

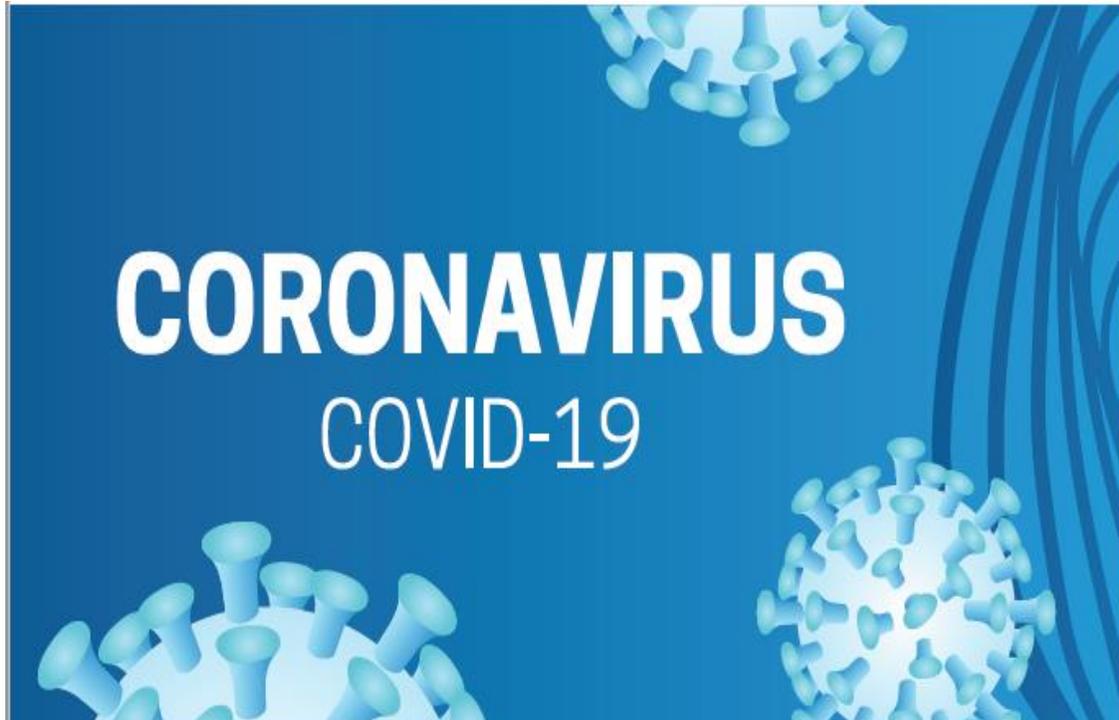


Indian Institute of
Technology Bombay

IIT Bombay



TATA CONSULTING ENGINEERS LIMITED



Emergency Alternative Mode of Oxygen Generation



Indian Institute of
Technology Bombay

IIT Bombay



SPANTECH
Engineers Pvt. Ltd.
generating solutions



TATA CONSULTING ENGINEERS LIMITED

Memorandum of Understanding on Teaming

Between

INDIAN INSTITUTE OF TECHNOLOGY BOMBAY

and

SPANTECH ENGINEERS

and

TATA CONSULTING ENGINEERS LIMITED

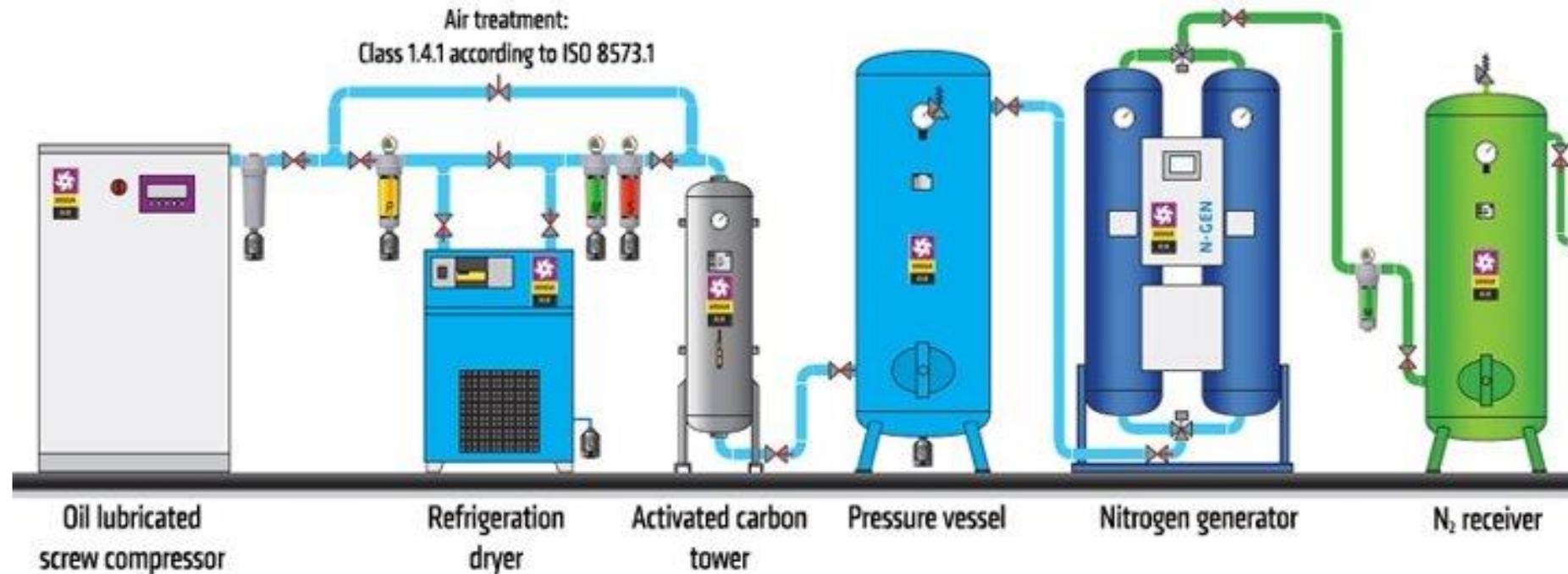
PSA Nitrogen Plant conversion to PSA Oxygen Plant

24th-28th April 2021



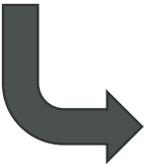
Conversion of Industrial Nitrogen Generation Units for Oxygen Generation

Pressure Swing Adsorption (PSA) technology



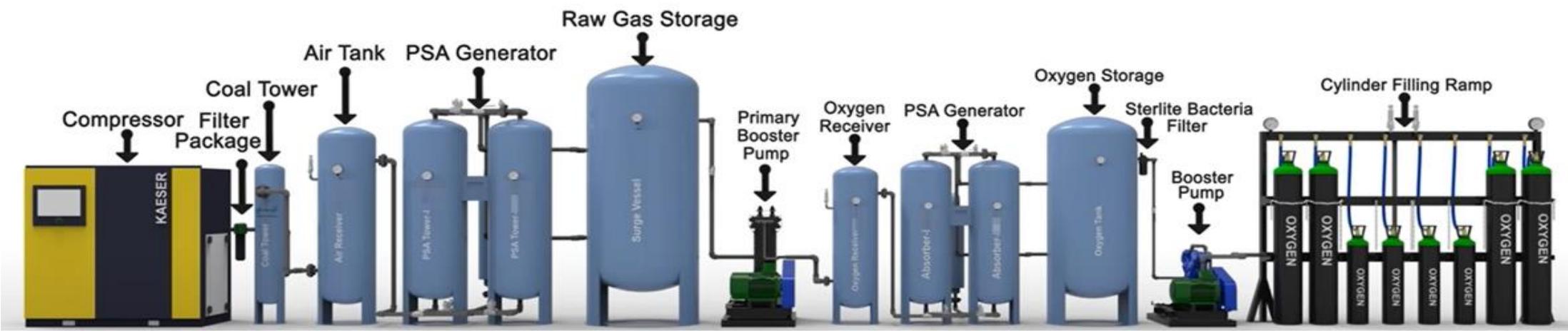
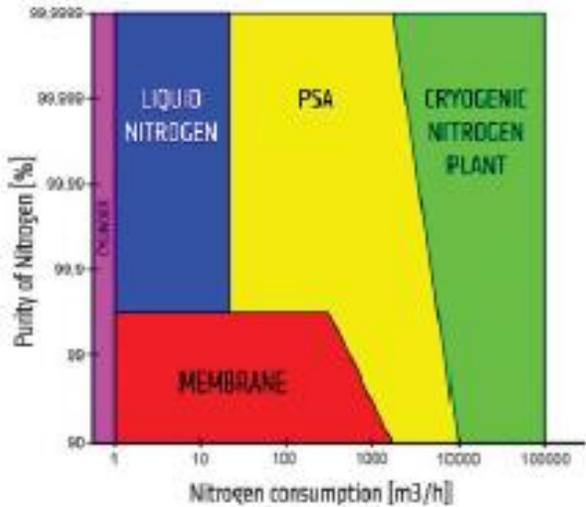
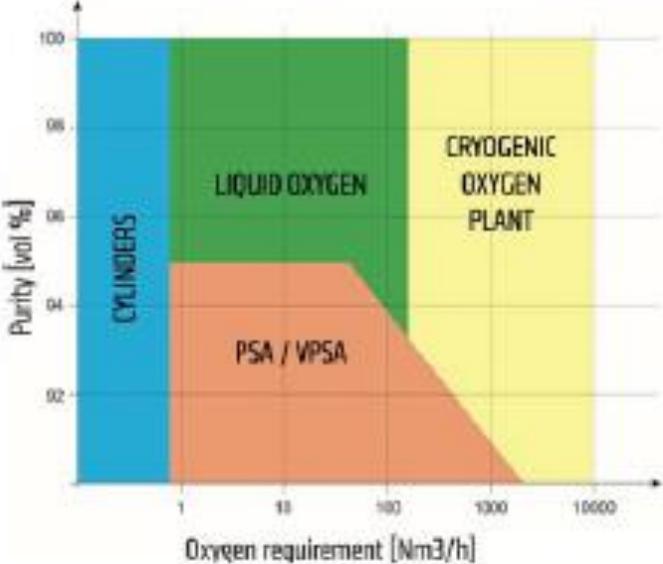
Conversion of Industrial Nitrogen Generation Units for Oxygen

Industrial Nitrogen and Industrial Oxygen are produced by



- Air Separation Units
- pressure swing Adsorption (PSA) technology

PSA OXYGEN PLANTS



PSA OXYGEN PLANTS

<https://youtu.be/LxaoBoOAFak>



99% Pure Oxygen Generators

Oxygen plant based on pressure swing Adsorption (PSA) Technology for Continuous process application like Metal Cutting, Oxygen Enrichment etc.



99% Pure Oxygen Generator with Cylinder Filling

Oxygen Plant based on pressure swing adsorption (PSA) Technology used for charging cylinders/bottles up to high pressure of 2900 PSI.

PSA NITROGEN PLANTS

<https://youtu.be/l0KDdil916E>



PSA Based Nitrogen Plant

Nitrogen plant based on pressure swing Adsorption (PSA) Technology for Continuous process application like Food Packing, Metal Cutting, Inerting, etc.



PSA Based Nitrogen Plant with Cylinder Filling

Nitrogen Plant based on pressure swing adsorption (PSA) Technology used for charging cylinders/bottles up to high pressure of 3200 PSI.

MOLECULAR SIEVE



Carbon **Molecular Sieve** used in the **PSA Nitrogen** generation, the **Nitrogen** generation by Pressure Swing Adsorption (**PSA**) process is a technology used to separate **nitrogen** from a mixture of gases under pressure according to the special selective adsorption characteristics of the Carbon **Molecular Sieves** (CMS).



PSA plant employs **Zeolite** molecular sieves to separate the **oxygen** from the air. **Oxygen** with high purity is delivered whereas the nitrogen adsorbed by the molecular sieves is sent back into the air through the exhaust pipe. Pressure swing adsorption (**PSA**) process comprises of two vessels filled with molecular sieves and activated alumina.

Adsorber Media (ARKEMA, BASF, ZEOX, UOP etc) – each have different properties and these must be studied before ordering
(1 NM³/hr of Oxygen requires approx. 30-35 KG of ZEOLITE media)

1. ARKEMA : [Products - Siliporite® Airsiev - Arkema Group \(cecachemicals.com\)](https://www.arkema.com/products/siliporite-air-siev)
2. ZEOX : [Medical Oxygen Generation | ZEOX Applications | Zeochem](https://www.zeochem.com/medical-oxygen-generation)
3. BASF : https://catalysts.basf.com/files/literature-library/92015BASF_Molecular_Sieve_Brochure_USL_190411_110814.pdf
4. UOP: [UOP Molsiv Adsorbent](https://www.uop.com/products/molsiv-adsorbent)

EXAMPLE OXYGEN NEW PSA OXYGEN GENERATOR Setup – Standard Modular Skids



PSA Onsite Oxygen Generator

Rs 2.35 Cr / Plant [Get Latest Price](#)

Automation Grade	Automatic
Design	Standard
Brand/Make	Airox
Capacity	Filling Capacity 275 Cylinder / day (D-Type)
Pressure	45-65 psig
Make	Airox
Purity	93+-3%
Cylinders Filling In A Day	275
Flow Rate	2500-2800 SCFH (1,917-1,321 LPM / 65.72-73.61 Nm3/hr)
I Deal In	New Only
Model Name/Number	AS-Q
Is It Leak Proof	Leak Proof
Country of Origin	Made in India

Interested in this product?

[Get Best Quote](#)

1. 1500 liters/min can provide 100-150 **Critical** patients needing 10-15 lit/min Oxygen
2. 1500 liters/min can provide 200-300 **serious** patients needing max 5 lit/min Oxygen
3. 1500 liters/min can provide 300-500 **moderate** patients needing 0.5-5 lit/min Oxygen

It is OBVIOUS that IF ONE can buy a NEW PSA OXYGEN Unit – That is preferred over PSA Nitrogen Unit Conversion to produce OXYGEN

Though NEW PSA Oxygen Plants will take between 4-10 weeks based on material availability

Meets a 100-500 bed COVID Hospital requirement

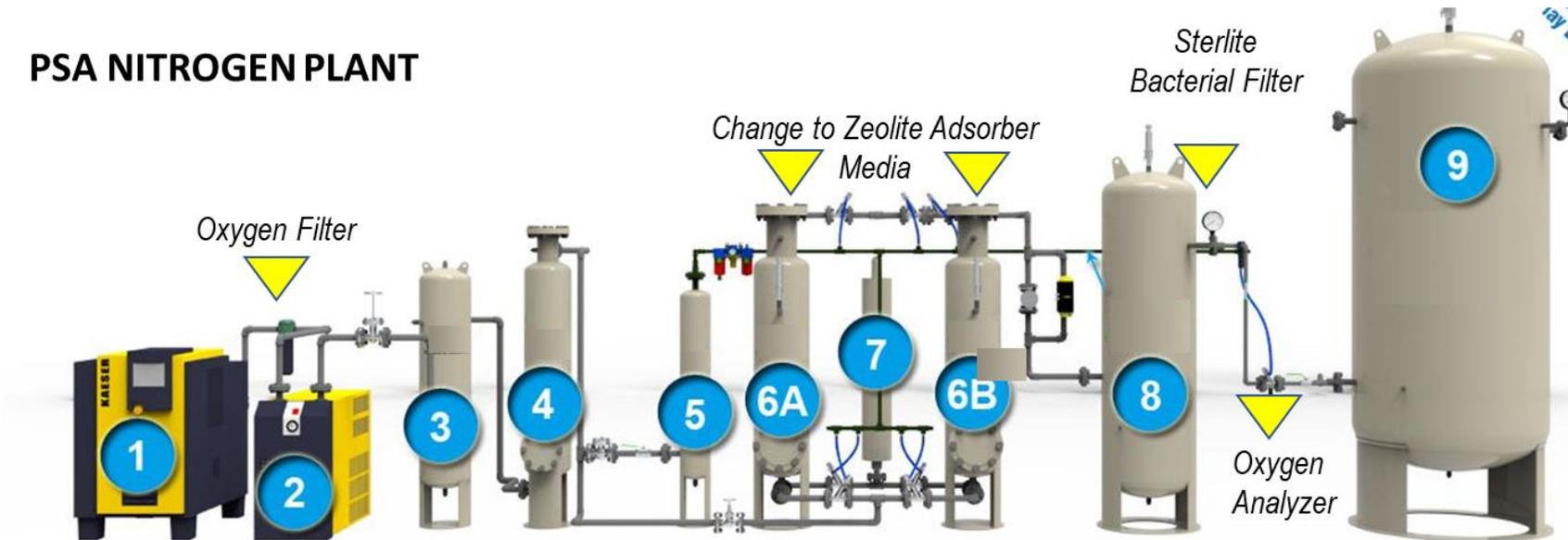
COMPARISON

PSA OXYGEN PLANT



1. Air Compression
2. Air Filtration
3. Air Drying
4. Air Buffer Tank
5. Trace Oil Particle Filter
6. Air Buffer for Pneumatic Valves
- 7.A Adsorbing Tower A B Adsorbing Tower B
8. Flue Gas Vent Silencer
9. Oxygen Surge/Buffer tank
10. Oxygen Storage Tank

PSA NITROGEN PLANT



1. Air Compression
2. Air Drying
3. Air Buffer Tank
4. Trace Oil Particle Filter
5. Air Buffer for Automatic valve
- 6.A. Adsorbing Tower B Adsorbing Tower B
7. Flue Gas Vent Silencer
8. Nitrogen Surge/Buffer tank
9. Nitrogen Storage Tank

 **Conversion Points**

PSA Nitrogen Plant Conversion to OXYGEN

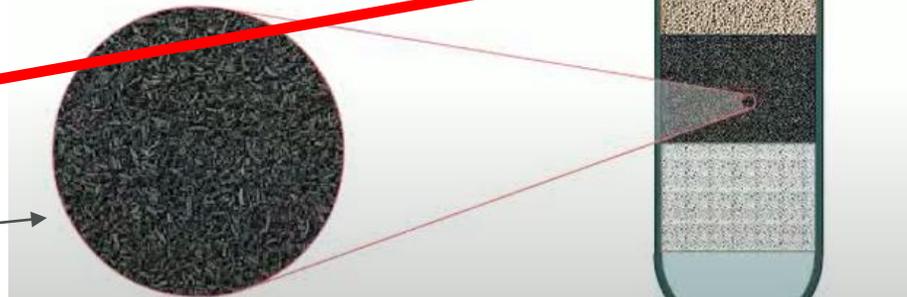
STEPS

1. Change Complete Adsorber with ZEOLITE OR Change Only the MOLECULAR SEIVE to ZEOLITE type from CARBON
2. Add Bacterial FILTER at the END
3. If existing Nitrogen Plant
 1. **WITH** Cylinder filling – then use for Oxygen Cylinder filling
 2. **WITHOUT** Cylinder filling – then **SHIFT** the plan to **HOSPITAL** and provide continuous Oxygen feed via Oxygen Line
4. Few valves and flow rate adjustments to PLC panel also needed – OEM can help on this front



ADSORBER
TOWERS (2)

MOLECULAR SIEVE



EXAMPLE of SKID mounted PSA Nitrogen Plant which can be converted to OXYGEN



PSA Nitrogen Generator



STEPS

1. Change Adsorber with ZEOLITE OR Change Only the SEIVE
2. Add Bacterial FILTER at the END
3. If existing Nitrogen Plant
 1. **WITH** Cylinder filling – then use for Oxygen Cylinder filling
 2. **WITHOUT** Cylinder filling – then **SHIFT** the plant to **HOSPITAL** and provide continuous Oxygen feed via Oxygen Line
4. Few valves and flow rate adjustments to PLC panel also needed – OEM can help on this front

Conversion Process

PSA Nitrogen to PSA Oxygen Conversion Timeline: Between 1 - 3 weeks - Which can be further shortened with focussed efforts by Government officials and other bodies.

- Up to Three week timeline because as per vendor interviewed : Internal process of Job creation, procurement of ZMS and other equipment like Oxygen Filter, Oxygen Analyser, some amount of piping change to add these additional equipment, transport to site, site installation, recommissioning etc. Site work will require flushing / cleaning/ purging of entire PSA Plant and making it suitable to medical Oxygen production. Three-week timeline is from order to Medical Oxygen Out – But this can be reduced to less than 5 days with better governance, control and direct government intervention.

Conversion KIT: To convert nitrogen plant to oxygen plant

- Things to be changed: Adsorber Media (ARKEMA, BASF, ZEOX, UOP etc) – each have different properties and these must be studied before ordering (**1 NM³/hr of Oxygen requires approx. 30-35 KG of ZEOLITE media**)
 - ARKEMA : [Products - Siliporite® Airsiev - Arkema Group \(cecachemicals.com\)](http://www.cecachemicals.com/products-siliporite-air-siev-arkema-group)
 - ZEOX : [Medical Oxygen Generation | ZEOX Applications | Zeochem](#)
 - BASF : https://catalysts.basf.com/files/literature-library/92015BASF_Molecular_Sieve_Brochure_USL_190411_110814.pdf
 - UOP: [UOP Molsiv Adsorbent](#)
- Things to be added: Oxygen Filter, Oxygen Analyser, Some Piping Changes, Pressure Control Valve to provide Oxygen at Controlled Pressure.
- Bulk of the cost is the cost of Zeolite, Oxygen Filter, Oxygen Analyser, Transportation and Site work.

Feasibility of Converting PSA Technology Based Nitrogen Plants to Oxygen Plants

1. The Technology applied to produce both Nitrogen and Oxygen based Pressure Swing Adsorption Principle, is more or less the same.
2. Compressed Air at approximate 7.5 Bar g pressure is the feed gas to produce both Nitrogen and Oxygen,.
3. However, the Medium used for separation is different – Carbon Molecular Sieves (CMS) is used for Nitrogen, whereas Zeolite Molecular Sieves (ZMS) is used for Oxygen.
4. Since atmospheric air has almost 79% of Nitrogen, it is possible to get purity up to 99.99% (N₂ plus other inert gases) by PSA Technology, as CMS has a high selectivity to adsorb Oxygen
5. Since Oxygen is less than 21% in atmospheric air, and ZMS has selectivity to only Nitrogen, but cannot adsorb Argon, so along with Oxygen, Argon also gets concentrated, thereby giving a mixture of approximately 93% Oxygen, 4.5% Argon, and balance Nitrogen with others inert gases.
6. For producing 1 Unit of 99.5% Nitrogen, we use around 4 units of Compressed Air for producing 1 Unit of Oxygen, we use around 16 units of Compressed Air to get 93% Oxygen.
7. Approximately 7 kgs of CMS is required to produce 1 Unit of 99.5% Nitrogen, whereas 30 kgs of ZMS is used to produce 1 Unit of 93% Oxygen.
8. So, if we use the same plants that are built for Nitrogen, we can get roughly 25% Equivalent of Oxygen. For example, if we have a 100 NM³/hr Nitrogen plant, and replace the CMS with ZMS in the same Adsorbers, we will get 25 NM³/hr of Oxygen.
9. We will have to replace 1-2 valves in the Desorption lines to adjust the flow rates.
10. We will also need to change the PLC Program for operation of the valves.
11. The Oxygen analyser used also needs to be replaced, so in effect it we will need to replace the Control panel.
12. The Flow meter will also have to be replaced with suitable range flow meter.
13. We also need to add a Sterile Filter at the outlet of the Oxygen plant to ensure sterile gas flowing from the plant.

Feasibility of Converting PSA Technology Based Nitrogen Plants to Oxygen Plants

To Build an Oxygen plant from scratch, it will take us approximately 30-45 days, but such a Retrofitting Job can be done within 10-15 days, subject to the following

1. Ready availability of ZMS
2. Availability of Control panel (we can make one in 4-5 days)
3. On Site manpower of 3-4 people to remove CMS, completely dedust the adsorbers, and fill the ZMS. (this operation will take 2-3 days max)
4. Commissioning of Oxygen plant (roughly 2-3 days)

For Commissioning an Oxygen Plant following need to be considered

1. Area required will based on the Size of Nitrogen plant available. For example, a Nitrogen plant of 100 Nm³, converted to Oxygen of approx. 25 Nm³, required a space of approx.3 m x 5 m and additional space for Compressor and Oxygen tank.
2. This plant once commissioned, should be connected to the same Manifold that the Cylinder Bank is connected to, and Oxygen is delivered through the same Oxygen distribution line.
3. In case of emergencies of power cuts, a suitable DG set is advised to keep the plant running.

Component	N ₂ PSA	To Convert to O ₂ PSA
Air Compressor	Existing	Available Flow and pressure to be confirmed for maximum usage for O ₂ production
Molecular Sieves	CMS	To be changed to ZMS. Volume of adsorber bed to determine quantity 0.65 as a factor of the adsorber volume
Air Treatment for Inlet air Quality	Remove – Particulate, Moisture and Oil	Remove – Particulate, Moisture and Oil
Pressure Equalisation Line	May or may not be in line	To be checked and adapted as per the O ₂ Gen Needed To be Added if not existing
Purging		Valve + Needle Valves as needed based on line size. Line size need to higher to handle higher exhaust flow
Exhaust		Valve size / Orifice to be adapted as per the O ₂ flow rate delivery
Flow meter	N ₂ Calibrated	To be replaced to O ₂ calibrated
Analyser	Low Purity Calibrated (typical range 0 to 25% O ₂)	To be changed for O ₂ Purity range of 0% - 100% O ₂
PLC	Programmed for N ₂ Cycles	Programme change to O ₂ Cycles
PHV		To be calibrated to required pressure
Gas Purification Sterile filter	Usually 0.1 micron	Need to Add additional filtration system to remove residual odours, particulate matter and pathogens

Setting up Of Medical Oxygen Facility:

For setting up of medical oxygen facility, one needs to obtain approvals mainly from following two government bodies.

1. Permission from Local Pollution Control Board:

- a) The applicant and operator of the medical oxygen facility must have an 'Establishment Registration License' from labour department of respective state government.
- b) Brief Project Report shall be submitted to local pollution control board authorities for obtaining a license for producing medical oxygen.
- c) Project report shall include (but not limited to:) - what are the raw materials used, Quantity per day/Month, Name plate capacity, etc. Any kind of hazardous material/or any other chemical used in the process must be highlighted. The report shall contain process description and Process brief of the manufacturing technology.

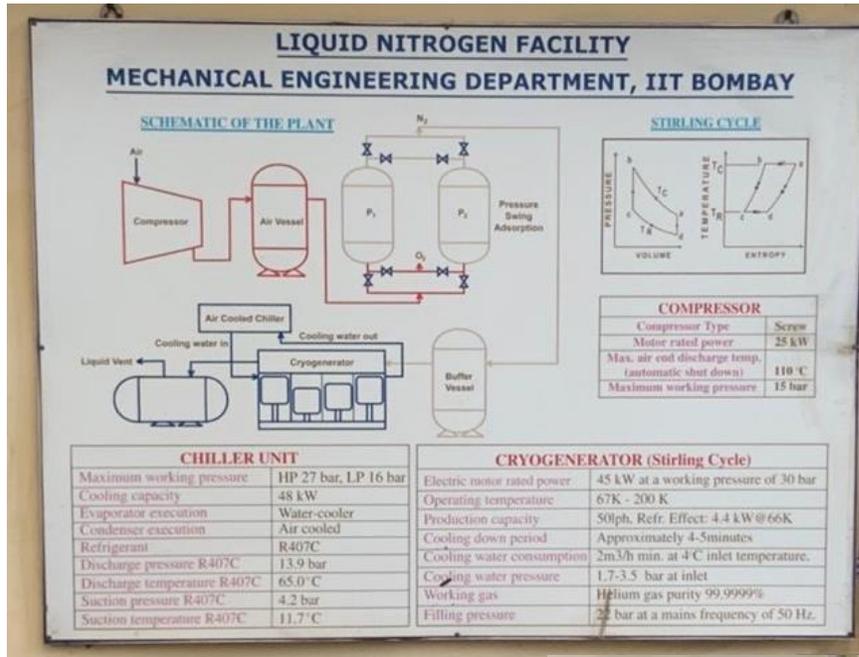
2. Approval from PESO:

Similar to any other chemical facility, engineering drawings such as plant Layouts, Area classification, etc shall be submitted for PESO approval. No approvals are required for commissioning .

3. Certification:

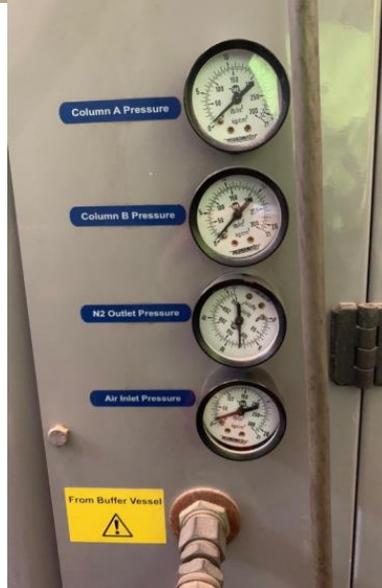
- a) No more certification is required for medical oxygen generation facility as govt has recently moved medical oxygen facilities into white category of manufacturing. White category is least polluting industrial sector.
- b) As of now, no certification is required for product purity but hospitals might require and demand it.
- c) Central pollution control board classifies industries in four categories such as Red, Orange, Green and White. {example Red for Chemical and explosives and more polluting sectors }.
- d) Union Environment Ministry introduced a 'White' category - a colour code that meant 36 industry sectors may need no green clearance at all. {<https://www.indiatoday.in/india/story/36-industries-white-category-central-pollution-control-board-967995-2017-03-28>}

4. Other Requirements: It is suggested to consult 'Liasoning dept' of the organization to confirm requirement of any other documents . This may include NOC from collector or district authority.



Proof Of Concept

Conversion of PSA Nitrogen to PSA Oxygen @ IIT Bombay Lab





PSA Nitrogen Plant conversion to PSA Oxygen Plant

Director IIT Bombay
Dean (R&D)

DEMO Plant at IIT Bombay

Contact:
Prof Milind Atrey
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Prof Milind Atrey
Dean (R&D) IIT Bombay

Prof Subhasis Chaudhuri
Director of IIT Bombay



Prof Milind Atrey
Dean (R&D) IIT Bombay

Mr. Amit Sharma
MD Tata Consulting Engineers

PSA Nitrogen Plant conversion to PSA Oxygen Plant

Director IIT Bombay
Dean (R&D)

DEMO Plant at IIT
Bombay

Contact:
Prof Milind Atrey
(dean.rnd@iitb.ac.in)

IIT BOMBAY Release

IIT Bombay demonstrates conversion of Nitrogen generator to Oxygen generator: A simple and fast solution for the current oxygen crisis -- requesting implementation bodies to set it up at different locations (wherever there is an existing nitrogen plant or air compressor) in the need of the day. In view of the national emergency in India with respect to pandemic and Oxygen production, Prof Milind Atrey, Dean (R&D), who also specialises in Cryogenic Engineering along with Tata Consulting Engineers Limited (TCE), took up a pilot project to evaluate the conversion of PSA (Pressure Swing Adsorption) Nitrogen Unit to PSA oxygen unit by fine-tuning the existing Nitrogen Plant setup and changing the molecular sieves from Carbon to Zeolite. Such Nitrogen plants, which take air from the atmosphere as raw material, are available across India in various industrial plants. Therefore, each of them has the potential of being converted to an oxygen generator to tide over the current emergency.

At IIT Bombay, a PSA Nitrogen plant in the Refrigeration and Cryogenics Laboratory was identified for conversion to validate the proof of concept. To undertake this study on an urgent basis, an MOU was signed between IIT-Bombay, Tata Consulting Engineers and Spantech Engineers to finalise a SOP that may be leveraged across the country.

Spantech Engineers, Mumbai, who deal with PSA Nitrogen & Oxygen plant production, agreed to partner with IITB and TCE on this pilot project and installed the required plant components as a skid at IIT Bombay for evaluation using IIT Bombay's infrastructure at the IITB Nitrogen facility at the Refrigeration and Cryogenics lab. This setup for the experiment was developed within three days, and the initial tests have shown promising results. Oxygen production could be achieved at 3.5 atm pressure (much higher rate possible by replacing the parts with higher ratings) with a purity level of 93-96 %. This gaseous oxygen can be utilised for COVID related needs across existing hospitals and upcoming COVID specific facilities by providing a continuous supply of oxygen.

Prof Milind Atrey acknowledges and thanks Mr Amit Sharma, Managing Director, Tata Consulting Engineers, along with Mr Rajendra Tahiliani, Promotor Spantech Engineers and alum IITB (1970), Mr Raj Mohan, MD Spantech Engineers and their passionate team members for their collaboration and partnership on this project. We encourage and request various government authorities, NGOs, and private companies to contact Prof Milind Atrey (dean.rnd@ iitb. ac.in), IIT Bombay, and Tata Consulting Engineers to know more about this project and its rapid adoption across the country. Let us work together to see that there is enough oxygen for all. I am told that the plant can be set up within 48 hours when components are available.

Amit Sharma, Managing Director, Tata Consulting Engineers, said, "We are delighted to partner with IIT Bombay and Spantech Engineers, and contribute towards an innovative solution for emergency oxygen generation using existing infrastructure towards helping the country tide over the current crisis. Such partnerships between industry and academia can accelerate our vision towards the AtmaNirbhar Bharat."

Subhasis Chaudhuri, Director of IIT Bombay has requested various government authorities, non-governmental organisations NGOs, and private companies to contact Atrey and Tata Consulting Engineers to enable the rapid adoption of this technology across the country.

PRESS RELEASE 29 April 2021 by IIT Bombay

The HINDU

[IIT-Bombay finds innovative way to generate oxygen](#)

MoneyControl

[IIT Bombay pilots technology to convert nitrogen plant into oxygen generator](#)

MyNation

[Oxygen crisis: IIT Bombay converts Nitrogen Unit to PSA Oxygen Unit](#)

Outlook

[COVID-19: IIT Bombay finds innovative way to generate oxygen](#)

TimesNow

[IIT Bombay: With aim to help COVID patients, team works to convert Nitrogen plants to Oxygen Generators](#)

Frequently Asked Questions:

Question: Can I convert any nitrogen generation plant into oxygen generation plant?

Answer: The technology is suitable **only** for the industrial nitrogen generation units which are based on the Pressure swing Adsorption (PSA) technology. This conversion is not applicable for any other nitrogen generation technologies (such as membrane or cryogenic air separation units)

Question: What should I do to convert the nitrogen PSA plant into Oxygen generation plant?

Answer: Please approach your Equipment supplier of Nitrogen PSA plant and discuss with him for conversion procedure. He will have the details and specification and may also refer to the details provided in this document.

Question: Using PSA technology can we fabricate smaller version of this, as an Oxygen Concentrator?

Answer: Yes you may –there are many open source designs available which you can search for –as an example for those interested to evaluate and explore www.oxikit.com

Question: What type of adsorber media to use?

Answer: Please refer to the details in this document on page 7 and 12 regarding adsorber media.

Frequently Asked Questions:

Question: Why are we converting Nitrogen plant for Oxygen, why don't we build the Oxygen plants?

Answer: Our Government and several organizations in India have already installed and have also additionally ordered thousands of new PSA Oxygen plants. Since these orders will take between 4-10 weeks for commissioning due to material availability, project timelines etc—the scope of this Pilot was to establish a PROOF OF CONCEPT (POC) to convert existing Nitrogen plants to Oxygen plants in less than 3-4 working days as an interim measure.

Question: In my existing nitrogen PSA plant, the oxygen adsorbed in the beds is vented to atmosphere during the regeneration step. Instead of converting the existing nitrogen PSA plant to produce oxygen, Can I use the oxygen being vented from nitrogen plant?

Answer: No. Concentration of oxygen in the vent stream from the regeneration step is generally ~30% and not fit for use as medical oxygen.

Question: Can I re-use my existing high pressure “Nitrogen Cylinder Filling Compressor” for filling medical grade oxygen cylinders?

Answer: No. The oxygen cylinder filling compressor are special compressors with Spark proof design. The oxygen compressors design must be oil free type. The recommended materials of construction to be suitable for medical grade oxygen so that any contamination is avoided. Existing nitrogen compressors may not be directly suitable for reuse as oxygen compressor.

Frequently Asked Questions:

Question: What are the changes required to the existing nitrogen PSA plant for converting it into medical oxygen plant apart from changing the adsorbent material?

Answer: A broad list of the changes for converting existing nitrogen PSA plant into medical oxygen plant are highlighted on sheet number 15. You may also like to contact the OEMs of PSA plant for implementation.

Question: I am interested to set up an oxygen plant for my hospital. Can you supply the same?

Answer: Please note that we do not fabricate or convert plants, we have conducted the proof of concept study in pilot unit. For actual supply of the unit, you will need to contact any PSA Oxygen plant provider. (Eg: SPANTECH Engineers-www.spantechengineers.com)

Question: Can I get contact details of the agencies who can provide required accessories and technical support for the same.

Answer: You may contact local PSA Plant vendors in– and search for them on Indiamart for your city. <https://dir.indiamart.com/search.mp?ss=PSA+Oxygen>

Question: Will I get the same capacity of Medical oxygen Product even after conversion of my existing nitrogen PSA plant?

Answer: You can expect the capacity of the medical oxygen plant to be 25% of its original nitrogen generation capacity.

Frequently Asked Questions:

Question: I operate a nitrogen PSA unit and willing to convert it to medical oxygen generation based on the concept presented. Do I need to add a bottling unit for sending the oxygen produced to the hospitals?

Answer: For filling the cylinders you will need a compressor which usually has a lead time of 2-3 months, unless you have it readily available. If compressor for filling is not available, best option is to shift the skid mounted existing unit near to a hospital for oxygen supply directly to the oxygen line of the hospital.

Question: Can I convert Hydrogen generator unit into Oxygen generator unit using the same concept?

Answer: No. This study was carried out for conversion of existing PSA Nitrogen Plant to generate Oxygen only, as the PSA nitrogen plants are available in large numbers spread across the country. We have not evaluated technologies for conversion of hydrogen into oxygen currently.

Question: Can I convert my nitrogen generator used for inflating tyres for converting into oxygen

Answer: The concept presented by IIT Bombay, TCE, and Spantech is applicable for conversion of industrial nitrogen generators using pressure swing adsorption (PSA) technology. The nitrogen generators used to inflate tyres may either use Membrane or PSA technology. Even when such nitrogen generators for tyre inflation are based on PSA technology, the design may not be suitable for continuous operation. Moreover, as the output of tyre inflator is limited to 60lpm, even if one converts to produce oxygen, the oxygen output may be limited to around 15lpm.

Frequently Asked Questions:

Question: What would be the approximate Cost of such conversion – of PSA Nitrogen plants to PSA Oxygen plants.

Answer: While this cost analysis will vary due to multiple factors, but your technical teams can study the details provided below for approximate costing. This is as per the cost our demo project observed.

APPROX CONVERSION COSTS : PSA Nitrogen to PSA Oxygen plants

The approx. cost of conversion from an existing PSA Nitrogen plant to PSA Oxygen plant will cost

1. Approx. 4-6 lacs of Consumables / PLC Reprogramming / Valves etc / Oxygen analyser / Additional air filters, sterile bacterial filter and 0.1 Micron filter will also need to be added.
2. Oil Free Air Compressor if not already attached to the existing PSA Nitrogen plant (approx. 4-8 lacs)
3. Approx. 500/kg of ZEOLITE ranging from 500-1000 kg which depends on the Nitrogen plant capacity
4. **ZEOLITE Cost**
 1. Note that a 1 Nm³/hr Nitrogen plant when converted will be able to produce 0.25 Nm³/hr of Oxygen – As such only existing PSA Nitrogen plants of above 100 NM³/hr capacity should be considered for conversion to Oxygen generation
 2. Also as a thumb rule 1 Nm³/kg of Oxygen requires 30 kg of ZEOLITE (Sodium based Zeolite)
 3. 1 Nm³/hr means approx. 16.66 LPM = caters to 3-6 patients modest Oxygen needs (critical maybe 1 patient itself may require 15 LPM)
 4. Hence we need approx. 500 LPM to support a decent size hospital = which translates to 30 Nm³/hr Oxygen capacity = which translates to 1000 kg of ZEOLITE for such a plant
 5. At ASSUME 1000/kg of ZEOLITE (cost ranges from 300-1000/kg including transportation as this is under scarcity across the globe) this translates to INR 30,000 for each Nm³/hr of Oxygen supply = for 30 Nm²/kg approx. 9 lacs.
5. The Nitrogen filling Compressors that fill Nitrogen gas into Cylinders cannot be used to full OXYGEN due to possible SPARKING – and hence such compressors for Cylinder filling may have to be checked or avoided.
6. Also the we need to shift the plant to a HOSPITAL Site – and have DG backup along with Oxygen Cylinder bank backup to mitigate any risks due to unplanned outage of the plant
7. Hence total cost may be between 17-20 lacs including ZEOLITE + Oil Free Compressor
 1. If PSA Nitrogen plant has its own compressor – total cost of conversion may be between 12-14 lacs
 2. If PSA Nitrogen plant DOES NOT have its own Oil free air compressor – total cost of conversion may be approx. 17-20 lacs

Frequently Asked Questions:

Question: What all information that you will need to advice on conversion of my existing PSA nitrogen plant into oxygen

Answer: Refer to the template below and fill in the details and send to either M/s. Spantech or OEM of your PSA Nitrogen plant

Date	
Customer Details	Customer Name
	Contact Person
	Email Id
	Phone Number
	Mobile Number
Compressed Air	Dedicated Air Compressor Yes / No
	Make
	Model
	Capacity (m ³ /h)
	Discharge Pressure (barg)
Compressed Air from Utility	Air is from Common utility
	If yes: Available Air Flow
	Available line air pressure
Air Dryer Available	Compressed Air Dryer Yes / No
	Type Refrigerated / Desiccant
	Make
	Model
	Capacity (m ³ /h)
	Outlet Temp. from Dryer (°C)
Nitrogen Generator Details	PSA Type
	Make
	Model
	N ₂ Flow rate
	N ₂ Purity
	ONLY WORKING CONDITION N ₂ GEN PLANTS TO BE MENTIONED

Frequently Asked Questions:

Question: If our existing Nitrogen plant is of TYPE PSA and with min 100-150 Nm³/hr, post conversion how much Oxygen will it produce and how do we use this Oxygen?

Answer: Your existing PSA Nitrogen plant with min 100 Nm³/hr can be a candidate for conversion **if it is in good working condition**. It will produce approx. 25% of its original capacity, i.e. if the PSA Nitrogen plant produced 100 Nm³/hr of Nitrogen, then the converted plant will produce 25 Nm³/hr of oxygen. This translates to about 400 LPM of Oxygen. You have two options: either set up a COVID makeshift emergency hospital next to the existing plant and provide oxygen via oxygen line or shift your plant if it **is a SKID mounted to a hospital** and connect to the Oxygen line. You MUST NOT use a NITROGEN cylinder filling Compressor to fill Oxygen cylinders, as it requires **Anti-SPARK and Oil-Free Compressor** to fill gases such as Oxygen and Hydrogen. Please obtain necessary approvals from PESO and other local bodies for compliance and statutory requirements, especially Cylinder filling.

Question: Is the technology suitable to obtain both nitrogen and oxygen as products from the same PSA unit after conversion to unit for generating oxygen.

Answer: No. Once the existing nitrogen PSA plant is converted to oxygen generator plant, it will produce only oxygen.

1. Identify a **RUNNING** and **CERTIFIED EXISTING PSA Nitrogen Plant** with min capacity of 100 Nm³/hr

- a. Has to be of type PSA – Pressure Swing Adsorption (PSA) ONLY and no other Nitrogen producing technology
- b. Must be in fully running and working state – not lying in the maintenance shop or old plant etc
- c. Once such a plant is converted – Nitrogen will not be available, but after say 3-6 months, once can convert it back from OXYGEN to NITROGEN when the Oxygen crisis subsides.
- d. We cannot RISK converting a low quality, non-working condition, or old PSA Nitrogen plant – and fail or repair etc – we don't have time, resources or bandwidth to repair old plants – and have the risk of them failing while operating at a Hospital and producing oxygen – SO SELECTION of the RIGHT plant has to be strict and with full quality
- e. For all of above a simple assessment template with technical details, photograph of critical areas, plant layout, plant condition shall be submitted by the existing Nitrogen plant entity for approval
- f. **At Central level CPCB – Central Pollution Control Board has been asked to steer this at central level with State PCB – as they have a list of all existing licensed PSA Nitrogen plants in the country**
- g. Once we receive the inputs in the assessment form from the party and post our assessment for conversion, SPANTECH ENGINEERS will send Order Acceptance,

2. Once the plant is identified and certified for conversion

- a. The identified PSA Nitrogen entity
 - i. Identifies/contacts a local PSA Oxygen/Nitrogen firm or their existing plant supplier/OEM
 - ii. **OR** our partner SPANTECH Engineers provides the details of its associates/partner in the location closest to the plant
- b. We will share a standard operating process (SOP) With all drawings and details
- c. Either a local party OR an order shall be placed on SPANTECH Engineers by the party – and if required SPANTECH shall supply a Kit consisting of the Control Panel, Flow Meter & Oxygen purification System (filters) with a manual of simple steps on how to connect the above.
- d. Training and other support shall be provided by a pool of trained engineers that have been created by IIT-Bombay, Tata Consulting Engineers and SPANTECH technical experts

ZEOLITE Quantity for PSA Nitrogen to PSA Oxygen Conversion

1. X Nm³/hr. of PSA Nitrogen Plant = (22-23% of X) Nm³/hr. of OXYGEN (min-max)
2. Per Nm³/hr. of OXYGEN = 28 - 30 Kg of Zeolite needed (min – max)
3. As such for X Nm³/hr. of PSA Nitrogen Plant = **7X kg** of ZEOLITE needed (**MAX**)
4. ZEOLITE in Liters to KG = Multiply by 0.67 for KG of Zeolite.

IF ZEOLITE requested is not within +/-2% of ABOVE additional validation needed

NOTE as below

1. Project execution shall not be entertained in-house, only competent parties who have PSA Nitrogen/Oxygen plant installation experience as normal course of business should undertake this project.
2. Please have the form signed by competent OEM/Contractors appointed on the project and share technical details of your existing PSA Nitrogen plant. Manual or documents with technical specification of your existing PSA Nitrogen plant.

PSA Nitrogen Plant Conversion – How and who will do this conversion?

Identify a RUNNING and CERTIFIED EXISTING PSA Nitrogen Plant

1. Has to be of type PSA – Pressure Swing Adsorption (PSA) ONLY and no other Nitrogen producing technology
2. **Must be in fully running and working state – not lying in the maintenance shop or old plant etc.**
3. Once such a plant is converted – Nitrogen will not be available, but after say 3-6 months, once can convert it back from OXYGEN to NITROGEN when the Oxygen crisis subsides.
4. **We cannot RISK converting a low quality, non-working condition, or old PSA Nitrogen plant – and fail or repair etc – we don't have time, resources or bandwidth to repair old plants – and have the risk of them failing while operating at a Hospital and producing oxygen – SO SELECTION of the RIGHT plant has to be strict and with full quality**
5. For all of above a simple assessment template with technical details, photograph of critical areas, plant layout, plant condition shall be submitted by the existing Nitrogen plant entity for approval

Once the plant is identified and certified for conversion

1. The identified PSA Nitrogen entity
 - a) Identifies/contacts a local PSA Oxygen/Nitrogen firm or their existing plant supplier/OEM – Validate Vendor Capability
 - b) **OR** TCE will assist with its list of empaneled VENDOR near to the plant location
 - c) To ensure safety and quality strict quality check and vendor approval shall be adopted
2. The identified FIRM for Conversion shall sign the commercial contract and finalise the Order for work execution – with The party providing its Existing Nitrogen Plant for Conversion with the empanelled vendor (The converted PSA Nitrogen plant to Oxygen can be reverted to NITROGEN production after few months if required for its original industrial use)
3. Standard operating process (SOP) along with FAQ has been shared – refer this document

IMPORTANT and CRITICAL POINTS

1. This is a MEDICAL GRADE OXYGEN project and only competent CONTRACTORS with past record of executing PSA Nitrogen and PSA Oxygen projects should undertake such projects
2. The project involves technical refinements, PLC controllers adjustments, valves timing changes, oxygen analysis, air-filter and bacterial filter additions and should only be undertaken by qualified OEM/Contractors with proven PSA Oxygen/Nitrogen past expertise
3. Without competent OEM/Contractor executing the project, the success of the plant conversion is doubtful and **MUST not be attempted**
4. To validate the forms and technical inputs, technical expert of OEM/Contractors are required to validate the technical feasibility and correctness
5. OEM/Contractors must share their credentials that prove beyond doubt their capability – at least a dozen past PSA Nitrogen/Oxygen plant projects executed along with their website.
6. This conversion **MUST** only be executed by **ONLY those OEM/Contractors** who have **proven past experience of having worked on PSA Nitrogen/Oxygen plants**
7. **Note : This conversion activity has to be completed under expert guidance only. “Do not undertake any refurbishment without confirmation”. This is very important. All OEM’s know their PSA Plants very well and they are the best experts to help carry-out the conversion. The SOP provided is to help people get a broad understanding of the conversion scheme but it is the OEM’s who will be able to guide their respective customers and help them with the conversion**

IMPORTANT and CRITICAL POINTS

1. Apart from the conversion project success in a safe manner (oxygen being an oxidiser that aids combustion), the Oxygen plant has to operate safely to produce Medical Grade Oxygen for patients.
2. it is critical that only proven parties with past basic minimum experience must only undertake this conversion project, ***as normal course of business for such OEM/Contractors.***
3. Anyone with past project completion certificates of having commissioned **at least a dozen such PSA Oxygen/Nitrogen plants** may **ONLY** be allowed to execute this conversion project.
4. It is critical to have a mechanism in place to ensure that due validation of executing parties be done before any such project conversion is initiated. This is a standard practice in the industry and is termed as “Pre-Qualification Criteria” requirement for any engineering project. OEM/Contractors are asked to submit their credentials and undertaking that they understand the project needs, have proven experience and certificates to prove their claim.
5. The conversion project involves engineering calculations and simulations by competent experts, technical refinements to the setup, PLC controllers adjustments, valves timing changes, oxygen analysis, air-filter and bacterial filter additions and should only be undertaken by qualified OEM/Contractors with proven PSA Oxygen/Nitrogen past expertise.

3. Important Links

- a) [SOP for Nitrogen to Oxygen](#)
- b) [PSA Valve System](#)
- c) [STD P&ID for Medical Oxygen Generator](#)
- d) [STD Valve Arrangement for Medical Oxygen Generator](#)
- e) [Emergency Oxygen - TCE - IIT Bombay – Spantech Video \(Hindi\)](#)
- f) [Emergency Oxygen - TCE - IIT Bombay – Spantech Video \(English\)](#)
- g) [Zeolite Requirement Form](#)

Important Links

[BEST PRACTICE Sharing by UPL Limited for Plant Handover](#)

[BEST PRACTICE Sharing by UPL Limited for Plant Troubleshooting](#)



Experience

Disclaimer:- These mitigation measures have been taken based on our best understanding of the process but respective industries should ensure that experts from their process / execution team are involved when troubleshooting any issues or concerns arising post start-up

For Further Details – Please write to below email IDs

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