



## **FOR OXYGENATED AND BREATHING GAS SYSTEMS**

### HEAD OFFICE:

BIOX Ltd,  
The Granary  
Yeo Lane  
North Tawton  
Devon  
EX20 2DD  
Tel: 01837 880135  
Fax: 01837 880063  
Email: [bioxint@hotmail.com](mailto:bioxint@hotmail.com)  
Web: [www.Bioxint.com](http://www.Bioxint.com)

### NOTE:

All procedures and recommendations here under are made in good faith but without guarantee, since the conditions and methods of application are out of our control.



## TABLE OF CONTENTS

SECTION NO.	CONTENT
1	Pure oxygen or oxygen rich breathing Systems
2	Compressed air breathing systems
3	Controlled area
4	Safety
5	Pre-cleaning
6	Pre-cleaning components using Biox 02 and Biodeg liquid (CAUTION)
7	Pre-cleaning hoses using Biox 02 liquid
8	Cleaning non-metallic components using Biox 02 and Biodeg
9	Ultrasonic cleaning using Biodeg / Cleaning metallic components
10	Cleaning Hoses / Hoses fitted with metallic and non-metallic fittings
11	Flexible metallic hoses
12	Cleaning breathing gas storage cylinder valves
13	Cleaning breathing gas storage cylinders (CAUTION)
14	Inspecting breathing gas storage cylinders
15	Valve refitting
16	Pipe work cleaning - breathing gas systems - New pipe work
17	Refurbishment of existing breathing gas pipe work
18	Cleaning oxygen gauges
19	Inspecting cleaned oxygen gauges
20	Calibration of oxygen gauges
21	Inspection procedure for all cleaning processes
22	Handling, preservation and packing - Handling precautions (CAUTION)
23	Preservation
24	Sealing
25	Storage

## APPENDICES

- 1) Health and safety data - Biox '02' liquid
- 2) Mara Engineering Oxygen and mixed gas cleaning procedure  
(Lloyds Register of shipping accreditation)
- 3) Biox '02' Cleaning Procedure for mixed gas and  
oxygen breathing apparatus

## IMPORTANT

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## 1 PURE OXYGEN OR OXYGEN RICH BUILDING SYSTEMS

- a) Pure oxygen is a colourless, odourless and tasteless gas. Under pressure oxygen may cause various materials to spontaneously ignite causing fire until either the oxygen or the material is exhausted. Therefore it is of paramount importance that the components for use with pure oxygen or oxygen rich gas are thoroughly cleaned to remove all traces of oil or grease contamination obtained during manufacture.
- b) It is particularly important that all material used with pure oxygen or oxygen rich mixtures (i.e. greater than 21% oxygen content) are fully tested for compatibility at the required working pressure and that documentary evidence, in the form of Certificate of Conformity, are produced for inspection.
- c) All components in the breathing-gas path of a system, are required to be oxygen-cleaned in accordance with the procedures detailed in this document.

## 2 COMPRESSED AIR BREATHING SYSTEMS

- a) Many of the procedures set out in this document are suitable for applying to compressed-air breathing systems and any component in the breathing-gas path is to be considered as a candidate for oxygen-cleaning, as described in the procedures detailed in this document. Particular consideration is to be given to the following components:
  - i) Valves and Regulators.
  - ii) Breathing-gas cylinders.
  - iii) Manifolds.
  - iv) Breathing-gas pipe work and hoses.

## 3 CONTROLLED AREA

- a) A controlled area is defined as any working space that is not a clean room, as referenced where cleanliness control procedures create an environment free of oil, grease and dust.

## 4 SAFETY

- a) It is essential that both management and operators comply strictly with the Health and Safety at Work Act, 1974, and the Factories Act of 1961. Particular attention is to be paid to the COSHH Regulations 1989.
- b) **Hazard and data sheets must be obtained for substances recommended in this document with particular attention to the following:**
- c) Biox BioDeg A highly concentrated, nearly neutral, aqueous degreaser. It is a preparation of low order toxicity containing non-ionic surfactants. The usual cleaning solution and distilled water. Important safety aspects are:
  - i) The concentrate dissolves the natural oils of the skin therefore avoid all contact.
  - ii) Gloves and other protective clothing are recommended to be worn.
  - iii) If any external contact is made, flush the affected area with copious quantities of water.
  - iv) If any internal contact is made, see BioDeg data sheet and seek medical advice
- d) High Purity Nitrogen (N2) (White Spot - filter to 10 microns). This product is non-toxic and non-flammable gas and when used in large concentrations, will deplete the oxygen content and cylinder assemblies with areas keep an oxygen gas analyser within the vicinity. Therefore, when venting high pressure systems nitrogen, ensure that adequate ventilation is available. In enclosed areas it is to be used to monitor the oxygen level, if the level falls to below 17%, all nitrogen venting is to **CEASE** immediately.
- e) It is advisable not use Biox 02 and Biox Bio Deg on dissimilar metals, ideally clean similar items each cycle in fresh product.

## 5 PRE-CLEANING

- a) Prior to oxygen cleaning breathing gas components and hoses using solution, excessively soiled metallic items are to be pre-cleaned using Biox Biodeg liquid. This is a biological cleaning agent which, when used diluted, will remove heavy grease and post manufacturing contaminants. (Refer to Sect 6.)

# BIOLOGICAL BIOX

## OXYGEN CLEANING PROCEDURES COMBINING: BIOX '02' IMMERSION FLUID BIOX BIODEG ULTRASONIC EQUIPMENT



### 6 PRE-CLEANING COMPONENTS USING BIOX 02 LIQUID AND/OR BIODEG WITH ULTRASONIC CLEANING

#### CAUTION

**DAMAGE TO EQUIPMENT.** The cleaning units are controlled by an 'on-pulse timer and in sequence should not be interrupted once the program has commenced. To this effect, operators are to ensure that:

- a) When a program has commenced, no attempt is made to change or interrupt that program.
- b) If there is a requirement for the program to be reset or altered, the selector switch is first set to OFF and then the sequence restarted.
- c) **Using an ultrasonic cleaner, pre-clean components as follows:**
  - i) Remove any loose particles of paint from
  - ii) Fill the ultrasonic bath tank with Biox 02 liquid or Biodeg for pre wash, dilute depending upon degree of contamination.
  - iii) Place components on the suspended screen in the ultrasonic bath tank and ensure they are completely immersed in the Biox 02 liquid or Biodeg as appropriate.

Place small components, that may fall through the screen, in a fine wire mesh tray or container first, and ensure they are completely immersed in the liquid.

- iv) With Biox 02 Liquid in Tank, set the 3-position selector switch to WASH, this activates the heater pads. When the Biox 02 liquid reaches a temperature of between 55C and 70C, the thermostat will operate to activate the 6 min timer and ultrasonic cleaning cycle.
- v) On completion of the cleaning cycle, slowly remove the screen from the liquid and allow to drain.

#### NOTE

**Biox 02 liquid or Biodeg may be used repeatedly, therefore it is not necessary to dispose of the bath tank contents after use.**

- vi) Drain the Biox 02 liquid from the bath tank into a suitable container, refill with clean fresh water and replace the screen complete with components.
- vii) Set the 3-position selector switch to Rinse, thus activating the 6 min rinse cycle.

- viii) On completion of the rinse cycle, remove the screen and allow the components to drain. Carry out the oxygen cleaning procedures to follow in section 8 onwards.

- d) When an ultrasonic cleaner is not available, immerse components in a suitable container filled with Biox 02 liquid or Biodeg for pre soak. Empty container and soak components in Biox 02 for a period of approximately one hour. After which, remove and rinse in clean fresh water. On completion, carry out the oxygen cleaning procedure.

### 7 PRE-CLEANING HOSES USING BIOX 02 LIQUID Pre-clean hoses as follows;

- a) Remove any loose particles.
- b) Heat Biox 02 liquid to 50oC.
- c) Fill hose and leave to soak for approximately one hour.
- d) Drain off liquid, flush through with clean fresh water and allow to drain.
- e) On completion, carry out the oxygen cleaning procedures from section 10 onwards.

### 8 CLEANING

#### Cleaning non-metallic components using Biox 02 Liquid and Biox Biodeg.

- a) Cleaning operations must only be carried out in controlled areas as defined in Section 3. The recommended cleaning procedures are detailed as follows:
  - i) Ensure that any necessary pre-cleaning has been carried out with Biox Biodeg or Biox 02 as detailed in Sections 6c or 6d.
  - ii) Immerse all the plastic or rubber components in to solution of Biox 02 Liquid neat and agitate until all oil, grease and particulate contamination have been removed. This solution is to be used exclusively for plastic and rubber components and is to be changed at regular intervals to maintain its cleaning action.
  - iii) When the components are clean, remove them from the solution and place on the suspended screen in the ultrasonic bath tank, which should be filled with clean distilled water.

Place small components, that may fall through the screen, in a fine wire mesh tray or container. Ensure that all components are completely immersed in the water.



- iv) Set the 3-position selector to RINSE, activating the 6 minute rinse cycle of the unheated water.
- v) The clean components are to be inspected as described in Section 21. If a further 6 minute cycle is required, set the selector to OFF and then back to RINSE.
- vi) Dry all the components thoroughly in the controlled area, either by natural evaporation or by use of the RS heat gun.
- vii) All parts that are not assembled immediately or installed into the system are to be identified and packed as detailed in Sections 22, 23 and 24.

## **9 ULTRASONIC CLEANING METALLIC COMPONENTS USING BIOX 02 LIQUID.**

- a) Proceed as follows:
  - i) Ensure that any necessary pre-cleaning has been carried out as detailed in Sections 6c and 6d.
  - ii) Place the component on the suspended screen in the ultrasonic bath ensuring that they are totally immersed in the Biox 02 Liquid either neat or 4 parts water :1 part Biox 02. Place small components that may fall through the screen, in a fine wire mesh tray or container, and ensure that they are completely immersed in the solution.
  - iii) Set the 3-position selector to WASH, this activates the heater pads. When the solution reaches 50 C the thermostat will operate to activate the 6 minute timer and ultrasonic cleaning cycle.
  - iv) On completion of the cleaning cycle, slowly remove the screen from the solution and allow the liquid to evaporate.
  - v) Drain the contaminated solution from the bath tank into a suitable container ready for disposal.
  - vi) Refill the bath tank with clean distilled water and replace the screen complete with components.
  - vii) Set the 3-position selector to RINSE, activating the 6 minute rinse cycle of unheated water.
  - viii) The cleaned components are to be inspected as described in Section 21. If a further 6 minute rinse cycle is required, set the selector to OFF and then back to RINSE.

- ix) Dry all components thoroughly in the Controlled Area, either by natural evaporation or by use of the RS heat gun.
- x) All parts that are not immediately assembled and installed into the system should be identified and packed as described in Sections 22, 23 and 24.

## **10 CLEANING HOSES FITTED WITH METALLIC AND NON-METALLIC FITTINGS.**

- a) The procedure for cleaning hoses with metallic or non-metallic fittings, is detailed as follows:
  - i) Ensure that any necessary pre-cleaning has been carried out as detailed in Section 7.
  - ii) Set up a loop system of hoses using adapters between various hose lengths. Immerse in Biox 02 liquid at approximately 50°C ready to clean the hoses.
  - iii) Flush the hose loop at least three times with Biox 02 (4 parts water :1 part Biox 02) solution, replacing the soiled solution between each flushing cycle. Determine an acceptable flow rate of litres per minute by multiplying the internal hose diameter (mm) by a factor of 0.3.
  - iv) Drain the Biox 02 solution and rinse the hose loop with clean fresh water, heated to approximately 50°C and at the flow rate calculated at Step iii). Repeat this procedure, using new flushing water each time, at least five times or until the water ceases to foam.
  - v) The cleaned components are to be inspected as detailed in Section 21.
  - vi) Remove the hose loop from the cleansing loop and suspend from suitable securing points for a minimum period of 24 hours to allow the hoses to drain.
  - vii) On completion of the draining period, connect the hose loop to a supply of high purity nitrogen heated to 50C. Adjust the nitrogen flow rate to allow a minimum 1/2 bar gauge pressure gas flow through the hose. Continue gas purging for 20 minutes and on completion seal each end of the hose using oxygen-clean metallic plugs.
  - viii) Cleaned hoses that are not immediately assembled and installed into the system should be identified and packed as detailed in Sections 22, 23 and 24.





## 11 FLEXIBLE METALLIC HOSES

- a) The procedure for cleaning flexible metallic hoses is detailed as follows:
  - i) Ensure that any necessary pre-cleaning has been carried out as detailed in Section 7.
  - ii) Remove all non-metallic items such as seals etc. from the hose.
  - iii) Externally clean the hose assembly using diluted warm Biodeg at 12.5% dilution rate.
  - iv) Place the hose in an oven heated to a temperature of between 70C. and 80C. for a minimum period of 30 mins.

### NOTE

**The time duration is dependent upon the temperature of the fluid, hose diameter and hose length.**

- v) Depending on the length of hose, internally clean the hose using Biox 02 Liquid (4 parts water : 1 part Biox 02) solution supplied under pressure, allowing a period of 15 minutes to soak.
- vi) Inspect a sample of discarded solution from the hose for contamination as described in Section 21.
- vii) Repeat Step v) until the sample of discarded solution is seen to be uncontaminated. Biox 02 Liquid is then blown from the pipes and back into the tank using clean, dry air. Potable water is then pumped through the pipes to remove any remaining droplets of Biox 02 Liquid solution. Flushing out of the system in this way is continued until the difference in PH value is less than 1 PH..
- viii) Place the hose in an oven heated to a temperature of between 70C. and 80C. for a minimum period of 30 minutes to allow any liquid to evaporate

### NOTE

**The time duration is dependent upon the temperature of the of the solution, hose diameter and hose length.**

- ix) Turn the oven off. Leave the hose in the oven until it has cooled to the ambient temperature.
- x) Option - (if stated on the drawing) purge and fill with white spot nitrogen.

- xi) Cleaned hoses that are not immediately assembled and installed into the system should be identified and packed as described in Sections 22, 23 and 24.

**Note:** For more detail cleaning procedures please see the Mara Data Pack on Hyper baric cleaning of pipe work.

## 12 CLEANING BREATHING GAS STORAGE CYLINDER VALVES

- a) Proceed as follows:
  - i) Remove any non-metallic items, such as seals etc.
  - ii) Remove any loose particulate and thread tape by gently cleaning with a wire brush.
  - iii) Strip down the valve to its component parts and inspect for wear and damage. Discard worn or damaged items, and replace with new.
  - iv) Pre-clean component parts as described in **Section 6c**.
  - v) Clean all component parts as described in **Section 9**.
  - vi) Inspect the cleaned components as described in **Section 21**.
  - vii) Reassemble the valve assembly in a Clean Room using oxygen-clean tools to ensure the components are free from contamination.
  - viii) All items that are not immediately assembled and installed into the system, should be identified and packed as detailed in Sections 22, 23 and 24.

### NOTE

**All replacement components used are to be cleaned in accordance with the appropriate paragraphs prior to assembly, or certified oxygen-clean.**

## 13 CLEANING BREATHING GAS STORAGE CYLINDERS

### CAUTION EQUIPMENT DAMAGE.

The temperature of the steam is not to exceed 150°C. If this is exceeded mechanical damage will be experienced in aluminium alloy cylinders (BS 5430 Part 3, Para 4.2.3 (1990) refers).

- a) Proceed as follows:
  - i) Remove the valve assembly.



- ii) Carefully remove any grease deposits from around the neck and thread area.
- iii) Using an oxygen-clean endoscope, inspect the inside of the cylinder for any signs of internal corrosion, blemish or foreign material.
- iv) All internal blemishes or corrosion to be removed by bead blasting. Once inspected fill with warm Biox 02 Liquid ideally neat (but could be diluted if necessary) for 15-20 minutes depending upon contamination.
- v) After soaking empty Biox 02, for reuse or dispose off as necessary. Place the cylinder vertically (neck down) onto a steam cleaning manifold.
- vi) Using a steam generator capable of producing a continuous quantity of clean, oil free, saturated steam, of 150 Deg. C. at a pressure of not less than 2 bar, circulate the steam for a period of:
  - a. 5 minutes for cylinders of 2 litre or less capacity.
  - b. 10 minutes for cylinders over 2 litre capacity.
- vii) On completion of steam cleaning remove the cylinder from the manifold and allow it to drain for ten minutes to dry. Purge the cylinder with white spot nitrogen at a pressure of 1 bar, for a minimum period of 5 mins depending on the cylinder capacity.
- viii) The cylinder must be either, immediately re-valved, or capped with an oxygen-clean cap, and the cylinder marked or labeled 'Oxygen-Clean'.
- iv) Tape must not start closer than two threads from the valve open end.
- v) Use only 1½ turns of tape.
- vi) Do not touch the threads unnecessarily.

**b) Proceed as follows:**

- i) Refit the valve and tighten to the specified torque level.
- ii) Charge the cylinder to its working pressure with high purity nitrogen.
- iii) Using soapy water, leak test at the following positions:
  - a. Joint between the valve and cylinder.
  - b. Valve spindle.
  - c. Valve seat.
- iv) On satisfactory leak testing, exhaust the cylinder to a 7 bar holding charge and label accordingly.

**16 PIPE WORK CLEANING - BREATHING GAS SYSTEMS - NEW PIPE WORK**

- a) On completion of manufacture, new pipe work, up to 10 metres long is to be cleaned using the following procedure which must be strictly adhered to and documented to show full compliance:
  - i) Inspect the completed pipe work internal bores using a suitable clean endoscope.
  - ii) Carefully and thoroughly inspect the areas around couplings and adaptors for general manufacturing debris, e.g. grease, bronze particles and release agents.
  - iii) Clean the pipe work by flushing with steam. Use a steam generator capable of producing continuous quantities of clean, oil free, saturated steam, at a pressure not less than 2 bar at 150 Deg. C, for a minimum cleaning period of 10 minutes.
  - iv) Alternatively the pipe work can be cleaned by flushing with a solvent fluid, (i.e. Isopropyl-Alcohol). Biox Biodeg can also be used for degreasing.
  - v) On completion of steam or solvent fluid cleaning, the pipe work is to be filled with Biox 02 Liquid (4 parts water :1 part Biox 02) and left for 1 hour.

**14 INSPECTING BREATHING GAS STORAGE CYLINDERS**

- a) Owing to the difficulty of inspecting storage cylinders on completion of cleaning, the cleaning process, if followed correctly, will ensure an oxygen clean cylinder. Inspection is limited to that detailed in Section 21.

**15 VALVE REFITTING**

**a) NOTES**

- i) Only oxygen clean valves and O-rings are to be used.
- ii) Only minimum quantities of high pressure (205 bar) oxygen compatible grease are to be used, e.g. 'FOMBLIN' Type YNX.
- iii) Only PTFE tape is to be used on taper threads. (Beldam Crossley Ltd, Type S.3313.)



## **b) NOTE**

- vi) After 1 hour, the pipe work, filled with Biox 02 solution, is to be drained and flushed with demineralised water. Inspect samples as detailed in Section 21.
- vii) On completion of flushing, the pipe work is to be dried by circulating heated high purity nitrogen.
- viii) When dry, the pipe work is to be inspected using a suitable clean endoscope. If the pipe work is clean, seal each end using clean metallic blanking caps or suitable sealed polythene bags.
- ix) If the brazing debris is not removed by the process detailed in Steps iii) to vi), it may be necessary to brush it off using a hard nylon brush. On completion of brushing, repeat the clean process detailed at Steps iii) to vi).

## **17 REFURBISHMENT OF EXISTING BREATHING GAS PIPE WORK**

- a) Proceed as follows:
  - i) Using a suitable clean endoscope, fully internally-inspect the pipe work for corrosion and braze; flux debris.
  - ii) Ensure that the endoscope instrument has suitable line adaptors, to allow any damaged area to be photographed. A record is to be kept of all internal damage or corrosion.
  - iii) If any corrosion or braze debris is present, it is to be removed using a hard nylon brush.
  - iv) Proceed to clean the pipe work as described in Section 16.

## **18 CLEANING OXYGEN GAUGES**

- a) Generally, suspect oxygen pressure gauges are to be replaced by new certified items.

## **19 INSPECTING CLEANED OXYGEN GAUGES**

- a) All oxygen gauge connectors are to be inspected as described in Section 21. The internal Bourdon tube cannot be inspected using readily available methods.

## **20 CALIBRATION OF OXYGEN GAUGES**

- a) The calibration of oxygen gauges is to be carried out using a dedicated oxygen clean, dead-weight tester and high-purity nitrogen as the calibration medium.
- b) Alternatively, gauges with a full scale deflection up to 210 bar, may be calibrated using a standard dead-weight tester fitted with an oil seal (viton sac) and using a calibrating medium of demineralised water or solvent fluid.
- c) All adaptors and connectors used during calibrations must be cleaned using a suitable solvent fluid and inspected with an ultraviolet light source.
- d) During the calibration of a batch of gauges, periodic checks on the calibration equipment must be carried out to ensure that the cleanliness standard of that equipment remains at an acceptable level as detailed in Section 21.
- e) On completion of calibration, using high purity nitrogen, gauges are to be flushed for 5 pressurising / vacuuming flushing cycles. On completion of cleaning or calibrating, gauges are to be identified and packed as detailed in Sections 22, 23 and 24.

## **21 INSPECTION PROCEDURE FOR ALL CLEANING PROCESSES**

- a) Inspection of equipment after cleaning processes are completed is as follows:
  - i) All inspection equipment is to be checked, using a long wave ultraviolet light (3600-3900 Angstrom), for oxygen cleanliness, i.e. free of areas of fluorescence.

## **b) NOTE**

**When illuminated by the ultraviolet light, deposits of hydrocarbon (oil or grease) will fluoresce.**

- ii) Gauges, breathing gas cylinders and end fittings are to be checked around the connector area, using ultraviolet light, for oxygen cleanliness.
- iii) A sample of the final cleaning solution is to be allowed to evaporate in a porcelain dish or similar receptacle.





iv) When dry, the receptacle is to be inspected as follows:

- a. Check under normal white light, that there are no fibre particles or liquid visible.
- b. Check there is no visible area of fluorescence in the receptacle when viewed under ultraviolet light.
- c. Use a clean White filter paper to wipe the receptacle and check that there is no visible fluorescence when viewed under an ultraviolet light.

v) If any contamination is detected during checks detailed in Step iv), the component is to be re-cleaned until free of all contamination.

vi) All end connections of gauges and cylinders are to be inspected using the long wave ultraviolet light.

## 22 HANDLING, PRESERVATION AND PACKING HANDLING PRECAUTIONS.

**Operators must ensure that gloves are worn before commencement of these operations.**

- a) Procedures for handling are as follows:
  - i) Sealing and packing is only to be carried out in a controlled area free of oil or dust contamination.
  - ii) Packaging material damaged during packing is not to be used.
  - iii) Packaging material is to be free from contamination.
  - iv) Care is to be taken when handling packed and sealed components to maintain the integrity of the sealing and packaging.
  - v) Gloves are to be worn when removing oxygen-clean items for use from their packaging.
  - vi) Any item in an opened or damaged package is NOT to be used for Oxygen service. Such items are to be considered contaminated and must NOT be used until they have been oxygen-cleaned.

## 23 PRESERVATION

- a) No preserving medium is to be used on oxygen-clean items.

## 24 SEALING

a) Procedures for sealing components and their packaging are as follows:

- i) Items cleaned for oxygen use are to have their apertures carefully cleaned. Any internal fitted plastic bungs, tape or other methods of sealing apertures that may lead to material becoming lodged inside the aperture, are NOT to be used.
- ii) Oxygen - clean items are to be heat-sealed in two polyethylene bags with an oxygen warning label placed between the layers.
- iii) If the heat-sealer is not available self-sealing polyethylene bags are to be used.
- iv) Items are only to be sealed in a controlled area as defined in Section 3.

## 25 STORAGE

a) Storage procedures are as follows:

- i) Cleaned items are to be stored in a sheltered area and are not to be subject to any adverse weather conditions, flooding or accidental damage. The storage area temperature is to be maintained between -130 C. and +550 C. Storage under tarpaulins is not permitted.
- ii) Packages containing cleaned items are to be visually inspected by the store keeping authority as follows:
  - a. On receipt.
  - b. After any movement of the item(s) within the store.
  - c. Immediately prior to use.
- iii) If the package or package sealing of a cleaned item is found to be damaged, defective or inadequate and any doubt is raised regarding the integrity of the sealing arrangements, the item is NOT to be used.

## b) NOTE

**Items received from contractors with damaged sealing or packing arrangements are NOT to be accepted for service.**