EPA-452/F-03-033

Air Pollution Control Technology Fact Sheet

Name of Technology: Permanent Total Enclosures (PTEs).

Type of Technology: Capture device - collects and vents pollutants to an abatement device such as an incinerator.

Applicable Pollutants: Organic hazardous air pollutants (HAP) and volatile organic compounds (VOC).

Achievable Emission Limits/Reductions: PTEs have a capture efficiency of 100% (EPA, 2002). Emissions reductions are dependant on the downstream pollution control device.

Applicable Source Type: Point or fugitive

Typical Industrial Applications: Any process or operation where total emissions capture is required. They are commonly used in flexographic printing, rotogravure printing, coating (paper, film, fabric, and metal), laminating, screen printing, can coating, and plastic card coating.

Emission Stream Characteristics:

a. **Air Flow:** PTEs draw clean air into the enclosure for venting of waste gas. The air flow through a PTE must provide adequate capture and transport of the waste gas. The direction of air flow through all natural draft openings (NDOs) must be into the enclosure. The average facial velocity of air though all NDOs shall be at least 3,600 m/hr (200ft/min) (EPA, 1997). The Occupational Safety and Health Administration (OSHA) requires a minimum of 4 room air changes per hour (RAC/hr) for industrial settings. Higher RAC rates, approximately 10 RAC/hr, are generally required for worker comfort (Lukey, 1997).

b. **Temperature:** Temperature inside the PTE must comply with standards established by OSHA. If the installation of a PTE results in heat buildup, an air conditioning system may be used to maintain the air temperature and humidity at comfortable levels. The air conditioner must be a closed loop system.

c. **Pollutant Loading:** The maximum concentration of VOC or HAP within the PTE should not exceed permissible exposure levels (PELs). PELs are the OSHA standards for worker exposure to toxic substances. They are expressed in terms of time-weighted average (generally 8-hour averages), short term exposure levels, and ceiling concentration.

   OSHA also limits the concentration of a flammable vapor or mist in the PTE. The lower flammable limit (LFL) is the lowest level at which a gas supports combustion. For large PTEs (entire manufacturing area), the concentration of any pollutant must not exceed 25% of the LFL. For small PTEs (several pieces of equipment), the pollutant concentration must not exceed 10% of the LFL. (EPA 2002)

d. **Other Considerations:** Local concentration of pollutants within the enclosure may vary by factors of 1 for well-designed ventilation systems to 10 for poorly designed systems (Worrall, 1997).

Emission Stream Pretreatment Requirements: None

Cost Information: All costs are in 2002 dollars (Lukey, 1997 and EPA, 2002)

The majority of all PTEs are custom designed. The capital costs depend on the process configuration and size of the emission sources within the PTE. The costs range from $10,200 for a single coating station to over $307,000 for an enclosure with five pieces of equipment (Lukey, 1997). The cost depends on the materials used for its construction. For instance, walls and ceilings cost $3 to $20 per square foot. Doors cost $300 for strip curtains and $8,000 for speed doors. A 4 x 4 foot safety glass window costs $200 (Lukey, 1997). The cost of air conditioners ranges from $30,000 for spot cooling to $150,000 for full conditioning (Lukey, 1997). The PTE cost also includes exhaust and make-up air fans and instrumentation. The abatement device is not included in the cost of the PTE.

Maintenance costs are minimal, except for such minor expenses as painting, repairs, and calibration of instruments. Operating costs consist primarily of electric utility costs for operation of exhaust and makeup air fans and air conditioners.

a. Capital Cost: $10,200 - $307,000

b. O & M Cost: $300 - $7,600 per year

c. Annualized Cost: $1,800 - $54,000 per year

d. Cost per Ton of Pollutant Removed: Variable cost per ton based on the removal efficiency of the downstream air pollution control device.

Theory of Operation:

PTEs are permanently installed structures that completely surround a source(s) of emissions. They consist of walls, roof, windows, doors, and exhaust and make-up air fans. The pollutants are captured by means of a ventilation system, which draws contaminated air from the enclosure and replaces it with clean supply air. The waste gas is vented to a control device, such as an incinerator or carbon adsorber, for abatement. The abatement device is not part of the PTE. Auxiliary equipment for the PTE includes pressure monitors, PEL and LFL monitors, smoke detectors, flame detectors and alarm bells.

In order to qualify as a PTE, an enclosure must meet EPA Method 204 Criteria for and Verification of a Permanent or Temporary Total Enclosure. If the criteria are met, the capture efficiency is assumed to be 100 percent. Overall control efficiency will be equal to the control device reduction efficiency. A capture efficiency test is not required for a PTE. The five point control criteria in Method 204 are given below.

1. All NDOs are at least four equivalent opening diameters from each VOC emitting point.
2. The total area of the NDOs shall not exceed 5 % of the surface area of the enclosure's walls, floor, and ceiling.
3. The average facial velocity (FV) of air through all NDOs shall be at least 3,600 m/hr (200 fpm), or the static pressure in the enclosure must be -0.007 in. of H_2O. The direction of air flow through all NDOs must be into the enclosure.
4. All access doors and windows shall be closed during routine process operation.
5. All VOC emissions must be captured and contained for discharge through a control device.

PTEs usually accommodate production personnel within its structure during operation; therefore, PTEs are regulated by OSHA. PTEs must provide fresh air to the space and safe and comfortable working conditions. There may be additional design requirements to meet fire and insurance regulations.

The PTE design must prevent build-up of pollutant levels in the enclosure. Localized concentrations within the PTE may vary greatly due to inadequate mixing and thermal stratification. Mixing depends on a number of variables such as:

- Temperature of the delivery supply air,
- Temperature within the PTE,
- Amount and locations of supply and exhaust air,
- Location of objects within the PTE,
- Shape and size of the PTE,
- Presence or absence of heat sources within the PTE, and
- Injection velocity of the supply air.

Advantages/Pros:

- Simple construction
- 100 percent capture
- Once design is approved, there is no need for capture efficiency tests

Disadvantages/Cons:

- Difficult to provide worker comfort and meet OSHA standards, additional air conditioning may be required to avoid substantial heat build-up.
- Once the PTE has been built, it is difficult to add on equipment or modify the process configuration.
- The PTE is only a capture device, the amount of pollutant removed is dependent on the abatement device installed.

References:

EPA, 1997. "EPA Method 204: Criteria for Permanent Total Enclosures. 40 CFR Part 51 Appendix M". Research Triangle Park, NC.

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