

Essential Information

Introduction

This directory was developed to provide important information and comparable data to assist in the selection of precision cleaning agents that may be suitable for oxygen service. The inclusion of any product in this directory is not an endorsement, recommendation, or approval by the Compressed Gas Association of the product for use in any application.

Comparative Parameters

The directory provides comparative information for both aqueous and solvent cleaners, as provided by the manufacturers, on items such as evaporation rates, corrosivity, pH, residue potential, flammability, health hazards, Threshold Limit Value (TLV) and Permissible Exposure Limit (PEL) factors, ozone depletion rating, EPA Clean Air Act, RCRA Hazardous Waste, and SNAP List Material Compatibility.

Cleaning Efficiency Factor (CEF)

The CEF was determined by testing each cleaning agent at an independent laboratory using ASTM protocols; ASTM G-121, *Practices for Preparation of Contaminated Test Coupons for the Evaluation of Cleaning Agents for Use In Oxygen-Enriched Systems and Components*, and ASTM G-122, *Standard Test Method to Evaluate the Effectiveness of Cleaning Agents*.

Standard Tests

The procedures for the standard CEF test for aqueous cleaners require a concentration of 5 percent at 150 °F immersed for 10 minutes without agitation. Solvents are tested by immersion for 2 minutes at room temperature without agitation. The manufacturers' recommendations for actual use may vary significantly from this procedure. It is important to understand that the CEF number is a cleaning efficiency factor based only on set parameters for the standard test procedure.

Nonstandard Tests

In addition to the standard test, the opportunity to request a nonstandard test was available to the cleaning agent suppliers to allow the use of alternative procedures and parameters involving concentration, temperature, time, and agitation. Such tests are so identified.

References

Precision cleaning for oxygen service requires many considerations. If you are cleaning equipment for oxygen service, you should be familiar with the following publications:

- ◆ CGA G-4.1, *Cleaning Equipment for Oxygen Service*, which is available from the Compressed Gas Association at (703) 412-0900, extension 799,
- ◆ ASTM G-127-95, *Standard Guide For the Selection of Cleaning Agents for Oxygen Systems*, and
- ◆ ASTM G-93-96, *Standard Practice for Cleaning Methods and Cleanliness Levels for Material and Equipment Used in Oxygen-Enriched Environments*, which are available from the American Society for Testing Materials at (610) 832-9585.

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Standard CEF Test Procedures

Testing of Cleaning Agents per ASTM G-121 and ASTM G-122

- Test Coupons:** Six per test (five plus one control): Coupons are 304 stainless steel in accordance with ASTM G-121, except mill finished instead of glass bead blasted. Coupons shall be used a maximum of 20 tests. Coupons shall be cleaned between tests. 1,1,1-trichloroethane or methylene chloride are acceptable cleaning fluids.
- Contaminant:** Hydrocarbon oil (Mobil 600)
- Contaminant Level:** 1615±538 mg/m² applied to one side of the coupon with swabs and/or wipes.
- Temperature:** Solvent based = 75±5 °F (23.9±2.8 °C) ; Aqueous based = 150±5 °F (65.6±2.8 °C)
- Immersion:** Coupons immersed in individual beakers 500 ml each. To avoid any possibility of cross-contamination, especially with the control coupon, separate 500 ml beakers should be used with each coupon.
- Immersion Time:** Solvent based = 2 minutes; Aqueous based = 10 minutes
- Rinse:** Solvent based, no rinse. Aqueous based, 5 minute "soak" with ASTM Type II water by immersing in a beaker (no flow).
- Dry:** Hang dry
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Solvent Evaporation Rate

Each solvent manufacturer has provided a comparative evaporation rate (Butyl Acetate=1.0) if known. The ability of a solvent to evaporate quickly is extremely important in cleaning applications.

Residual Solvents/Cleaners

A cleaning agent remaining in an oxygen system is a severe hazard. It is essential that residual cleaning agent (in hidden areas, crevices, or porous surfaces) be completely removed. This factor has equal importance to the CEF.

Selection of Cleaning Agent

The type of cleaning application involved is an important element in selecting the best cleaning agent for the job. We recommend that you contact the cleaning agent suppliers for further details involving performance and application. The suppliers' telephone numbers are available in the directory.

PLEASE NOTE:

The information contained in this document was obtained from the manufacturers of cleaning agents and from the test results of those agents. The tests were performed by independent laboratories and were based on ASTM protocols. The Compressed Gas Association is reprinting this information as obtained from the manufacturers and the laboratories and makes no representation as to the accuracy or completeness of such information.

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Recommended Practices for the Selection of Cleaning Agents for Equipment in Oxygen-Enriched Service

The following recommended practices address precision final cleaning for oxygen service. For equipment with gross contamination, a precleaning step needs to be done before the final cleaning. Precleaning can be done by mechanical methods such as wire brushing, swabbing, vacuum cleaning, and blasting and/or with more aggressive/corrosive chemical treatments using caustic or acid solutions.

The effectiveness of cleaning methods applied to equipment used in oxygen-enriched service is strongly influenced by:

- the chemical nature of contaminants to be removed;
- the configuration and complexity of equipment to be cleaned;
- the processing parameters such as mechanical/ultrasonic energy, temperature, and concentration of cleaning agents employed for the cleaning operation; and
- the detailed cleaning procedures.

As a result, the cleaning efficiency factors (CEF) published in this *Directory of Cleaning Agents for Oxygen Service* reflect neither the best nor the worst cleaning efficiencies that one may achieve in a cleaning operation. To obtain a representative CEF that is pertinent to the equipment of interest, it is necessary to conduct an evaluation using specific cleaning agents under the environmental conditions expected in actual service in accordance with standard operating procedure. The CEF is only one dimension of the oxygen cleaning process. The following are recommended practices to assist oxygen cleaning practitioners in the selection of suitable cleaning agents for oxygen-enriched service.

- Obtain a copy of the existing cleaning procedures that were developed for either aqueous or nonaqueous cleaning agents. If there are no existing cleaning procedures, efforts should be made to develop a preliminary one, which can then serve as a reference for evaluation of specific cleaning agents. Since drop-in replacements to hydrofluorocarbon cleaning agents such as CFC 113 (1,1,2-trichloro-1,1,2-trifluoroethane) and/or 1,1,1-trichloroethane (methyl chloroform) are yet to be developed and most market-available cleaning agents are generally less tolerant to deviations from their proven cleaning effectiveness test conditions, detailed cleaning procedures need to be developed based on the test results obtained from an evaluation of the cleaning agent. In some cases it is necessary to repeat the cleaning process, which can be time consuming and capital intensive.
- Select nonaqueous or aqueous based cleaning agents based on the chemical nature of the cleaning agents as well as contaminants that might be present; the level of oxygen enrichment that will occur; the complexity of the equipment; the chemical compatibility (such as corrosion) with the equipment; the overall cost of the cleaning agents and peripheral processing accessories; and the personnel training and in-house facility to comply with local environmental, safety, and disposal regulations. Nonaqueous cleaning agents may be more appropriate for equipment configurations such as valves, heat exchangers, compressors, etc. with crevices, intricate passages, and/or inaccessible areas where visual/instrumental inspection and removal of cleaning agents is restricted. In another application, fabrication of process piping can use a high pH value for the aqueous cleaning agent to prevent etching of the pipe material, which can be detrimental to welding quality. For medical, breathing, or USP oxygen piping applications, exercise extreme care in the selection and use of cleaning agents so that there is no inhalation hazard to individuals. Consult NFPA 99, *Standard for Health Care Facilities*, Chapter 4 for guidance.
- Select a cleaning agent with a higher CEF for the evaluation of the cleaning of equipment that is representative of the majority of applications that are expected to be cleaned in the future. The evaluation should be conducted under similar environmental conditions to those expected in actual use in accordance with stan-

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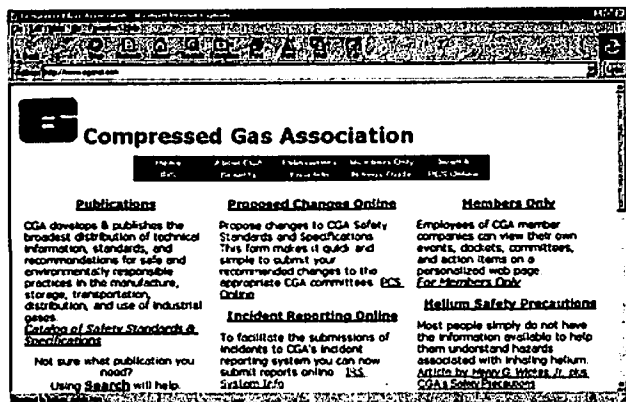
standard operating procedures. The results should be evaluated against a measurable contamination concentration (representative of a level of cleanliness) determined and validated by test results.

- If a nonaqueous cleaning agent is used, select one with a low level of nonvolatile residue (NVR) and ensure that all of the cleaning agent has been drained from the system and all remaining traces are thoroughly evaporated to dryness before the introduction of any oxygen-enriched fluids.
- If an aqueous cleaning agent is used, ensure that the cleaning process is followed by a rinsing step using a sufficient quantity of clean, potable or deionized (DI) water. All water must be drained from the system, and all traces must be thoroughly evaporated before introduction of oxygen-enriched fluids. It is important to carry out the rinsing step immediately after the cleaning process and before the cleaning agent has dried since all aqueous cleaners leave NVRs after the contained water evaporates. Potable water will frequently leave "water spots" after rinsing and drying. These mineral deposits are the result of the hardness of the water and are typically harmless in contact with oxygen.

Any residual cleaning agents remaining in a system containing oxygen-enriched fluids could result in serious consequences once oxygen-enriched fluids are reintroduced into the system. Most aqueous and nonaqueous cleaning agents are not compatible with oxygen, or may leave behind an NVR that is not oxygen-compatible. Consult a cleaning agent manufacturer for the compatibility of the cleaning agent with the material to be cleaned as well as with oxygen. It is important to emphasize that the primary consideration for selection of cleaning agents for oxygen service is their effectiveness in removing contaminants from equipment in accordance with a specific cleaning procedure. Since most cleaning agents are not compatible with oxygen, it is necessary to ensure that no residual cleaning agents are left behind in the equipment after the cleaning operation, the equipment is drained and rinsed thoroughly where appropriate to the nature of the cleaning agent, and all traces of the cleaning agent are evaporated to dryness with dry, oil-free compressed air or inert gas stream.

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 Phone: 609-386-8770 Fax: 609-386-8438
 E-mail: mkt@ipcol.com

PROPERTIES

Type of Cleaner:	Concentrated Aqueous Detergent		
Active Ingredient:	Surfactants		
CAS Number	Mixture		
Cleaning System Options:	Immersion: Yes	Spray Wash: No	Wipe: Yes
Practical Use and Procedure Summary:	Make solutions of 1% to 2% in water, in temperatures from ambient to 150 °F, rinse thoroughly.		
Cleaning Ability per Contaminant - Test Method:	ASTM G121/122		
Contaminant:	Mobil 600		
Average Initial Contamination Level (mg/m ²):	1735		
Method:	Immersion		
Time (minutes):	10 minutes		
Cleaning Effectiveness Factor (CEF):	0.96 (Accuracy factor ±.01)		
Evaporation Rate Referenced to Butyl Acetate:	N/A	Flammability	
Vapor Pressure (mm Hg at 20 °C):	N/A	Flammable	No
Corrosivity (Al, Cu, Fe):	May etch aluminum	Combustible	No
pH:	9.5	Flash Point	None
Residue Potential:	Negligible if rinsed thoroughly	LEL (%)	N/A
		UEL (%)	N/A

CEF = 0.96

ENVIRONMENTAL FACTORS

Health Hazard (MSDS):	Eye irritant
Carcinogen:	No
TLV-TWA (ppm):	Not determined
Carcinogen per CA Prop 65:	No
Sara Title III Section 313 Toxic:	None
OSHA PEL, PPM:	Not determined
ACGIH TLV, PPM:	Not determined
Acute Derma LD ₅₀ mg/kg H < 4,300:	Not determined
Acute Inhalation LD ₅₀ mg/m ³ H < 10,000 PPM:	Not determined
Fish Toxicity 96 HR LC ₅₀ , mg/L H, 500 mg/L:	Not determined
Ozone Depleting:	No
Volatile Organic Compound (Global Warming Issue):	None
EPA Clean Air Act Hazardous Air Pollutant:	No
RCRA Hazardous Waste:	No
On SNAP list:	Yes

OTHER

Storage Period:	1 year
Ease of Disposal/Recyclable:	No restrictions
Special Handling:	Normal handling procedures
Material Incompatibility:	Chlorine-based materials, aluminum, zinc
Warranty:	1 year
Availability:	Worldwide, orders normally shipped within 24 hours
Price/Unit:	Call 609-386-8770
Additional Information:	

MICRO-90[®] — Nonstandard Test

Aqueous

International Products Corp., P.O. Box 70, Burlington, NJ 08016-0070
 Phone: 609-386-8770 Fax: 609-386-8438
 E-mail: mkt@ipcol.com

PROPERTIES

Type of Cleaner:		Concentrated Aqueous Detergent	
Active Ingredient:		Surfactants	
CAS Number		Mixture	
Cleaning System Options:		Immersion: Yes	Spray Wash: No Wipe: Yes
Practical Use and Procedure Summary:		Make solutions of 1% to 2% in water, in temperatures from ambient to 150 °F, rinse thoroughly.	
Cleaning Ability per Contaminant - Test Method:		ASTM G121/122	
Contaminant:		Mobil 600	
Average Initial Contamination Level (mg/m²):		1532	
Method:		Immersion	
Time (minutes):		10 minutes	
Cleaning Effectiveness Factor (CEF):		0.99 (Accuracy factor ±.01)	
Evaporation Rate Referenced to Butyl Acetate:		N/A	Flammability
Vapor Pressure (mm Hg at 20 °C):		N/A	Flammable No
Corrosivity (Al, Cu, Fe):		May etch aluminum	Combustible No
pH:		9.5	Flash Point None
Residue Potential:		Negligible if rinsed thoroughly	LEL (%) N/A
			UEL (%) N/A

CEF = 0.99

ENVIRONMENTAL FACTORS

Health Hazard (MSDS):	Eye irritant
Carcinogen:	No
TLV-TWA (ppm):	Not determined
Carcinogen per CA Prop 65:	No
Sara Title III Section 313 Toxic:	None
OSHA PEL, PPM:	Not determined
ACGIH TLV, PPM:	Not determined
Acute Derma LD₅₀ mg/kg H < 4,300:	Not determined
Acute Inhalation LD₅₀ mg/m³ H < 10,000 PPM:	Not determined
Fish Toxicity 96 HR LC₅₀, mg/L H, 500 mg/L:	Not determined
Ozone Depleting:	No
Volatile Organic Compound (Global Warming Issue):	None
EPA Clean Air Act Hazardous Air Pollutant:	No
RCRA Hazardous Waste:	No
On SNAP list:	Yes

OTHER

Storage Period:	1 year
Ease of Disposal/Recyclable:	No restrictions
Special Handling:	Normal handling procedures
Material Incompatibility:	Chlorine-based materials, aluminum, zinc
Warranty:	1 year
Availability:	Worldwide, Orders normally shipped within 24 hours
Price/Unit:	Call 609-386-8770
Additional Information: Test coupons wiped, rinsed with flowing D.I. water, followed by D.I. water immersion.	