

## ULTRA-CLEANLINESS FOR APPLICATIONS INVOLVING OXYGEN

An extremely clean surface is required for components and systems that are used for production, storage and transport and come into contact with liquid or gaseous oxygen. An ultra-clean surface may also be required for the production of other gases (such as nitrogen, argon, neon etc) where the purity of the gas is important.

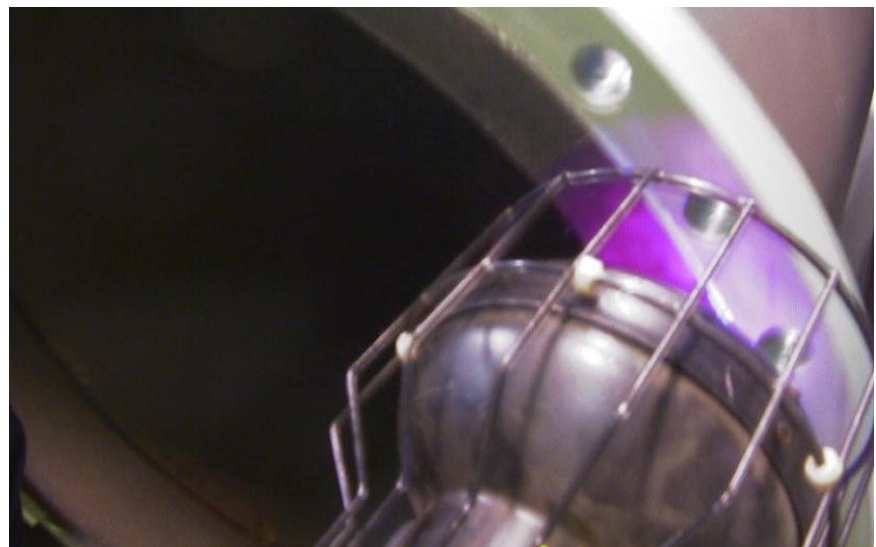
Ultra clean surfaces are necessary for oxygen production because the smallest traces of contamination will inflame spontaneously if they come into contact with pure oxygen and may even lead to an explosion! Ultra-cleanliness thus means the absence of:

- grease, oil and other organic materials (hydrocarbon compounds)
- water
- varnishes, paint systems and other coatings
- loose rust, mill-scale, fillers, welding discolouration and welding spatters.

### Cleaning

The components to be cleaned for oxygen production can be piping, heat exchangers, air coolers, filters, compressor housings etc. In addition the type of cleaning required depends on both the amount of contamination and the type of material involved. The most common materials are stainless steel and carbon steel, but copper alloys, aluminium, nickel and chromium are also used. Often the surface treatment involves only degreasing. This is usually carried out using hot alkaline cleaners.

Components made of carbon steel, such as a compressor, generally receive extensive treatment, because the presence of any rust contamination is not acceptable. After degreasing the steel, there is a chance of flash rust. To prevent this, surface treatment is carried out using VPX One Step<sup>®</sup>. This pickling and passivating product, based on phosphorus compounds, removes flash rust and passivates the surface by



creating an iron phosphate layer in one step. The VPX One Step<sup>®</sup> working solution has a neutral pH-value, can be used for both the immersion and circulation methods and is particularly suitable for oxygen applications.

If stainless steel has been welded, the typical surface discolouration (heat tints) must be removed by a pickling and passivating treatment. Before pickling, the surface is thoroughly degreased. The pickling treatment is carried out with a solution based on nitric acid and hydrofluoric acid. By flushing with demineralised water the stainless surface will form a clean passive chromium oxide skin from a reaction with oxygen in the air. When components have surfaces that are difficult to reach, due to relatively small distances between individual parts, such as filters, ultrasonics can be used to reinforce the cleaning effect. In combination with a cleaning agent that is specially developed for ultrasonic use, ultrasonic waves loosen the contamination (mainly grease, carbon and other organic materials).

### Inspection

To check whether the cleaning has met the requirements and because the cleanliness requirements for oxygen applications are severe, intensive inspection is carried out on the treated components:

#### UV test

Most organic materials (greases, lubricants, oils etc.) fluoresce when they are placed in a darkened area and the surface is lit by ultraviolet light (Black light, see photo above). This method can be used for visual inspection of the surface.

#### Wipe test

A wipe test is carried out using a white cloth and is mainly used on locations that are difficult to reach by means of UV light. After wiping approximately 1 m<sup>2</sup>, the cloth is inspected, also using UV light, for the presence of organic materials.

#### Solvent extraction

The quantity of hydrocarbon compounds can be determined by applying a strong solvent to the surface (methylene chloride for example). An

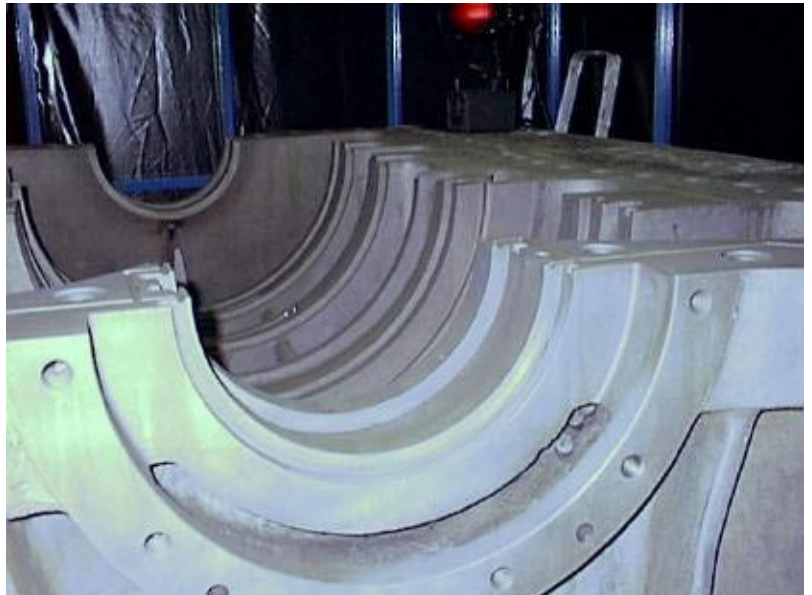
exact quantity of solvent for a given surface area is flushed on the surface - 1 litre of solvent comes into contact with 1 m<sup>2</sup> of the surface. The solvent is collected and the quantity of hydrocarbon contamination is determined gravimetrically. The result is expressed in milligrams (mg) of hydrocarbon contamination per square meter (m<sup>2</sup>). A frequently encountered requirement (or specification) is that the amount of residual hydrocarbon must be less than 100 mg/m<sup>2</sup>.

#### Final approval

After cleaning and inspection, components are carefully packaged to avoid contamination. Also a certificate of ultra-cleanliness is drawn up, including the results of the inspections carried out. Reference is often made to standard specifications.

Vecom has all the required techniques at its disposal for making components, that are subject to stringent requirements because they are used for the production, storage and transport of oxygen and other gases, ultra-clean.

Author: ing. T. van Os (Laboratory)  
Reactions and/or questions: e-mail: [tb@vecom.nl](mailto:tb@vecom.nl)



above: a compressor housing is treated with the VPX One Step method  
below: inspection of a compressor housing in a darkened room



Ref.  
Standard D.I. CS274.01d Air Liquide  
Standard Oxygen Clean (Class AA) 4WPI-SW70003 (2005) former A03 norm Air Products  
Linde Class 2 (oxygen) cleaning revised issue 1981