10th International Congress on Civil Engineering, 5-7 May 2015
University of Tabriz, Tabriz, Iran

# Mathematical Modeling of Activated Sludge Process for Control of Wastewater Treatment Plant

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**Abstract**

Mathematical modeling of activated sludge systems have gained increasing attention in wastewater treatment within the last years. In this work the problem of over-parameterization in complex models describing the activated sludge process has been approached. Existing complex models of system dynamics do not have a unique set of parameters which can explain certain behavior, that is, the models are not identifiable. An attempt has been made to develop reduced order models with a smaller number of states and parameters, which are capable of adequately describing the major dynamical behavior of both the carbonaceous and nitrogenous activities of the process. Still, the mechanistic structure of the modeled reactions has been retained when possible. Furthermore, the lack of available on-line sensors emphasizes the need for a more realistic complexity of models for operational purposes. The opportunities for further applications of the plant model are discussed.

**Keywords: Mathematical Model, Activated Sludge Process, System Control, Wastewater Treatment**

## 1. INTRODUCTION

Mathematical modeling of activated sludge processes became a popular tool in the last Decade and has wide application in research, plant design, optimization, training, and model based Process control [1,2]. Most of these models are able to simulate organic matter removal, nitrification, denitrification and some of them also Phosphorus removal by bio- and physical-chemical methods. However, the large numbers of Processes which are described by even more parameters results in a high model complexity. But, several studies indicated that only a few of the model parameters have to be adjusted during model calibration.[3,4,5]
The growth of industry and the development of towns and cities have resulted in the design, construction and operation of wastewater treatment facilities of increasing size and complexity [7].
Modern wastewater treatment (WWT) techniques have been in use for over a century. Many different processes have been developed and many variations tested. The activated sludge process is one of the most common processes used today.
Many wastewater treatment plants are presently operated according to predetermined schemes with very little consideration to the variations of the material loads. Using on-line sensors for on-line control of the operation of the plants may enhance the ability to comply with assigned effluent standards. In general, a better understanding of the dynamic behavior of the process, adequate mathematical models and an on-line identification of model parameters and influent loads in combination with the use of control systems have significant potential for solving operational problems as well as reducing operational costs. In addition, this knowledge may be used for reduction of volume holdings in the design of the plants to be constructed in the future.
As shown in figure 1, control of wastewater treatment plants relies on four building blocks. 1) The process itself, 2) The actuators that allow manipulation of the process, 3) The control algorithm that calculates a proper action for disturbance rejection or set point tracking and 4) The measurement devices that provide information on the important output variables and disturbances.

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