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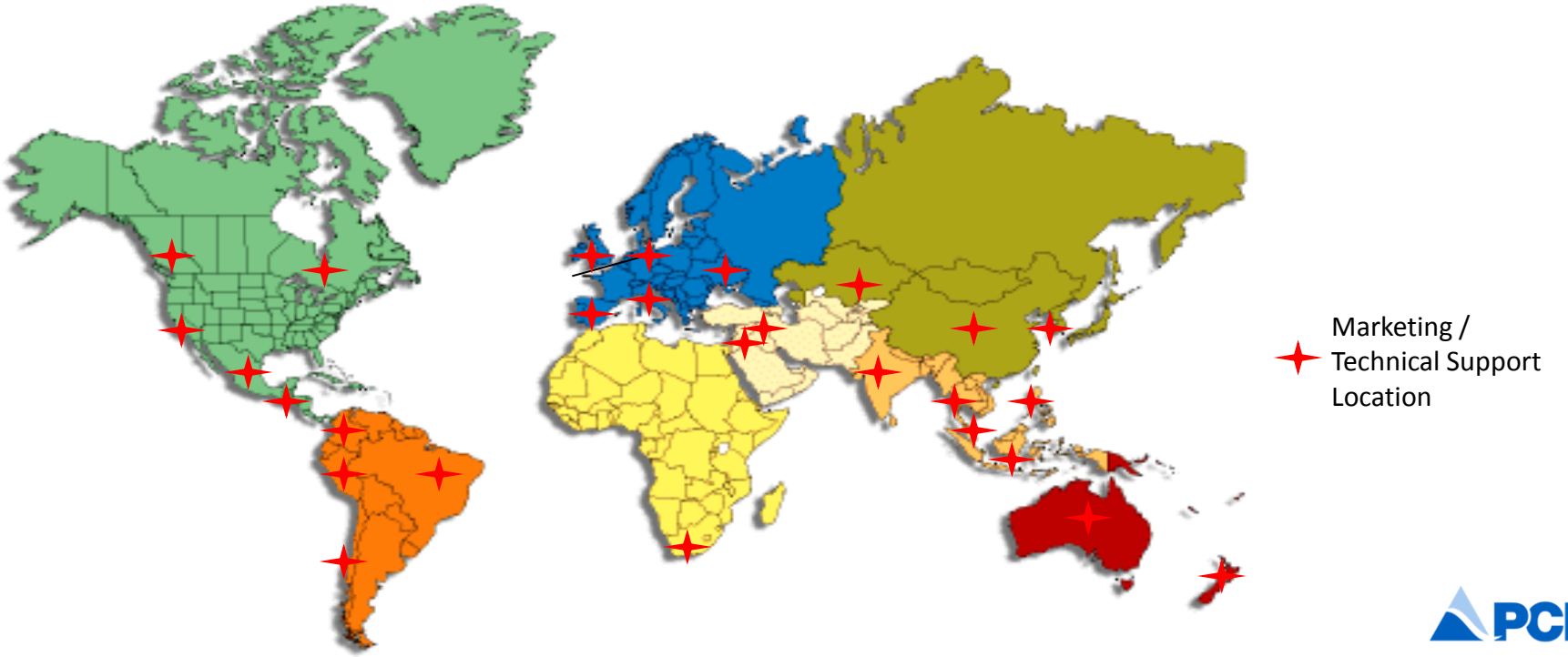
Bangalore

About PCI Gases

- Leading manufacturer of O_2 and N_2 generation systems for the Industrial, Water, Medical, and Military markets
- Founded in 1984, headquartered in Riverside, California, USA
- 85 employees with marketing & technical support in 20+ countries
- Starting 2008, only manufacturer worldwide with Single-Bed Vacuum Swing Adsoprtion (VSA) technology for Industrial O_2



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PCI DOCS VSA Oxygen Systems

5 Models with Capacities of 80 to 5000 lpm (335 to 21,000 lbs/day)

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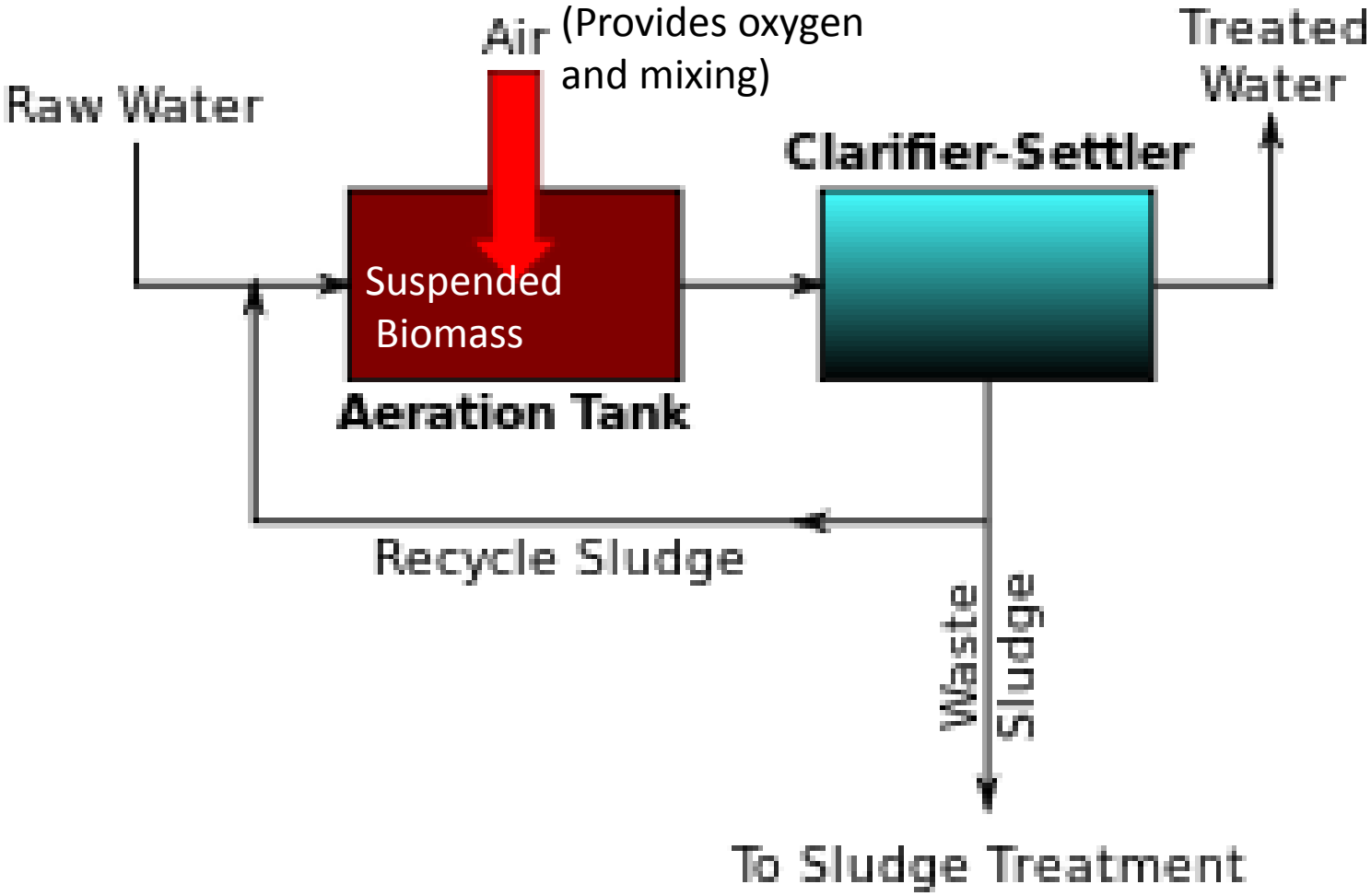
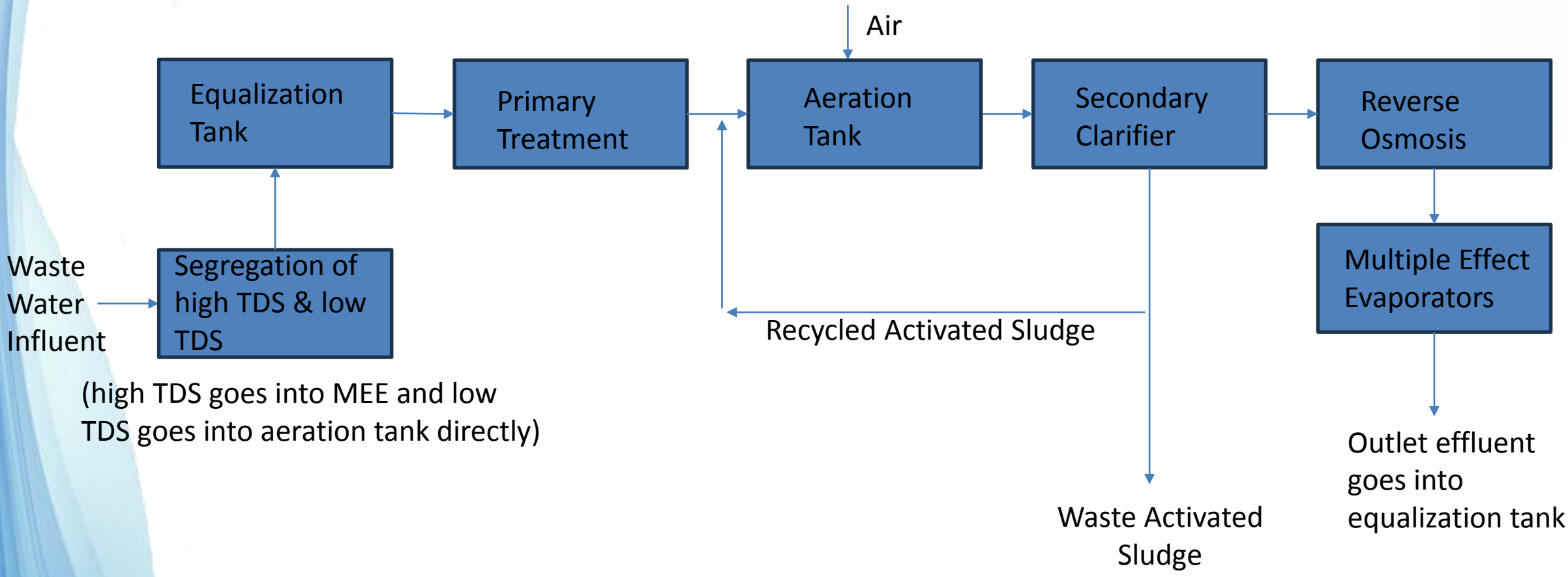
Activated Sludge Process



Conventional Extended Aeration Tank



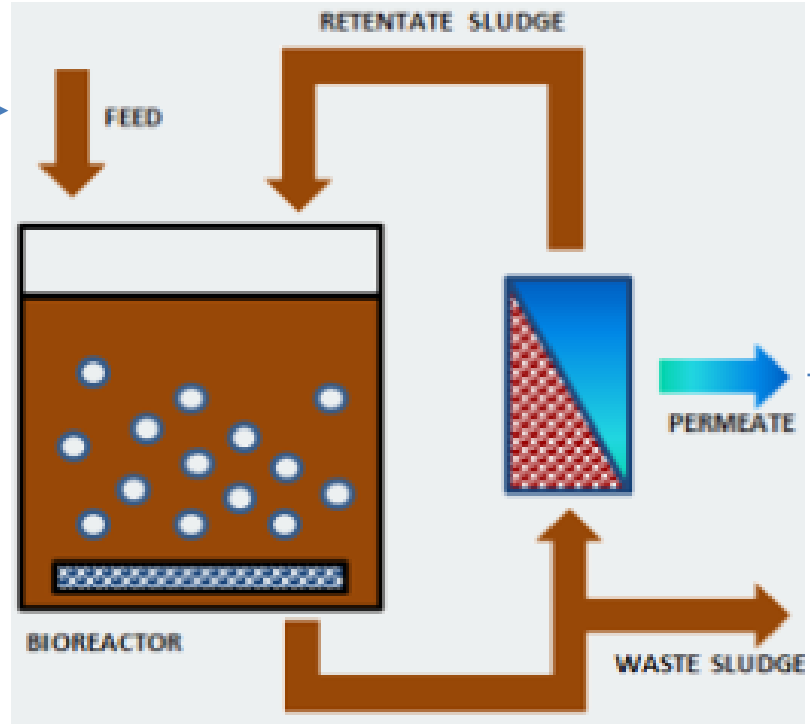
Membrane Bio Reactor

Waste Water Influent

Preliminary Treatment

Equalization Tank

Primary Treatment



Reverse Osmosis

Multiple Effect Evaporators

Outlet effluent

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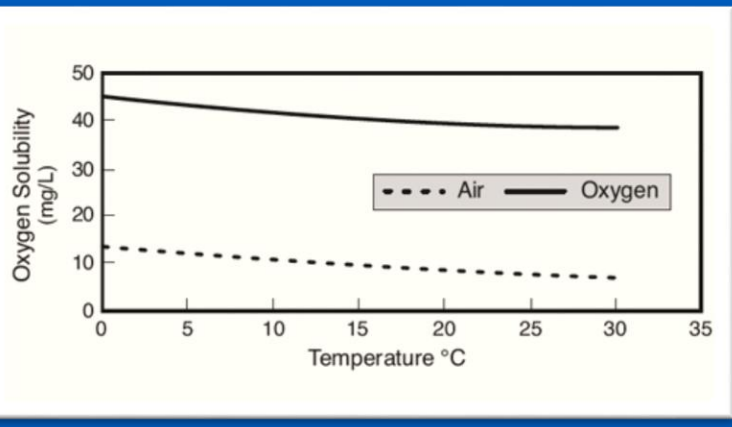
Oxygen Aeration Technology Basics
An Economical Supplement or Alternative to Air

- High oxygen transfer rate into mixed liquor
  - Treat more capacity in less space
  - Treat more reliably under difficult conditions – high loads, high temperature, high solids
- Injecting only oxygen "the useful gas" – no nitrogen
  - Low power usage = lower cost for power and power infrastructure
  - Very little off gas from basin = eliminate odor and emissions issues
  - Reduced foaming
- Simple equipment, easily installed without emptying basin
  - Easy maintenance & operation



Solubility - O2 & Air vs Temperature

Higher Oxygen Transfer Rate (OTR) with Oxygen

$OTR \propto (C^* - C)$

OTR is proportional to oxygen saturation concentration driving force

C^* is oxygen saturation level in water

Oxygen $Cs \approx 35$ mg/l AirCs ≈ 7 mg/l

C is the DO level at any particular time (typical 2 mg/l for wastewater)

Ratio of OTRs Oxygen/Air $\cong 35/7 = 5$

OTR of Oxygen is ~4x that of Air

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Pure Oxygen Aeration - Economically Enhance WW Treatment Operations

Increase WWTP Capacity – Enhance Treatment Reliability - Reduce Emissions

Operational Benefit	Typical Results	Potential Cost Savings
Capacity Increase in Existing Footprint	20% - 50% Increase in Load and/or Flow(100% with domestic sewage limited to clarifier capacity)	Avoid New Basin CAPEX Savings in Aerator Capital Better Space Utilization Shorter Project Completion Time Wet Install - No Disruption in Operations
Enhanced Treatment Reliability	Maintain DO Set Point Reliably Treat Variable Loads Meet Discharge Limits	Eliminate Surcharges & Fines
Odor or VOC Emissions Reduction	>90% Reduction	Avoid Costs of Emissions Treatment System
Reduced Maintenance	Fewer Aerators Required	Maintenance Cost Savings
Aeration Power Reduction	30% - 70% Savings in Aeration Power	Reduced Power Use & Costs
Ozone Reactor Vent O2 Reuse for Aeration	30% - 70% Aeration Power Savings	Reduction in Power Use & Costs

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Pure Oxygen Aeration Advantages:
Maintains Operational Stability of Treatment Plant

- Periods of Zero or Low DO
- Inability to Manage Influent Variations
  - Changes in BOD/COD/NH4 load
  - Daily variance in flow
  - Unanticipated loads spike O2 demand
- Unstable Plant Operation
  - Deterioration in sludge settlability
  - Exceeding discharge limits
  - Odor problems
  - Excessive foaming from over aeration
- Added Surcharges or Fines
- Increase in Chemical Additive Usage
- Requires Closer Operator Attention

- Higher OTR with Pure Oxygen
  - Aeration system highly responsive to load swings
  - Tighter DO control and management
  - Enhanced Plant Stability
- O2 Aeration Easier to Operate & Maintain
  - Ability to regulate O2 flow w/o changing mixing
  - Design has less potential for clogging
  - Less potential for foaming
- Solution Typically Simple Supplementation of Air System with Oxygen
  - No downtime - wet install of aeration system
  - Less capital than air system
- Avoid Surcharges & Fines
- Potential Savings in Chemical Additives
- Lowering COD brings down the reject

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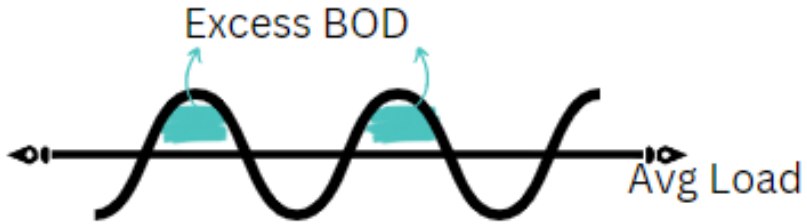
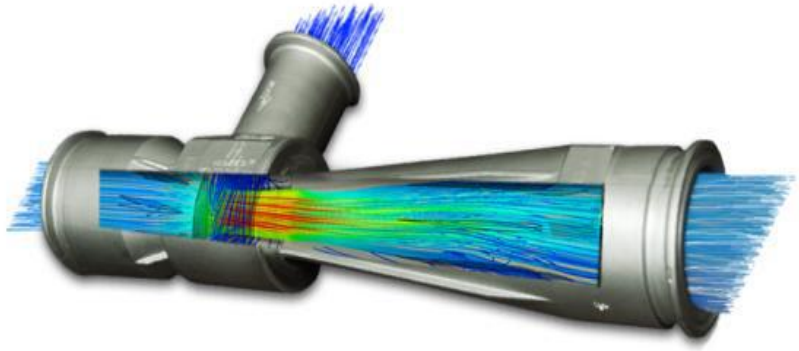
Combination of Air and Oxygen

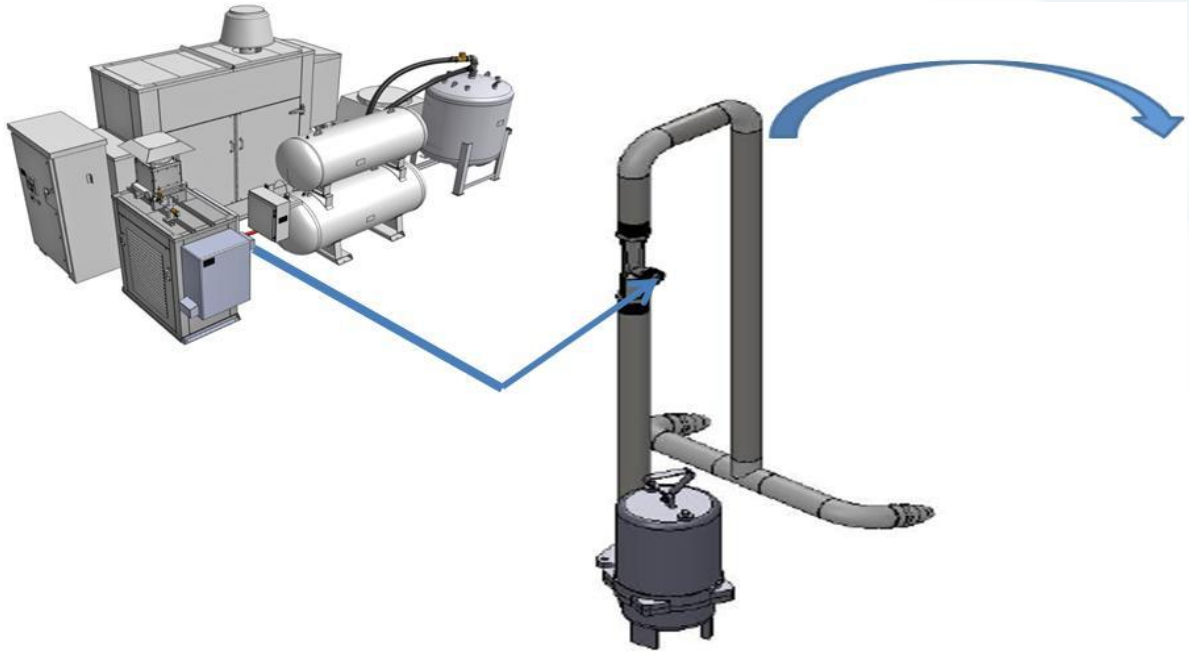
- Combination of air and oxygen in biological tank provides the flexibility of reduced capital, land and recurring costs.
- It also provides the flexibility for operating the ETP in case of failure of one system i.e., either air or oxygen.
- Compared to conventional system there is a possibility of saving chemicals and reduction of RO reject which could cut down the operating cost of the ETP.
- PCI would be able to provide the design for such combination of air & oxygen so that the process is economically viable and effective.



The Oxygen injection system

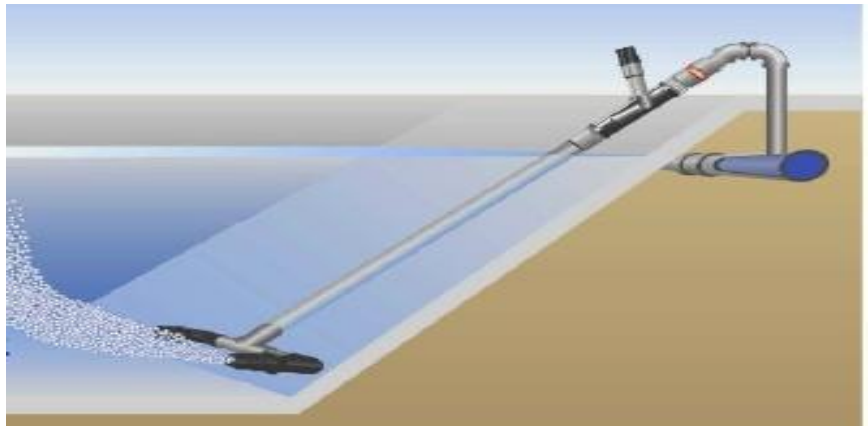
- **Venturi Aeration System**: This operation is based on the principle of differential pressure to induce the oxygen into the equalization tank and mix with the wastewater.





- Effluent to be pumped to the tank and in the path using venturies (injectors) , oxygen from oxygen generation plant to be mixed with the water.

- Specially designed nozzles to be used to discharge the oxygen mixed water.



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Oxygen Injection

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Uttarahalli Lake STP

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Results and Discussion

- Effluent flow was augmented by 100% with same discharge parameters as per control
- No capital investment for the STP(The municipality could save ~2.5 crores for new STP against capital purchase of VSA).
- Total elimination of odour and foam
- Reduction of power consumption per m3 of effluent treated
- Scope for further increase of sewage flow depending on input COD/BOD

			AIR		Oxygen
Sewage Flow	m3/day		350-400		900-1000
Design BOD in	mg/lit		300		300
Design COD in	mg/lit		700		700
BOD in	mg/lit		200		200
BOD out	mg/lit		20		20
COD in	mg/lit		450		400-450
COD out	mg/lit		50		50
MLSS	mg/lit		1500		3500-4000
Aeration Tank volume	m3		375		375
Air Blowers	Kw		40		32
Clarifier	m3		112		112
Oxygen Usage	m3/day				15
Oxygen Available from VSA oxygen generator				**m3/hr**	**30**

Raw and Treated Water

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Uttarahalli Treated Water Discharge

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Lake

Problem

- High volume of untreated sewage enters into the lake from multiple sources.
- The dissolved oxygen level becomes 0 ppm in the lake.
- Untreated BOD and ammonia creates anaerobic condition generating methane.
- Sludge generated gradually turns anaerobic.
- Due to NPK present in the untreated sewage, it gives rise to algae which consumes oxygen at night.

Benefits

- The increased DO levels in vicinity of sewage entry to the lake will stabilize the BOD and Ammonia.
- The oxygen enriched stream will gradually spread into the lake by natural mixing, improving the aquatic environment.
- The oxygen injection system can cover upto 10x10 m2 area in the lake followed by natural mixing.
- Subsequently multiple such installations maybe be required at the intersection of sewage channel connecting to the lake.

Solution

- Need to prevent sewage entering the lake as a long term solution.
- Injecting oxygen in the lake and elevating dissolved oxygen level at the intersection of sewage mixing with the lake water as a short term solution.
- Constructing a basin across the drain and installing side stream oxygen injection through venturi and nozzles to elevate DO levels. The enriched oxygen stream is allowed to enter into the lake thereafter.

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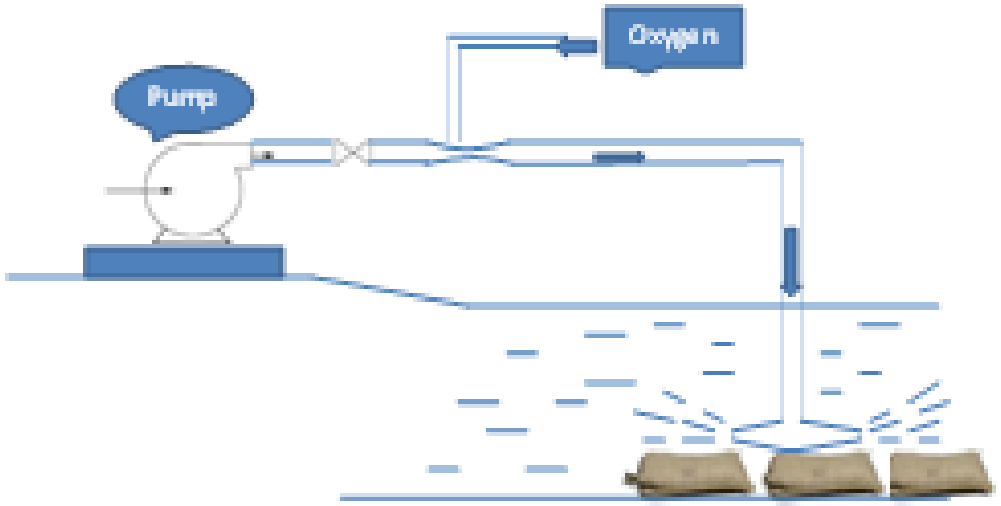
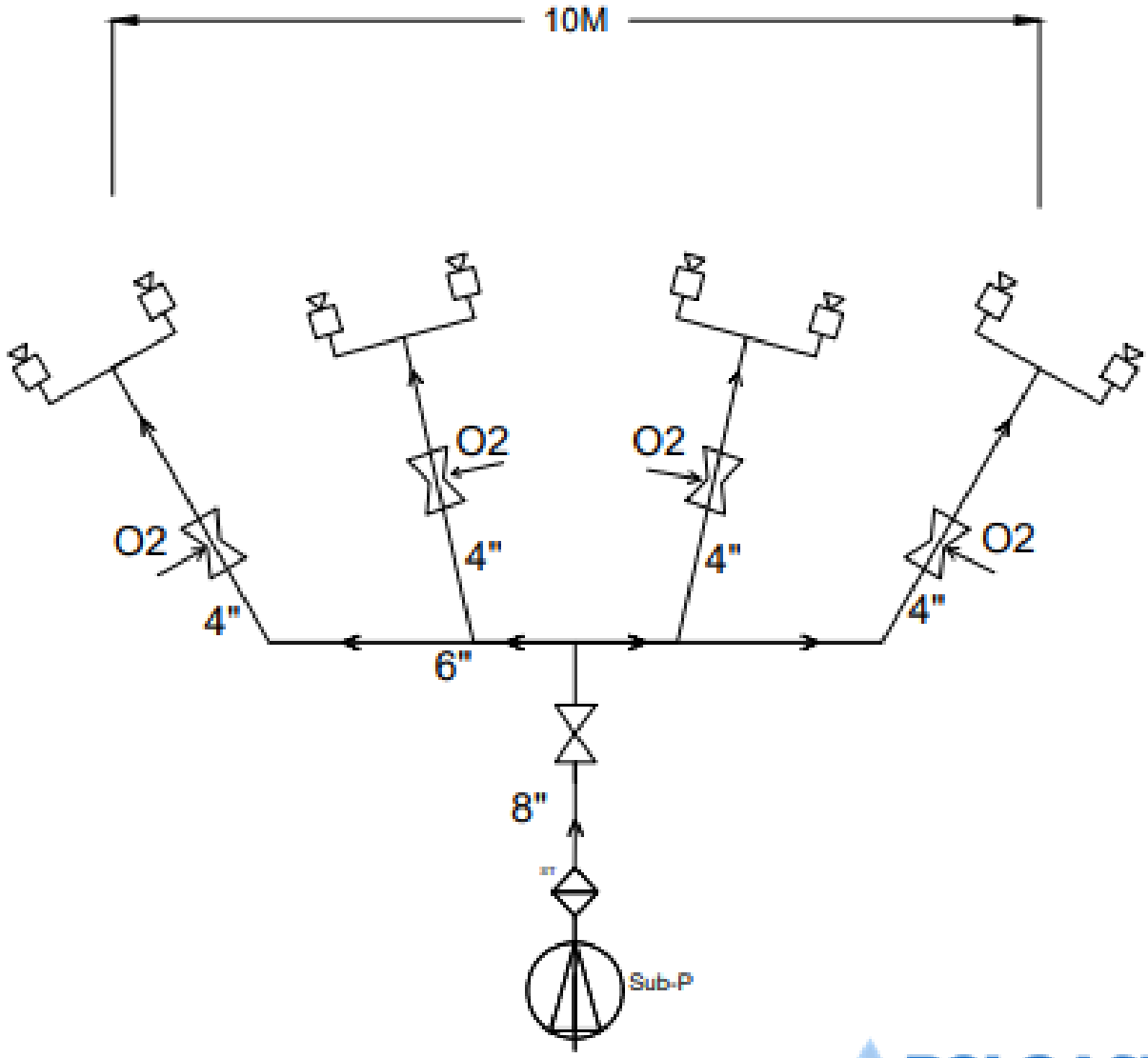
Arrangement of Nozzles & Injector for Oxygenating Lake Water





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Sulphide Removal

- Had severe odor problem due to generation of hydrogen sulphide from the tannery effluent.
- PCI introduced VSA based oxygen injection system into their equalization tank resulting into complete oxidation of hydrogen sulphide.
- Destruction of H2S also had a positive impact on improvement of biomass in the aeration tank.
- Reduced corrosivity due to removal of sulphide also helped increase the life of metallic parts related to blowers, spargers.
- Sulphide free atmosphere provided a healthy working environment for the workers.

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Conditions required for Sulphide Removal

- Components like Na_2S and K_2S can be oxdised chemically with high DO levels and the resultant Na_2SO_4 and K_2SO_4 can be removed along with the sludge in the aeration tank.

- Dissolved oxygen level must necessarily be >5ppm in aeration tank
- pH should be adjusted between 8-8.5
- Small dose of $MnSO_4$ catalyst
- Minimum detention time of 6 hours
- Mixing energy of 40-50Watt/m^3

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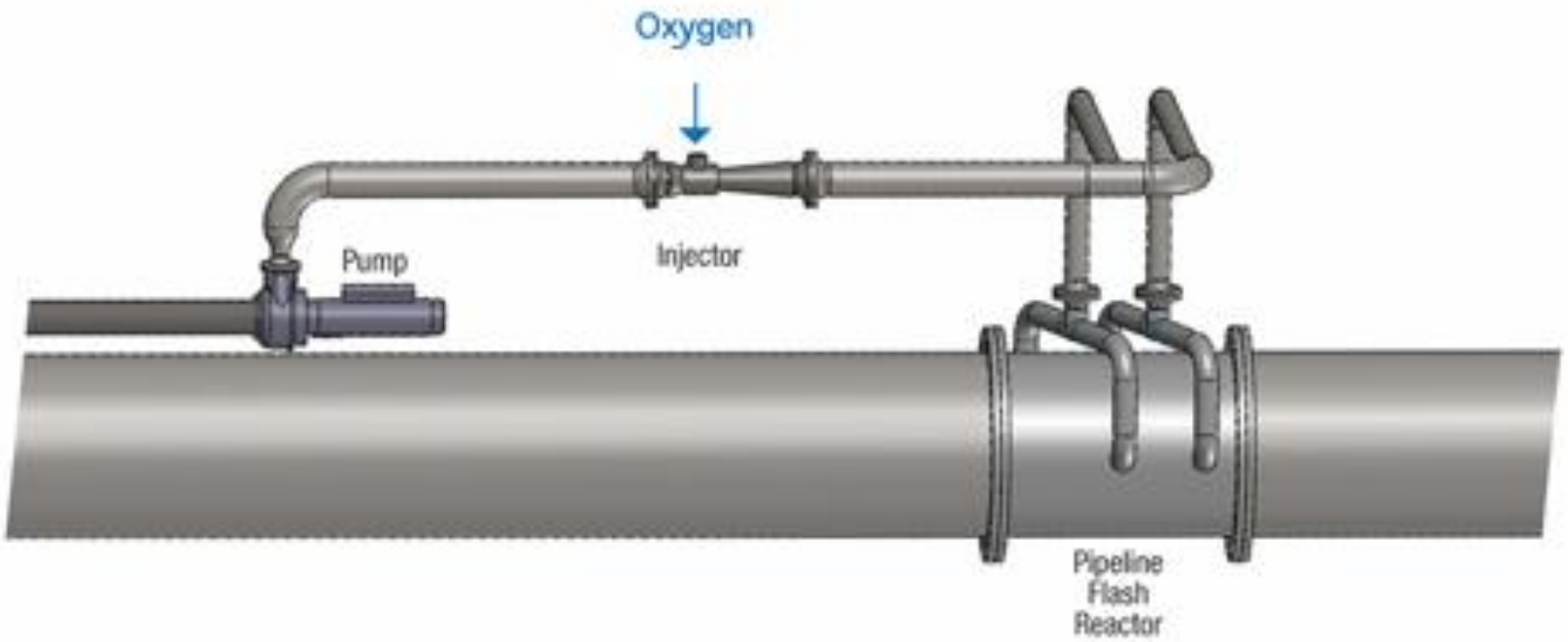
Flash Reactor



- It is advantageous to increase DO level of the raw water prior to entering the equalization tank.
- Pipeline Flash Reactor provides rapid oxygen transfer. The system utilizes a small side stream passed through a venturi injector to draw in concentrated oxygen or ozone.
- The oxygenated side stream is then delivered to the Pipeline Flash Reactor where it aggressively mixes with the main flow, uniformly transferring gas into the pipeline effluent.
- This is essentially meant to reduce the odor while effluent travelling from the source to the equalization tank. The transfer pipe is required to be filled at least up to 75% of the volume.
- While travelling from the source to the destination, some BOD amount of is expected to be reduced during the transition.
- Where space is an issue, such as in existing built-out urban areas, it eliminates the need for large post-treatment cascading systems or diffuser basins required by other technologies.
- It can also be utilized for the dissolution of oxygen gas in systems with high DO requirements.

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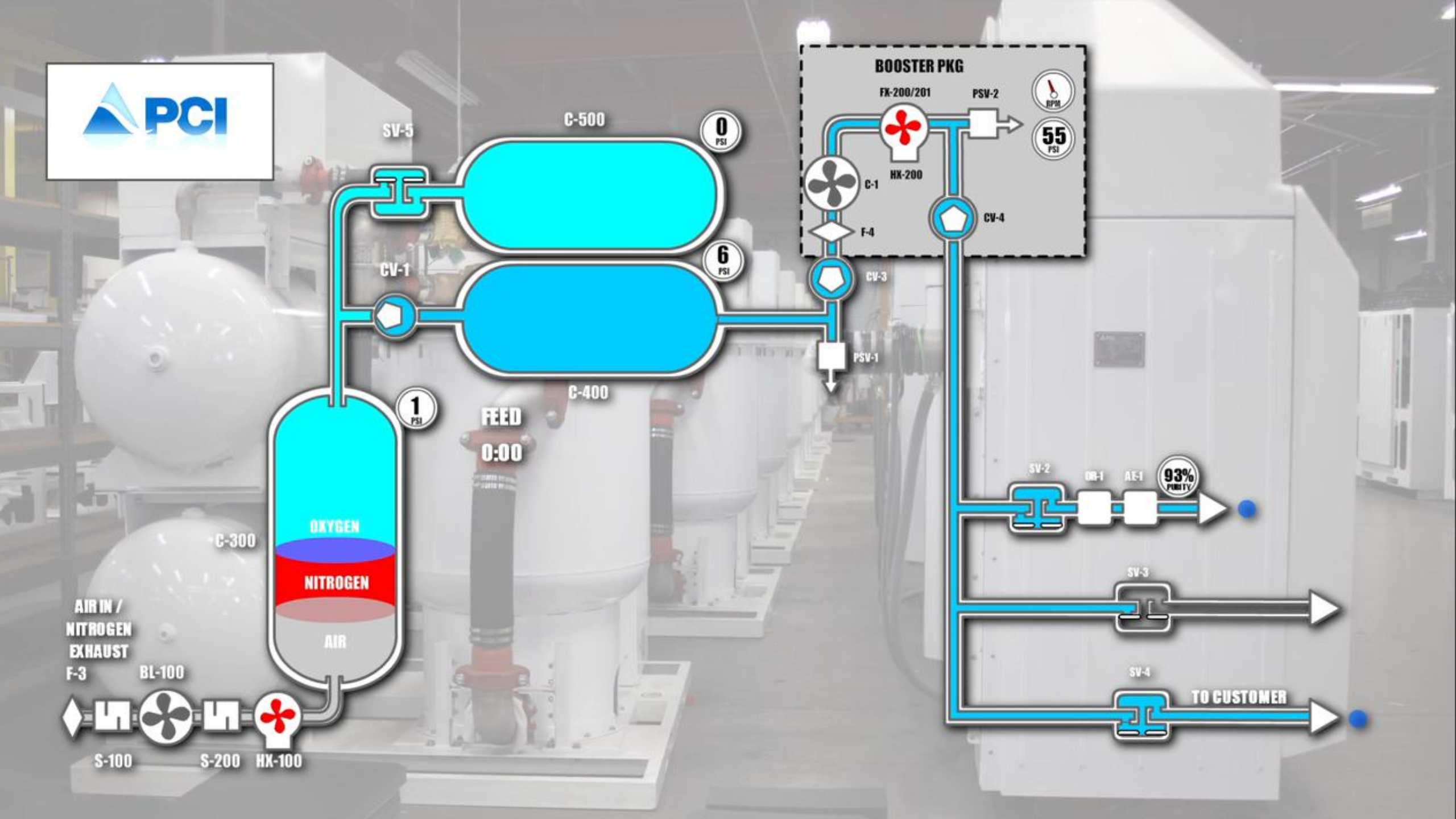
PCI
BOOSTER PKG
FX-200/201
PSV-2
RPM
55
PSI
HX-200
C-1
CV-4
F-4
CV-3
PSV-1
SV-5
C-500
0
PSI
6
PSI
CV-1
C-400
1
PSI
FEED
0:00
C-300
OXYGEN
NITROGEN
AIR
SV-2
OR-1
AE-1
93%
PURITY
SV-3
SV-4
TO CUSTOMER
AIR IN /
NITROGEN
EXHAUST
F-3
BL-100
S-100
S-200
HX-100

EQUIPMENT DETAILS – DOCS 500

Sl No	Description	Brand
1	Oil Free Reversible Blower (1 no, Rotary Two Lobe Blower 4180 RPM)	Kaeser
2	Oil Free Scroll Compressor (1 no, COMPRESSOR, SCROLL, 5 HP, SPEED 3250 RPM)	Anest Iwata
3	VSA Molecular Sieves/ Zeolites Tank (625 Litres, Zeolite Molecular Sieves)	PCI Gases
4	Bacterial Filter (2 nos, 0.01 micron, 6C Filter Element)	Parker
5	Oxygen Tanks (2 nos, 300 Litres each, operating pressure less than 13 psig)	PCI Gases
6	Oxygen Purity Display Panel (LCD Panel)	Schneider Electric
7	Electrical Panel (Compatible for the VSA Plant) (Control Panel with 37 kW & 3.7 kW Variable Frequency Drives)	Schneider Electric
8	Oxygen Analyzer, Ntron Ireland make, Zirconium type	Ntron Ireland make

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Any Questions?

Thank You