

Preface

The concern about the effects of urban life on the ecological cycle has activated several research areas that attempt to tackle part of this problem in one way or another. Nowadays, much of the efforts concentrate on new sources of clean energy, transportation and, of course, wastewater treatment. Since the quality standards for wastewater treatment plants (WWTPs) are getting tighter, efficient control methods need to be implemented for economic and environmental reasons. As an example, there are effluent requirements defined by the European Union (European Directive 91/271 Urban wastewater) with economic penalties.

From the operation and control point of view, several control methodologies have been tested for WWTPs. Ranging from simple proportional-integrative (PI) and PI-like single-loop controllers to multivariable model predictive controllers, from model-driven to model-free, data-driven controllers. However, it is well known that biological WWTPs are complex nonlinear systems with very different time constants. The intricate behavior of the microorganisms and the large disturbances in concentrations and flow rates of the influent makes the control of the WWTP a complex task. In fact, during the last decade, the community has emphasized the importance of integrated and plant-wide control and the wastewater industry is now starting to realize the benefits of such an approach.

The purpose of the control methodologies presented in this book is to operate WWTPs with the aim of improving the effluent quality and reduce operational costs. However, it is important to emphasize the distinguished viewpoint of the approach presented here with respect to existing works that can be found in the research literature. Most of the approaches concentrate their efforts in providing a trade-off between operational costs and effluent quality, being this quality measured in an aggregated way by means of an appropriately defined index. In addition, as environmental regulations establish maximum concentrations of pollutants for the discharged effluent to receiving waters, it is therefore important to concentrate on being under those limits if the plant is to be operated according to the regulations. However, usual approaches found in the research literature for WWTP control and operation do not tackle the effluent violations in an explicit way. The control and decision operation system proposed here is aimed at proving that, in addition to

achieving an improvement in the effluent quality, it is also possible to reduce the percentage of time of pollution violations. It should be emphasized that none of works in the literature are focused on reducing peaks of pollutant concentrations until the complete elimination of effluent violations. It is of significant importance because high concentrations of pollutants in the effluent can damage the environment and the health of the population.

The purpose of this book is therefore to present a proposal for WWTP operation based on an incremental construction of the intelligent decision system that prevents effluent pollutant concentrations to overpass the established environmental limits. As it is conceived, these limits can be adapted to other design values on the basis of eventually different local regulations. Even the presentation and design are based on the well-known and established Benchmark Simulation Models, the proposal idea can be conveniently extended to other WWTPs frameworks and scenarios.

This book is based on the research work that the authors have carried out over recent years. It is not intended to be a research report but a unified presentation of the works carried out. It can be found in the references chapter a complete list of journal papers in which there are a deeper discussion of some control topics. Also the comparison of the proposed design approach with some other previously existing in the literature has been minimized in the book content. These comparisons can be found in the journal referenced works whereas the main goal of the book is to serve as a methodological presentation of a design approach that, in the authors' opinion, deserves some extensions and particular applications that would be difficult to forecast just by looking at the set of disconnected results that journal papers usually constitute.

The book is intended to be used for by M.Sc. and Ph.D. students, consulting engineers and process engineers at wastewater treatment plants. Even the discourse is based on benchmark simulation scenarios, it is intended to provide a methodological, and scientifically based, steep way to deal with effluent WWTP requirements without forgetting about costs of operation.

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