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EPA Project Summary

Design and Construction of a Mobile Activated Carbon Regenerator System

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Activated carbon adsorption has become a standard treatment for the cleanup of contaminated water streams. To facilitate such cleanups, mobile carbon adsorption units have been constructed and are now in use. Such units can be moved to spill sites or other points requiring water cleanup. Their primary drawback is the logistics associated with the disposal of the spent (contaminated) carbon and its replenishment.

The adaptation of adsorption systems to a mobile base suggested that regeneration systems could be similarly adapted. A program was undertaken to assess the feasibility of such adaptation and to design and build a mobile carbon regeneration unit that would also incorporate an incinerator and scrubber system to degrade and dispose of the offgases.

A system was designed and built based on technology developed for the fabrication of a laboratory-sized regenerator. Housed in a standard van-type trailer, the system met all weight and size limitations for over-the-road operation. The system includes a rotating barrel kiln to regenerate the carbon thermally, an incinerator or afterburner and a scrubber to treat the offgases, and a separator to reclaim the reactivated carbon granules.

Test runs using spent carbon from treatment of a spill were quite successful. The carbon was returned to essentially 100% activity, with an 88% volume recovery. The unit has been delivered to EPA for their use.

This Project Summary was developed by EPA's Hazardous Waste Engineering Research Laboratory, Cincinnati, OH, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

The full report details the development and construction of a mobile unit for regenerating activated carbon in the field. The system was developed to solve some problems presented by a portable carbon adsorption system used to treat contaminated water streams on site.

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When hazardous chemicals spilled in the field or leachate from landfills or waste storage sites threaten a water supply, activated carbon treatment is standard practice. Because activated carbon has a natural tendency to adsorb selected classes of chemicals, when such chemicals are dissolved or dispersed in water, carbon preferentially removes them.

To facilitate cleanup, portable carbon adsorption systems have been developed. These trailer- or skid-mounted units can be moved by road or air to the cleanup site. The portable systems have proved quite versatile and effective, but they have a significant drawback — the logistic and administrative barriers associated with the disposal of spent (contaminated) carbon and its replacement. Large quantities of carbon are usually required for cleanup operations. Although the carbon can technically be regenerated commercially, it must be moved to a facility having the necessary processing equipment and appropriate permits for carbon reactivation. Also, fresh carbon must be moved to the field site to keep the cleanup operation active. This approach to regeneration can be complicated if hazardous materials (such as PCBs or TCDD) are involved for which strict regulations or prohibitions exist that affect commercial reactivation. For economic reasons, commercial regeneration facility operators are unwilling to operate their equipment routinely at the temperatures needed to destroy PCBs and TCDD. Further, the regeneration market for carbon contaminated with these substances is not large enough to justify the facility operator's incurring the public concern that would result if the facility were to accept such substances. Because of these problems with commercial reactivation, carbon used to treat PCBs or TCDD is currently being disposed of in chemical landfills rather than being regenerated. Thus, the toxics accumulated on the carbon are not destroyed, only stored, and may enter the environment in the future.

Clearly, the utility of portable activated carbon systems (particularly when used on contaminated carbon that is not commercially regenerable) would be enhanced if the carbon could be regenerated at the cleanup site. Since the adsorption system had been adapted to a mobile base, it was not difficult to conceive of a regeneration process that could be fitted onto a skid or mobile trailer bed.

Many materials that would be adsorbed by the carbon can be stripped off by means of steam or other thermal treatments to regenerate the adsorptive capacity of the carbon. The residue removed by this stripping would contain much higher concentrations of the adsorbed materials than the contaminated water would. Since this residue still has to be disposed of at an acceptable facility, the regeneration system would have to convert the residue at the spill site to a form suitable for disposal.

In an earlier federally sponsored program (Juhola, A.J., "Laboratory Investigation of the Regeneration of Spent Activated Carbon," U.S. Public Health Service, Contract PH 14-12-469, 1970 Final Report MSAR 70-184), a laboratory-sized carbon regeneration unit was developed that used thermal treatment to strip the adsorbed material. This unit provided a starting point for the design of a portable unit that could provide on-site carbon regeneration and waste material incineration at spills and hazardous waste sites.

System Description

The carbon regeneration system consists of a direct-fired thermal regenerator or kiln, an incinerator to degrade the material stripped from the carbon, and a scrubbing tower to remove undesirable materials from the offgases (Figure 1).

The carbon regeneration unit is trailer mounted for rapid transport to the spill site, and self-contained for operation when deployed near a source of fresh water and provided with fuel. Only two trained operators are required.

Spent carbon feed is drained of excess water and transferred to a feed hopper at the rear of the trailer. A screw feed meters the spent carbon into a kiln. The carbon is regenerated as it progresses through a rotating kiln barrel, which is direct-fired with a controlled-gas composition. The regenerated carbon product is discharged from the kiln barrel through a firing breech to a slurry quench tank where a screening section removes fines and discharges the remaining carbon for reuse.

Flue and adsorbate gases are ducted

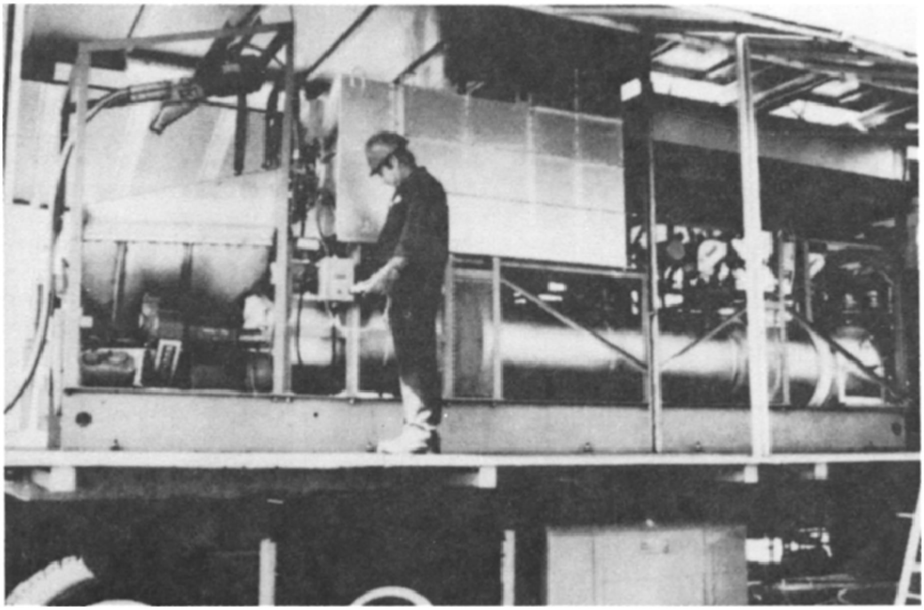

Figure 1. *Profile of kiln and incinerator.*

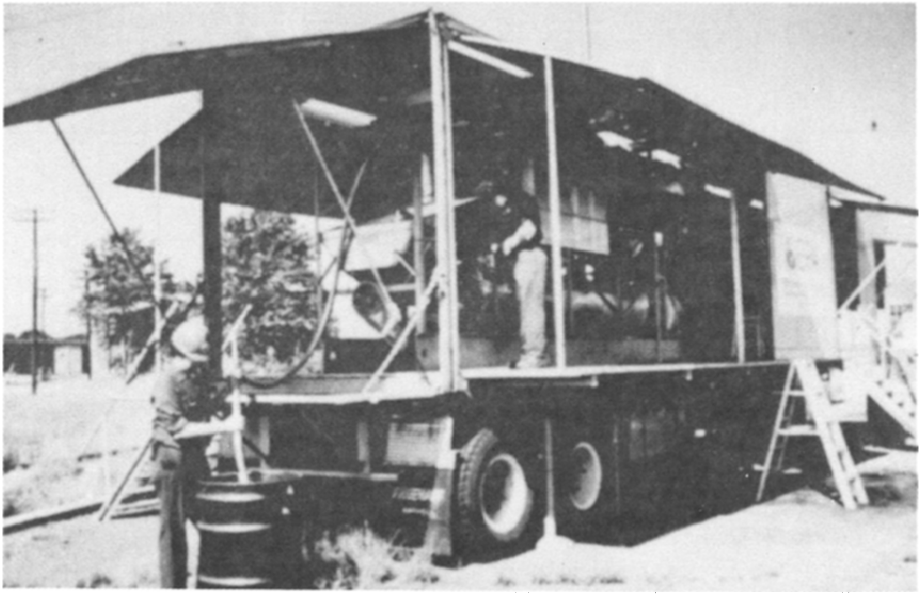

Figure 2. *Trailer open for system operation.*

from the fume breech into a direct-fired incinerator (afterburner) to oxidize the objectionable contaminants. Incinerator gases are then quenched with water sprays and scrubbed with water or a caustic solution to neutralize acids and remove particulates before venting to the atmosphere. Spent process water is filtered, treated, and either recycled or discharged to its source.

System design parameters were imposed by limitations of trailer size and weight along with the expected over-the-road stresses. Lightweight and resilient fabrication was emphasized throughout, including light structural containment, ceramic fiber thermal insulation, and flexible piping sections. Areas subject to abrasion or corrosion at high temperatures are protected with Inconel or stainless steel.

All process equipment is mounted in a special semi-trailer van measuring 2.44 m W x 13.7 m L x 4.1 m H when closed for storage or transit. A self-supporting platform base was selected for off-the-road operation with minimal bed deflection. Full enclosure is provided during transport. The sides open to become an awning and a platform to provide rain protection and equipment access walkways during operation (Figure 2). The van is fitted for transportation by tractor-truck or piggy-back by rail in accord with all applicable requirements and regulations. Conventional width, height, length, and weight road limits are met.

Results and Conclusions

The program resulted in the successful design and fabrication of a trailer-mounted carbon regeneration system that met the original objectives. The regeneration rate was 45.4 kg/hr of 40-mesh granular carbon regenerated at $<20\%$ carbon loss and $>75\%$ adsorption capacity.

A pilot run was made with the unit before its shipment to EPA. An activated carbon material contaminated with Toxaphene ($C_{10}H_{10}Cl_6$) and minor quantities of other chlorinated hydrocarbons was obtained from EPA. Loadings were 13% contaminant and 52% water. Regeneration yielded an 88% volume of a completely reactivated material based on iodine numbers. Vent gas analysis showed CO and hydrocarbons to be below detectable limits.

The full report was submitted in fulfillment of Contract No. 68-03-2110 by MSA Research Corporation under the sponsorship of the U.S. Environmental Protection Agency.

The development of the Mobile Carbon Regenerator is continuing at Edison, New Jersey, where testing on a variety of contaminants under controlled conditions and in the field will be conducted.

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The complete report, entitled "Design and Construction of a Mobile Activated Carbon Regenerator System," (Order No. PB 86-156 486/AS; Cost: $11.95, subject to change) will be available only from:
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