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Project Summary

Environmental Assessment Data Base for Petroleum Refining Wastewaters and Residuals

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The objectives of this study were to develop a comprehensive environmental data base for the characterization and control treatment of petroleum refinery wastewaters and residual sludges and the recommendation of areas where further research is needed to improve the data base.

The project was conducted in three phases. Phase one was the establishment of a Peer-Group Review Committee to provide direction to the project and to ensure that a diversity of viewpoints was considered. Six eminent experts in the field of waste treatment were chosen to serve on the committee.

Phase two involved the preparation of four state-of-the-art reviews, by outside consultants, to provide a comprehensive environmental data base on refinery wastewaters and residual sludges as well as identifying the control technologies used in the refining industry.

Phase three included a critical examination of the four individual state-of-the-art reviews and selection of specific areas where further research was needed to improve the data base.

Each of the specific research areas selected as needing improvement is discussed in some detail so as to explain why further research might be fruitful and to highlight the benefits that might be expected of such research.

The study also includes a summary of conclusions regarding future trends in refinery processing technology, future trends in wastewater reuse within refineries, and the performance capabilities of current wastewater treatment technology.

This Project Summary was developed by EPA's Robert S. Kerr Environmental Research Laboratory, Ada, OK, 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

This study developed a comprehensive environmental assessment data base for the characterization of petroleum refinery wastewaters and residuals, and for the performance capabilities of refinery wastewater treatment technology. As a result of the study, areas were selected where further research was needed to improve the data base. The work was accomplished by establishing a Peer-Group Review Committee; developing four state-of-the-art reviews by outside consultants; critical examination of those reviews and selection of specific areas where further research was needed.

A Peer-Group Review Committee of six eminent experts in the field of refinery wastewater treatment, most of whom had actual experience in refinery wastewater management, were chosen to serve on the committee which provided oversight direction to the project. The committee members chosen represented a broad spectrum of diverse viewpoints from industry, universities, and the consulting field.

To develop the environmental assessment data base, state-of-the-art reviews were prepared by outside consultants on four topics:

1. Characterization of the petroleum refining industry and refinery wastewaters. The parameters affecting the generation of wastewater pollutants are discussed, including crude oil compositions, refinery technologies and classifications, wastewater sources and wastewater pollutants.

2. A pollutant discussion and rationale for characterizing the wastewaters from petroleum refineries and their toxicity effects upon aquatic organisms. This rationale includes a review of the analytical procedures used to measure, define, and assess the effects of the various pollutants. The pollutants considered include the current permit parameters (COD, BOD, etc.) as well as the priority pollutants.

3. A comprehensive discussion and evaluation of existing and emerging wastewater treatment and control technology. Data on the performance capabilities of the various technologies are included.

4. A compilation of data on the discharge levels of refinery wastewater pollutants including their avenues of discharge. The data include estimates of accuracy, precision, variances and causes of variance.

Research Needs

The amount and composition of wastewaters and sludges generated by petroleum refineries are highly variable and are dependent upon a complete matrix of factors. There is a large existing data base on the characteristics and variability of refinery wastewaters. There is also a large body of literature, data, and case histories concerning the existing control technologies for treating refinery wastewaters and sludges. The four state-of-the-art reviews included in the complete study report present the details of the existing data base in a comprehensive manner. Based upon a critical examination of the individual state-of-the-art reviews, key areas within the existing data base were selected as needing further research in order to provide:

- More valid and better correlated data on the variability in the characteristics of refinery wastewaters and sludges.

- More information related to the long-term toxicity effects of refinery wastewaters upon fish.

- Better demonstrated data on the design parameters, economics, and performance capabilities of specific control technologies for the treatment of refinery wastewaters and sludges.

- More and better guidance as to the technological and economic feasibility of methods proposed for the ultimate disposal and/or reuse of treated wastewaters, concentrated pollutant brines and residual sludges.

Based upon the above criteria, eight specific areas are identified in the study report as being in need of further research in order to improve the existing data base. Each specific area is discussed in detail to explain why further research is needed and what benefits might be expected from such research. Two of the areas selected involve gathering and correlating actual plant data from existing control technologies: activated sludge biotreatment and chemical oxidation treatment. Two other areas selected involve laboratory research to: identify specific refinery pollutants which exhibit long-term, lethal or sublethal fish toxicity; develop techniques for the more rapid determination of long-term fish toxicity; and develop new pollutant analysis methods which are more reliable and would therefore reduce the effect of unreliable analytical methods upon effluent quality variability. Three of the selected research areas involve pilot-scale and demonstration-scale testing and development work: the development of a method for regenerating spent powdered activation carbon (PAC) used to enhance biotreatment; large-scale demonstration of the granular activated carbon process (GAC), and pilot testing of landfarming to define odor and air emission problems and their mitigation. The final research area selected involves a comprehensive feasibility and guidance study regarding the methods of producing a concentrated residual pollutant brine (reverse osmosis and evaporation), and the ultimate disposal of residual wastewater pollutants in subsurface injection wells, evaporation-percolation ponds or remote disposal dumps.

Conclusions and Recommendations

Existing refinery technology is very complex, and the development of new technology is an on-going process. Within the period 1940 to 1960, a number of technological "breakthroughs" occurred which included the development of fluid catalytic cracking and processes involving catalysis in a hydrogen atmosphere. With the current body of knowledge on catalytic processes, the future development of new refinery technology is expected to be more evolutionary in nature. Another period of rapid technological breakthroughs is not expected.

Many refineries already practice the in-plant reuse of treated wastewaters to some extent, and air cooling has replaced much water cooling. For those reasons, there is little likelihood that more intensive emphasis on wastewater reuse will dramatically reduce wastewater volumes.

The current technology for refinery wastewater treating includes the in-plant reduction of wastewater generation, primary removal of oil and suspended solids, and secondary treatment via biological oxidation. In general, that current technology can satisfy the regulatory criteria for control of the conventional pollutants such as oil, suspended solids, BOD, COD, phenols, sulfides, ammonia, etc. There is also much evidence that the current technology essentially removes or degrades those pollutants which cause lethal short-term (96-hour) toxicity to fish.

Eight areas are identified in which further research is needed to improve the environmental data base for characterizing and treating petroleum refinery wastewaters and residual sludges. Those areas of research needs are briefly listed below:

Actual Plant Data and Correlation

1. Correlation of the key design factors in activated sludge biotreatment, such as mixing horsepower and reaction retention time, with pollutant removal efficiency.

2. Correlation of actual case history data on the use and effectiveness of chemical oxidants (hydrogen peroxide, chlorine and ozone) in treating refinery wastewaters.

Laboratory-Scale Research and Development

3. Identifying the specific refinery wastewater pollutants which exhibit long-term fish toxicity. Development of techniques for the rapid determination of long-term fish toxicity effects.

4. Determination of which analytical test methods are the least reliable and quantifying their contribution to overall effluent quality variability. Development of more reliable test methods, if possible.

Pilot and Demonstration-Scale Research

5. Development of an economic method for recovering and regenerating the spent powdered activated carbon (PAC) used to enhance the performance of activated sludge biotreaters.

6. Funding the demonstration and operation of the granular activated carbon process (for the secondary or tertiary treatment of refinery wastewaters) at a scale capable of the treatment of 200-400 gpm of refinery wastewater.

7. For the landfarming of oily sludges, determination of the relationship between sludge vapor pressure and problems of odor control and air emissions. Development of methods for mitigating such problems; and investigation of methods of resolving problems with landfarming vis-a-vis RCRA regulations if such problems exist.

Feasibility and Guidance Study

8. Development of a comprehensive feasibility and guidance study regarding the methods of producing a concentrated pollutant brine (by reverse osmosis and evaporation) and the ultimate disposal of residual wastewater pollutants in evaporation-percolation ponds, subsurface injection wells and remote disposal dumps. The study should include: realistic assessment of capital costs and energy usages, realistic assessment of the benefits to be gained in terms of the magnitude of improvement in the quality of the nation's waters, and determination of the cost-benefit ratio of the EPA's current NSPS "no discharge" requirement for refineries relative to control of other pollutant sources such as non-point sources.

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The complete report, entitled "Environmental Assessment Data Base for Petroleum Refining Wastewaters and Residuals," (Order No. PB 83-164 749; Cost: $20.50, subject to change) will be available only from:
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