

SUMMARY AND CLOSURE

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The papers in this volume are intended to present a perspective of several technical areas and their potential for application in water technology. Some basic concepts of biochemistry, plant physiology, transport phenomena, kinetics, computers, mathematical modeling, and optimization are followed by two papers discussing applications of these concepts.

Mathematics may be used to illustrate why more sophisticated concepts are needed in water problems. Traditionally workers in the water field have used mathematics only to "explain" or "describe" observed data. The power of mathematics which properly defines a reaction on a fundamental basis is that the equation(s) can be used to synthesize, and optimize, a system to accomplish a specific objective. These equations can also show the response of a system to a perturbation or change in operating protocol. Examples of such perturbations would be a change, quantitative or qualitative, in feed to a biological process, or the addition of another source of pollutants to a stream or estuary. Obviously, the formulation of such potent mathematical expressions requires detailed knowledge of all factors operating in the system, from biochemistry to transport characteristics.

Several salient points characterize the primary emphasis of the papers:

- 1) Biochemical reactions involved in biological systems are much more difficult to describe than chemical reactions normally encountered in the process industries. The stoichiometry and kinetics of a specific sequence of reactions may be markedly affected by the reaction environment or system in which the reactions occur. Transport phenomena are quite significant in considering the influence of environment on overall stoichiometry and kinetics.

- 2) The photosynthetic processes play a major role in nature's environmental balance. An understanding of these processes permits their application to some of the problems in water technology.

- 3) The two basic types of computers now available have specific applicability for some water problems. Solution of a particular problem is facilitated by selection of the appropriate type of computer.

4) Mathematical modeling and use of optimization techniques require detailed knowledge of the system under study. Establishment and solution of an involved equation may be less than significant unless the equation does indeed describe the system.

5) The importance of having detailed knowledge of a system is particularly illustrated by both bacterial systems and the stream and estuary problem. These problems may be so complex as to defy direct solution. Sufficient knowledge enables simplifying modifications to be made which permit solution without critically weakening the model.

In this age of exploding technology, an individual has difficulty in keeping abreast of even his field of specialization. When this field is water and thus requires knowledge from many disciplines for use in problem solving, a little knowledge can indeed be dangerous. As examples, we find in the literature references to "nonoxidizable" or "nonremovable" BOD, and to "thermodynamics" of nonequilibrium reactions. Clearly, upon reflection, such phrases are not valid and their very existence emphasizes the need for a conference of this type. The reason for erroneous usage of new concepts lies in the failure to apply simple equations to simple systems and complex equations to complex systems. Most textbooks use the simplest possible example to explain a concept, such as free energy. This does not mean that free energy values for glucose oxidation to carbon dioxide and water can be applied to a complex biochemical reaction producing the same end products from glucose.

Similar comments hold for defining broad-based, or general, "reaction orders" from inadequate or superficial data taken from restricted systems.

To illustrate further, BOD is obviously oxidizable because it is measured as an oxidation, and becomes "nonremovable" only in a system inadequately designed for its removal.

In short, common sense is an excellent framework in which to fit inductive logic. But, because common sense is based upon experienced knowledge, study in depth is required to either vindicate or condemn a concept purportedly based on "scientific fact."

Perhaps the greatest contribution this conference can make is to provide time for reflection and to define the pitfalls as well as the analytical power of a multidisciplinary perspective.