National Personal Protective Technology Laboratory

Concepts for PAPR Gas/Vapor Certification Evaluation

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Docket 008A

Proposed Changes for PAPR Gas/Vapor Test Requirements

- **Discontinue equilibration (pre-conditioning) requirements**
  - Only as-received cartridge/canister samples tested
- **Two tests are performed:**
  - Three as-received samples at 25%RH challenge air humidity
  - Three as-received samples at 80%RH challenge air humidity
- **Cyclohexane used for organic vapor tests**

Proposed Changes for PAPR Gas/Vapor Test Requirements

- **Minimum test capacity, maximum breakthrough concentration and challenge concentration specified for each gas/vapor.**
  - Generally unchanged from as-received service life requirements currently in 42 CFR Part 84
- **Discontinue the current allowance for multiple gas type approvals where minimum required test times are halved (Table 11, 42 CFR part 84)**
- **Tests performed to assess multiple work rates**
  - Samples can be tested at different test flow rates.

Examples of Cartridge Test Capacities, Maximum Breakthrough and Challenge Concentrations

Gas/Vapor	Test Concentration (ppmv)	Maximum Break Through (ppmv)	Minimum Capacity ***(Liters)	Minimum Allowable Service Life at 170Lpm Test flow rate (minutes)
Ammonia	800	20	8.2	60
Carbon monoxide*	4800	35**	49	60
Chlorine	300	1	3.1	60
Chlorine dioxide	250	0.1	2.6	60
Cyclohexane	800	5	8.2	60
Unlisted contaminant****	4 x IDLH	REL	0.0408xIDLH (in ppmv)	60

Examples of Canister Test Capacities, Maximum Breakthrough and Challenge Concentrations

Gas/Vapor*	Test Concentration (ppmv)	Maximum Break-through (ppmv)	Minimum Capacity ***(Liters)	Minimum Allowable Service Life at 115Lpm Test flow rate (minutes)
Ammonia	5000	10	6.9	12
Carbon monoxide**	10000	500***	59	60
Chlorine	5000	10	6.9	12
Chlorine dioxide	5000	10	6.9	12

Test Air Flow Rates

PAPR Bench Test Constant Air Flow Rate Requirements		
Low Rate	**Moderate Rate**	**High Rate**
115 Lpm	**170 Lpm**	**235 Lpm**

Flow Rate Effects

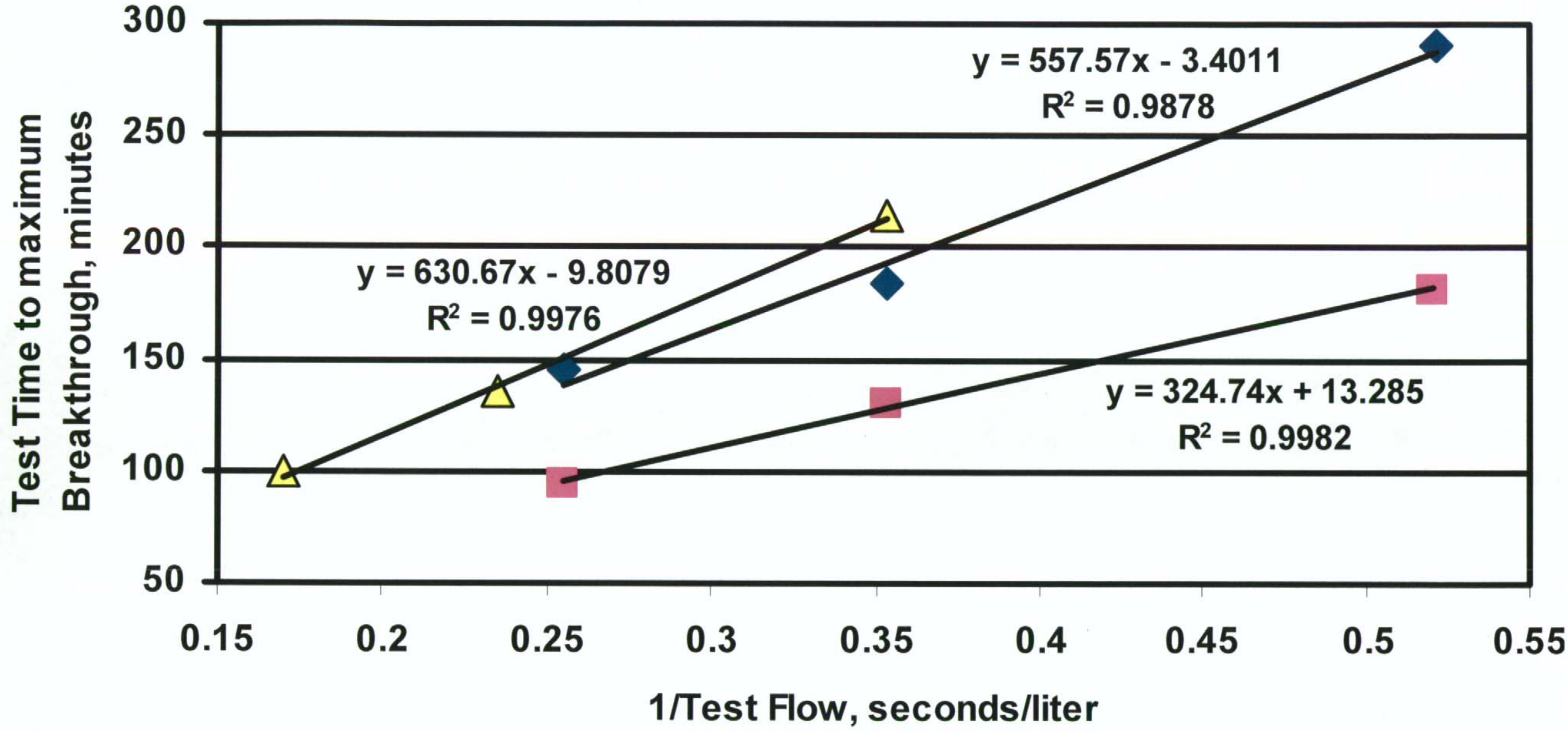
Time to breakthrough , t_b, is inversely proportional to flow rate, *Q* :

$$t_b = \frac{A}{C_0} \bullet \frac{1}{Q} - \frac{B \ln(C_0 / C_x)}{C_0}$$

Wheeler Equation

Jonas *et. al.* J. Phys. Chem. 75:3526-3531 (1971)

Flow Rate Effects



Wheeler Relationship for PAPR Cartridges Tested with Cyclohexane 800 ppmv 25%RH 25°C

Test Air Flow Rates

Capacity for PAPR Cartridges from Wheeler Results

Sample	Test flow rate	Capacity	Average Capacity
	Lpm	Liters	Liters
A	115	26.8	26.4
	170	25.0	
	235	27.3	
B	115	16.7	17.4
	170	17.7	
	235	17.8	
C	155	27.6	28.2
	170	29.1	
	352	28.1	

Capacity estimates can be made from samples tested at different flow rates.

Cyclohexane for Organic Vapor Tests

Organic Vapor Test Life for Cyclohexane versus Carbon Tetrachloride :

Sample	Test Condition	Average test life with cyclohexane	Test life with carbon tetrachloride	Cyclohexane difference from CTC
	%RH	minutes	minutes	%CTC
A	25	186	203	-8.73
	80	114	120	-5.96
B	25	136	236	-11.25
	80	86	142	-8.05
C	25	209	131	3.57
	80	128	88	-4.43

Observe the same differential that has generally been seen (Terry and Murray 2005).

Conclusions

- Current requirements are conserved as proposed capacities.
- Cartridge/canister test plan reflects current respirator use compared to equilibration approach
- Can apply accepted method of assessing effect of flow rate
- Cyclohexane can replace carbon tetrachloride.

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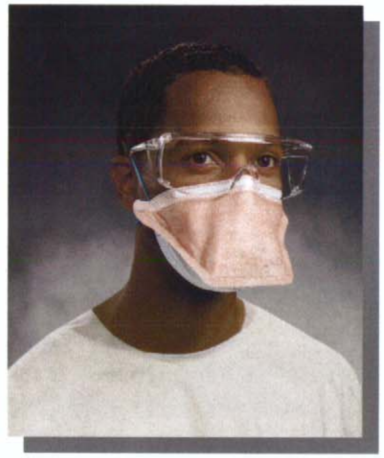

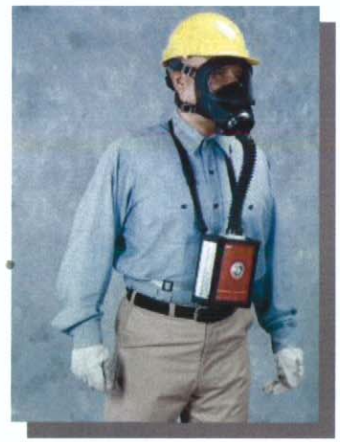

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