Innovative Technologies using Industrial Gases for Increased Productivity and Yield, Improved Economics

Sudhir R. Brahmbhatt, Ph.D. MBA, TSI
AGENDA

- Introduction to Technology Services Incorporated TSI-US and Industrial gases
- Industrial gases and their applications
- Project I - Pure Oxygen and Organisms
- Project II - Environmental Technologies
- Project III - Pure oxygen and high temperature applications
- Project IV - Pure Oxygen and WWT process
- Conclusion
Technology services Incorporated: The company

**Highlights:**
Expert in Industrial gases applications in
- Chemical Industry, Environmental Industry, Pharma and Biotech Industry
- Metal Industry, Pulp & Paper Industry, Cryogenic Applications
- Industrial gases related experience more than 35 years with top 100 corporations.
- More than 25 patents in a variety of industries, Commercialized new concepts successfully with very attractive ROI
- Have developed variety of markets from small portfolio to large no of clients.
- Work with end users very closely to understand their needs and prepare solutions to their needs.

**Our Services:**
Technology Support for productivity improvements, Yield increases in
- Support in Environmental, Chemicals, High temperature and Metal industry in productivity gain, meet EPA regulation
- Pharma/Biotech, In processes such as fermentation, Lyophilization, Deoxygenation, Support in Global pharmacopeias requirements.
- Creating Innovative ways to optimize operations. Premier Consulting
- Add value to your products.

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**Oxygen and Nitrogen Production**

**Compression/Expansion**

**Distillation Column**

**Liquifier**

**Nitrogen**

**Oxygen**

**Argon**

**Oxygen:** Non Flammable, supports combustion, heavier than air, used as gas in most industrial applications.

**Nitrogen:** Inert to most of the chemical reactions, lighter than air, can impart cold to system using LIN, can prevent oxidation by using GAN in its industrial applications.

**Argon:** Inert to most of the chemical reactions, heavier than air, Used as gas when applied in the industrial applications.

**A100 = 100 TPD Oxygen, 300 TPD Nitrogen**

**L200 = 200 TPD of Liquid Products**

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## Application: OXYGEN & CRYOGENICS

### Description
- Volatile Organic Chemicals escape into atmosphere.

### Uses of Technology
- Lower solvent consumption, meet environmental emission limitation.

### Gases Used
- Liquid Nitrogen

### Industry
- Chemical Manufacturers

### Uses of Technology
- EPA requires manufacturers to meet emission limits

### Uses of Technology
- Manufacturers have particulate emission and product loss problems

### Uses of Technology
- Improve combustion efficiencies, meet environmental emission limitation.

### Gases Used
- Gaseous

### Industry
- Combustion Process

### Uses of Technology
- Sewage overloading, risk of high corrosion in the sewer pipes, concentrated foul odor, high nitrogen compounds in effluents

### Uses of Technology
- Overcome operational problems with minimum capital investment. Meet spec. on BOD, COD

### Gases Used
- Oxygen

### Industry
- Waste water treatment industry

### Uses of Technology
- Process water issues such as concentration of pollutants in recycled process water, formation of bacteria and algae in cooling water.

### Uses of Technology
- Replaces substance not naturally found in water e.g. chlorine, no extra salination. Low capital investment.

### Gases Used
- Oxygen

### Industry
- Process water industry

### Uses of Technology
- Fish Farming

### Uses of Technology
- Intensive Fish Farming

### Gases Used
- Gaseous

### Industry
- Fish Farming

### Uses of Technology
- Clay Industry

### Uses of Technology
- High carbon content leads to potential coring, quality problems, production increase limitations, environmental issues

### Gases Used
- Oxygen

### Industry
- Clay industry such as (Brick)

### Uses of Technology
- High return on capital investment for pure oxygen use.

### Gases Used
- Gaseous

### Industry
- Clay industry such as (Brick)

### Uses of Technology
- High temperature processes where fuel price is high, difficult to maintain temperature, high NOx in the stack, long furnace start up time.

### Uses of Technology
- Higher foundry capacity, higher melt temperature, faster furnace start up after shut down, rapid and precise adjustment of carbon content, reduced fuel consumption, improved productivity and efficiency

### Gases Used
- Oxygen

### Industry
- Combustion Processes

### Uses of Technology
- Chemicals

### Uses of Technology
- Oxidation processes in synthesis, conversion of hydrogen sulfide, thermal breakdown of waste sulfuric acid, safe handling of inflammable chemicals, repair of pipelines containing liquid, hazardous waste incineration.

### Uses of Technology
- Pure oxygen instead of air as oxidizing agent provides high yield, faster reactions, no nitrogen reactions, low capital investment, Claus process provides high throughput, thermal breakdown using oxygen provide flexible operation, high SO2 concentration.

### Gases Used
- Gaseous

### Industry
- Chemical Industry

### Uses of Technology
- Refineries,

### Uses of Technology
- Incineration Processes

### Uses of Technology
- Glass Manufacturing

### Uses of Technology
- Foundry processes

### Uses of Technology
- Steel mills

### Uses of Technology
- Ferrous and Non Ferrous Processes.

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Project 1  Pure oxygen in Pharma & Biotech industry

Objectives: Investigate the use of Pure Oxygen instead of air in Aerobic fermentations and Cell Culture processes
Opportunities:  
> Increased bacteria life and performance leading to 30% productivity improvements  
> Attractive in yield improvement due to healthier bacteria  
> Significant reduction in exhaust volumes and opportunity to develop revenue stream  
> Reduce the lag phase of the cycle by proper mechanism to adjust bacteria when moved from seed Fermenter to production Fermenter
Aerobic Fermentation Cycle

Figure 1: Typical Fermentation Cycle

- **Living Cells**
- **Second Metabolite**
- **Primary Metabolite (Living and Dead)**

Log (Concentration) vs. Time

- **Exponential**
- **Stationary**
- **Death**
- **Oxygen Injection**

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## TSI and AEROBIC Fermentation

**TITLE**
OXYGEN ASSISTED FERMENTATION

**TECHNOLOGY**
COMPARSED TO AIR, OXYGEN PROVIDES A SIGNIFICANT
PRODUCTIVITY AND OXYGEN UTILIZATION BENEFITS.

### Definitions
- $D_s$: Bubble mean diameter $\alpha f$(volume fraction of dispersed phase, Holdup)
- $\alpha$: Interfacial Area (bubble surface per unit bubble volume)
- $K_{La}$: Mass transfer coefficient
- $N_{AV}$: Transfer rate per unit volume

### Assumptions
- 2m dia x2m Height Vessel
- Bubble rise velocity 0.2 m/s
- 0.667 m diameter impeller
- Flat-bladed turbine impeller
- Henry’s constant @ 86°F = 2.11e-06

### Table
<table>
<thead>
<tr>
<th>Base</th>
<th>Flow</th>
<th>RPM</th>
<th>O2 Application</th>
<th>O2 Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>O2 (56)</td>
<td>21</td>
<td>21</td>
<td>21</td>
<td>100</td>
</tr>
<tr>
<td>N2 (56)</td>
<td>79</td>
<td>79</td>
<td>79</td>
<td>0</td>
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<tr>
<td>Flow (m$^3$/hr)</td>
<td>100</td>
<td>150</td>
<td>150</td>
<td>100</td>
</tr>
<tr>
<td>RPM</td>
<td>180</td>
<td>180</td>
<td>250</td>
<td>180</td>
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<tr>
<td>$P$ (kW)</td>
<td>15.7</td>
<td>12.1</td>
<td>40.6</td>
<td>15.7</td>
</tr>
<tr>
<td>$D_s$ (mm)</td>
<td>3.97</td>
<td>5.04</td>
<td>3.49</td>
<td>3.97</td>
</tr>
<tr>
<td>$\alpha$ (mm$^{-1}$)</td>
<td>0.16</td>
<td>0.19</td>
<td>0.27</td>
<td>0.16</td>
</tr>
<tr>
<td>$K_{La}$</td>
<td>$3.6x10^{-2}$</td>
<td>$4.3x10^{-2}$</td>
<td>$6.4x10^{-2}$</td>
<td>$3.7x10^{-2}$</td>
</tr>
<tr>
<td>DC=([O$_2$]$_i$-[O$_2$]$_b$)</td>
<td>$4.4x10^{-5}$</td>
<td>$4.4x10^{-5}$</td>
<td>$4.4x10^{-5}$</td>
<td>$2.11x10^{-5}$</td>
</tr>
<tr>
<td>$N_{AV}$</td>
<td>$1.63x10^{-7}$</td>
<td>$1.9x10^{-7}$</td>
<td>$2.81x10^{-7}$</td>
<td>$7.75x10^{-7}$</td>
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<tr>
<td>% Increase</td>
<td>16.6</td>
<td>72.4</td>
<td>375.5</td>
<td>88.3</td>
</tr>
</tbody>
</table>

* Assumes $[O_2]_b = 0$
Fermentation with Oxygen

Efficiency of oxygen transfer in Air based case
Fermentation with Oxygen

Efficiency of oxygen transfer in pure oxygen trial

![Graph showing efficiency of oxygen transfer over time](image)
# Potential Products That Can Use Pure Oxygen

<table>
<thead>
<tr>
<th>Product formed by Fermentation</th>
<th>Potential Products That Can Use Pure Oxygen</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ANTIBIOTICS</strong></td>
<td><strong>ENZYMES</strong></td>
</tr>
<tr>
<td>Adriamicin</td>
<td>Amylases</td>
</tr>
<tr>
<td>Alzomycin</td>
<td>Amyloydulcosidase</td>
</tr>
<tr>
<td>Aminosidin</td>
<td>Catalase</td>
</tr>
<tr>
<td>Amphotomycin</td>
<td>Cellulase</td>
</tr>
<tr>
<td><strong>Bacteriace</strong></td>
<td><strong>Glucanase</strong></td>
</tr>
<tr>
<td>Bicyclomycin</td>
<td>Glucose Isomerase</td>
</tr>
<tr>
<td>Capromycyin</td>
<td>Glucose Oxidase</td>
</tr>
<tr>
<td>Celloidin</td>
<td>Hemi-Cellulase</td>
</tr>
<tr>
<td><strong>Erythromycin</strong></td>
<td>Invertase</td>
</tr>
<tr>
<td>Fusagillin</td>
<td>Lactase</td>
</tr>
<tr>
<td>Fusidic Acid</td>
<td>Lipase</td>
</tr>
<tr>
<td>Hygromycin</td>
<td>Pectinase</td>
</tr>
<tr>
<td>Josamycin</td>
<td>Pentosamase</td>
</tr>
<tr>
<td>Myxin</td>
<td><strong>Proteases</strong></td>
</tr>
<tr>
<td>Penicillin G</td>
<td>VITAMINS</td>
</tr>
<tr>
<td>Penicillin O</td>
<td><strong>AMINO ACIDS</strong></td>
</tr>
<tr>
<td>Pencillin V</td>
<td>L-Alanine</td>
</tr>
<tr>
<td>Pimaricin</td>
<td>L-Arginine</td>
</tr>
<tr>
<td>Sarkomycin</td>
<td>L-Citrulline</td>
</tr>
<tr>
<td>Siccamin</td>
<td>Yeast</td>
</tr>
<tr>
<td>Spectinomycin</td>
<td>Vitamin B12</td>
</tr>
<tr>
<td>Streptomycinycins</td>
<td>Zearalenol</td>
</tr>
<tr>
<td><strong>Tetracycline</strong></td>
<td>L-Lysine</td>
</tr>
<tr>
<td>Trichomycin</td>
<td>L-Ornithine</td>
</tr>
<tr>
<td>Validamycin</td>
<td>L-Proline</td>
</tr>
<tr>
<td>Cephalosporins</td>
<td>Acyloin</td>
</tr>
<tr>
<td>Chloramphenicol</td>
<td>Desferrioxamine</td>
</tr>
<tr>
<td>Gentamycin</td>
<td>Dextran</td>
</tr>
<tr>
<td>Lincomycin</td>
<td>Xanthan</td>
</tr>
<tr>
<td>Neomycin</td>
<td>Steroid Oxidation</td>
</tr>
<tr>
<td><strong>MISCELLANEOUS</strong></td>
<td></td>
</tr>
</tbody>
</table>

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Technology Services Inc and Aerobic Fermentation

OXYGEN INJECTION BENEFITS:

1. An increase in production yields from existing Fermenter. Industry reported as much as 30+% productivity improvement and 10%+ yield increase.
2. Better control over oxygen dissolution throughout the entire fermentation cycle with operation equipped with safety systems.
3. Higher Dissolved Oxygen level available to satisfy demand in the fermentation broth
4. More Efficient use of pure oxygen, less foam.
5. Reduced power consumption and cost by reducing air compression, air filtration, and agitation.
6. No capital outlay for new fermenter to provide additional production capacities.

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## Project 2  Industrial Gases, Chemistry and Environmental Industry

### Operations and Industrial Gases applications

<table>
<thead>
<tr>
<th>Sewage &amp; Process Water Treatment</th>
<th>Drinking &amp; Surface Water Processes</th>
<th>Oxidation &amp; High Temperature Processes</th>
<th>Operational Safety, Repair &amp; Maintenance</th>
<th>Extraction &amp; Pressure Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>O₂, O₃, CO₂</td>
<td>O₂, O₃, CO₂</td>
<td>O₂</td>
<td>N₂, CO₂</td>
<td>CO₂</td>
</tr>
</tbody>
</table>

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CO₂ Applications

- Algae
- Greenhouse Gases
- Flavors/Fragrances
- Decaffeination
- Methanol
- Urea
- CO
- Methane
- Refrigeration
- Dry Ice
- Injected into metal castings
- Added to medical O₂ as a respiratory stimulant
- Aerosol can propellant
- Dry ice pellets used for sand blasting
- Red mud carbonation

- Oil
- Gas
- EOR
- EGR
- ECBM

- Carbonated Beverages
- Food
- Food/Products
- Biological Conversion
- Extractant
- Mineralization
- Carbonates
- Liquid Fuels

- Polycarbonate Polymers
- Plastics
- Refrigerant
- Miscellaneous

- Fire Extinguishers
- Inerting Agent
- Fuel Recovery

- Blanket Products
- Protect Carbon Powder
- Shield Gas in Welding

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# Use of Carbon Dioxide in pH control

<table>
<thead>
<tr>
<th>Current Condition</th>
<th>Proposed Condition</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overshooting of pH, discharge violation</td>
<td>Improved pH control, no overshooting</td>
<td>Eliminate notice of violations, fines, reporting</td>
</tr>
<tr>
<td>Operator handling, PPE, and risk of employee exposure to burns</td>
<td>No operator handling or risk of exposure to burns</td>
<td>Loss time accidents Liability issues</td>
</tr>
<tr>
<td>Routine replacement of acid pumps and feed lines</td>
<td>No additional maintenance costs associated with acid</td>
<td>Reduced Maintenance</td>
</tr>
<tr>
<td>Acid Cost per year</td>
<td>CO2 Cost per year</td>
<td>Direct Cost Savings</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total Value</th>
<th>+ per year</th>
</tr>
</thead>
</table>
Oxygen for biological sewage and process water treatment.
- Biological Waste water treatment using O\textsubscript{2} for municipal, industrial WW.

Biological Nitrogen elimination with Oxygen
- Two steps Nitrogen removal. Nitrification zone where NH\textsubscript{4}+ (Ammonium) ion is oxidized to NO\textsubscript{3}– (Nitrate) with need of sufficient oxygen supply and the denitrification zone where elemental nitrogen is formed from the nitrates (NO\textsubscript{3}–) in absence of oxygen.

Prevention of odor and corrosion in pressure pipelines with Oxygen
- Oxygen in WW during transport into pressure mains, can be consumed leading to anaerobic conditions resulting into H\textsubscript{2}S which can convert into H\textsubscript{2}SO\textsubscript{4}, an aggressive acid that can destroy concrete pipes.

Boiler water using hydrogen and/or Oxygen
- In some applic. It is desirable to remove dissolved O\textsubscript{2} by using H\textsubscript{2} and palladium catalyst reducing DO below 0.5 µg/l.

Treatment of landfill leachate with Ozone
- Leachate such as AOX(Adsorbable Org. Halides) and COD follows Denitrification and Nitrification step using O\textsubscript{2} and then leachate follow O\textsubscript{3} a or UV treatment.

Precipitation of calcium and heavy metals from process water with CO\textsubscript{2}

Super Cirtical Water Oxidation (SCWO)
- SCWO destroys all organic waste. Oxygen is used in oxidation reaction.

Drinking & Surface Water Processes

O\textsubscript{2} – Reducing high concentration of iron, manganese and NH\textsubscript{3}

PH control in drinking water production with CO\textsubscript{2}

Raising water hardness with CO\textsubscript{2} and lime water

Cracking persistent organic pollutants (viruses, germs)
Oxidation & High Temperature Processes

- Claus Process for \( \text{H}_2\text{SO}_4 \) manufacturing
- Sludge incineration
- Incineration of highly polluted waste water (PSU)
- Reprocessing/Recycling sulphuric acid
- \( \text{O}_2 \) for chemical reactions / oxidations

Operational Safety, Repair & Maintenance

- Alternative fire fighting
- Inerting of closed and open systems
- Inerting in the petrochemical industry
- Pigging and pipe inspection

Extraction and pressure applications

- SCFE (Super Critical Fluid Extraction)
  - Conventional applications (extraction of natural products)
  - New SCFE applications
  - Cleaning, Recycling, Debinding, pharma drug sterilization
- Atomization and crystallization processes with \( \text{CO}_2 \) or \( \text{LN}_2 \) for the production of fine and special chemicals
Use of Liquid Nitrogen for Solvent Recovery
Opportunities

- Excellent economical way to handle increased Environmental loading.
- Improved Safety and increased flexibility in operation
- Reduced organic emission as less turbulence
- Reduced maintenance and operating cost as no mechanical aeration units needed. Reduced energy usage as no mechanical units needed.
- Increased reliability and uptime as even with no electricity as no pump needed to supply oxygen.
- No back up needed in case of power failure.
- Excellent means to economically expand the load handling capacity.
- Opportunity in reducing the emission in the WWT plants
- Excellent Economical solution in reducing the energy use as it impacts not only in efficiency improvements, but impacts maintenance, operating cost
- Attractive ROI as oxygen cost can be offset by realizing impact on electricity use, maintenance cost, man power requirement, flexibility in handling load increase, less organic emission due to less turbulence, no need for aerators.
- Effective to meet the BOD, COD requirements.
FEATURES:

-OXYGEN TECHNOLOGY IS A RETROFIT SYSTEM TO FURTHER OPTIMIZE THE FURNACE OPERATION. EITHER OXYGEN INJECTION OR OXYFUEL BURNERS OR OXYGEN ENRICHMENT ARE UTILIZED IN SUCH APPLICATIONS.

-AN OXYGEN CONTROL SYSTEM IS UTILIZED TO AUTOMATE THE USE OF OXYGEN.

-OXYGEN SPEEDS UP COMBUSTION LEADING TO SUPERIOR EXHAUST GAS QUALITY AND PERFORMANCE, LOWER ENERGY CONSUMPTION FOR SAME PRODUCTION RATE OR MORE.

-SAFETY FEATURE AUTOMATICALLY SHUTS DOWN THE OXYGEN USE. A MANUAL START ENSURES THE SAFE START UP OF THE OPERATION.

-DEPENDING ON THE TYPE OF TECHNOLOGY; OXYFUEL, ENRICHMENT, INJECTION ETC; ECONOMIC BENEFITS ARE REALIZED. THE ATTACHED CHART SHOWS DEPENDENCE OF COMBUSTION EFFICIENCY ON OXYGEN CONTENT.

-EASE OF OPERATION, EASY TO MAINTAIN, DESIRED TURN DOWN RATIO, SAFE TO USE, ARE KEY BENEFITS.
Pure Oxygen and High Temperature Processes

Flue Gas Volume Reduction With Oxygen, Fuel-Methane, Flue Gas
at 2000 deg F, 6% excess O2

Flue Gas Volume Ratio for same Available Heat

Percent Oxygen in the Oxidant

CO2 value
Water Value
Oxygen Value
Nitrogen Value
Total Exhaust Value

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Oxygen in Combustion Processes

Effect of Percent Oxygen on Flame Temperature - Oxygen and Natural gas

Flame Temperature, Deg F

Percent Oxygen, Vol %

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The oxygen is aimed at the coke bed such that 20%-30% oxygen impacts upon the coke. The remaining 80%-70% oxygen travels over the top of the bed burning volatiles and some coke fines.
High temperature Applications

- Waste water incineration
- Spent sulfuric acid recycling
- Black liquor oxidation
- Soil decontamination
- Claus process
- CO post incineration
- Cracking of iron sulfate
- Incineration of sewage water sludge
- Liquor oxidation
- Special waste incineration
Opportunities

• Excellent economical way to handle increased Environmental loading. Increased combustion efficiencies leading to high productivity and flexibility.

• Improved Safety and increased flexibility in operation

• Reduced CO emission and significantly reduced exhaust volume

• Potential of capturing high purity CO2 that can become revenue stream with additional investment.
The Effective Purification of Industrial Waste Water

WATER OXYGENATION WITH PERFORATED HOSES

OXYGEN IN THE WASTE WATER INDUSTRY

IMPACT OF OXYGEN BUBBLE SIZE

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Liqueide phase reactions

Liquid Phase reactions:

water + air ---- water with dissolved oxygen (DO) 8 ppm at ambient conditions.

water + O₂ --- water with DO 42 ppm at ambient conditions.

water + O₂ at 100 psig -- water with DO 100+ ppm at 100 psig and 60 deg F.

Observation:

-Liquid phase reactions depend on DO in water. With higher DO aqueous reactions speed up allowing higher production.

Applications:

Fish Farming, fermentation, pharmaceutical industry waste water treatment etc.
OXYGEN SOLUBILITIES AT DIFFERENT CONDITIONS

Oxygen Saturation at Elevated Pressures

System Pressure in Bar, Gauge

O2 Conc. in MG/L or PPM

Oxygen Saturation values at 1 atm Pressure

System Temperature in deg C.

O2 Conc. in MG/L

1 bar = 14.5032 PSI, values are at T= 60 deg F.

Pure Oxygen

Air
### COMPARISON OF DIFFERENT SYSTEMS TO DISSOLVE OXYGEN

<table>
<thead>
<tr>
<th>ITEM</th>
<th>BIOX HOSE</th>
<th>OXYDATOR</th>
<th>AERATORS</th>
</tr>
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<tbody>
<tr>
<td>Investment</td>
<td>LL</td>
<td>M</td>
<td>H</td>
</tr>
<tr>
<td>Efficiency of Oxygen</td>
<td>H</td>
<td>H</td>
<td>LL</td>
</tr>
<tr>
<td>Power consumption</td>
<td>N</td>
<td>H</td>
<td>HH</td>
</tr>
<tr>
<td>Maintenance</td>
<td>LL</td>
<td>M</td>
<td>H</td>
</tr>
<tr>
<td>Flexibility</td>
<td>HH</td>
<td>L</td>
<td>N</td>
</tr>
<tr>
<td>Expandability</td>
<td>L - M</td>
<td>H - E</td>
<td>HH - E</td>
</tr>
</tbody>
</table>

**NOTE:**
- None **N**
- Very low **LL**
- Low **L**
- Medium **M**
- High **H**
- Very high **HH**
- Expensive **E**
ADVANTAGES AND BENEFITS OF OXYGEN

- Low Investment and Operating Cost
- High Oxygen Efficiency
- No Energy Consumption
- Easy to Operate (system works automatically)
- Maintenance Free
- Immediately Ready for the start up
- High Availability
- Noiseless operation
- Extendable (modular design)
- High Flexibility to meet Varying Loads
- No Odor Problem
Benefits of using Oxygen in Aquaculture such as Fish Farming

Benefits:
- High Rate of Growth
- Occupation densities up to 100 kg/m3
- Reliable regulation of the optimum oxygen content
- High resistance of the Fish to disease
- Low freshwater demand
- Favorable flow conditions in the farming tanks
Spark Free and Antibacterial Unidirectional Multipurpose Wrench:
(Patent No. US 6, 450,069 B1)

TSI has developed an unique tool for all industries that use gas cylinders. It is called Unidirectional Multipurpose wrench making the opening of cylinder valves much easier. This spark free and antibacterial wrench is a versatile patented ratchet tool that has multifunctional uses. It is designed to ensure the safe use of the tool when engaged in operation.

Its wide applications include:
..Most of the high pressure gas cylinders of different sizes
..Most of the liquid nitrogen, liquid oxygen, liquid argon cylinders or dewars
..Home Health care oxygen cylinder type E
..Welding gas cylinders type MC
..Specialty/Medical/Industrial gases Distribution centers
..Antibacterial environment such as hospitals, and medical centers
..Pharma and Biotech manufacturing and R &D operations
..Environment containing VOC, Hydrogen, or oxygen.
The one side of this unidirectional wrench is the ratchet disc with pins (Fig.1). Its special feature of being unidirectional ensures that the cylinder stem cannot be damaged by excessive torque if it was to be used for closing. The recommended method is to recess the pins of the tool into the grooves of the cylinder valve stem wheel and gently apply opening torque. This will open the valve. To close the cylinder valve, simply use hand.

(Fig 1)
The other side has two openings, one is for home health care cylinder type E and the other is for welding cylinder type, MC, (Fig 2). Simply insert the valve stem of cylinder E or MC into the appropriate opening in the wrench and slowly open the valve. To close valve, simply reverse the action. It is necessary to ensure the operator does not use excessive pressure that may damage the valve stem and may cause unexpected release of the gas cylinder content.