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Project Summary

Wastewater Dechlorination State-of-the-Art Field Survey and Pilot Studies

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A study of dechlorination was conducted in the County Sanitation Districts of Los Angeles County to determine the utility and efficiency of the sulfur dioxide method and to provide a cost-effective comparison of sulfur dioxide and two other methods of dechlorination, namely, activated carbon and holding tank processes. Study objectives were accomplished through three main phases of work: literature review, pilot-scale testing, and full-scale evaluation in the field.

The literature review involved an extensive search on the practice of dechlorination in the United States and abroad, an assessment of the need for reaeration and pH adjustment in the dechlorinated effluent, and an examination of the extent of bacteriological aftergrowth in outfall pipelines and receiving waters.

The pilot-scale testing indicated that no degradation of physical and chemical water quality occurred in the dechlorinated effluents from any of the three dechlorination processes investigated. However, a one to two order of magnitude increase in total coliform density in the 10-minute samples following dechlorination was commonly observed among the three dechlorination processes. The increase seemed to originate from contamination by the existing microorganism communities in the dechlorinated effluent rather than from the reactivation of injured bacterial cells.

The field survey involved the canvassing of 55 operating plants in California by mail, telephone, and site visits to selected facilities. The feed forward method of sulfur dioxide dosage control with signals received from both a flow and residual chlorine controller appeared to be the most commonly employed method. Although overdosing of sulfur dioxide was frequently necessary to meet the residual chlorine discharge standards, most installations found pH adjustment and reaeration of the dechlorinated effluent unnecessary.

Process cost estimates based on the field survey and pilot-plant study have been prepared for all three dechlorination processes. The sulfur dioxide process seems to be the most cost-effective method for dechlorination.

The Project Summary was developed by EPA's Municipal Environmental 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

Because of growing concern over the effects of chlorine and chloramines on the aquatic environment, dechlorination has become an important unit process to be considered as part of a wastewater treatment system employing chlorination as its disinfection process. The chlorine residuals, either free chlorine

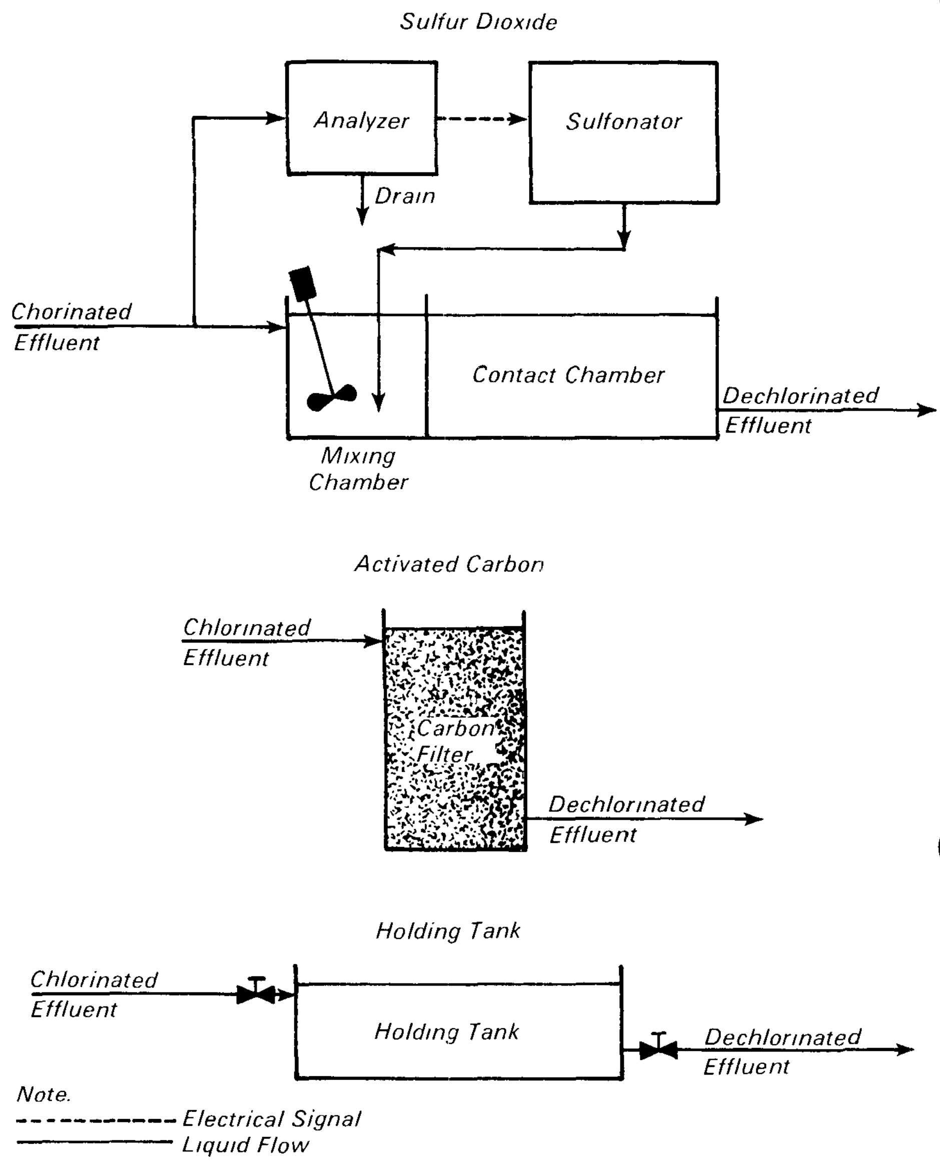

Figure 1. *Flow diagram of dechlorination pilot-plant systems at Pomona, California*

or chloramines, have been well demonstrated to be toxic to fish and other aquatic organisms. Therefore, the regulatory agencies are in the process of establishing, or have already established, chlorine effluent standards for wastewater discharges. These established standards or proposed criteria for chlorine residuals are normally dictated by the residual chlorine detection limits.

The County Sanitation Districts of Los Angeles County are required by the California Regional Water Quality Control Board to provide dechlorination facilities at their water reclamation plants for chlorine residual control. The total chlorine residuals allowed in these plant effluents, which are discharged into nearby creeks or rivers, are equal to or less than 0.1 mg/l. This study was initiated as a result of the need for dechlorination in the County Sanitation Districts' facilities. The study had three main objectives:

1. To establish on a pilot scale the utility and efficiency of sulfur doixide for dechlorinating chlorinated municipal wastewater treatment plant effluent.
2. To demonstrate on a full scale the cost-effectiveness of sulfur dioxide dechlorination under actual operating conditions.
3. To examine the cost-effectiveness of other methods of dechlorination (i.e., activated carbon and holding tank processes)

The pilot-plant study was conducted at the County Sanitation Districts' Advanced Wastewater Treatment Research Facility, Pomona, California The three methods of dechlorination evaluated were sulfur dioxide, granular activated carbon, and holding tank impoundment. The schematic flow diagram for these processes is shown in Figure 1 Emphasis was placed on the sulfur dioxide process because of its potential for being the most cost-effective method for dechlorination. The granular activated carbon method had been investigated previously at the same research facility, and the results are included in the final project report The holding tank impoundment method was evaluated concurrently with the sulfur dioxide method.

The full-scale evaluation was conducted by means of a field survey of all California treatment plants that practiced dechlorination by any means The primary objectives of the field survey were to assess the effectiveness and reliability of actual full-scale dechlorination installations. Information on the methods of control for the sulfonation system, cost-effectiveness, and the bacteriological aftergrowth in the dechlorinated effluent were also requested through the field survey, which was conducted with both questionnaire correspondence and site visit followup

Results

The most common layout of a sulfur dioxide dechlorination system employed in the plants visited is shown in Figure 2. As indicated in the figure, a feed forward residual signal and a feed forward flow signal were fed to the sulfonator. These two signals were sometimes combined into a product signal through an electronic multiplier before feeding to the sulfonator. This was done to avoid having to excessively overdose the chlorinated effluent with sulfur dioxide.

The feed forward control system requires an overdosing of sulfur dioxide to accomplish the stringent dechlorination goals. Such an overdosing cost may become a significant factor in large dechlorination installations. Alternate sulfur dioxide control systems as shown

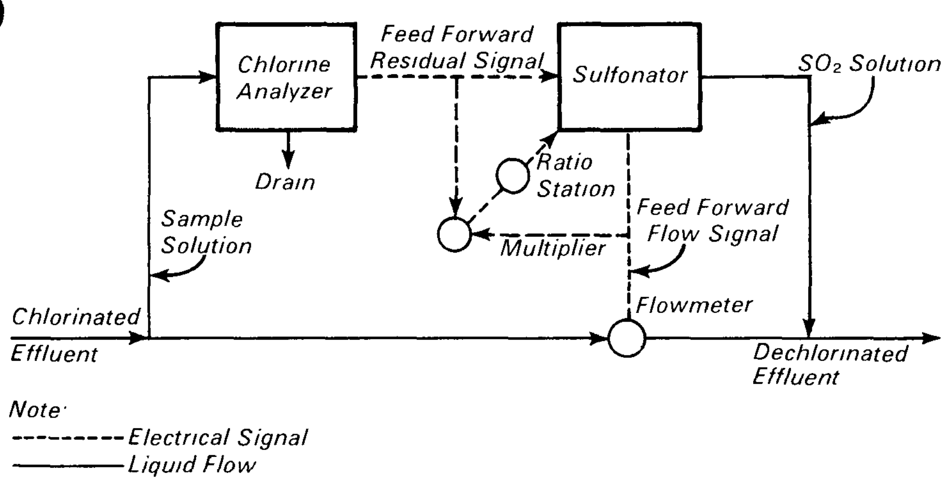

Figure 2. *Feed control system most commonly employed in sulfur dioxide dechlorination facilities in California.*

in Figure 3 will reduce the sulfur dioxide overdose requirement and hence the operating chemical cost.

According to the field operators contacted, the weakest link in a sulfur dioxide feed control system was the chlorine residual analyzer. The measuring electrode of the chlorine analyzer lost its sensitivity rapidly in a dechlorinated effluent. The presence of some amount of chlorine residual seemed to help prevent polarization of the electrode. The abrasive grits in the measuring cell block were found unable to prevent oxides from forming on the electrode in the absence of chlorine residual.

During the site visits, it was also learned that poor performance was experienced with the chlorine analyzer when the plant received a high proportion of industrial wastes. Plugging of the measuring cell block frequently occurred. However, the operators of the dechlorination facilities were generally satisfied with the reliability of their sulfonators

No significant depletion of dissolved oxygen or reduction in pH was observed in the pilot-plant studies at a sulfur dioxide to residual chlorine dosage ratio of as high as 2 to 1. Therefore, no reaeration or pH adjustment for the dechlorinated effluent was found necessary in the pilot-plant studies The field survey results also indicated that more than 97 percent of the dechlorination facilities in California did not have the need for pH adjustment and reaeration for their dechlorinated effluents.

The pilot-plant studies indicated that both sulfur dioxide and activated carbon adsorption are very efficient and rapid dechlorination processes, in contrast to the rather slow holding tank process. In the latter, the average dissipation rate for residual chlorine was found to be about 1 mg/l for every 20 hours. Thus, the volume and land area requirements for dechlorination by holding ponds are considerable.

Bacteriological aftergrowth in some microorganism populations was found in all the dechlorination processes investigated. This was observed predominantly in the total coliform group. Figure 4 indicates typical results in a sulfur dioxide dechlorination system. Some increases in fecal coliforms and other bacteria (as detected in the total plate count) were also found in the dechlorinated effluents *Salmonella* was not detected in most of the samples. Fecal streptococci in the effluent remained relatively unchanged after dechlorination. The bacterial increases in the dechlorinated effluents seemed to be attributed to contamination by the microorganism communities existing in the dechlorinated effluent rather than reactivation of injured bacterial cells. The rate of contamination after initial startup of the dechlorination systems is shown in Figure 5, which indicates a saturation level of contamination established after 5 days of operation.

No significant chemical-physical degradation of the dechlorinated effluent quality was found for the sulfur dioxide, carbon adsorption and holding tank dechlorination processes.

A comparison of total process costs, including capital, operation and maintenance costs, for sulfur dioxide, carbon adsorption and holding pond dechlorination processes is presented in Figure 6. Clearly, the sulfur dioxide process is the most cost-effective method for dechlorin-

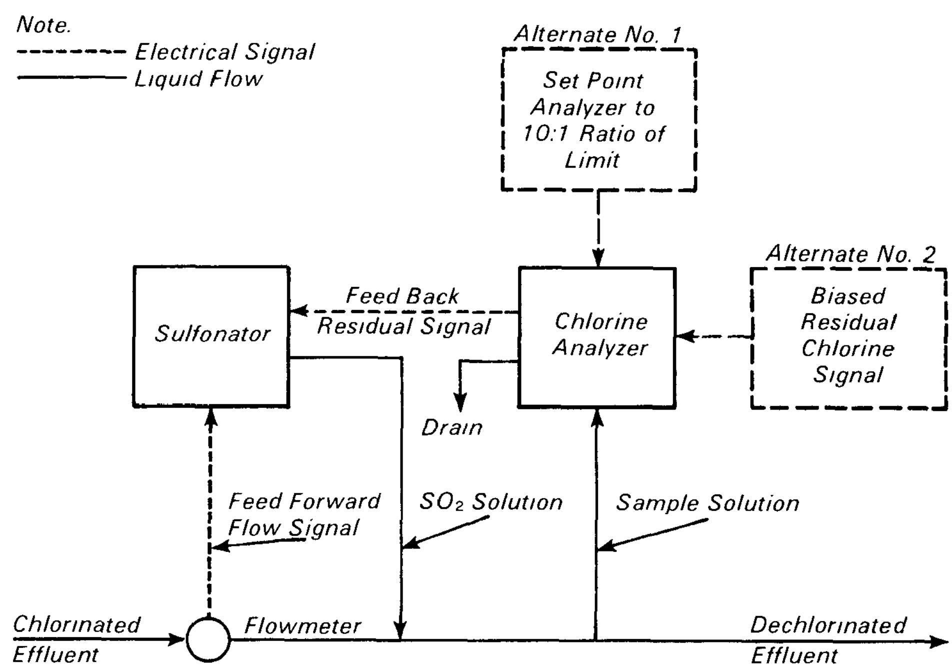

Figure 3. *Feed control systems used in dechlorination facilities to avoid excessive SO_2 overdose*

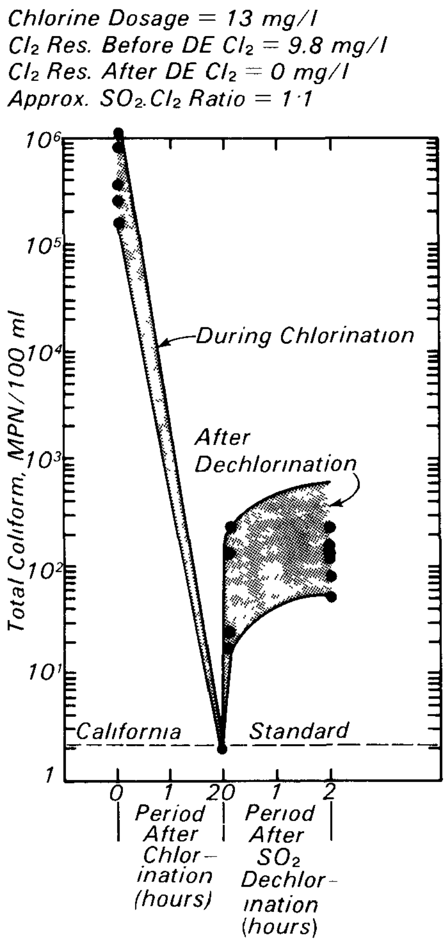

Figure 4. *Pilot-plant observation of total coliform before and after dechlorination with SO_2.*

ation, particularly in the State of California. The carbon adsorption process is substantially more expensive than the other two dechlorination processes investigated. It is not economically feasible to use the carbon adsorption process solely for dechlorination purposes. The holding pond process may become more cost-effective than the sulfur dioxide process for dechlorination, only if an inexpensive land is available and a simpler pond construction is acceptable.

Recommendations

Both field survey and pilot-plant study results indicated that a more reliable chlorine analyzer should be developed to perfect the automation of the sulfur dioxide feed control system The effects of organic loading on the carbon capacity for dechlorination should be thoroughly evaluated

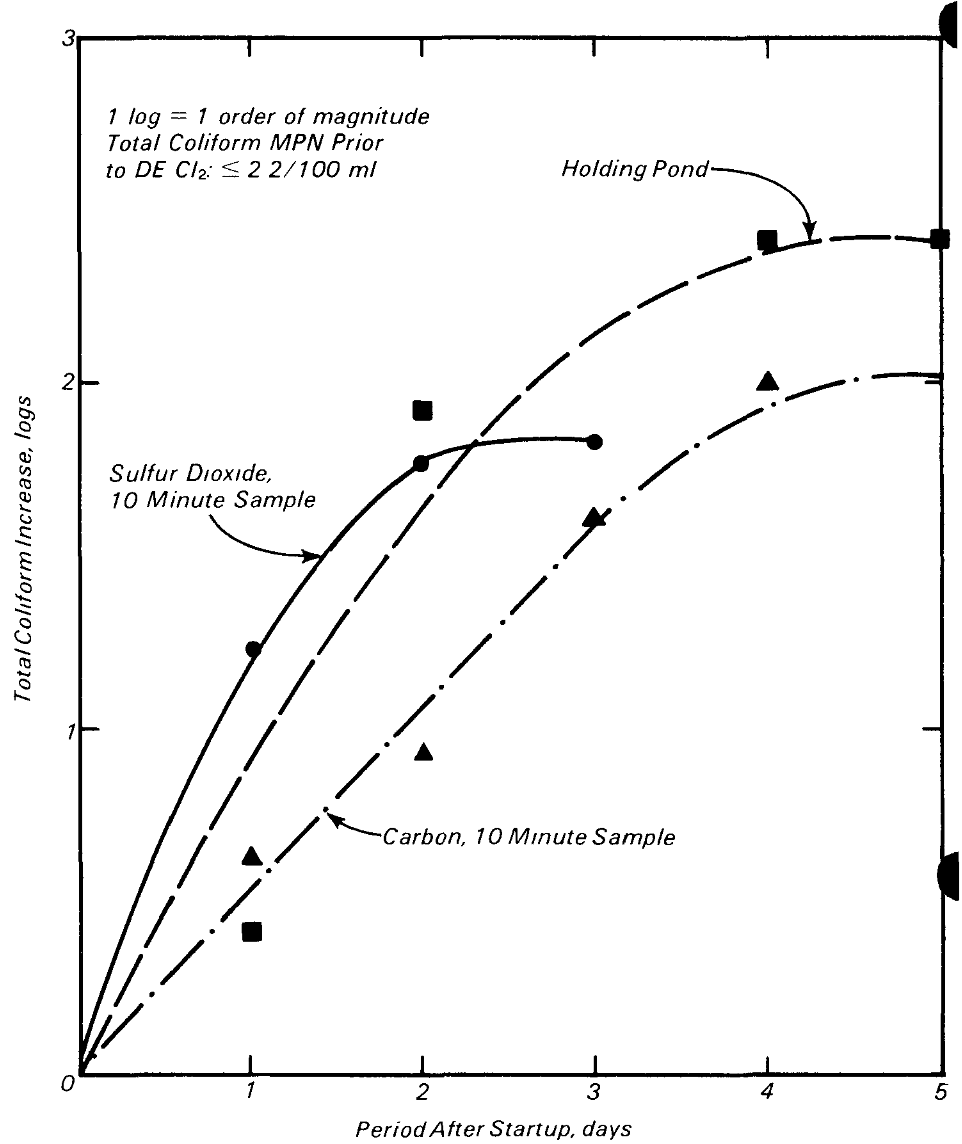

Figure 5. *Rate of contamination after initial startup in clean dechlorination pilot-plant systems.*

The full report was submitted by the Sanitation Districts of Los Angeles County, Whittier, California, in fulfillment of Contract Nos. 14-12-150 and 68-03-2745 under the partial sponsorship of the U.S. Environmental Protection Agency.

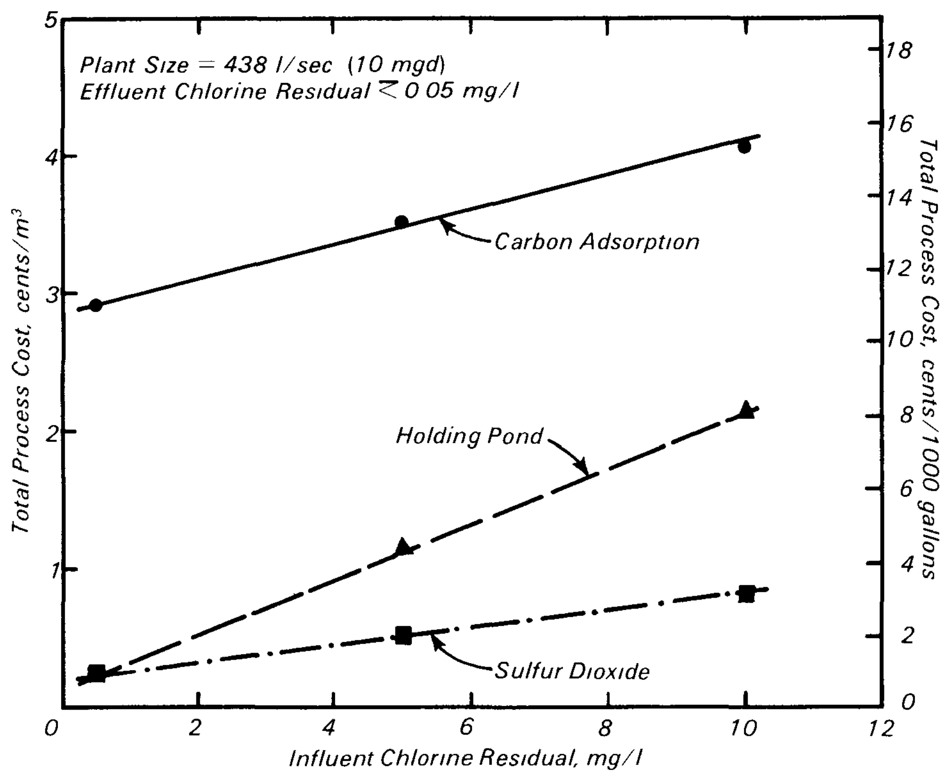

Figure 6. Process cost comparison among different dechlorination processes.

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Albert D. Venosa and **Irwin J. Kugelman** are the EPA Project Officers (see below).

The complete report, entitled "Wastewater Dechlorination State-of-the-Art Field Survey and Pilot Studies," (Order No. PB 82-102 336; Cost: $11.00, subject to change) will be available only from:

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Telephone: 703-487-4650

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