

## Tender Notification for Procuring

### PRESSURE SWING ADSORPTION SYSTEM FOR HIGH PURITY HYDROGEN FROM A MIXTURE OF GASES

#### Centre for Sustainable Technologies, Indian Institute of Science, Bangalore 560012

As a part of an MNRE sponsored project, we need to separate hydrogen from a mixture of gases to generate hydrogen of 99.99% purity acceptable for PEM fuel cell application. Towards generating Hydrogen of the indicated purity, a pressure swing adsorption (PSA) system is sought to be procured. The complete PSA system for specified requirement shall be supplied and installed at CGPL, Indian Institute of Science, Bangalore on a turnkey basis and shall include erection of a suitable facility for the system.

Quotations are invited to procure a “**PRESSURE SWING ADSORPTION SYSTEM**” on **CIP, Indian Institute of Science, Bengaluru Basis**. The quotation should clearly indicate the terms and conditions of delivery, delivery schedule, entry tax, payment terms, warranty coverage etc. The quotation should be submitted in two parts: Part I (Technical bid) and Part II (Commercial bid).

Sl.No	Item / Description	Date / Details
1	Pre-Bid /consultation/discussion/meeting	18 June 2018 Between 3.00pm-4.00pm IST
2	Final Specifications	25 June 2018
3	Two bid tenders last date The tenderer should submit Technical and Financial Bid separately in sealed envelope super scribing the envelope as ‘Technical Bid’ and ‘Financial Bid’. Both these envelopes should again be put in a single envelope superscribed ‘ <b>TENDER FOR .....</b> ’ should reach the ....., Dept of....., <b>Indian Institute of Science, Bengaluru 560 012 on or before 13 July 2018 by 3.30 pm</b>	02 July 2018  1530 hrs at  <b>CGPL, Indian Institute of Science, Bangalore 560 012, India</b>
4	Technical Bid opening date <b>The Financial bids of the short listed agencies, qualifying in the technical scrutiny of the Committee set up by the Institute, will be opened at a later date and will be intimated to qualifying bidders to attend the price bid opening.</b>	13 July 2018  1600 hrs At the same venue
5	<b>Validity of the quote.</b>	06 Months

The venue for all the meeting will be

**Conference room,  
CGPL, Indian Institute of Science, Bangalore 560 012, India**

## 01. Background

Proton exchange membrane (PEM) fuel cells require high levels of Hydrogen purity, as high as 99.99%, for stable operation. While Hydrogen for fuel cell applications is typically generated by steam reforming of Methane, Hydrogen can also be obtained from thermo-chemical conversion of biomass in a process known as gasification. Gasification process generates a gaseous mixture known as producer gas or syngas, typically composed of CO, H<sub>2</sub>, CH<sub>4</sub>, CO<sub>2</sub> and N<sub>2</sub>. Syngas has typically been used as a fuel in internal combustion engines but when the same needs to be used for PEM fuel cell application, the purity of the gas and presence of compounds other than Hydrogen also need to be addressed. The following table provides the typical fuel requirement for the PEM fuel cell.

Standard reference	ISO-DIS14687-2
Characteristics (assay)	Type I, Type II, Grade D
Hydrogen fuel index (minimum mole fraction)	>99.97%
Maximum concentration of Impurities	
Total non-hydrogen gases	<300 µmol/mol
Helium (He)	<300 µmol/mol
Nitrogen (N <sub>2</sub> ), Argon (Ar)	<100 µmol/mol
Carbon dioxide (CO <sub>2</sub> )	<2 µmol/mol
Carbon monoxide (CO)	<0.2 µmol/mol
Water (liquid)	<5 µmol/mol
Water (Vapor)	-
Total hydrocarbons b (C1 basis)	<2 µmol/mol
Oxygen (O <sub>2</sub> )	<5 µmol/mol
Total sulfur compounds c	<0.004 µmol/mol
Formaldehyde (HCHO)	<0.01 µmol/mol
Formic acid (HCOOH)	<0.2 µmol/mol
Ammonia (NH <sub>3</sub> )	<0.1 µmol/mol
Total halogenated compounds	<0.05 µmol/mol
Maximum particulates concentration	<1 mg/kg
Max Particulate size	<10µm
Conductivity due to Max Inorganic Content	< 5 mS
Max Inorganic Content	< 0.01 % ash
Na Concentration	<0.05 mg/liter
K Concentration	<0.08 mg/liter

In order to address the needs of the Hydrogen for PEM fuel cell requirements, IISc has developed a gasification system which has the capability of generating Hydrogen rich syn-gas using a mixture of Steam and Oxygen as the reactive media. While the Oxy-Steam biomass gasification system delivers Hydrogen enriched syngas, to realize 99.99% purity, it is intended to have a Pressure Swing Adsorption (PSA) system to handle the mixture of gases generated from gasification of biomass. Following are the typical specifications of the PSA;

Properties of the gaseous fuel		
Feed gas composition range to be handled	Component	Mol %
	CO	20 ± 5
	H <sub>2</sub>	40 ± 10
	CH <sub>4</sub>	6 ± 3
	CO <sub>2</sub>	25 ± 10
	N <sub>2</sub>	35 ± 10
Feed gas pressure	10 bar absolute	
Feed gas temperature	Nearly ambient ~ 25 dec C	
Feed gas flow rate	150 ± 25 NM <sup>3</sup> /h	
Moisture content	Dew point moisture for the gaseous mixture	
Expected performance/output		
Exit gas composition	H2 at 99.99% purity	
Desired H2 recovery	As high as possible depending upon the inlet gas composition	
Exit gas pressure	As high as possible	
Exit gas temperature	Nearly ambient	
Initial start-up time	Under 30 minutes	
Feed flow rate change flexibility	Ability to handle variable flow rates	
Feed composition flexibility	Ability to handle varying composition as indicated above	
Material of construction	Industrial standard material with ability to handle H2 rich gas / pure stream of H2 at high pressure	
Pressure safety	Necessary safety aspects with pressure relief valves must be installed both at columns and surge tanks. All pressure vessels and piping must be ASME compatible to handle syngas and H <sub>2</sub> .	
Fire safety	Fire proof electric motors and switches to be used (satisfying Class I Division II standards).	
Power supply	The system be designed to be compatible with 50 Hz power supply.	

## 02. Key features/requirement to be considered;

- Should be a fast cycle PSA.
- Low power consumption system.
- Maximum turndown ratio of 25%.
- The battery limits for the intake gas, intake power and other utilities like compressed air, water and outlet conditions must be clearly specified.
- Integrating with the control system for remote/control of the system.
- Minimum gas storage volume in the PSA system.
- No emissions/leakage of gases during the operation (presence of CO).
- The tail gas energy should be low.
- Skid mounted with small area foot print.
- Experience in using producer gas/syngas as an input feed.
- The adsorbent should have large lifespan without degradation.

- There should be an explicit facility to remove any condensate.
- Maintenance free / low maintenance valves in the system.
- HAZOP study aspects should be addressed.
- An advanced product mass flow meter with parametric real time corrections should be included as an optional item.

### **03. Interfaces required.**

- Syn Gas, air, liquid and power interfaces at the inlet and exit of PSA
- Control I/O from and to the PSA
- Access of data acquisition from the PSA at module level

### **04. Automation, Control, Safety and warning systems**

- Should allow operation of the system under both manual and automatic mode.
- Provision to change the cycle time and incorporate the same into system control towards addressing the turn down ratio and product gas quality.
- Should include multi-level (component) safety valves and gas leak audio/visual warning system.

### **05. Services to be supplied on various aspects related to the installation:**

Detailed input electrical connection diagrams must be made available for power supply readiness. Detailed foundation civil drawings along with necessary purge plumbing details must be made available in the form of detailed drawings.

#### **Mechanical Installation and Commissioning:**

Ensuring correct erection of the mechanical parts of the system (according to the scope of supply) and to guarantee compliance to installation specifications prior to test system commissioning and productive operation.

- Positioning and mounting of all equipment in cooperation (if necessary with local subcontractor)
- Removal of protection coatings and transport locking device(s)
- Alignment of equipment at designated location
- Commissioning of mechanical system elements

Well trained, qualified and certified engineers shall perform all required steps to get the complete test system ready for the acceptance test. Following activities are to be included:

- Check of power & media supply, data, measurement and sampling connections.
- Installation, configuration and parameterization of all software.
- Allocation and verification of user I/O and measurement channels according to engineering.
- Interfacing of peripheral equipment based on scope of supply.

### **06. Documentation:**

Includes a compilation of following documents in digital format in ENGLISH language;

- Operating manual
- Material safety data sheet
- Maintenance instructions and schedules

- Spare and wear parts lists for a period of 3 years as well as a list of consumables, safety instructions and a troubleshooting guide
- Emergency measures according to the safety matrix.
- Documentation of third party products.
- System engineering drawings.
- Description of the PSA system and functionality
- Trouble shooting and emergency measures

#### **07. Other standard requirements:**

- Complete integration and testing of all components as a turnkey responsibility
- Training courses and expert support over 3 years at least for all applied
- Proof of suitability of equipment for industrial research is required, e.g. references for all technologies at leading OEM's in international automotive industry shall be available. Reference lists in India and any relevant documents from the client is a must.

#### **09. Other items**

- The cost of the PSA system and that of each accessory to be quoted separately.
- The vendor must submit a signed compliance document mentioning whether their equipment meets each and every specification detailed above.
- The award of the tender will be decided by the institute as per price of the complete system. All insurance charges shall be borne by the vendor.
- Technical and financial bids should be submitted separately.
- All prices of the PSA system and accessories should be quoted in currency of respective country of origin of the equipment.
- The specifications mentioned shall be understood to be the minimum required. Additional technical and research features suitable to our requirements shall be given due reference.
- Vendors that submit qualifying technical and financial bids are required to send competent representatives from the sales and technical divisions for further negotiations.

#### **All the communication in this regard should be addressed to:**

The Chairman  
CST,  
Indian Institute of Science  
Bangalore 560 012  
India

With attention to Prof. S Dasappa.

The email communication should be to [dasappa@iisc.ac.in](mailto:dasappa@iisc.ac.in).

#### **10. Specific Terms and Conditions**

The following requirements should be specifically adhered to by the vendor, and express indication should be given regarding adherence.

1. **Guarantee period:** The equipment should be guaranteed for a period of 12 months from the date of handing over the fully functional unit to the Institute, against manufacturing defects of material and workmanship.
2. **Spares list:** Separate list of spares desirable (like valves and other general spares) for an R and D lab along with costs for a period of three years to be provided separately with individual costs as optional items.

3. **Warranty:** The complete system is to be under warranty period of 36 months including free supply of spare parts, and labour from the date of functional installation, commissioning and acceptance. During the period of warranty the supplier is required to take full responsibility to recommission the system in the event of failure whatsoever reasons.
4. **Post guarantee annual maintenance contract (AMC):** Annual maintenance contract (AMC) for the complete system will be start after expiry of the warranty period as per agreed terms and conditions. The contract will also include the recommissioning of the system for what so ever reasons. Costs for the post-guarantee 3 years of annual maintenance contract for the complete system which includes all the accessories supplied during the installation. One annual visit by relevant subject expert(s) must be scheduled during the period of AMC. The amount due every year on account of the AMC will be paid at the beginning of the year to the vendor.
5. **Warranty:** The complete system is to be under warranty period of 36 months including free supply of spare parts, and labour from the date of functional installation, commissioning and acceptance. During the period of warranty the supplier is required to take full responsibility to recommissionthe system in the event of failure whatsoever reasons.
6. **Replacement of defectives:** Items found not acceptable or missing by the committee should be replaced by the supplier free of cost including the forwarding and Insurance expenses. Replacement of parts that become defective during installation and warranty should be arranged free of cost through the Indian associate of the supplier including all incidental charges.
7. **Documentation:** Two sets of operational/service/application manuals are to be provided along with the Equipment in English. Detailed documentation on various sequences, application software/firmware are to be provided and the same must be updated regularly for next 10 years as and when these are released. Supplier is required to ensure mailing of product/research newsletters released from their R&D sites to the site on a regular basis. This is to keep this centre abreast of the latest developments taking place in system technology and research techniques. *The vendor is to provide a tender compliance sheet by giving all the necessary specifications, which should be supported by printed documentation sheets and certification of each item. In the absence of such documentation, a letter from the principals of the company should be provided.*
8. **List of installations:** The vendor should share a list of installations currently operational in India and abroad.
9. **Design Codes and Specifications:** The following design codes and specifications should be adhered to.
  - Equivalent of IP or NEMA standards to be followed along with necessary explosion proof protection for enclosures.

## 11. Research cooperation (Optional)

- The vendor is required to provide work in progress packages to us for research trial as for their other research sites. The firm should provide an exhaustive list of performance of various systems which will help the research and cooperation.
- The vendor should extend demonstrated cooperation regarding design and implementation of novel hardware and software inputs as required by the user, such as newer analysis techniques, emissions standards, post-processing, synthesis of data. Specific proposal regarding research collaboration will be submitted subsequently for consent and counter signatures of the principals on the research proposal.

## **12. Delivery, Installation and Commissioning**

The facility should be built and the PSA system should be delivered, installed at CGPL, Indian Institute of science, Bangalore and functionally commissioned within 6 months from the date of receipt of confirmed supply order. The supply of the items will be considered as effected only on satisfactory commissioning and inspection of the system by the institute. After successful installation and inspection of the PSA, the date of taking over of the entire complete running of the PSA system by the institute shall be taken as the start of the warranty period.

## **13. Custom clearance**

The Institute will furnish the necessary papers for the import of items into India, necessary custom duty exemption certificate and other supporting documents to facilitate the import of the items.

**Note: Institute has got into an agreement with M/S FEI Cargo for custom clearance of all imported equipments to the Institute.**

## **14. Training**

The supplier, at their expense, will arrange for an application specialist, immediately after the installation and commissioning of PSA system, to demonstrate the capabilities/features of the system and also to impart training to staff members. The supplier, at their expense, shall provide initial specialized training at our site by a research scientist and a research engineer from the supplier's international R&D Centre or from an internationally renowned centre; the training shall cover the state of art research application, together with system operation and first line maintenance of the system, system and application software, along with developmental aspects for modifications and development of user defined sequences, for various application purposes, etc. The travel, boarding and lodging expenses of the above personnel, scientist and engineer shall be borne by the vendor and this training should be completed before handing over the PSA system to us.

## **15. Mode of shipment**

For Local orders the shipment is at vendor's discretion considering the safety aspects and to be installed by the supplier at the installation site.

For foreign orders the consignment must be air-lifted, insured and transported to the installation site by the supplier.

## **16. Payment terms**

For Local Orders- 100% payment will be after satisfactorily supply and installation of the item.

For foreign orders a confirmed irrevocable and divisible letter of credit should be opened with the bank designated by the vendor with 80% of the total cost payable against confirmed proof of dispatch and the remaining 20% balance on successful installation against a bank guarantee of 10% of the total cost for the 3 years warranty period.

### **For pre Bid meeting:-**

Vendors who wish to attend the pre bid meeting on the 02<sup>nd</sup> of July must send an intimation regarding the same latest by 25<sup>th</sup> June through a mail to Prof. S. Dasappa ([dasappa@iisc.ac.in](mailto:dasappa@iisc.ac.in)).