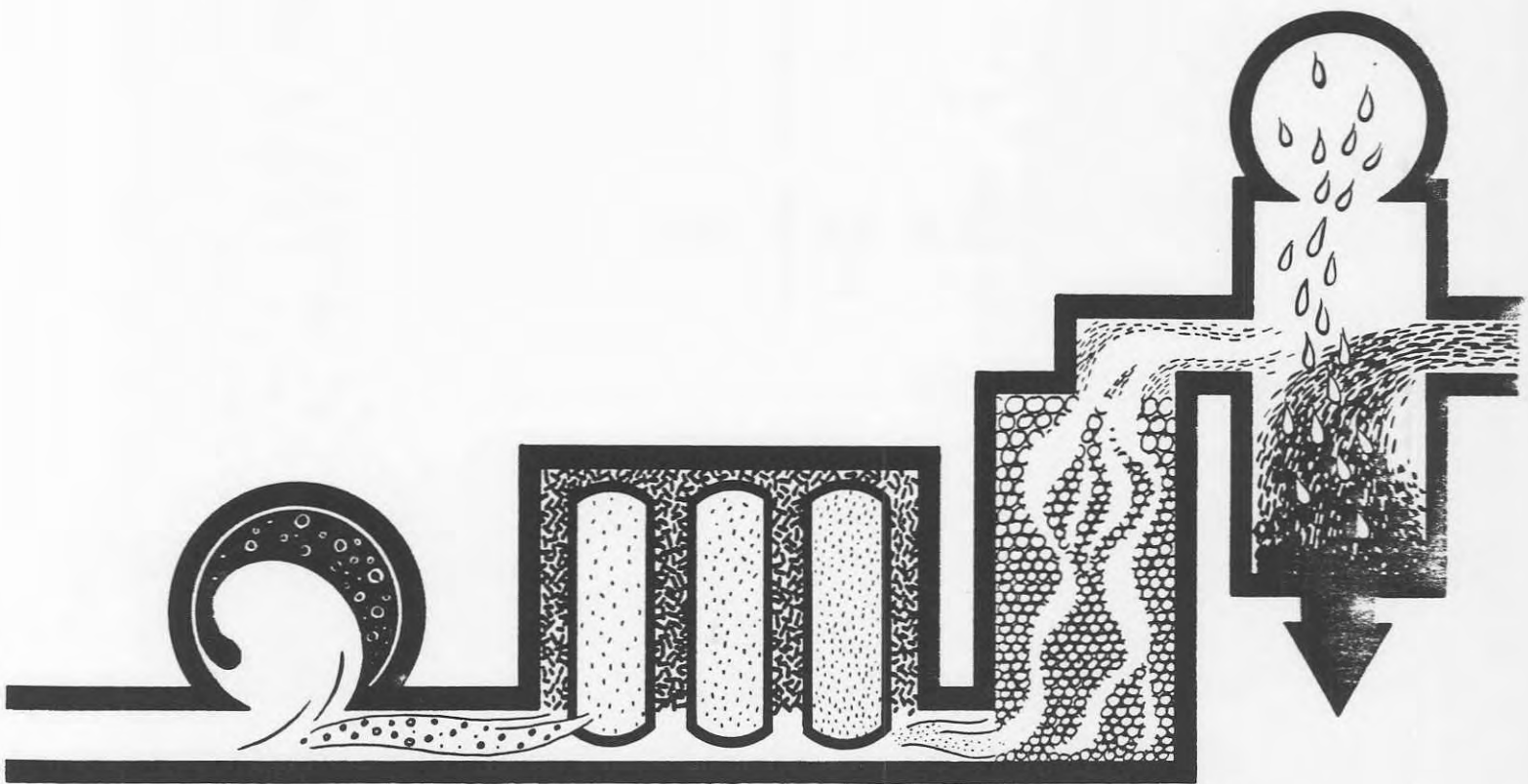




Biomass Determination - A New Technique for Activated Sludge Control

Methods based upon the ability of microorganisms to produce ATP for energy during the oxidation of organic matter have been developed for the rapid quantitative assay of solutions containing biomass. Pilot plant studies were conducted to test the use of ATP for control of return sludge ratios. A concentration of 2 mg/l ATP in the influent reactor tank was found to be most effective for control of return of 500 mg/l BOD₅.

Preliminary studies using ATP measurements for control of activated sludge treatment have been performed in full-scale wastewater plants. The assay was performed without difficulty and gave indications of possible benefits.



SECTION I

CONCLUSIONS

1. Adenosine triphosphate can be extracted from sludge and mixed liquor using boiling Tris buffer, perchloric acid or trichloroacetic acid; however, the use of boiling Tris buffer had advantages over the other methods.
2. Methods based upon the firefly bioluminescent reaction were developed for the rapid quantitative assay of solutions containing ATP.
3. Pilot plant studies were conducted to test the use of ATP for control of return sludge rates. A concentration of 2 $\mu\text{g/ml}$ ATP in the first aeration tank was found to be most effective for treatment of waste of 240 mg/l BOD_5 .
4. Preliminary studies using ATP measurements for control of aeration sewage treatment have been performed in full-scale treatment plants. The assay was performed without difficulty and gave indications of possible utility.

SECTION II

RECOMMENDATIONS

Studies in both the Baltimore and Arlington plants were designed as preliminary investigations of the feasibility of operational control by means of ATP assay of biomass. These initial goals have been reached. Studies should now be conducted for longer periods of time throughout seasonal changes. If possible, the plants under study should be divided into test and control sections.

In addition to the influence of weather and climate conditions, in-plant ATP measurements should be made during bulking, shock loading, severe hydraulic overloading, introduction of toxic materials, heavy silting, and foam formation.

Pilot plant studies should be continued to support full-scale plant operations when these types of problems arise. Many of the operational stresses mentioned above can be duplicated in the pilot plant. Information gained by pilot plant operation can be rapidly converted into useful action in a full-scale plant.

Further studies to determine the optimum concentration of ATP should be conducted. The influence of sewage strength, temperature, contact time, and sludge activity should all be determined and integrated into a workable operational procedure.

A manual for the plant operator should be prepared providing information on methods and procedures to be followed in actual plant operation. This should apply to several types of activated sludge plants and contain precise information to permit effective control under all types of foreseeable conditions.

SECTION III

INTRODUCTION

The operation of an activated sludge sewage treatment plant depends upon microorganisms in the return sludge. The basic assumption is that the recycled sludge is composed of living cells which absorb and metabolize components of the incoming waste. The effectiveness of the return sludge is related directly to the number and physiological state of these cells. The parameter currently used for return sludge control is total suspended solids. McKinney (1) points out that living microorganisms may constitute as little as 25% of the suspended volatile solids. Patterson, et al. (2) came to a similar conclusion and state that "a significant portion of the suspended volatile solids is nonviable organic material not associated with the oxidative degradation of the substrate."

Since the functional portions of any biological treatment plant are the living microorganisms which comprise the sludge, a means of measuring this active fraction is highly desirable. Conventional methods of microbial enumeration are difficult to apply because of the mixed and clumped nature of the flora present, and the time required for culturing techniques. Conventional plating methods do not produce results for at least one day - too late to be of use for control of the plant.

Adenosine triphosphate (ATP) is universally present in living microorganisms and its measurement by the firefly bioluminescent reaction is rapid. This study was therefore undertaken to determine the feasibility of using the measurement of ATP in sludge as a workable parameter for control of aeration sewage treatment. The task involved the fabrication of an instrument suitable for measurement of light emitted in the firefly bioluminescent reaction, establishment of suitable controls and standards, selection of an extraction procedure, establishment of a methodology which would yield useable levels of precision and accuracy, correlation of ATP measurements with other parameters of cellular activity and plant operation, and a preliminary test of the basic principle in full-scale plant operations.