Activated Carbon Adsorption System Addresses VOC Emissions Problems for New York Circuit Board Manufacturer

A number of technologies were investigated. The concentration method using regenerative activated carbon was selected for this high flow low concentration application. It incorporates the Croll-Reynolds patent pending, Revaporative™ technology to reduce operating and capital costs.

PHOTOCIRCUITS manufactures printed circuit boards, primarily for automotive use in motor vehicle dashboards and personal computers with manufacturing facilities in Glen Cove, NY and Peachtree City, GA.

Photocircuits is the largest industrial company in Glen Cove and one of the largest manufacturers of printed circuit boards. As its facilities and output grew, Photocircuits continued its commitment to focus upon abatement needs for the facility.

The company's emissions result from the process of coating circuit boards. When heated during the curing process, some of the chemicals release volatile organic compounds (VOCs).

The route to abatement

The route to abatement was simple: remove the trace amounts of VOCs from the airstream. The process would have to be continuous, as the firm's operation is on a twenty-four hour, seven day schedule.

Croll-Reynolds Clean Air Technologies of Westfield, NJ, evaluated technologies for the application. The technologies considered and conclusions reached include:

1) Direct thermal oxidation: Burning VOCs in a high-temperature incinerator. It is simple and effective as a destruction method, but highly uneconomical in Photocircuits' circumstances. Typical temperatures of destruction are on the order of 1500 F. This level would have to be reached almost entirely by burning purchased fuel, as the low VOC concentrations would contribute very little toward heating the airstream. Thermal incineration was, however, considered cost-effective for endpoint destruction following another remediation process.

2) Catalytic incineration: A catalyst is coated onto the surface of a ceramic packing material. The catalyst increases the rate of conversion of pollutants to non-pollutants. However, catalytic incineration was considered entirely too costly. In addition, effluent stream contamination may quickly poison the expensive catalyst.

3) The biofiltration method: In the process of biofiltration, airflow is directed through a peat bed seeded with microorganisms which consume the VOCs. The process is effective, but only in a narrow operating range as it is highly sensitive to moisture, heat, and concentration of organics and solids in the gas.

4) Activated carbon adsorption: This method removes VOCs from the airstream and concentrates them to higher levels, permitting cost-effective regeneration followed by incineration in a nearly self-sustaining process.

Parameters of carbon adsorption technology

In an activated carbon adsorption system, the contaminated airstream is passed across the carbon bed. The carbon extracts the VOCs from the airstream and absorbs them, holding them on the surface and in its pores. The VOC-free air is exhausted to atmosphere. Carbon is an excellent adsorber of organic materials like low molecular weight VOCs. In the process selected by Photocircuits, the activated carbon is produced from coconut shells. This offers an extremely large surface area per unit weight providing tremendous filtration ability in a relatively small bed.

In the regenerative method selected, after eight hours of continuous operation, the concentrated VOCs collected in the bed are desorbed into a low-pressure steam flow and destroyed in a small thermal oxidizer.

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Critical considerations

The carbon adsorption technology involves two critical areas:

• The airstream must be low in moisture. In addition to VOCs, carbon will adsorb moisture. This would quickly fill the bed to capacity, causing premature breakthrough of volatiles and requiring unduly frequent regeneration.

• The airstream must be low in particulate matter, as this will clog the carbon, and will be difficult to desorb in the regeneration cycle.

In order to properly condition the airstream for adsorption, a prefilter for particulate material and if necessary, a dryer to remove excess moisture must be included.

The composite system selected:

Ninety-five percent effective

Photocircuit's carbon adsorption system was supplied on a turnkey basis by Croll-Reynolds Clean Air Technologies. The composite system includes dual carbon adsorber beds, steam regeneration, thermal oxidizer and automatic controls.

The manufacturer guarantees ninety-five percent removal of VOCs, and adds that in-service testing shows that most of its systems achieve significantly better than ninety-nine percent removal.

System details

Photocircuits' continuous process mandates availability of the system at all times. The carbon-adsorption system supplied by Croll-Reynolds consequently incorporates parallel carbon beds. One is always available for service while the other is being regenerated or on standby.

The system provides for automatic switching from one bed to the other. This occurs in intervals of hours selected as the design percentage of VOC saturation is approached.

The regeneration process reverses the adsorption process. The bed is taken out of operation, and a small stream of low-pressure steam is passed through it countercurrent to the effluent flow. The highly concentrated VOCs are released into the steam. More than ninety-nine percent of adsorbed VOCs are desorbed within ninety minutes, and the bed is dried and placed on standby, ready to go back on line.

End-of-line thermal incineration

To finally dispose of the VOCs, destruction by thermal oxidation was chosen. The amount of steam to be treated is far less than the original volume of the contaminated airstream, and the highly concentrated VOCs in the regeneration steam are available as fuel, making the process cost-effective.

The small thermal oxidizer incorporates a patent pending heat exchanger called a Revaporator™, which allows the oxidizer size to be minimized, reducing cost. The oxidizer utilizes the Btu value of the collected VOCs. The only purchased fuel for the process is a small stream of natural gas, used to preheat the incinerator, and to supplement the low concentration VOCs at the end of the cycle.

The incinerator operates at 1500 F with one second residence time and achieves a destruction efficiency of better than ninety-nine percent.

Operating the system

Although each carbon adsorber is actually operating in a batch mode, cycling the adsorbers in and out of service allows uninterupted filtration of the effluent gas from the continuous process. It was considered a very satisfactory answer to Photocircuits' needs.

In operation, a number of parameters have changed from the originally contemplated design. Nevertheless, the flexible design of the equipment has the ability to adjust to accommodate changes, and continues to function according to design.

The system operates in a fully automatic, eight-hour cycle handled by a microprocessor-based control system. Switching from the saturated bed to the standby bed, desorption of the saturated bed, cooling and drying of the carbon, entering standby mode and return to line service are automatic, with no operator intervention.

The entire system, including tanks housing the carbon beds, incinerator, and all peripherals, is designed for outdoor installation. It is located beside the building which houses the manufacturing line.

Three more ordered

With the successful introduction of the first activated carbon adsorption system, Photocircuits has installed three more, virtually identical systems.

One is for another manufacturing line in the Glen Cove plant, and two for the company's facility in Peachtree City, GA. The systems have operating cycles adjustable to suit varying makeup and concentration of VOCs and other conditions of service.

CROLL-REYNOLDS

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