

REDUCTION OF CARBON MONOXIDE EMISSIONS WITH REGENERATIVE THERMAL OXIDIZERS

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Abstract

Regenerative thermal oxidizers (RTOs) have been extensively used for the control of volatile organic compound (VOC) emissions from various sources. However, very little information is available on the ability of RTOs to control carbon monoxide (CO) emissions. This paper presents the results of extensive tests conducted on two RTOs to determine their VOC and CO control efficiencies.

The inlet gas stream to the RTOs includes VOC and CO concentrations as high as 2,000 ppm and 3,600 ppm, respectively. The testing demonstrated that both RTOs were capable of controlling greater than 98% of both inlet VOCs and CO. While the destruction efficiencies within the combustion chambers exceeded 99.9%, direct leakage past valves accounted for the lower control efficiencies.

The tests indicated that the overall VOC and CO control efficiencies of the RTOs may be limited by valve leakage. The design and permitting of a RTO should include conservative control estimates which account for possible valve leakage.

Introduction

The Passaic Valley Sewerage Commissioners (PVSC) own and operate a 330 million gallon per day secondary wastewater treatment facility located in Newark, NJ. The area serviced by PVSC is highly industrial, with a population of approximately 1.5 million people. The wastewater treatment process includes primary treatment and a pure oxygen activated sludge process followed by secondary clarification. Sludge generated in the treatment of the wastewater is thickened in gravity thickeners prior to treatment through the Zimpro Wet Air Oxidation Process. The Zimpro treated sludge is then thickened in decant tanks and dewatered in recessed plate filter presses. The current sludge production is close to 250 wet tons per day.

The Zimpro process utilizes high temperature (420°F) and pressure (650 psi) with the addition of air to oxidize approximately 65 percent of the volatile matter in the liquid sludge. Bound water within the sludge is released through the Zimpro process, which results in the improved coagulation of the solids. The vapors released during the decanting of the

treated sludge are odorous and contain high concentrations of VOCs, CO₂, and CO. The original odor control system included a carbon adsorption system which did not effectively control the Zimpro odors.

In 1991 PVSC purchased and installed two identical RTOs to control odors and VOC emissions from the Zimpro process and the filter press building. One RTO operates at all times with the second unit acting as a stand-by.

Each RTO consists of three canisters containing ceramic media which captures thermal energy from the exhaust stream during an outlet cycle and transfers this energy to the inlet gas stream during an inlet cycle. The flow is controlled by butterfly valves which are opened and closed by linkage arms connected to a drive shaft which completely rotates once every 3-4 minutes. A common combustion chamber is located above the canisters. Two natural gas fired burners, located at opposite ends of the combustion chamber, maintain a temperature of 1,500°F. Prior to an outlet valve opening (an outlet cycle) a purge valve is opened to evacuate any foul gas within the canister and valve area to prevent excessive levels of contaminants from being discharged. A simplified diagram of the system and the valve positions during each cycle are shown in Figures (1) and (2).

The inlet gas stream consists of approximately 30,000 cfm of highly odorous off-gas from the Zimpro process with a VOC concentration as high as 2,000 ppm and an oxygen concentration between 15% and 9%. The inlet gas stream also has a high concentration of CO ranging from 1,800 ppm to 3,600 ppm. The concentration of VOCs, CO, and the percent oxygen entering the RTOs varies with the amount of sludge processed through the Zimpro facility. Both the VOC and CO concentrations increase with the amount of sludge processed by the Zimpro units, while the percent oxygen decreases as more sludge is processed by the Zimpro units.

The original permit to operate required a VOC destruction efficiency of 98%. The permit also allowed a maximum CO outlet concentration of 50 ppm or 100 ppm corrected to 7% O₂, when the oxygen concentration was below 14%. This permit condition is typical of a common combustion source such as a boiler, and indicates efficient combustion of the process off-gas and any auxiliary fuel within the combustion chamber. The