ILC DOVER

BEYOND BOUNDARIES®

Technical Bulletin

S-4002 HEPA, S-4012 OV/AG/HE & S-2027 Multi-Gas Cartridges

The Sentinel XT PAPR system with its unique clear hoods is available with multiple filters and cartridges to support a broad range of pharmaceutical operations. The Sentinel XT coupled with its full hoods delivers an APF of 1,000 and provides respiratory protection in a number of pharmaceutical unit operations including blending, milling, powder addition, sampling, tablet coating, high shear granulation, API blending, weigh and dispensing and others.

S-4002 HEPA CARTRIDGE

Used to support operations where API powders are being processed and there is no gas/vapor threat.

S-4012 OV/AG/HE CARTRIDGE

Provides a broad range of protection against organic vapors and acid gases while incorporating HEPA protection. Required NIOSH chemical data is shown as well as supplemental testing performed on a number of solvents over a range of concentrations between the OEL and the IDLH.

In addition, specific testing for a mixture of solvents including peracetic acid, hydrogen peroxide, and acetic acid (Spor-Klenz® cleaner) is provided.

S-2027 MULTI-GAS CARTRIDGE

Delivers broad protection against a series of acid gases and bases while incorporating HEPA protection. Specifically required to address ammonia and formaldehyde challenges.

S-4002 HEPA, S-4012 OV/AG/HE & S-2027 Multi-Gas Cartridges

The Sentinel XT accommodates 2 particulate filters (S-4002), classified as HEPA cartridges. The HE designation means the high efficiency particulate air filter provides greater than 99.97% DOP filtration efficiency. NIOSH test data supporting this performance claim is provided below. These cartridges are strongly resistant to oil. The S-4012 Cartridge and the S-2027 cartridge also provide HE particulate filtration performance and their test data is provided.

S-4002 PARTICULATE PERFORMANCE TESTING

Filter	Flow Rate	Maximum Allowable Percent Leakage	Actual Percent Leakage	Result
1	85.0	.03	.001	PASS
2	85.1	.03	.002	PASS
3	85.1	.03	.001	PASS

S-4012 PARTICULATE PERFORMANCE TESTING

Filter	Flow Rate	Maximum Allowable Percent Leakage	Actual Percent Leakage	Result
1	84.6	.03	.005	PASS
2	84.9	.03	.009	PASS
3	84.9	.03	.003	PASS

S-2027 PARTICULATE PERFORMANCE TESTING

Filter	Flow Rate	Maximum Allowable Percent Leakage	Actual Percent Leakage	Result
1	56.7	.03	.001	PASS
2	56.7	.03	.002	PASS
3	56.7	.03	.003	PASS

S-4002 HEPA, S-4012 OV/AG/HE & S-2027 Multi-Gas Cartridges

S-4012 CHEMICAL CARTRIDGE TESTING (NIOSH REQUIRED)

Chemical	CAS #	Chemical Class	Chemical Formula	IDLH (ppm)	Equilibration Prior to Test	Challenge Concentration	Test Conditions, RH (%)	NIOSH Required Service Time (min)	Actual Service Time
Carbon Tetrachloride	56-23-5	Solvents / Chlorinated Aliphatic	CCl_4	200	A/R	1000	50	25	157
				200	25% RH	1000	50	12.5	161
				200	85% RH	1000	50	12.5	20.1
Chlorine Dioxide	10049-04-4	Acid Gas / Oxidizer	CLO_2	5	A/R	500	50	30	95
				5	25% RH	500	50	30	97
				5	85% RH	500	50	30	87
Chlorine	7782-50-5	Acid Gas / Oxidizer	CL_2	10	A/R	500	50	17.5	>60
				10	25% RH	500	50	8.75	>60
				10	85% RH	500	50	8.75	>60
Hydrogen Chloride	7647-01-0	Acid Gas / Inorganic	HCL	50	A/R	500	50	25	>75
				50	25% RH	500	50	25	>75
				50	85% RH	500	50	25	>75
Hydrogen Fluoride	7664-39-3	Acid Gas / Oxidizer	HF	30	A/R	70	50	30	>60
				30	25% RH	70	50	30	>60
				30	85% RH	70	50	30	>60
Sulfur Dioxide	7446-09-5	Corrosive Gas / Inorganic	SO_2	100	A/R	500	50	15	27.6
				100	25% RH	500	50	7.5	27.1
				100	85% RH	500	50	7.5	62.6

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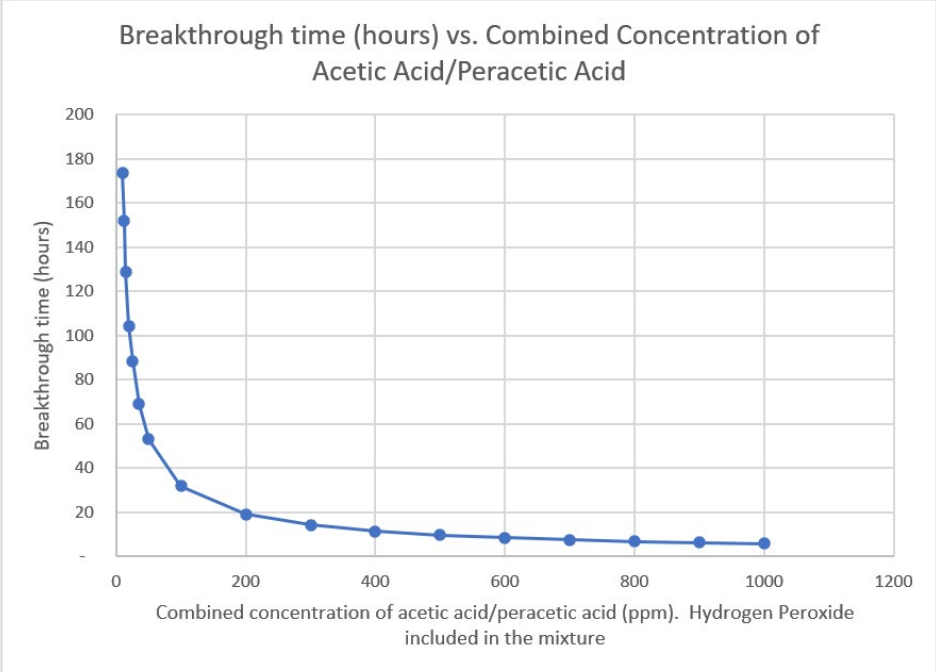
SUPPLEMENTAL TESTING - SPORICIDAL DISINFECTANTS

Cartridges were tested against a mixture of 210 ppm acetic acid, 130 ppm hydrogen peroxide and 80 ppm peracetic acid at a flow rate of 57 lpm and 50% relative humidity. Service life was at least 19 hours with acetic acid breaking through first. Because the respirator uses 3 cartridges, this flow rate is appropriate for a loose fitting PAPR hood in which the minimum flow rate is 170 lpm.

Chemical	Acetic Acid (ppm)	Peracetic Acid (ppm)	Hydrogen Peroxide (ppm)	Flow Rate (lpm)	RH (%)	Break Concentration (ppm)	Time (min)
Peracetic Acid Mixture	210	80	130	57	50	5	1149
						5	1207
						5	1154

Additional testing against sporicidal disinfectants (e.g. SporKlenz® was peformed over a range of acetic acid/peracetic acid concentrations shown in green below. Breakthrough times in hours/days of continuous use are provided.

Combined Concentrataion (ppm)*	Hours	Days
7	226	28.2
10	174	21.7
12	152	19.0
15	129	16.1
20	104	13.0
25	88	11.1
35	69	8.6
50	53	6.6
100	32	4.0
200	19	2.4
300	14	1.8
400	11	1.4
500	10	1.2
600	9	1.1
700	8	1.0
800	7	0.9
900	6	0.8
1000	6	0.7



Notes: *Combined concentration of acetic acid/peracetic acid. 6:1 ratio by volume. Acetic acid always breaks through first.

AJE report actual test concentrations - 6/23/2023, 8/29/2023

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S-4012 CHEMICAL CARTRIDGE SUPPLEMENTAL INFORMATION

Chemical	CAS #	Chemical Class	Chemical Formula	OEL (ppm)	IDLH (ppm)	Challenge Concentration (ppm)	BT Concentration (ppm)	Test Conditions, RH (%)	Actual Service Time (min)
Acetone	67-64-1	Solvents / Ketones	$(CH_3)_2CO$	1000	2500	1000	100	70	109
						1580	100	70	80
						2500	100	70	59
Acetonitrile	75-05-8	Nitrogen Compunds / Nitriles	CH_3CN	40	137	40	4	70	93
						74	4	70	75
						137	4	70	60
Chloroform	67-66-3	Solvents / Chlorinated Aliphatics	$CHCL_3$	50*	500	50	5	70	393
						158	5	70	238
						500	5	70	144
Ethyl acetate	141-78-6	Solvents / Esters	$CH_3COOC_2H_5$	400	2000	400	40	70	308
						894	40	70	168
						2000	40	70	92
Ethyl alcohol	64-17-5	Solvents / Alcohols	CH_3CH_2OH	1000	3300	1000	100	70	102
						1825	100	70	71
						3300	100	70	50
Ethyl ether	60-29-7	Solvents / Ethers	$C_2H_5OC_2H_5$	400	1900	400	40	70	189
						872	40	70	106
						1900	40	70	60
Isopropyl alcohol	67-63-0	Solvents / Alcohols	$(CH_3)_2CHOH$	400	2000	400	40	<10	336
						894	40	<10	184
						2000	40	<10	100
Methyl alcohol	67-56-1	Solvents / Alcohols	CH_3OH	200	6000	200	20	70	15
						1095	20	70	8
						6000	20	70	4
Methyl ethyl ketone	78-93-3	Solvents / ketones	C_4H_8O	200	3000	200	20	70	530
						775	20	70	197
						3000	20	70	73
Methyl isobutyl ketone	108-10-1	Solvents / ketones	$CH_3COCH_2CH(CH_3)_2$	100	500	100	10	70	1379
						224	10	70	630
						500	10	70	289
Methylene chloride	75-09-2	Solvents / Chlorinated Aliphatics	CH_2Cl_2	25	2300	25	2.5	70	132.2
						240	2.5	70	56
						2300	2.5	70	24
Tetrahydrofuran	109-99-9	Solvents / Ethers	C_4H_8O	200	2000	200	20	70	338
						632	20	70	164
						2000	20	70	80

* The OSHA PEL for chloroform is a ceiling limit, not an 8 hour TWA

The following pages provide the test data for each chemical in the table above in graphical form, with an equation relating the test concentration to the breakthrough time.

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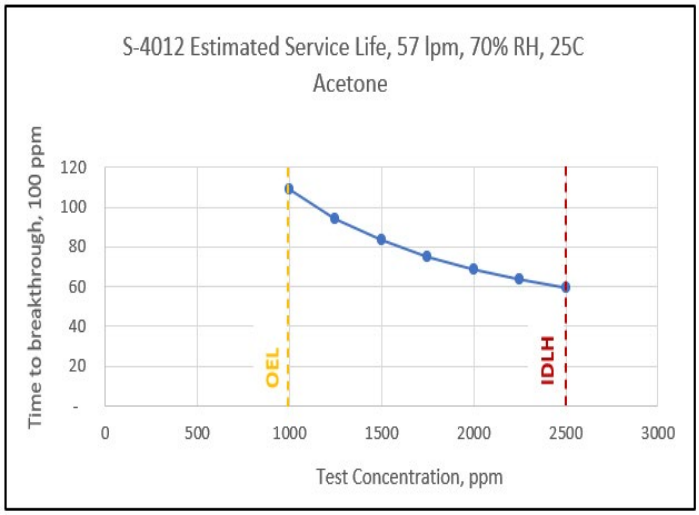
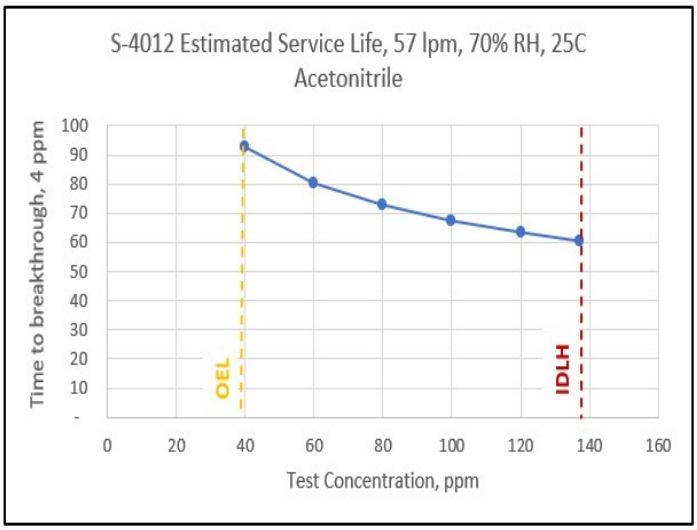
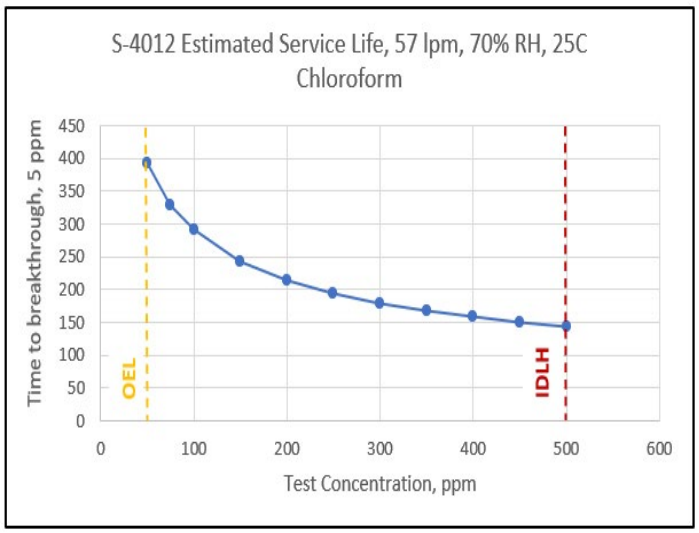
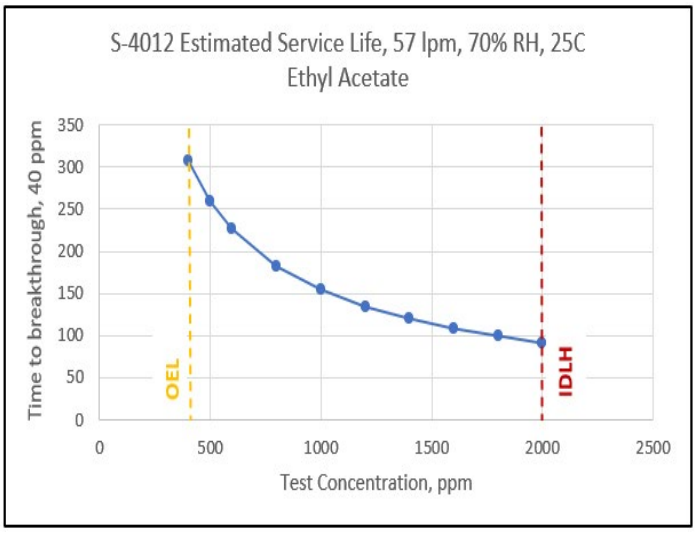
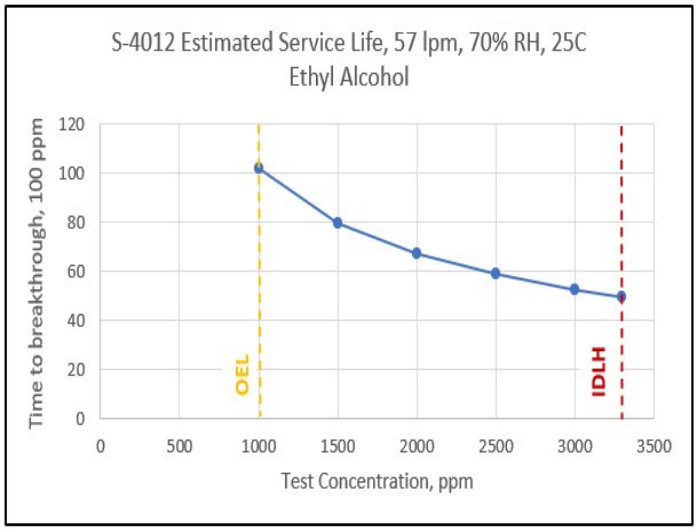
DATA FOR S-4012 CARTRIDGES

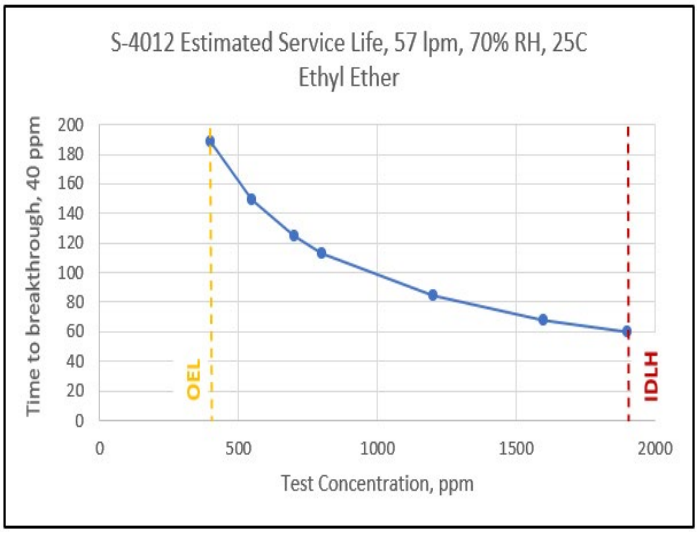












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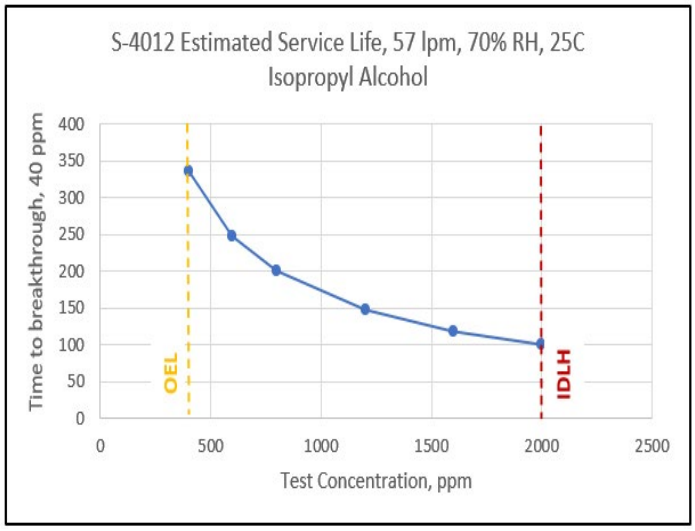

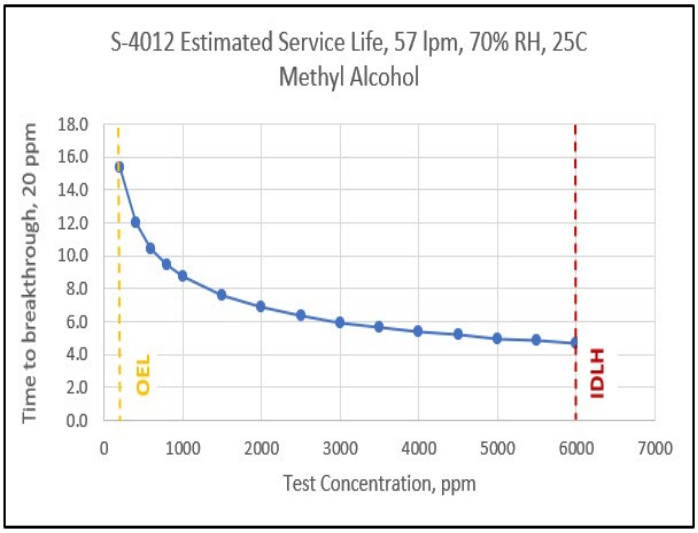

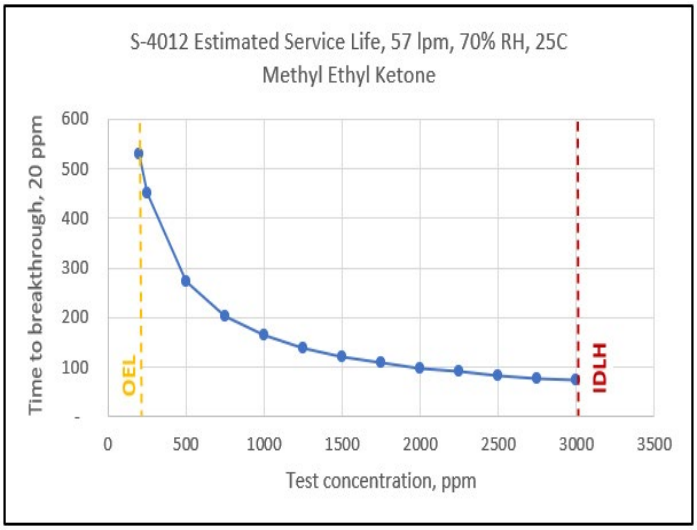

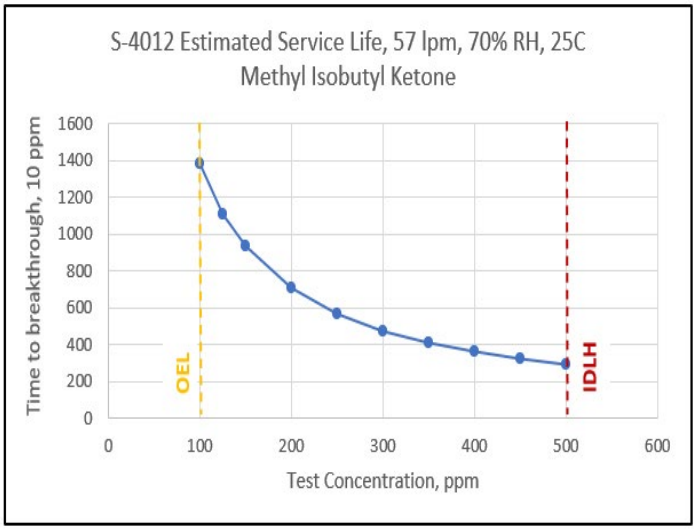

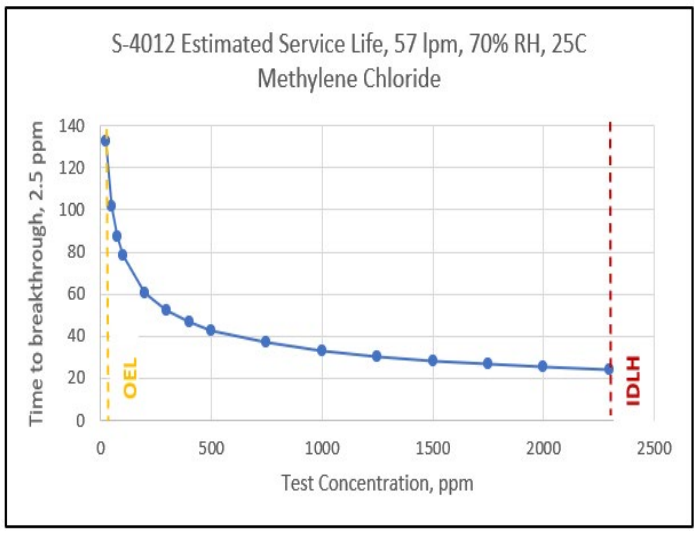

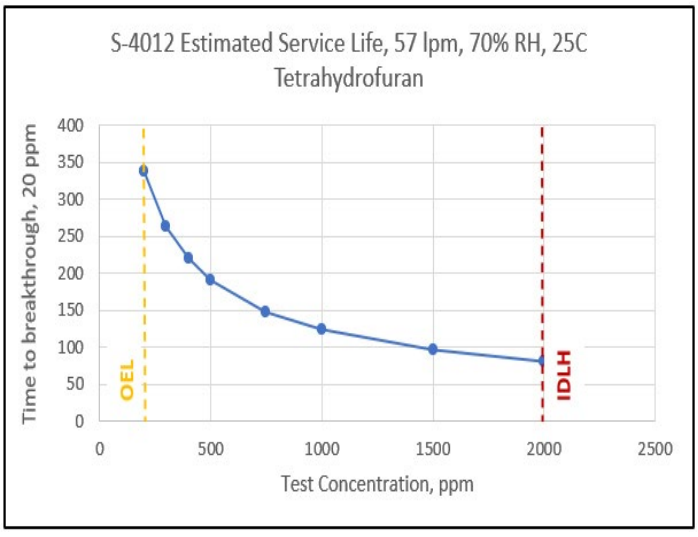

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S-2027 CHEMICAL CARTRIDGE TESTING

Chemical	CAS #	Chemical Class	Chemical Formula	IDLH (ppm)	Challenge Concentration (ppm)	Pre-conditioning, RH (%)	NIOSH Required Service Time	Actual Service Time
Ammonia	7664-41-7	Base Gas	NH3	300	1000	as received	25	65
					1000	25% RH - preconditioned	12	64
					1000	85% RH - preconditioned	12	>60
Sulfur Dioxide	7446-09-5	Acid Gas	SO2	100	500	as received	15	>40
					500	25% RH - preconditioned	7.5	>40
					500	85% RH - preconditioned	7.5	>40
Chlorine	7782-50-5	Acid Gas	CL2	10	500	as received	25	>40
					500	25% RH - preconditioned	12.5	>40
					500	85% RH - preconditioned	12.5	>40
Hydrogen Chloride	7647-01-0	Acid Gas	HCL	50	500	as received	25	>40
					500	25% RH - preconditioned	25	>40
					500	85% RH - preconditioned	25	>40
Chlorine Dioxide	10049-04-4	Acid Gas	CLO2	5	500	as received	30	>40
					500	25% RH - preconditioned	30	>40
					500	85% RH - preconditioned	30	>40
Formaldehyde	50-00-0	Organic Acid	HCHO	30	100	as received	50	>60
					100	25% RH - preconditioned	50	>60
					100	85% RH - preconditioned	50	>60
Methlamine	74-89-5	Monoalkylamine	CH3NH2	100	1000	as received	25	>30
					1000	25% RH - preconditioned	12.5	>30
					1000	85% RH - preconditioned	12.5	>30

CAUTION

Please note the chemical breakthrough information is for the specific conditions identified and testing was performed in a laboratory. Results will vary based on the actual usage conditions.

WARNING

Respirators help reduce exposure to specific airborne contaminants. Before use, the wearer must read and understand the User Instructions provided as a part of the product packaging. Misuse could result in sickness or death.

ILC DOVER
BEYOND BOUNDARIES™

ILC Dover LP
One Moonwalker Road
Frederica, DE 19946 USA
+1.302.335.3911
+1.800.631.9567
customer_service@ilcdover.com

www.ilcdover.com