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# " Industrial POLLUTED AIR To Make Oxygen Generator System"

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## ABSTRACT

Industrial air pollution is one of the leading contributors to environmental degradation and public health issues, primarily due to the emission of harmful gases such as carbon dioxide ($CO_2$), sulfur dioxide ($SO_2$), nitrogen oxides ($NO_x$), and particulate matter. This paper proposes a novel **Industrial Air Pollution to Oxygen Generator System** that not only reduces harmful emissions but also converts pollutants into usable oxygen, thereby creating a dual-benefit environmental solution. The system integrates advanced air filtration technologies with photocatalytic and electrochemical processes to capture and break down pollutants. Captured $CO_2$ is processed through an artificial photosynthesis mechanism, mimicking natural plant activity to produce oxygen. Additional modules filter and purify air particulates and oxidized gases before releasing the clean air back into the environment. The proposed system can be integrated into industrial chimneys or standalone air-purification units, making it a scalable and sustainable approach to combating air pollution while simultaneously enhancing atmospheric oxygen levels. This innovation offers a promising step towards eco-friendly industrial operations and contributes to the global fight against climate change. The paper will also look at four methods of producing oxygen: cryogenics, pressure swing absorption, membrane filter technology and electrolysis. the paper will then select the appropriate process for each industry discussed, This paper is intended to address the above issue in such a way that a facility manager would be able to make an educated decision on whether or not to consider creating/using oxygen enhanced air in his/her process as well as which technology would be best suited for his/her process.

# INTRODUCTION

Oxygen is generated from Compressed air by a separation process which uses the principle of selective adsorption. The air is passed through a bed of Zeolite Molecular Sieves (ZMS) which has a property of very high degree of affinity to nitrogen. The ZMS contains an infinite number of micropores and it retains the adsorbed nitrogen and carbon molecules in these pores. Before this process is effected, the compressed polluted air has to be purified by removing all contaminants i.e. solids, condensed liquids and oil & water vapors by passing it through Prefilter. Oil Removal Filter (not required if oil-free Compressor is used) and Air Dryer. The dry & oil-free air from Air Dryer is stored in a Dry Air Receiver before it enters the PSA System. In this System, there are two adsorbers filled with ZMS, where nitrogen along with any traces of moisture are adsorbed and product gas (dry oxygen) comes out and passes to Oxygen Surge Vessel. In the PSA System, one adsorber is in production cycle while the other is regenerated (desorbed) by depressurization. The two adsorbers keep switching from adsorption to desorption automatically, through a sequence timer. The pressure in the adsorbers swings from atmospheric pressure to line pressure, which is why this process is known as Pressure Swing Adsorption (PSA).

**What is Industrial air pollution?**

Industrial air pollution is when factories, mines, and transportation release harmful substances into the air. These pollutants can cause health problems such as respiratory diseases, cancers, decreased lung function, and asthma. They can also harm the environment, leading to things like acid rain and climate change. Industrial facilities emit a wide range of pollutants into the air, including particulate matter, sulfur dioxide, nitrogen oxides, and other toxic chemicals.

**Sources of emissions in Industries:**

Point-Source Emissions – also known as stationary sources of emission, are released at height or ground level, from an identifiable source, and are dispersed in the atmosphere. Emissions from stationary sources. It is easy to trace the source of such emissions back to stacks, outlets, etc.

Non-Point Source – A source of emission that is not easily identifiable. These are called mobile and fugitive emissions, they consist of leaks of particulate matter from transportation and loading, for example, are not identifiable and stationary sources. Also called diffuse or ‘fugitive emissions’ (non-point sources), are contrary to stack emissions and originate from an area, such as a stockpile or a road.

## OBJECTIVE

The primary purpose of an industrial air filter is to purify indoor air in the industrial environment by reducing the concentration of airborne fine particles.
With such a filter, directly installed in the ventilation system, you get :

- Improved air quality in workplaces and industrial zones,
- Enhanced workplace safety measures, due to exposure to an activity that can be particularly polluting.
- Indeed, when you consider the accumulation of gases, carbon monoxide from combustion, dust, fumes and solvents, the health of industrial workers can be severely tested.
- The main aim of an industrial air filter is therefore to capture all these harmful particles and improve working conditions for employees in this sector.

## HUMAN IMPACT

The impact of industrial air pollution on the residents of an industrial township can be significant. Long-term exposure to these pollutants can cause respiratory and cardiovascular diseases, as well as cancers. It can also lead to decreased lung function, increased frequency of asthma attacks, and other respiratory illnesses. In addition, industrial air pollution can also contribute to environmental degradation, such as acid rain and climate change, which can have far-reaching impacts on human health and the environment.

## Stage By Stage Equipment Description

### A.AIR COMPRESSOR

Screw oil-free Air Compressor is used to provide feed air for the Oxygen Generator. See Annexure I for capacity & power requirements.

### B. AFTERCOOLER WITH MOISTURE SEPARATOR

The After cooler is a vertical, shell & tube type where compressed air is cooled by plant cooling water. When the compressed air cools down, condensed liquids are separated by the in-built Moisture Separator. These condensates are drained out automatically by Auto Drain Valve.

### C .WET AIR RECEIVER

This is a vertical pressure vessel provided with safety valve & pressure gauge in which some condensates accumulate. These are drained out automatically by Auto Drain Valve.

## D. PREFILTER

Carried forward fine contaminants such as liquids, dust, rust, etc are filtered out up to a 5 micron level in the Prefilter. The separated contaminants are drained out automatically by Auto Drain Valve.

## E. OIL REMOVAL FILTER

During compression of air, lubricating oil vaporizes due to heat of compression. This oil vapour is removed in the Oil Removal Filter. Separated oil is drained out automatically by Auto Drain Valve. This Filter is not provided when oil-free Air Compressor is used.

## F. AIR DRYER

The filtered air now contains only water vapour and can be purified further only by an Air Dryer. Removal of moisture is essential since this will add unnecessary adsorption load on the Page 2 of 7 ZMS in the PSA System. Heatless type or Refrigeration type Air Dryer is used depending on dew point requirements.

## G. DRY AIR RECEIVER

Dry & oil-free air coming from the Dryer is stored in the Dry Air Receiver, Some air is drawn out for operating the various valves of the Generator.

## H. ZIO-LITE SYSTEM

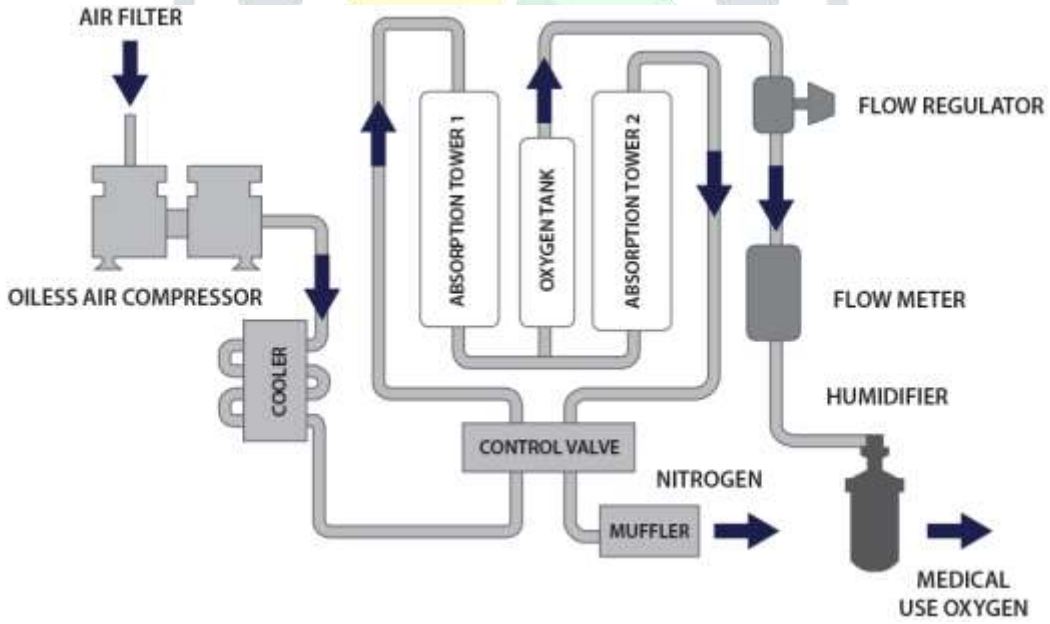
This System has got two adsorbers filled with ZMS and interlinked by valves required for different functions of the PSA System. Dry oxygen gas is generated by the processes of adsorption, desorption (by depressurization) and repressurization. These processes are carried out by operating the System valves at preset timings and are controlled by the sequence timer.

## L. MEASUREMENT & CONTROL DEVICES

- Oxygen Analyzer – this periodically monitors the oxygen content of the gas in a program preset in factory.
- Rotameter – This monitors the flow of oxygen from the Generator. It can be set at a desired value by adjusting the valve provided at its entry.
- Back Pressure Controller – this ensures that the oxygen pressure in the Surge Vessel is maintained by closing whenever the pressure falls below set pressure and opening whenever the pressure rises back.

## M. SAFETY INTERLOCKS

- Pressure Switch (AR)– Switches off O2 Generator when pressure in Air Receiver reaches lower set point & restarts it when pressure rises back to upper set point.
- Temp Switch - Gives audio-visual indication when temp. in Air Receiver reaches above set point.
- Vent Valve – Operated by Operator whenever O2 content of gas is observed to be below preset value. It vents out the impure gas into atmosphere and is closed after O2 content is brought within range
- Pressure Switch (OV) : Switches off O2 Generator when pressure in Oxygen Vessel reaches upper set point and restarts it when pressure falls to lower set point.

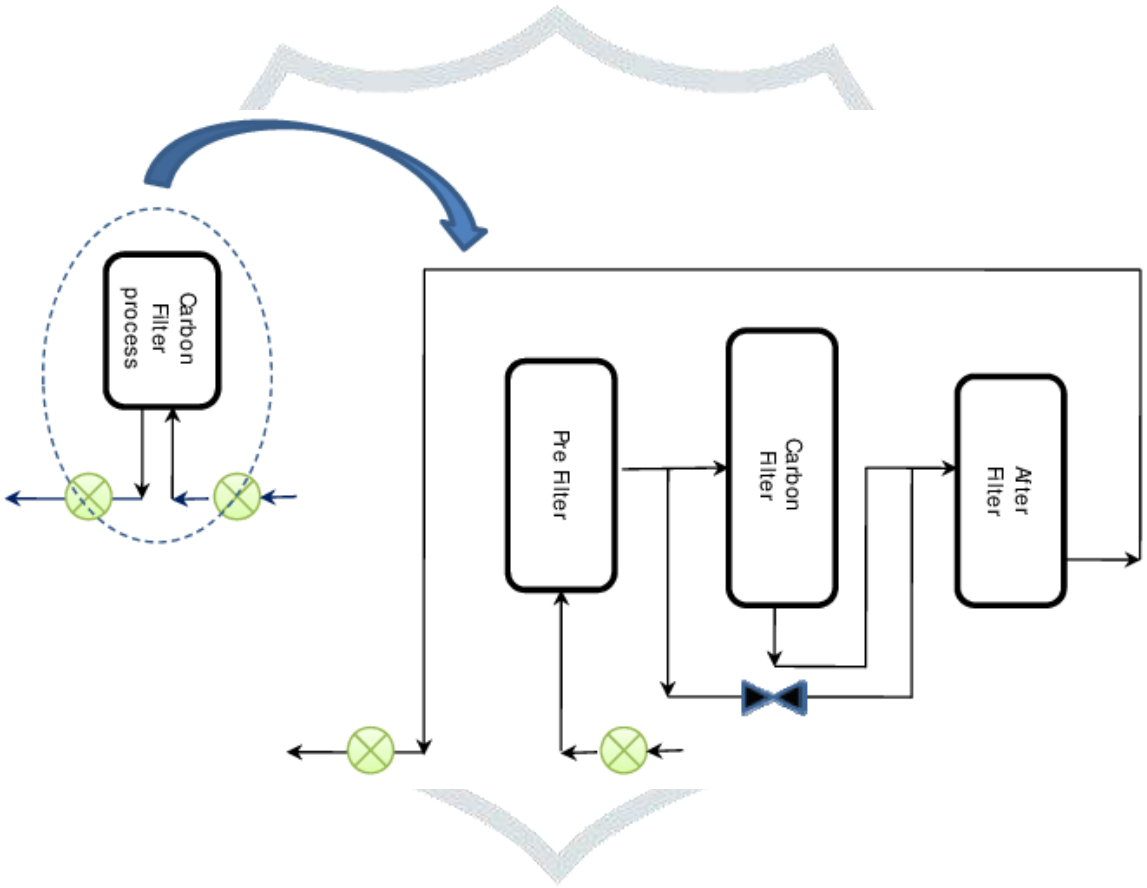



## OXYGEN GENARATION PROCCESS

## Oxygen Concentrator

1. Pre Filter + Oil Filter + Air Dryer – With Auto Drain /OILLESS AIR COMPRESSOR
2. Pressure Swing Adsorption [PSA] Oxygen Concentrator
3. High Pressure Zeolite Molecular Sieves [ZMS] - - 6 – 8 bar
4. High Strength, Friction & Abrasive Resistant ZMS

5. Longer Operation Life - - - -
6. Serge Tank for Stabilization & Purity
7. PLC Bases Operation - Precise Timing Control
8. Pneumatically Operating High Speed Solenoid




## CARBON FILTARATION PROCCESS

### Integration with Advanced Control Strategies

Oxygen (O2) monitoring systems function by employing sensors to measure the concentration of oxygen in a specific environment. These systems are designed to ensure that oxygen levels remain within a defined range to meet safety, regulatory, or operational requirements. Here's a general overview of how O2 monitoring systems work:

1. **Sensor Technology:**

- **Electrochemical Sensors:** Commonly used in O2 monitoring systems, these sensors generate a current proportional to the amount of oxygen present. The current is then converted into an oxygen concentration reading.
- **Infrared Sensors:** These sensors detect the absorption of infrared light by oxygen molecules, providing a non-contact method for measuring oxygen concentration.

2. **Data Collection:**

- The sensors continuously collect data on the oxygen levels in the monitored space.

3. **Signal Processing:**
• The collected data is processed by the monitoring system's electronics, which interpret the sensor signals and convert them into meaningful oxygen concentration readings.

4. **Display and Alarms:**
• The system typically displays real-time oxygen levels on a user interface. If oxygen concentrations deviate from predefined thresholds, the system triggers alarms to alert operators or automated control systems.

5. **Calibration:**
• O2 monitoring systems may require periodic calibration to ensure accuracy. Calibration involves comparing the sensor readings to known reference values and adjusting the system accordingly.

6. **Integration with Control Systems:**
• In some applications, O2 monitoring systems are integrated with control systems to enable automatic adjustments to ventilation, gas supply, or other processes to maintain optimal oxygen levels.

7. **Data Logging and Reporting:**
• Many O2 monitoring systems log data over time, allowing for historical analysis and reporting. This information can be valuable for compliance, quality assurance, or troubleshooting purposes.

8. **Application-Specific Features:**
• O2 monitoring systems can include additional features depending on the application, such as explosion-proof housings for hazardous environments, communication interfaces for remote monitoring, or connectivity with other safety systems.

## Conclusion

The primary focus of air pollution regulation in industrialized countries has been on protecting ambient, or outdoor, air quality. This involves the control of a small number of specific "criteria" pollutants known to contribute to urban smog and chronic public health problems. The criteria pollutants include fine particulates, carbon monoxide, sulfur dioxide, nitrogen dioxide, ozone, and lead. Since the end of the 20th century, there also has been a recognition of the hazardous effects of trace amounts of many other air pollutants called "air toxics." Most air toxics are organic chemicals, comprising molecules that contain carbon, hydrogen, and other atoms. Specific emission regulations have been implemented against those pollutants. In addition, the long-term and far-reaching effects of the "greenhouse gases" on atmospheric chemistry

and climate have been observed, and cooperative international efforts have been undertaken to control those pollutants. The green house gases include carbondioxide, chlorofluorocarbons (CFCs), methane, nitrous oxide, and ozone. In 2009 the U.S. Environmental Protection Agency ruled that greenhouse gases posed a threat to human health and could be subject to regulation as air pollutants.

The best way to protect air quality is to reduce the emission of pollutants by changing to cleaner fuels and processes. Pollutants not eliminated in this way must be collected or trapped by appropriate air-cleaning devices as they are generated and before they can escape into the atmosphere. These devices are described below. The emphasis of this article is air pollution control technology as it is designed to remove particulate and gaseous pollutants from the emissions of stationary sources, including power plants and industrial facilities. (The control of air pollution from mobile sources is described in emission-control system.)

## References


1. Aarnio Pet al. (2005). The concentrations and composition of and exposure to fine particles (PM2.5) in the Helsinki subway system. *Atmospheric Environment*, 39(28):5059–5066.
2. Abbey DEet al. (1999). Long-term inhalable particles and other air pollutants related to mortality in nonsmokers. *American Journal of Respiratory and Critical Care Medicine*, 159(2):373–382.
3. Abello Net al. (2009). Protein tyrosine nitration: selectivity, physicochemical and biological consequences, denitration, and proteomics methods for the identification of tyrosine-nitrated proteins. *Journal of Proteome Research*, 8(7):3222–3238.
4. Acker Ket al. (1998). Atmospheric research program for studying changing emission patterns after German unification. *Atmospheric Environment*, 32(20):3435–3443.
5. Adams Het al. (2001). Fine particle (PM2.5) personal exposure levels in transport microenvironments, London, UK. *Science of the Total Environment*, 279(1–3):29–44.
6. AesifSWet al. (2009). In situ analysis of protein S-glutathionylation in lung tissue using glutaredoxin-1-catalyzed cysteine derivatization. *American Journal of Pathology*, 175(1):36–45.
7. AkerstromMet al. (2013). Associations between urinary excretion of cadmium and proteins in a nonsmoking population: renal toxicity or normal physiology? *Environmental Health Perspectives*, 121(2):187–19P
8. Akesson A, Julin B, WolkAet al (2008). Long-term dietary cadmium intake and postmenopausal endometrial cancer incidence: a population-based prospective cohort study. *Cancer Research*, 68(15):6435–6441.
9. AkinagaLMYet al. (2009). Effects of chronic exposure to air pollution from Sao Paulo city on coronary of Swiss mice, from birth to adulthood. *Toxicologic Pathology*, 37(3):306–314.P
10. Alberg Tet al. (2011). Nitrogen dioxide: no influence on allergic sensitization in an intranasal mouse model with ovalbumin and diesel exhaust particles. *Inhalation Toxicology*, 23(5):268–276.

11. Alexis NEet al. (2010). Low-level ozone exposure induces airways inflammation and modifies cell surface phenotypes in healthy humans. *Inhalation Toxicology*, 22(7):593–600.
12. Allen RWet al. (2011). An air filter intervention study of endothelial function among healthy adults in a woodsmoke-impacted community. *American Journal of Respiratory and Critical Care Medicine*, 183(9):1222–1230
13. Alm Set al. (2001). Personal carbon monoxide exposures of preschool children in Helsinki, Finland – comparison to ambient air concentrations. *Atmospheric Environment*, 35(36):6259–6266.
14. Alves CA, Scotto MG, Freitas MCet al (2010). Air pollution and emergency admissions for cardiorespiratory diseases in Lisbon (Portugal). *Química Nova*, 33(2):337–344.
15. AmannMet al. (2008). *Health risks of ozone from long-range transboundary air pollution*. Copenhagen, WHO Regional Office for Europe

