WWT-013: State Point Analysis for Secondary Clarifiers

Time: 90 minutes

Description: This course gives an in-depth discussion of secondary clarifier state point analysis which is a mathematical model used to predict secondary clarifier performance based on sludge settling characteristics, solids loading rate, surface overflow rate, and return activated sludge rate.
At the end of this course, the student should be able to:

1) Outline the process and objectives of each component in an activated sludge system.
2) Solve mass balance problems relating to solids treatment systems.
3) Conduct a state-point analysis for optimization of clarifiers.
4) Explain the issues that can negatively impact state-point analyses and mass-balance.
5) Demonstrate, using a state-point analysis, how changes will affect the system.
1) Basic Activated Sludge System Control Points
   a. Aeration Basin
      i. Organic Carbon to Mixed Liquor Volatile Suspended Solids
      ii. Bacterial Growth
      iii. System Locations of Carbon Removal

2) Secondary Clarifier
   a. Process Objectives
   b. Operational Assumption Problems

3) Solids Mass Balance
   a. Calculation Assumptions
      i. Mass TSS in and Mass TSS Out
      ii. Simplifying the Equation
   b. RAS TSS Concentration

4) State Point Analysis
   a. Goals of Analysis
   b. Plotting the Analysis Chart
      i. Overflow Rate
      ii. Underflow Rate
      iii. Settling
   c. Analyzing the Chart

5) Example Problems
   a. Increased Flow Causes Overload
   b. Taking One Clarifier and One Pump Offline
   c. Taking One Aeration Basin Offline
   d. RAS Flow Ideal
Experience Summary
Eric Wahlberg has 26 years of experience in the wastewater treatment profession including seven as a certified operator. His unique career path includes work in both the public and private sectors in operations, management, research, and engineering. He is world renown for his expertise in primary and secondary clarifier design and operation. He co-authored Secondary Settling Tanks: Theory, Modeling, Design and Operation which focuses on the role of the secondary settling tanks in achieving stringent effluent quality standards. His award winning publications and presentations exemplify his resolve to put theory and research into the hands of frontline operators and engineers responsible for the quality of wastewater treatment plant effluents. His dedication to the practical implementation of pertinent research to process optimization has earned him the Water Environment Foundation’s 1995 Harrison Prescott Eddy Medal, 1997 George Bradley Gascoigne Medal, and 2007 Philip F. Morgan Medal. Last year, he was recognized by Public Works magazine as a 2008 Trendsetter for his development of activated sludge troubleshooting and process control tests.

Wastewater Treatment Plant Design/Research

Hyperion Treatment Plant Ultimate Build–Out of Secondary Treatment System, City of Los Angeles, Bureau of Engineering, California
Project Manager. Managing the restoration of the capacity of the existing secondary system to 450 mgd average dry weather flow at a savings of approximately $50 million. Providing, at build–out or sooner, one plant that will simplify plant operations and provide an overall secondary effluent quality of 16 mg/l, or less of total suspended solids. Managed a large stakeholder process during the development of this project.

[May 2008–Ongoing, $750K, 135408.]

Easton Water Pollution Control Facility Optimization Study, Easton Area Joint Sewer Authority, Pennsylvania
Operations Specialist. Operation of oxidation ditches at excessively long solids residence times were resulting in the proliferation of low-F:M filaments and a solids inventory that the secondary clarifiers could not handle. Provided the Authority a process control spreadsheet and a comprehensive document that established an extensive list of recommendations for improving the operation of the plant from the grit removal facilities to the belt filter presses used to dewater anaerobically digested sludge. Authority is now fully compliant with NPDES permit requirements and expects to be compliant thru the 2009/2010 wet weather season.

Primary Clarifiers No’s. 16–31 and Related Facilities, Reclamation Plant No. 1, Project No. P1–37, Orange County Sanitation District, Fountain Valley, California
Operations Specialist. Provided operational assistance to optimize the performance of the newly constructed primary clarifier complex. Worked with the District’s operations and engineering staffs to optimize the sludge solids concentration from the thickening clarifiers. Also provided invaluable consensus building between our design engineers and the District’s Plant 1 operators to get the new thickening clarifiers as close to maximum capacity as possible. This
Eric J. Wahlberg, Ph.D., P.E

Client Accolades

“With his experience in operations, engineering, and research, Eric provides a rational, practical bridge between engineering and operations that help make designs on paper do what they are designed to do in real life.”

— Nick Arhontes
Orange County Sanitation District

“[Eric’s] work with us over these past months as a process consultant but more importantly as a teacher and coach has been outstanding. Your ability to take complex process control and explain it in plain English so operators not only understand the material but are willing to try new methods has lead to break through performance in the wet streams of our plants. Our teams look forward to your participation at their Optimization meetings and we see some of the best attendance when you’re

project included design and construction of 16 rectangular primary clarifiers with a total capacity of 96 mgd. The clarifiers were designed as combination clarifiers/thickeners, and will provide enhanced primary treatment of the effluent in addition to thickening of all the primary sludge generated from the new and existing primary clarifiers. Enhanced primary treatment is provided by the addition of polymer and ferric chloride. Foul air ducting and a scrubber were designed to control odors.


Membrane Bioreactor Implementation Study, City of Oxnard, California
Project Manager. The City was designing an Advanced Water Purification Facility (AWPF) to clean secondary effluent from the Oxnard Wastewater Treatment Plant (OWTP) to produce reclaimed water for groundwater recharge and to upgrade and expand their secondary facilities. Under this project, conducted a Membrane Bioreactor (MBR) study that considered the consequences of converting some of the existing OWTP activated sludge tankage to MBRs to offset the costs of micro filtration (MF) at the City’s AWPF. Created a conceptual design of the MBR facilities used to do a life-cycle cost comparison. As a result of this study, the City decided to retain MF at the AWPF for the first two phases of construction, but will consider MBRs at the OWTP in subsequent phases.

[June 2007–May 2008, $70K, 133181.]

Central Treatment Plant South Secondary Complex Operational Evaluation and Operations Support, Metro Wastewater Reclamation District, Colorado
Process Engineer. The first phase of work involved a comprehensive assessment of the high-purity oxygen activated sludge (HPOAS) system in the District’s South Secondary Treatment Complex (South Plant). Identified operational changes that would allow Metro to achieve additional capacity from their HPOAS without significant capital investment. Project elements included assessment of plant operating data; special sampling; operational assessment; BioWin and HPOAS modeling; and recommendations for optimizing the South Plant. During the second phase, provided science-based process control lectures for key operations personnel, identified key performance indicators for all unit processes, activated sludge process control – in both the North and South Plants, assisted in implementing a monthly permit compliance strategy meeting, and reviewed weekly targets.

Process Optimization, Municipal Sewer District of Greater Cincinnati, Ohio
Process Engineer. Provided operations optimization at five of the District’s seven wastewater treatment plants (WWTP). Already the District’s largest WWTP shows increased peak flows through the secondary treatment facilities, decreased effluent quality variability, and savings in the hundreds of thousands of dollars in reduced electricity usage.
Capital Improvement Management Program, Metro Wastewater Reclamation District, Colorado
Process Engineer. Provided operations optimization to meet discharge requirements during equipment and process outages related to ongoing construction. His performance-based operations approach vs. “making permit” has allowed the District to increase capacity of the existing facilities, improve unit process performance, increase reliability, and manage costs more effectively.
Feasibility Analysis of the Hydro-Electric Plant at Lauro Reservoir, City of Santa Barbara, California
Project Manager. Studied alternatives and costs to place an existing 2 MW hydro power plant back in service and looking for other power production opportunities within the City’s water system. The project included a permitting evaluation, benefit/cost analysis, and final report with recommendations.

Determine the Effect of Individual Wastewater Characteristics and Variances on Primary Clarifier Performance, Water Environment Research Foundation, Oregon
Principal Investigator. The objective of this full-scale study was to look at what wastewater characteristics affected primary clarifier performance. Ten facilities with different primary clarifier configurations collected a year’s worth of monitoring data. The report of findings was published by WERF in 2006.

Update and Publish American Society of Civil Engineers (ASCE) Clarifier Research Technical Committee (CRTC) Protocol for Secondary Clarifiers, Water Environment Research Foundation, Virginia
Principal Investigator. The ASCE CRTC published a draft protocol for evaluating activated sludge secondary clarifier performance. Served as principal investigator of this two year, nationwide field study in the early 90’s evaluating the CRTC protocol. Although numerous papers were published from that study, a revised version of the protocol was not published at that time. Updated, revised and published a protocol based on his experience in an earlier study for evaluating activated sludge secondary clarifier performance.

Wastewater Treatment Plant Improvement Project, City of Ukiah, California
Project Manager. Provided thorough evaluation and capacity analysis of the plant including the existing trickling filters. The City’s 2.8-mgd trickling filter plan with advance wastewater treatment capabilities for winter discharge to the Russian River is being expanded and upgraded to the trickling filter/solids contact process. Project highlights include the conversion of the existing rectangular secondary clarifiers to primary clarifiers, conversion of the existing primary clarifiers to solids contact tanks, and the initial stages of a reclaimed water system. The construction cost of the project is expected to be approximately $40 million with a design fee of $4 million.

Process Evaluation, Central Contra Costa Sanitary District, Martinez, California
Project Manager. Conducted a capacity analysis of the Central Contra Costa Sanitary District wastewater treatment plant with a whole plant perspective to establish revised capacities for all unit operations and to identify bottlenecks and limitations of existing facilities. Historical plant data was validated using a mass balance model and was used to evaluate historical flows and loads. Several different approaches were used to evaluate liquid stream treatment capacity. Settling tests were conducted to evaluate the capacity of the primary sedimentation tanks. The biological treatment plant computer simulator, BioWin, was used to evaluate the activated sludge system. A state point analysis was used to evaluate the capacity of the secondary clarifiers. The analysis demonstrated the interrelationship of the treatment processes in setting reliable treatment capacity.

Statistical Process Control, Metropolitan Council Environmental Services, Minnesota
Project Manager. Trained operations staff in Statistical Process Control fundamentals and facilitated implementation of Statistical Process Control for use in making process control decisions at the 12-mgd Empire Wastewater Treatment Plant.
Secondary Treatment Improvements Project, Metropolitan Council Environmental Services, Minnesota

Process Engineer. Involved in the conceptual design of the modifications to one quarter of the existing rectangular secondary clarifiers at the Council’s 250–mgd Metropolitan WWTP. A key element of these modifications was the removal of the mid-tank transverse sludge collection chain-and-flight system and replacement with two stationary sludge suction headers. Managed the process-proving testing that convinced the Council to retrofit all 26 secondary clarifiers at the plant.

Sugar Creek Wastewater Treatment Plant Secondary Clarifier Evaluation, Charlotte Mecklenburg Utility Department, Charlotte, North Carolina

Project Engineer. Evaluated six secondary clarifiers at Sugar Creek Wastewater Treatment Plant. Different field tests were performed. Numerical modeling was applied to identify the most cost–effective modifications needed to improve the performance and increase the capacity.

Process Evaluation, Central Contra Costa Sanitary District, Martinez, California

Project Manager. Calibrated and used the activated sludge simulator, BioWin to evaluate the effectiveness of using existing tankage as an anaerobic selector.

Process Evaluation, Sacramento Regional Wastewater Treatment Plant, Elk Grove, California

Project Manager. Performed a process evaluation of the plant’s primary sedimentation tanks to assess the need for a planned expansion. The expansion was deferred for five years, significantly improving the clients cash flow.

Process Design, Silverthorne/Dillon Joint Sewer Authority, Blue River Treatment Plant, Silverthorne, Colorado

Project Engineer. Calibrated and used BioWin to determine the plant’s ability to nitrify under widely varying flows, loadings, and influent temperatures.

Engineering Feasibility Study, Wastewater Treatment Plant, City of Tracy, California

Project Manager. Studied feasibility of returning to service four rectangular secondary clarifiers that were abandoned due to chronically poor performance.

Evaluation Study, Wastewater Treatment Plant, Delta Diablo Sanitation District, Antioch, California

Project Engineer. Evaluated field data for determination of impact of including a flocculation step on secondary effluent quality.

Experimental Design, Equipment Procurement and Installation, Field Study, ASCE Clarifier Research Technical Committee, County Sanitation Districts of Los Angeles County, Whittier, California

Project Engineer. Two-year nationwide field study involved evaluation of activated sludge secondary clarifier performance. Responsibilities included supervision of assisting engineers and technicians.

Conceptualization, Design, Construction, and Implementation of Experimentation Associated with Three Research Projects, Clemson University, Clemson, South Carolina

The studies included:

- A pilot-scale study of vapor recompression as an alternative energy source for low-temperature sludge drying.
- Two studies at full-scale facilities of activated sludge settling behavior and bioflocculation properties.
Wastewater Treatment Plant Operations

Treatment Plant Management, Frisco Sanitation District, Frisco, Colorado
Chief of Operations. Responsible for all aspects of the District's wastewater collection, treatment, and disposal systems. Tasks included:

- Preparation and disbursement of annual budget
- Supervision and training of plant operators
- Preparation of monthly performance, operations, and NPDES reports
- Recommendations to the Board of Directors on employee hiring, wage, and disciplinary actions
- Attendance at monthly Board meetings
- Representation of the District on a number of committees

Treatment Plant Operations, Inverness Water and Sanitation District, Englewood, Colorado
Plant Operator. Provided operation and maintenance of the District's wastewater collection, treatment, and effluent land-disposal systems, including preparation of quarterly NPDES reports, and involvement with water distribution system maintenance.

Treatment Plant Operations, United States National Park Service, Yellowstone National Park, Wyoming
Sewage Disposal Plant Operator. Provided operation and maintenance of the Old Faithful Village activated sludge wastewater treatment plant and supporting wastewater collection and effluent disposal systems.

Treatment Plant Operations and Laboratory Integration, Frisco Sanitation District, Frisco, Colorado
Assistant Chief/Laboratory Technician. Integrated a newly constructed laboratory support facility into plant operations, including process control and permit-required analyses. Demonstrated an environmentally unsound sludge land-disposal operation that resulted in its abandonment.

Treatment Plant Operations, Breckenridge Sanitation District, Breckenridge, Colorado
Operator II. Provided operation and maintenance of an advanced wastewater treatment plant experiencing seasonal overloads.

Treatment Plant Operations, Silverthorne/Dillon Joint Sewer Authority, Dillon, Colorado
Assistant Plant Operator. Provided operation and maintenance of an expanding advanced wastewater treatment plant.

Memberships

Water Environment Association
International Water Association
California Water Environment Association
Rocky Mountain Water Environment Association
Water Environment Federation Task Force Updating MOP11, Operation of Municipal Wastewater Treatment Plants
American Society of Civil Engineers, Clarifier Research Technical Committee
Honors


Publications


41. “Field Application of the CRTC’s Protocol For Evaluating Secondary Clarifier Performance:


52. “Solids Flux Curve Development Using A Single Activated Sludge Settling Parameter,”


Client References
Donald Linn, Superintendent, Wastewater Treatment; Metropolitan Sewer District of Greater Cincinnati
1600 Gest Street, Suite 2, Cincinnati, OH 45204-2022; Phone: 513. 244.1300

Nick Arhontes, Director, Operations and Maintenance Department; Orange County Sanitation District
10844 Ellis Avenue, Fountain Valley, CA 92708; Phone: 714.593.7210

Steve Rogowski, Director of Operations and Maintenance; Metro Wastewater Reclamation District
6450 York Street, Denver, CO 80229; Phone: 303.286.3244
Course Contact

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Course website is http://indigowatergroup.com/On-Line%20Training.htm

Course Logistics

On-line training courses are sold through Indigo Water Group’s website and are hosted on iSpring which is SCORM compliant. Someone wanting to attend an on-line training course may do so on demand. These are not live webinars. A visitor to the website will select the desired course, place it in their virtual shopping cart, and then pay for the course with a credit card. (We can also set up on-demand accounts or invoice in place of credit cards. Please see our FAQs.) Courses are priced at $20 per contact hour so a one hour course is $20 while a 2.5 hour long course is $50. Receipts for payment are issued automatically by e-mail along with a link to the training login location. Each attendee receives a unique login ID and password. Only they can access their training account.

There are currently 50 unique on-line training courses. Classes last between 30 minutes and 2.5 hours, depending on the topic.

There is no time limit for course completion provided courses are completed before the end of the calendar year. Most of the courses are broken into smaller pieces so an operator can complete each piece when it is convenient for them. Each piece is followed by an interactive quiz to reinforce concepts learned and to demonstrate attendance. If an attendee starts a training course and has to leave for some reason, the next time they log into the system, they will be asked if they want to start over or continue on from where they left off.

Documentation of Course Attendance:

On-line courses use a combination of narrated PowerPoint presentations and movie clips. The file format is either shockwave media (PC based) or html5 (iPhone, iPad, and other mobile devices).

Attendees must watch each slide or animated clip in its entirety to receive credit and may not “skip” forward on a particular slide or within the presentation. Attendees can use the back button to review a missed slide, but cannot move forward. Lastly, we want to be sure that folks don’t login to a class and then walk away from their computer or start doing other work while the class plays. To prevent this, we force the attendee to press the “next” button to move from one slide to the next and we incorporate quizzes throughout the presentations.

Throughout the courses, mini-quizzes of three to five questions each are embedded. At the end of each course, there is a larger final quiz of up to 15 questions. The course attendee must enter their name and
e-mail address before they can take each quiz. Quiz results are e-mailed to Sidney Innerebner and are tracked on the iSpring site.

The training accounts within iSpring track total time spent on each training course as well as quiz scores. An attendee can log in and see a list of courses paid for as well as those already completed.

Attendance is verified by 1) tracking total time spent on a course within iSpring, 2) ensuring that all of the quizzes for a particular training course have been completed, 3) the date/time stamps for the individual classes are spaced a reasonable distance apart, and 4) checking to see if questions are answered correctly. Attendees are not required to obtain a minimum passing score to earn their training unit certificate or credits. Once a course has been completed, training unit certificates may be printed directly from the iSpring site by the attendee. In the event of a technical glitch, Indigo Water Group will manually issue a training unit certificate and/or reports attendance to State agencies once course completion has been verified.

Requested time does NOT include time required for attendees to answer quiz questions.

**Biographical Information for Instructor**

The primary instructor will be Sidney Innerebner, the Principal Engineer and Owner of Indigo Water Group. Her resume is attached as part of this training unit application. Sidney is a licensed professional engineer in the State of Colorado and has a PhD in Environmental Science and Engineering from the Colorado School of Mines where she now serves as an adjunct professor. Sidney holds an A level Wastewater and an A level Industrial Wastewater in Colorado and has been the Operator in Responsible Charge for several activated sludge wastewater treatment plants over the last ten years. She is the Chair of the Water Environment Federation Plant Operations and Maintenance Committee and has been the primary or contributing author to numerous publications and books on wastewater process control and has served as a reviewer for many others.

Other instructors include: Stacy Passaro, Joshua Baile, Dale Colerick, Dave Flowers, Toni Glymph-Martin, Eric Wahlberg, Ken Schaars, Michael Lutz, and Gary Parham. Their resumes are included with specific training unit applications as appropriate.

**Agreement to Provide Training Documentation**

Training records are maintained for a minimum of three years.