copolymer powder is blended together in a blender for uniform polymer powder and the blended polymer powder is stored in a closed container/silo under dust free condition at 25-30C under dry atmosphere with no direct sunlight.