

Webinar 3: PSA Oxygen Generation
Plants: Operation and Maintenance

September 23, 2021

**Technical Assistance for National Capacity-
Building and Enhancing the Oxygen Logistics
and Supply Management System to the States
of West Bengal, Meghalaya, Uttarakhand, and
Andhra Pradesh**

The World Bank
September 2021



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WEBINAR SERIES

**BUILDING SUSTAINABLE MEDICAL OXYGEN SYSTEMS:
EXPERIENCES AND LESSONS FROM INDIA'S COVID-19 RESPONSE**

AGENDA FOR WEBINAR #3
PSA OXYGEN GENERATION PLANTS: OPERATION AND MAINTENANCE

Lessons from health facilities

September 23, 2021 | 4:30 PM to 06:00 PM IST (GMT +5:30)

04:30 PM – 04:40 PM **Welcome and Context Setting**

Dr. Gandham NV Ramana, Lead Health Specialist, World Bank

04:40 PM– 04:55 PM **Keynote Address**

Large scale deployment of PSA Oxygen Generation Plants: Experience and lessons from India

Mr. S Suresh Kumar, Joint Secretary, Ministry of Commerce and Industry

04:55 PM – 05:10 PM **Questions and Answers with the Keynote Speaker**

05:10 PM – 05:40 PM **Panel Discussion**

Lessons on operations and management of PSA oxygen generation plant

Dr. K V Thrilok Chandra, Commissioner, Health and Family Welfare Services, Government of Karnataka, India

Dr. Sameer Khandekar, Professor, Department of Mechanical Engineering, Indian Institute of Technology, Kanpur

Mr. Karan Bhatia, Managing Director, Uttam Air Products Pvt Ltd

05:40 PM – 05:55 PM **Open House**

Questions and answers from the audience

05:55 PM – 06:00 PM **Summary and Closing Remarks**

Dr. Gandham NV Ramana, Lead Health Specialist, World Bank

Background

The second wave of COVID-19 has overwhelmed India's health care infrastructure with an unexpected rise in the cases. The demand for hospital beds, health care personnel, drugs, testing kits, and, above all, the life-saving oxygen spiked to unprecedented levels. Medical oxygen therapy has been one of the most fundamental elements of the treatment regimen for patients with severe COVID-19. The existing production and supply chain systems were inadequate to meet patient care needs in various pockets across the country. Despite its vital role in the management of various medical conditions, access to medical oxygen in health care settings has been disregarded for a long time. The COVID-19 pandemic has provided us with an opportunity to understand the criticality of the oxygen situation and substantially invest in creating sustainable systems for the provision of this essential therapy.

The Government of India has been undertaking various measures to meet the patient care needs with respect to medical oxygen. To ensure long-term systemic improvement, India is making concerted efforts to improve both the production and supply of medical oxygen across the nation. Investments are being encouraged not only in boosting the production of medical oxygen but also in strengthening the supply chain systems, including operations and maintenance of oxygen equipment. Several corporate sectors, philanthropic foundations, and governments have stepped up, offering to build the pressure swing adsorption (PSA) oxygen generation plants at various hospitals and health care facilities across many states. Multiple countries have also donated oxygen concentrators, oxygen plants, and tankers to India at the time of battling its second wave of the pandemic. Government hospitals up to primary health care facilities are setting up oxygen concentrators to prepare for the anticipated next wave.

Considering the anticipated third wave and the benefits of knowledge sharing in the present times of crisis, the World Bank, in collaboration with PATH, is conducting a five-phase regional webinar series to share the challenges faced, best practices, lessons learnt, and insights on India's evolving oxygen ecosystem in the context of the COVID-19 pandemic. As India races against time to establish and commission over 1,500¹ oxygen generation plants at government hospitals across the country and encourages its private hospitals to augment its oxygen capacities, there are numerous valuable lessons to learn from the country's experience for all the stakeholders within country and even in the South Asia region.

The third out of the five webinars, was held on September 23, 2021, which brought together government, not-for-profit, corporate, and other relevant stakeholders from India and other South Asian countries to share their knowledge about the use, operation, and management of PSA plants and offer best practices with respect to these plants. The webinar was attended by more than 320 subject matter experts, government officials, development partners, health care professionals, and private-sector representatives from India as well as South Asian, North African, and Middle Eastern countries. The speakers for the third webinar of the series on "PSA Oxygen Generation Plants: Operation and Maintenance—Lessons from Health Facilities"

- shared experience and lessons on the procurement, installation, and commissioning of PSA oxygen generation plant,
- explored sustainable strategies for building a pool of technical and engineering personnel for operating and maintaining PSA plants,
- discussed operational challenges with PSA plants in low-resource settings and approaches to address them, and
- ideated on long-term use of PSA oxygen generation plants.

¹ Source: <https://www.aninews.in/>

The current report provides a summary of key discussions, lessons learnt, and recommendations that emerged from the webinar.

Large-scale deployment of PSA oxygen generation plants: experience and lessons from India

Mr. S. Suresh Kumar, Joint Secretary, Ministry of Commerce and Industry, India, shared insights on expansive installation of PSA plants during the second wave of COVID-19. The quick surge in COVID-19 cases requires life-saving medical facilities such as medical oxygen in a very short time span. There are two major challenges with supplying adequate oxygen: (i) the lack of production capacity for the rising demand and (ii) geographical mismatch of demand and supply. Key strategies that can be adapted to address these challenges and improve access to oxygen include the following:

- Real-time oxygen demand assessment must be done using an online, demand aggregation system by
 - involving all the states to undertake extensive demand assessment
 - modeling the state-wise and district-wise oxygen requirement, and allocations based on factors, such as caseload and number of beds and ventilators available
- GPS tracking of delivery of liquid medical oxygen must be done to ensure timely supply of oxygen to the facilities in need.
- Building the production capacity is critical to sustain the demand for medical oxygen by means of
 - funds from the central and state governments and even foreign aids could be utilized for sanctioning the installation of PSA plants. 20%–30% of the oxygen demand can be met through the installation.
 - highly advanced technology required in installing PSA plants may lead to challenges, such as need for importing the plants and its parts from other countries. Some strategies to tackle such a situation are as follows.
 - involving various departments/organizations such as Defence Research and Development Organisation and Ministry of Commerce, and their expertise should be utilized through collectively working toward improving the production capacity.
 - enabling coordination of these departments with the major manufacturing companies to leverage support in the manufacturing of PSA plants indigenously.
 - bilateral international missions will also highly contribute in ramping up the production by providing with the raw materials such as zeolite filters for PSA plants, which could only be imported.
- It is vital to build capacity for installation and operation of PSA plants
 - Various government agencies such as the National Highway Authority of India and Central Public Works Department must work together for ensuring availability of appropriate resources for installation of PSA plants such as installation sites and uninterrupted power supply.
 - It is also essential to build a strong human resource pool for installation of PSA plants and regular follow-ups must be done to make sure things are implemented properly at the site.
 - Capacity-building of human resource is critical, and development of training modules must be accomplished in association with ministries such as the Skills Development Ministry. It will also be beneficial to involve prestigious engineering institutions including professionals from department of biomedical engineering for the preparation of these training modules.
 - These certified training sessions must be provided on various levels such as installation, commissioning, operation, maintenance, and repair of PSA plants.
 - Another important factor to consider is the provision of training in multiple languages to address linguistic barriers and ensure better outreach.

- It is also essential to enlist all the trained professionals on a common portal for easy access at the facility level, especially in times of emergency.
- Since the manufacturer warranty for PSA plants exists mostly for 2–3 years, the administration must work toward maintenance schemes even after this warranty expires.

Lessons on operations and management of PSA oxygen generation plant

Dr. Sameer Khandekar, Professor, Department of Mechanical Engineering, Indian Institute of Technology, Kanpur, India, shared insights on the development of training modules and training process.

- An empowered group must be created consisting of officials from different departments and subject matter experts from national institutions, who would efficiently coordinate for the preparation of online training modules.
- It is important to make the training modules easily accessible, which can be done by creating an online portal specifically for training purpose.
 - Training should be provided in the form of recorded lectures through an online platform, and the training modules must be made available in the public domain using a web-based portal.
 - The training modules must contain all the essential information, such as WHO guidelines, ISI standards, and videos recordings about various aspects of functioning of PSA plants.
- Departments such as the Ministry of Skills Development in India must be involved in the creation of a pool of “master trainers” for delivering live training sessions.
- Prestigious educational institutions must systematically bolster the synergy between engineering community and medical fraternity.
 - Educational establishments such as Academy of Engineering, Ministry of Education, and Ministry of Skills Development can encourage development of innovative medical equipment indigenously, in addition to the training modules by involving both medical and engineering professionals. This will help in reducing the need for importing it from other countries.
 - Catalyzing this intervention should be achieved by bringing in some policy-level changes with respect to creating synergies between these educational streams.
 - It is important to have a “lab to land” teaching approach in institutions. Along with classroom teachings, students will be taken to field visits where the actual work is performed.

Mr. Karan Bhatia, Managing Director, Uttam Air Products Pvt Ltd, shared his experience on the challenges faced and strategies implemented for supply, installation, and operation of PSA plants.

- It is essential to get the right products of the right quality, along with timely delivery and installation.
 - It is important to get the right products of right quality, get them delivered timely, and have a pool of trained human resource personnel for installation of PSA plants.
 - The biggest challenges while installing a PSA plant include the following:
 - The first one is to get the raw materials such as the zeolite filters in time. This is mainly because the entire world has been competing for the same, keeping in view COVID-19 as a global pandemic.
 - Another challenge pertaining to COVID-19 has been the clogging of shipping routes and manufacturing during a lockdown.

These challenges can be tackled by working together with various stakeholders and leveraging the relationships built over years, for gaining priority access to this life-saving equipment.

- It is critical to better prepare for any upcoming surges, and one must be proactive instead of reactive in such times of crisis.
- It is critical to build production capacity and implement innovative strategies for the supply of medical oxygen.
 - Considering PSA a technology with simple inputs, an improved capacity should be created specifically for generation of medical-grade oxygen.
 - Adaptation of innovative strategies such as “oxygen express” for transportation will also be helpful.
- Appropriate allocation of oxygen sources in various settings
 - It would be more viable to make oxygen tanks available in rural/ remote settings, which have challenges of regular electricity, trained staff for operation and maintenance, and so on, and so such a setting will require low maintenance of oxygen devices.
 - For a hospital setting with well-established infrastructure and adequate power supply, it would be feasible to set up a PSA plant. Setting up a PSA plant requires less than 1% of the hospital’s infrastructure cost.
 - It is essential for tertiary hospitals to get independent and generate medical oxygen in their premises than completely relying on factory supply. PSA plants offer captive capacity to sustainably generate oxygen. Mr. Bhatia observed that PSA plants also reduce the cost of transport. In addition, these are environmentally safer as compared to liquid medical oxygen (LMO).

Mr. Mohammad Ameen, Head—Primary Healthcare, Technology & Innovations, PATH, shared insights on various strategies for improvement of operation and maintenance of PSA plants and ensuring adequate oxygen purity.

- The strategies for improvement of operation and maintenance of PSA plants include the following:
 - Third-party agencies must be involved in the management and maintenance of PSA plants. However, it is essential to have formal guidelines for empaneling such agencies to ensure quality control.
 - It is essential to invest on capacity-building for operation and maintenance by creating a hub of technical professionals and end-to-end support for strengthening skills along with creation of a pool of subject matter experts as master trainers.
 - Technical assistance must be provided for a conducive policy for medical oxygen involving oxygen maintenance policy. This will ensure program planning, budgeting, and resourcing.
 - It is also important to think of incentives for private-sector participation in the supply, operation, and maintenance of PSA plants.
 - For sustainable and uninterrupted supply of medical oxygen, following measures should be undertaken:
 - Use of green energy solutions to overcome power outages.
 - Use of voltage stabilizers and uninterrupted power supply for better functioning of plants.
 - Use of booster compressors to facilitate sustainable availability and supply of smaller facilities.
 - Real-time, data-based decision-making is extremely important.
 - E-trainings and analytics to ensure our mechanisms for operation and maintenance are well monitored.
- There are important capacity parameters for ensuring oxygen with adequate purity (above 93%).
 - It is essential to have a sophisticated mechanism such as a real-time monitoring of oxygen purity using inbuilt oxygen analyzers. Advanced features such as generation

- of an alert if oxygen purity goes out of range and automated switchover system in terms of any failure concerning purity or oxygen production will be useful.
- Bidding documents should have clear provisions about lab testing so that there are no impure gases.
 - It is also essential to consider the distance of PSA plants from the hospital manifold and the power requirement.
 - PSA plant should be located quite close to a hospital; otherwise, the pressure might be compromised.
 - Additional boosters should be installed if the distance of a PSA plant is much larger.
 - The power requirement of PSA plants is mostly dependent on the size of the compressor, which varies for different manufacturers.
 - It is essential to have a reliable power backup.

Conclusion

- The very first step in the deployment of large-scale PSA plants is the assessment of oxygen demand. This is followed by building production capacity which should be achieved through collective working by all the stakeholders. Moreover, it is extremely important to build capacity for operation and maintenance by providing appropriate training to the professionals.
- To improve operation and maintenance, it is beneficial to collaborate with organizations such as educational institutions and formation of an exclusive team working to achieve this goal.
- Leveraging existing technologies will be gainful in terms of time and capital investment.
- Quality testing is a fundamental step while procuring oxygen equipment. One must obtain the right products at the right time.
- Allocation of oxygen sources to different settings must be a thoughtful process, as settings have different needs and supporting resources.
- Well-regulated third-party agencies should be involved in management and maintenance of PSA plants.



Building Sustainable Medical Oxygen Systems

South Asia Webinar Series

**PSA Oxygen Generation Plants:
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Lessons from health facilities

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Detailed Agenda

Welcome and Context Setting 04:30 – 04:40 PM



Dr. Gandham NV Ramana
Lead Health Specialist, World Bank

Keynote Address 04:40 – 04:55 PM

Large scale deployment of PSA oxygen generation plants:
Experience and lessons from India



Mr. S Suresh Kumar
Joint Secretary, Ministry of Commerce and Industry

Question and Answers with the Keynote Speaker 05:00 – 05:10 PM

Panel Discussion 05:10 – 05:40 PM

Lessons on operations and management of PSA
oxygen generation plants



Dr. K V Thrilok Chandra
Commissioner, Health and Family Welfare Services,
Government of Karnataka, India



Dr. Sameer Khandekar
Professor, Department of Mechanical Engineering,
Indian Institute of Technology, Kanpur



Mr. Karan Bhatia
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Dr. Gandham NV Ramana
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Save the Date



Building Sustainable Medical Oxygen Systems

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SAVE THE DATE

Pressure swing adsorption (PSA) oxygen generator plants were used as a key healthcare response to battle India's oxygen shortage. They are a clean & innovative technology that significantly helped ease India's COVID-19 crisis.

Join the upcoming session on,
PSA Oxygen Generation Plants:
Operation and Maintenance

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Welfare Services, Government of
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Dr. Sameer Khandekar
Professor, Department of
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Moderated by
Dr. Gandham NV Ramana
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