

Reprinted From: **PRODUCTS FINISHING Magazine**

Safe Exhaust Recirculation of Manned Spray Booths

How to keep the cost of pollution control from hurting you...

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Spray booths that use robots or automatically reciprocating paint application equipment are unoccupied during the paint process. For many of these unmanned spray operations, the time has passed for simple open-faced spray booths with all of the airflow exhausting out of the back filter bank plenum. During the last 15 years, spray booth exhaust has been recirculated in unmanned spray booths in more and more paint finishing systems. Now, unmanned spray booths are commonly equipped with recirculation fans, automatically advancing roll-up filters and ultra-fine return air filters. Recirculation has been done primarily to reduce the capital equipment and operating costs when air pollution control equipment for Volatile Organic Compounds (VOC) is required.

Case studies have shown examples of cost effective air pollution controls on recirculated spray booths where the Regenerative Thermal Oxidizer (RTO) or other control device is one-fourth the size and cost required without recirculation. When the savings

Recirculating spray booth system



Painter in full personnel protective equipment

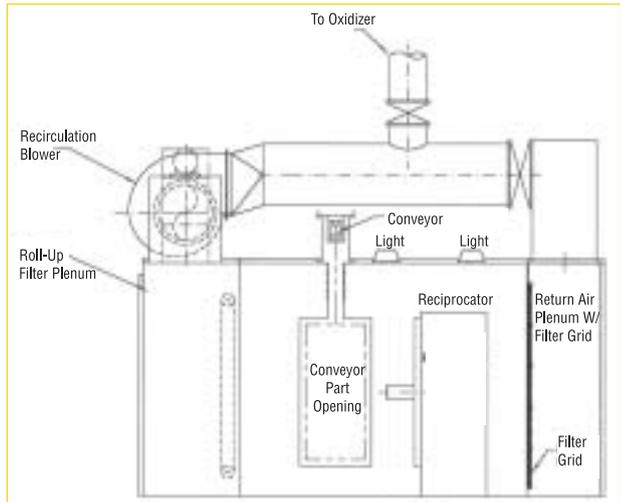


TABLE 1: Cost Effective Pollution Control Equipment

	Standard Design	Recirculated Booth Design
Automatic Booths (4)	60,000 cfm	16,000 cfm
Manual Booths (4)	48,000 cfm	0
Flash-off Areas	0	3,000 cfm
Cure Oven	4,000 cfm	4,000 cfm
Total Exhaust Flow	112,000 cfm	23,000 cfm
Annualized Operating Cost	\$176,000/yr.	\$21,600/yr.
Annualized Heated Air Make-up	-	(\$37,000/yr.)
Cost Savings with Reduced Airflow		
Based on \$0.06/KW, \$4.00 per MM Btu, 100 lb/hr. VOC, Heated air make-up required 60% of the year.		

from reducing heated air make-up costs are factored in, recirculation of spray booth exhaust can actually pay for the operating or running cost of air pollution control.

Similar savings can be obtained by recirculating spray booth exhaust in manned spray booths such as manual touch-up booths and large-part spray booths. However, return of air with VOC's to an occupied space invokes important safety questions. Paint line supervisors may ask if painters will have to wear respirators or even fresh air masks. Plant management may wonder if this meets OSHA and fire safety codes. Here are some suggestions for the practical design and safe operation of manned spray booths with recirculated exhaust.

Fire Safety of spray booths with exhaust recirculation has been addressed by the

National Fire Protection Association (NFPA) in its national consensus code entitled NFPA 33 – 2000 “Spray Application Using Flammable or Combustible Materials,” NFPA 33 Section 5.5.1 limits recirculation to when the actual VOC concentration in the return air is kept to less than 25% of the Lower Explosive Limit (LEL), and an LEL probe is interlocked to the spray operation. LELs typically run in the 5-10% range for recirculated spray booths.

Use of exhaust recirculation does not change the need for fire detection or fire suppression systems. But if some type of fire detection or fire suppression system is required, then these systems must be properly designed for the recirculating spray booth. For example, additional fire sprinkler heads in the return air plenum may

TABLE 2: Effect of Spray Booth Exhaust Recirculation

	No Recirculation	Partial Recirculation	Full Recirculation
Spray Booth Exhaust Rate (cfm)	10,000	3,333	2,000
Paint Use (gal./hr.)	5	5	5
Solvent Exposure (ppm)	30	90	150
Solvent PEL (ppm)	100	100	100
Hazard Ratio	0.3	0.9	1.5
PPE Required	No	No	Yes

be needed to effectively protect a recirculating booth.

Painter Health and Safety requirements are spelled out in OSHA's respiratory protection standard (29 CFR 1910.134). This standard requires the use of approved respirators or other Personal Protective Equipment (PPE) when workers are exposed to actual paint solvent or VOC concentrations that exceed the OSHA Permissible Exposure Limit (PEL). PELs for commonly used paint solvents range from 50 ppm for toluene to 500 ppm for acetone. Since paint formulations contain a mixture of solvents, a Hazard Ratio must be calculated for each solvent by dividing the actual concentration of the specific solvent by its respective PEL. If any solvent Hazard Ratio is greater than 1.0, then a respiratory protection plan with PPE is required.

Keep in mind that some catalyzed paints have components with a very low PEL (0.02 ppm for methyl isocyanate). These may require use of PPE such as supplied breathing air for spray operations even if recirculation is not used. Also, it is very possible that adding recirculation to an existing spray booth may increase the actual exposure level by concentrating the solvents to a level above the permissible PEL. In this case, PPE must be used.

Once the need to use PPE has been established, the next step is to select the proper type of PPE. PPE is rated by protection factors and each PPE manufacturer has approved products at various protection factor ratings. Generally, a half-mask respirator with particulate and organic cartridges has a protection factor of 10X. Full-face respirators with eye protection have protection factors to 50X, and supplied breathing air systems have protection factors to 1000X. At a minimum, the protection factor required for the PPE to be used must exceed the highest Hazard Ratio.

In situations where the PPE protection factor is many times higher than the high-

est Hazard Ratio, painter exposure to solvent in the recirculated booth may be lower than it would be without PPE and recirculation. Also, some painters prefer the use of more comfortable, battery-operated self-purging face masks (protection factor of 25X) over half mask respirators when the lower protection factor is still adequate for health and safety.

A health and safety professional should be consulted with when setting up any respiratory protection plan. This could be a large company's corporate or plant level industrial hygienist. Smaller companies can use a representative from an established supplier of PPE as a resource. These professionals can help write the respiratory protection plan, provide training and medical referrals if needed, document fit testing and implement safeguards to assure PPE is always in good working condition.

Questions such as what is the permissible PEL, what is the actual exposure, and what is the best PPE may seem complicated. The important point is that there are scientific methods and OSHA procedures available to answer all of these questions. When required, PPE can be combined with properly designed fire safety features such as LEL interlocks to provide a safe manned spray booth with recirculating exhaust. As VOC pollution control becomes more widespread and applicable to smaller VOC emission sources, one is likely to see more recirculated manned spray booths. 

MORE INFORMATION?

On exhaust systems for manned and unmanned spray booths

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Reprinted from February 2003

PRODUCTS FINISHING Magazine and

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