FOCUS: VOC Control TABC Eliminates Solvent Emissions

New thermal oxidizer eliminates solvent emissions and reduces operating costs...

By James P. Wikenczy Manager of Mfg. Engineering TABC, Inc. Long Beach, California

oyota Auto Body of California (TABC), Inc., Long Beach, California, manufactures truck beds that are supplied to other Toyota plants for assembly. The facility includes a stamping plant, body shop for assembly and a paint shop. It currently produces 170,000 truck bed per year using two nine-hr shifts.

Truck bodies first pass through a nine-stage zinc phosphate pretreatment system. This is followed by an electrocoat primer and cure at 375F. After curing, truck beds receive a primer-surfacer and an enamel topcoat, which are both cured in convection ovens. Each of the ovens is exhausted to thermal oxidizer units when the paint solvents are oxidized.

Controlling VOCs emitted during curing the electrocoat primer is always challenging. When a freshly painted truck bed leaves the electrocoating tank and enters the curing oven, a combination of unreacted resins, coalescing solvents and high-molecular-weight organics are exposed to the oven's high temperature. This results in a significant amount of smoking as the parts enter the oven through an air seal. Controlling air balance in order to retain this smoke within the oven is crucial, since escaping fumes can make a shop uncomfortable for employees.

In late 1992, TABC noticed that its four-year-old thermal oxidizer was showing signs of structural failure. An inspection determined that even with temporary repairs, the unit would probably only last six to 12 months. Rather than look at replacing the oxidizer with a similar unit, the company decided to investigate all the options available.

The goal was to reduce the cost of

operating the thermal oxidizer, which was exhausting approximately 5,000 cfm at 900F. Also, production personnel wanted to increase the exhaust flow rate by venting a canopy between the electrocoating tank and the oven to the oxidizer. This would eliminate a lingering problem of fume spill-out from the entry end of the oven.

Reviewing the Options. The challenge was to find a technology that increased the vent rate approximately 11,000 cfm without costing more to operate than the smaller existing thermal oxidizer. Other issues, such as equipment size and weight, lead time and proven ability to treat the highly resinous exhaust from the oven, were crucial in the evaluation.

Table I summarizes a number of possible options that were considered. Following a thorough review, two options were selected for further analysis: recuperative and regenerative thermal oxidation.

While the existing recuperative oxidizer was effectively destroying the electrocoating oven fumes, the relatively high operating cost was a concern. This was particularly true since TABC wished to increase its exhaust rate. Regenerative thermal oxidation offered low operating costs, primarily due to the high (95 pct) thermal energy recovery possible. However, the large size and weight of the regenerative unit meant a new location was needed. Table II compares the two forms of thermal oxidation with a nominal flow rate of 11.000 scfm.

Considering this analysis, TABC OCTOBER, 1995

selected a Compact Regenerative Thermal Oxidizer (CTO) unit from Durr Industries, Inc., Plymouth, Michigan. The skid-mounted CTO unit is shop built to minimize field erection time. Because of its weight, the unit was located at grade level beside the paint shop.

Figure 1 shows an isometric view of the three ceramic-filled chambers in the unit. VOC-laden air enters the bottom of one of the chambers and is preheated as it flows upward through the hot ceramic bed. The burner at the top of the chamber adds additional heat to oxidize organic materials into carbon dioxide and water vapor. The clean hot gases exit through one of the adjacent chambers and transfer heat to that ceramic bed before release to atmosphere.

After a certain time, the cycle is reversed so that inlet and outlet chambers switch to outlet and inlet cycles. At any given time, one of the three towers is purged. In this process, clean air is vented through a tower, pushing any unburned hydrocarbons through the burner prior to that tower switching to an outlet cycle. This ensures that no unburned solvents are vented to atmosphere. This process is responsible for the high thermal efficiency of the regenerative oxidizer.

The unit is vented through an exhaust fan located downstream of the unit. An Allen-Bradley 1336VT 125-hp drive is used to maintain flow and air balance in the electrocoat oven, guaranteeing ventilation of the solvent and smoke from the oven through a signal from a pressure transducer in



the interconnecting duct.

When tested, the CTO unit destroyed more than 95 pct of the incoming organics at an operating temperature of 1,370F. The increased air flow from the oven and entry canopy area also improved the working environment for TABC employees. Operating costs of the unit are lower than for the smaller recuperative unit it replaced. **PF**

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1. REGENERATIVE thermal oxidation system schematic

2.

COMPACT regenerative thermal oxidation system at TABC

TABLE I—Comparison of Optics

OPTION	CAPITAL Costs	OPERATING COSTS	COMMENTS
Electrostatic Precipitator	High	Low	High maintenance experienced at other Toyota plant, not effective at controlling VOCs with high efficiency
Scrubber	Low	Very High	Low efficiency at VOC control
Carbon Adsorption	High	High	Not suitable for high temperature oven exhaust
Catalytic Oxidation	Medium	Medium	Poisoning of catalyst and high maintenance experienced in other Toyota plants.
Thermal (Recuperative) Oxidation	Low	High	Proven in ED fume oxidation. Very high operating cost and high NO _x emissions.
Thermal (Regenerative) Oxidation	High	Low	Proven in ED fume oxidation, very low operating cost, low NO _x emissions.

TABLE II—Comparison of Regenerative and Recuperative Thermal Oxidation

	RECUPERATIVE	REGENERATIVE
Size	12 ft diameter ∞ 22 ft	$15\text{ft} \sim 48\text{ft}$
Thermal Efficiency	22,000 lb	68,000 lb
VOC Destruction Efficiency	65 pct	95 pct
Capital Cost (Installed)	\$600,000	\$800,000
Operating Cost	\$190,000	\$68,000
Delivery Time	16-18 weeks	18-20 weeks



ABC Also Controls NOx

NOx is a common air pollutant, generated by many operations. Most of the NOx produced at TABC is generated within the area devoted manufacturing catalytic converters. Ceramic substrates, which become the inside of the converters, are coated with proprietary materials.

These coatings are applied at room temperature and cured in a gas-fired oven. Seven-thousand two-hundred scfm of NOx-laden air is directed to a Tri-NOx system engineered and manufactured by Tri-Mer Corp., Owosso, Michigan. The system separately counterflows solutions of oxidizers and reducers, destroying the NOx.

There are five processing columns, each assigned a separate processing stage. The first quenches the incoming material to reduce temperatures from 120 to 40C. The second (oxidizing) stage converts NO to NO_2 . Subsequent stages reduce NO_2 to ordinary nitrogen gas, while the oxygen becomes part of a soluble salt.

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Sidebar caption: FIVE COLUMN NOx destruction system at TABC