

## Operator Training Courses - H<sub>2</sub>O'C Engineering - 2007

1. SDWA Provisions and Rules: *Total Coliform Rule / Turbidity; Operator Certification Rules; SWTR*
2. Chloramines for DBP Control: *Chemistry, Disinfection, Feed Alternatives, Distribution System*
3. Surface Water Characteristics: *Seasonality, Particles, TOC, Metals, Electroneutrality Condition*
4. Ground Water Characteristics: *Composition, Fe, Mn, H<sub>2</sub>S, Arsenic, Dissolved Gases, Microorganisms, Ground Water Rule, Disinfection, Disease*
5. Coagulation, Sedimentation and Filtration:  
*Coagulants, Jar Testing, Settling and Filtration Practice, Evaluation of Filter Media Condition, Operational Problems*
6. Lime Softening Processes: *Required Dosages, Slaking, Process Control, Recarbonation*
7. Iron, Manganese and Hydrogen Sulfide Removal *Engineering Practice and Alternatives*
8. Ion Exchange Processes *Hardness Reduction, Radium Removal, Ammonium Ion*
9. Removal of Organic Substances: *Total Organic Carbon, Color, Tastes and Odors, Atrazine*
10. Drinking Water Disinfection / Disinfection By-Products Formation
11. Inorganic Contaminants and their Removal:  
***Pb & Cu** / Willmar, MN Case History; Removal of Radionuclides  
**Arsenic**: Regulation, Health Effects, Occurrence, Removal*
12. Water Distribution and Storage *Pipe Materials, Main Breaks, Surge, Unaccounted for Water*
13. Transmission of Treated Water: *Modeling, Demonstration of EPANet, Pressure, Travel Time*
14. Distribution System Maintenance and Remediation of Microbial Problems  
*Distribution System Maintenance, Control of Microbial Nitrification*
15. Package Plants, Point-of-Entry, Point-of-Use Systems; Evaluations of Bottled Water Quality
16. Water System Design: *Water Use, Projections, Capacity Analysis, Storage Requirements*
17. Water Treatment Processes and Plant Configurations *Summary of Basic Designs and Criteria*
18. Basic Water Chemistry: *Acid-Base Equilibria, Solubility, Oxidation-Reduction, Corrosion*
19. Basic Water Microbiology: *Organisms, Health Effects, System Monitoring, Microscopy*
20. The History and Philosophy of Drinking Water Protection *Why and What we Regulate*
21. Wastewater Treatment: History and Development of Treatment Processes  
*Early Disposal Systems, Outhouses, Toilets, Sewers,  
Primary, Secondary, Tertiary Treatment Processes;  
Sludge Treatment and Disposal, Nutrient Removal, Disinfection*
22. Removal of Radionuclides *Application and Costs of BAT Alternatives for Radionuclides;  
Plant Design: Case Studies of Radium Removal in Missouri*

## Outlines of Operator Training Presentations

### SDWA Provisions and Rules

A review of the history and provisions of the Safe Drinking Water Act is keyed to a summary of the major provisions affecting the specific small utilities. Elements of the drinking water standards (definitions, regulations, monitoring requirements, state primary enforcement responsibilities, best available technology, variances and exemptions) are reviewed. Summaries of the Disinfectants-Disinfection By-products Rule, Surface Water Treatment Rule, Groundwater Disinfection requirements, Total Coliform Rule, Information Collection Rule, Operator Certification requirements, Lead and Copper regulations and other provisions are outlined.

### Chloramines

A special day-long program developed to assist surface water treatment utilities in making decisions related to conversion to chloramine residuals to minimize formation of disinfection by-products. The chemistry of chlorine, ammonia and chloramine formation, along with breakpoint curve characteristics are described. Procedures and equipment for feeding ammonia are illustrated. Case studies of utilities' experience with conversion to chloramines as well as the fate of chloramines in the distribution system are detailed.

### Characteristics of Midwestern Surface Waters

The composition of various regional surface waters has been summarized and contrasted. Elements of elementary inorganic chemistry (nomenclature, units) are introduced in the context of the composition of natural river and lake waters. The agricultural, industrial and municipal sources and extent of organic, radiological and microbial contamination of surface waters are described using regional examples. Data on temporal and seasonal variations in surface water composition are presented and interpreted.

### Characteristics of Midwestern Ground Waters

The composition of numerous ground waters have been summarized, compared and illustrated using conventional tables and bar graphs. The physical, chemical and biological characteristics of ground water are contrasted with regional surface waters to illustrate the characteristics of ground water under the influence of surface water. Special attention is given to well waters derived from Karst regions.

### Coagulation, Sedimentation and Filtration

Examples of the basic coagulation and filtration processes are described and illustrated. The properties of alternate coagulants, including recycled coagulants, are discussed. Conventional waterworks engineering design practice for the determination of required chemical dosages and the sizing of treatment units are demonstrated. Methods commonly used for monitoring and controlling treatment plant performance are described. Manual and automatic control of filter washing, return-to-service flow ramping and filter-to-waste practices are described and illustrated.

### Lime Softening Processes

This presentation provides an introduction to the chemistry of conventional lime softening, the excess lime process, and split treatment. The added benefits of trace metals removal and supplementary disinfection at high pH are described. Comparative assessments of upflow contact clarifiers. Means for control of post-precipitation of calcium carbonate by stabilization with acid or by recarbonation are compared as are lime softening solids dewatering and disposal practices. Published data on the costs and benefits of lime softening are reviewed.

### Ion Exchange Processes

A comprehensive description of the cation exchange process for municipal water softening, including throughput rates and bed volumes, brine disposal, media life and cleaning, is presented. In addition, the effectiveness of alternate exchange media (e.g., for ammonia, nitrate or organics removal; deionization) is evaluated. A comparison is made of the costs and benefits of softening by cation exchange and lime precipitation for small and medium-sized systems.

### Iron, Manganese and Hydrogen Sulfide Removal

Aeration, detention and pressure filtration for the precipitation and removal of ground water contaminants is reviewed. Illustrations are given of when the supplementary use of oxidants, such as chlorine and permanganate, are and are *not* required. The concept of chemical kinetics (e.g., the design for a detention basin to allow for metals precipitation and agglomeration) is introduced, with case study examples. Problems with the fouling of filter media are illustrated, with recommendations for remediation.

## **Removal of Organic Substances: Color, Tastes and Odors, Atrazine**

Practical alternatives are presented for the removal or oxidation of organic compounds that cause color, tastes, odors or react to form disinfection by-products. The application and comparative effectiveness of powdered or granular activated carbon, ozone, permanganate and chlorine dioxide is assessed. The results of studies of enhanced coagulation at a Missouri utility is also discussed.

## **Drinking Water Disinfection**

This presentation includes a discussion of all currently available alternatives for disinfection and their application to smaller systems. It includes chlorination, chloramination and the elements of breakpoint chlorination; ozone, chlorine dioxide, ultraviolet light, mixed oxidants; methods to limit or avoid the formation of disinfection by-products; simplified, elementary calculations of required disinfectant dosages; disinfectant persistence studies to ensure maintenance of disinfectant residuals during distribution.

## **Inorganic Contaminants and their Removal**

This presentation incorporates a summary of the occurrence and control of arsenic, barium, cadmium, chromium, copper, lead, mercury, nickel, selenium, asbestos, fluoride, nitrate, radium and other metals found in natural waters. It provides a review of emerging data on toxicity and health effects of inorganic contaminants. Best available treatment for the removal of each metal is presented.

## **Water Distribution and Storage**

A discussion of current trends in the use of alternative pipe materials and their reported breakage rates. The control of surge in distribution systems. The modification of existing water distribution systems to improve circulation, minimize dead-ends and avoid prolonged storage in tanks is illustrated using recent case studies. Main sizing, flow velocities, solids deposition, control of leakage, surges, backflow and cross-connection prevention plus the need for looping, flushing and cleaning are illustrated. Videos of valve exercising and main cleaning practices are included.

## **Transmission of Treated Water**

A basic introduction is given to the procedures, methods and formulas (e.g., Hazen-Williams, Moody Diagram) used to determine the capacity and size of pressure conduits. Illustrations are presented of the effects that system head, pump characteristics, specific speed and cavitation have on pump selection and design. Examples are shown of pump selection for small systems. This presentation is a primer to acquaint operators with the procedures used by hydraulic engineers to design transmission systems.

## **Distribution System Design**

The conceptual aspects of distribution system design, including hydraulic gradients, one and two-directional flow, elevated storage, pipe grids, structural components, required capacity and pressures are described. Procedures for field testing by pressure surveys and hydrant flow tests are reviewed. An illustration of the use of the original Hardy Cross method for distribution system network analysis is shown.

## **Package Plant, Point-of-Entry, Point-of-Use Systems; Bottled Waters**

Commercially available alternatives for small-scale and household water supply. Recent examples of special circumstances in which these methods have been used are examined. Current data on the costs of 'point of entry' systems will be contrasted with comparative costs of connecting to a central system for small numbers of connections. Known water quality problems with POE / POU devices and bottled waters are presented.

## **Water System Design: Water Needs and Availability**

This presentation is a review of the data required for the design of municipal water systems based on domestic, commercial, public service, lawn watering, leakage, pressure and firefighting requirements. Seasonal variations and peak flows used for sizing system piping, storage and pumping requirements are evaluated. The National Board of Fire Underwriters fire demand requirements for fire flow rates coincident with maximum daily flow rates are discussed. The effects of drought on Midwestern water supplies, as well as agency support for water conservation efforts, are summarized. Supplementary or back-up water supply alternatives are considered.

## **Water Treatment Processes and Plant Configurations**

The individual unit processes and treatment configurations of commonly used treatment systems are outlined and illustrated using line drawings and photographs. The commonly used ranges of unit size, flow velocity and detention times are summarized. The concept of overflow rate for sedimentation tank design and the effect of seasonal temperature changes on particle settling rates are illustrated by example calculations. This training presentation provides an overview of water treatment system components and indicates appropriate points for chemical additions.

## **Basic Water Chemistry**

This presentation provides a summary of the principal elements of water chemistry related to water treatment and distribution. Chemical nomenclature, units, aqueous constituents, solubility, equilibrium, kinetics, and the measurement of some of the principal constituents of water are described. Sample calculations are given involving hardness, alkalinity, pH, chlorine, iron and aluminum. Examples of the construction and practical uses of electroneutrality conditions (bar diagrams) illustrating ionic composition are shown.

## **Basic Water Microbiology**

This presentation is a vivid pictorial and video review of organisms naturally-present in water supplies and distribution systems. Organisms of special interest in water supplies include algae, protozoans, bacteria and virus while distribution systems exhibit methane oxidizers, nitrifiers and sulfate reducers. A summary is given of recent disease outbreaks due to *Giardia*, *Cryptosporidium*, and other pathogens.

## **Chemical, Biological and Radiological (CBR) Warfare Agents**

As early as 1957, at the specific request of the Office of Civil and Defense Mobilization, the American Chemical Society Committee on Civil Defense began a long-term, systematic review of chemical, biological, and radiological (CBR) warfare agents in conjunction with military agencies. A comprehensive review of the potential CBR agents and recommended water utility defenses against them is presented along with case studies of the steps taken by regional utilities to decrease water system vulnerability. Monitoring of water systems for early detection and early warning of CBR threats.

## **The Philosophy of Drinking Water Protection**

Reflections on the history of water supply technology; technical milestones; water supply industry heroes; the history of legislative mandates; consumer perspectives. A philosophy for water supply professionals.

## **Wastewater Treatment History and Development**

A review of the history of waste disposal from the Middle Ages to the development of outhouses, toilets, sewerage, individual household and municipal sewage treatment systems. The evolution of wastewater treatment and disinfection practice from primary treatment to the activated sludge process, tertiary treatment and nutrient removal. A review of current practices in aerobic and anaerobic sludge digestion, dewatering, stabilization and ultimate disposal methods.

## **Filter Profiling: Evaluation of Filter Media and Filter Particle Removal Performance**

An illustrated case study of procedures for filter profiling, including the evaluation of changes in filter media size distribution by sieve analysis and the observation of surface accumulations by microscopic analysis. An evaluation of microbial growth on and sloughing of organisms from filter media. Videos of the removal, augmentation, replacement and disinfection of filter media, including granular activated carbon filter cap. Recommendations for the control of accumulations of precipitates and organisms on filter media.

## **Use of the Microscope and Particle Counter in Water Treatment**

Water Treatment Process Performance Evaluation: Coagulation, Sedimentation, Filtration  
Evaluation of Microbial Regrowth in Water Distribution Systems and Household Plumbing  
Microbially-Mediated Corrosion and Water Quality Deterioration During Distribution  
Evaluation of Particle Count Data; Relation of Particle Count to Turbidity

Stereo Microscopic Examination of Filter Media (Sand, GAC), Invertebrates

Compound Microscopic Examination and Enumeration of  $\mu\text{m}$ -sized Particles, Microorganisms  
Preparation of Samples for Epifluorescence (UV) Microscopy

Use of the Computer Microscope  
Picture Capture; Photo Editing, Real-Time Video; Time-Lapse Movies  
Preparation of Slide Show Presentations; Image Archiving

## **Removal of Radionuclides**

Application and costs of BAT for removal of gross alpha, radium and other radionuclides from water supplies. Comparative process effectiveness and disposal of waste concentrates produced from adsorption, cation exchange, proprietary media, & co-precipitation during softening