Concepts of Drinking Water Treatment

Maryland Center for Environmental Training
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Concepts of Drinking Water Treatment

7 contact hours
9 CC10 hours

Totally new to the drinking water treatment field or just looking for a refresher? Recently hired apprentices and trainees will be introduced to the Safe Drinking Water Act and how it applies to the operator. The concepts of water sources, water storage and distribution systems will be introduced during this course. Other topics covered will include basic concepts of pumping and pressure maintenance, disinfection, storage tanks, fluoridation, corrosion control, and plant safety. Participants will further discuss the key elements of an effective safety program. **Class size is limited to 15 participants.**

1. Recognize and discuss current Safe Drinking Water Act (SDWA) regulations;
2. Identify raw water sources;
3. Discuss the basic principles of plant operations;
4. Explain the purpose of and the operational procedures for storage tanks.
5. Estimate flows through a distribution system;
6. Discuss the key principles of water treatment.

Agenda

8:00 AM to 9:00 AM	Introduction Safe Water Drinking Act of 1972 Maryland Department of the Environment Compliance with State, Federal, and Local Regulations
9:00 AM to 9:30 AM	Types of Public Water Systems and the Water Cycle
9:30 AM to 10:15 AM	Water Sources Common and Uncommon Treatment Techniques for Ground and Surface Water
10:15 AM to 11:00 AM	Chemical Contaminants Storage and Safe Handling of Chemicals
11:00 AM to 12:00 PM	LUNCH
12:00 PM to 1:00 PM	Physical Treatment Techniques: Sedimentation; Flotation; Flocculation; Filtration; Aeration
1:00 PM to 2:00 PM	Microbiological Contaminants of Concern
2:00 PM to 2:30 PM	Filters and Factors Affecting Filter Performance

2:30 PM to 3:00 PM	Types of Safety Training Needed in the Water Treatment Field
3:00 PM to 4:00 PM	Review Final Exam

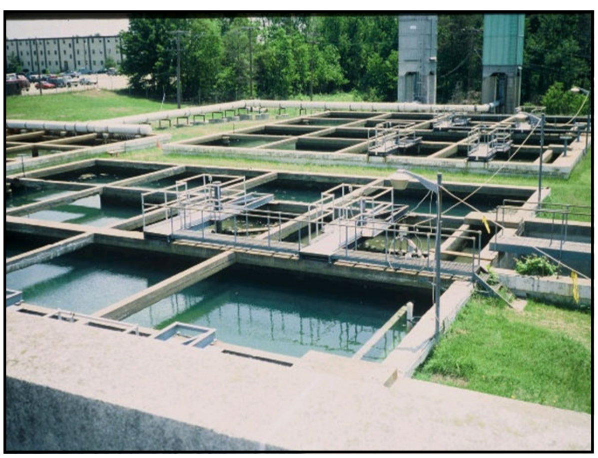
CONCEPTS OF DRINKING WATER TREATMENT

Maryland Center for Environmental Training

Eddie Cope, CET
Instructor

COURSE DESCRIPTION

- Relevant for:
  - Recently hired or
  - Grandfathered operator
- Concepts of water sources, treatment, water storage and distribution systems.
- Topics include: pumping/pressure maintenance, coagulation, clarification, filtration, disinfection, fluoridation, corrosion control and safety.



PURPOSES OF DRINKING WATER PRODUCTION

- Produce a safe, aesthetically pleasing product.
- To meet laboratory testing requirements.
- To meet regulations.

TREATMENT CONCEPT-MULTIPLE BARRIER APPROACH

- Source Assessment/Protection
- Treatment
- Distribution

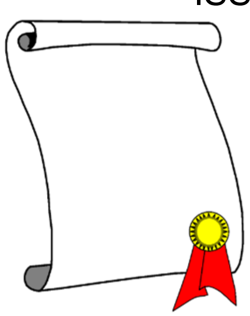
--------------to protect against----------------------------

- Microorganisms
- Inorganic Chemicals (metals)
- Organic Chemicals (SOC's and VOC's)
- Disinfection By-Products
- Radionuclides

WATER UTILITY PRIORITY ISSUES

- Compliance with Environmental Rules & Regs.
- Compliance with Safety Rules & Regs. Efficiency
- Maintenance of Facilities
- Communication
- Public Relations
- Personnel Issues

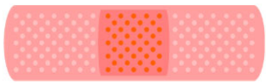
WATER UTILITY MAJOR ISSUES



Compliance with Environmental Rules & Regulations

The Safe Drinking Water Act (FEDERAL) and Related Maryland Regulations (COMAR 26.04.01)

WATER UTILITY MAJOR ISSUES



- Compliance With Safety Rules and Regulations:
  - Federal (OSHA, EPA)
  - State (MOSH, MDE)
  - Local or Utility

WATER UTILITY MAJOR ISSUES

- Efficiency
  - Responsibility to rate or tax payer
  - Use of personnel
  - Major Expenditure Monitoring
  - Inventory and Inventory Control

WATER UTILITY MAJOR ISSUES

Maintenance of Facilities

- Predictive, Preventive, Routine, Emergency
- Organization
- Consistency
- Follow-Through
- In-house VS. Contractual

WATER UTILITY MAJOR ISSUES

- Communication
- Communication Techniques
  - Treatment Goals and Objectives
  - Utility Goals and Objectives
  - Government or Owners Goals and Objectives
  - Improvements Identified

WATER UTILITY MAJOR ISSUES

- PUBLIC RELATIONS
  - Communicating the utility's message
  - Dealing with customers
  - Presentation of the Utility

WATER UTILITY MAJOR ISSUES

- PERSONNEL ISSUES
  - Personnel law at local, state or federal level
  - Applicable Union contracts.
  - Evaluations and methods
  - Counseling and discipline
  - Use of leave, payment of overtime
  - Teambuilding

PUBLIC SUPPLIES-from epa.gov

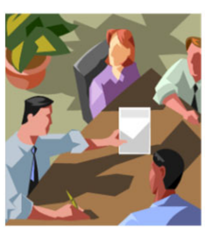
- The public drinking water systems regulated by EPA, and delegated states and tribes, provide drinking water to 90% of Americans.
- These public drinking water systems, which may be publicly or privately-owned, serve at least 25 people or 15 service connections for at least 60 days per year.

TYPES OF PUBLIC WATER SYSTEMS

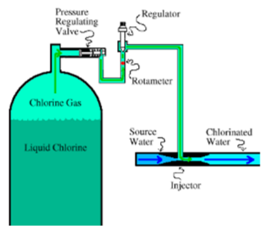
- Community Water System (CWS)
- Nontransient, Noncommunity Water System (NTNCWS)
- Transient Noncommunity Water System (TNCWS)
- Public Water Systems are identified with unique ID number. (PWSID)

PERSONNEL OPERATING PUBLIC WATER SYSTEMS

- Required by law to hold either a temporary or permanent license if they operate, maintain or interact with the treatment and delivery of drinking water in specified ways.

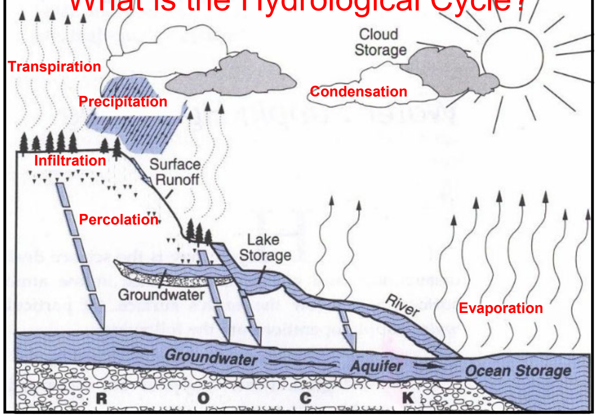


WATER CERTIFICATION IS BASED ON FUNDAMENTAL "NEED TO KNOW" CRITERIA



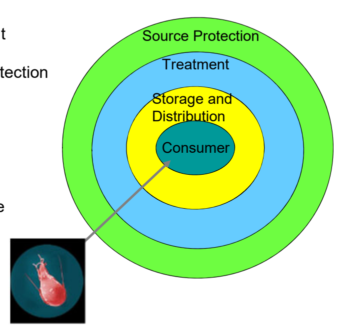
- This criteria is outlined in several specific subject areas.
- Need to know criteria is nationally reviewed and regionally assigned.
- MDE/MCET developed this criteria.

What is the Hydrological Cycle?



MULTIPLE BARRIERS In WATER SUPPLY PROTECTION

- Sources
  - Watershed management programs
  - Intake and wellhead protection
- Treatment
  - C/F/S
  - Filtration
  - Disinfection
- Storage
  - Disinfectant contact time
  - Screens
- Distribution
  - Pressure
  - Disinfection



TREATMENT VS. MICROBIOLOGICAL CONTAMINANTS

- Source Control
- Disinfection
- pH
- C/F/S
- Filtration
- Membrane Filtration

SOURCE WATER QUALITY

- Proximity to contamination
- Substances that alter quality
  - Organic
  - Inorganic
  - Biological
  - Radiological
- Sources of impurities

CHEMICAL CONTAMIANTS

- ORGANIC-of “animal” or “vegetable” origin- includes man-made chemicals and always contains CARBON.
- INORGANIC-of “mineral” origin such as ions, metals, asbestos, color, radionuclides.

NFPA PANEL LABEL

Health Hazard
- 4 – Deadly
- 3 – Extreme danger
- 2 – Hazardous
- 1 – Slightly hazardous
- 0 – Normal material

Fire Hazard

Flash Points
- 4 – Below 73 degrees F.
- 3 – Below 100 degrees F.
- 2 – Below 200 degrees F.
- 1 – Above 200 degrees F.
- 0 – Will not burn

Special Hazard

Oxidizer	OXY
Acid	ACID
Alkali	ALK
Corrosive	COR
Use NO WATER	**-W-**
Radiation hazard	

Reactivity
- 4 – May detonate
- 3 – Shock & heat may detonate
- 2 – Violent chemical
- 1 – Unstable if heated
- 0 – Stable

EXAMPLE CONTAMINANTS

- Turbidity
- Lead and Copper
- Trichloroethylene (TCE)
- Methyl Tert-Butyl Ether (MTBE)
- Nitrates
- Haloacetic Acids (HAA's)
- Trihalomethanes (THM's)

MCL's

Microorganisms

Turbidity	**0.30 ntu (95% of the time)**
Crypto.	**2 log (99% removal)**
Giardia.	**3 log (99.9% removal)**

MCL's

Inorganic Chemicals

Copper	1.30 mg/l
Lead	0.015 mg/l
Fluoride	4.00 mg/l
Nitrate	10.0 mg/l

MCL's

Radionuclides

Radium 226 & 228 5 pCi/l

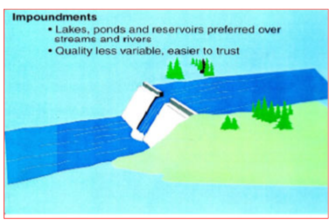
SMCL's

Aluminum	0.2 mg/l
Chloride	250 mg/l
Fluoride	2.00 mg/l
Iron	0.30 mg/l
Manganese	0.05 mg/l

SOURCE WATER PROTECTION

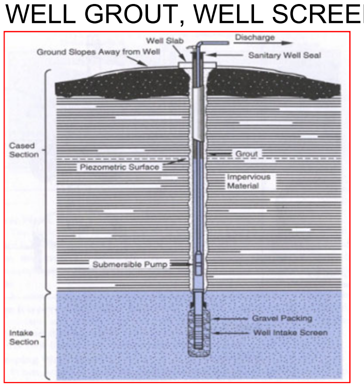
- Define the watershed area
- Identify actual or potential sources of contamination in the defined area
- Determine the water supply's susceptibility to contamination from identified sources
- Implement measures to control sources of contamination
- Plan for the future and develop a contingency plan

SURFACE WATER QUALITY



- Vulnerable to contamination
  - Natural
  - Man-made
- Streams and rivers
- Impoundments

HIGHLIGHT WELL CASING, WELL SLAB, WELL GROUT, WELL SCREEN

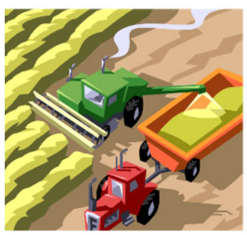


COMMON TREATMENT TECHNIQUES

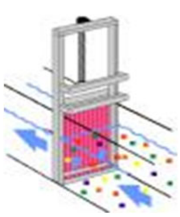
- GROUNDWATER
  - pH adjustment
  - Disinfection
  - Fluoridation
  - Corrosion Control
- SURFACE WATER
  - Screening
  - Coagulation
  - Flocculation
  - Sedimentation
  - Filtration
  - Disinfection
  - Corrosion control

‘UNCOMMON” TREATMENT TECHNIQUES

- GROUNDWATER
  - Nitrate removal
  - VOC removal
  - Adsorption
- SURFACE WATER
  - Adsorption
  - VOC removal
  - Man-made organics removal (SOC's)



SCIENCE OF WATER TREATMENT

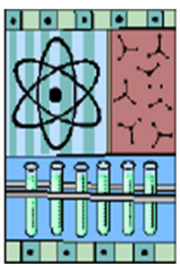


- Utilizing Physics and Chemistry to control Biological, Microbiological, Chemical and Physical pollutants in Ground or Surface Water.

PHYSICAL PRINCIPLES

- Physical Measurements
  - Distance-area-volume
  - Time
  - Temperature
  - Mass

PHYSICAL PRINCIPLES



- Physical Measurements cont.
  - Force
    - Gravity
    - Weight
    - Pressure
  - Miscellaneous
    - Electrical
    - Sound
    - Light

PHYSICAL PRINCIPLES

- Mechanics
  - Speed, velocity, acceleration
- Mass
  - Space, density, weight, pressure

PHYSICAL PRINCIPLES

- Heat
  - Temperature
    - Heating
    - Cooling
- Miscellaneous
  - Sound
  - Electricity
  - Magnetism
  - Light
  - Atomic structure/nuclear

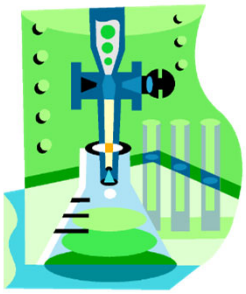
UNDERSTANDING MEASUREMENTS

- Length, area, volume, time, temperature
- Basic English vs. Metric comparisons
- Scientific notation concepts
- Concentration, dosage
- Density-liquid, vapor
- Specific gravity
- Boiling point/volatilization

APPLIED CHEMISTRY

- The science of actually using chemical principles in the workplace is practiced everyday at many industrial and commercial facilities.
- Chemical reactions, dosages are found in such things as:
- disinfection
- fluoridation
- precipitation
- coagulation
- water processes
- maintenance and housekeeping.

CHEMICAL MEASUREMENTS



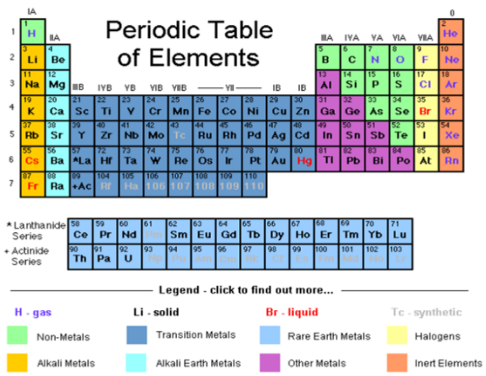
- Accuracy and precision are essential.
- Think of them the next time you prepare food, cookbook style, or take medicine.
- What could happen if you gave a child one TBS instead of one TSP of Tylenol?

CHEMICAL ACCURACY

- Analytical instruments are required to measure out precise volumes or masses. They should be treated with respect.
- What kinds of things happen if you add just one mg/L or ppm more of the following: salt, sugar, hot sauce?
- How about chlorine in a pool, insecticide or herbicide on grounds?
- Water treatment examples

KEYS TO INTERPRETING ANALYTICAL DATA

- What is being measured?
- What reflects the representative sample?
- Sampling technique
- Sample preparation
- Analysis
- QA/QC of data
- Chain of Custody



pH AND ACIDS AND BASES

- One of the most important principles in understanding life chemistry and the reactions, efficiency of most water processes.
- It's as easy as H
- And will make you say OH

pH MEASUREMENT

- Accomplished by a pH meter which measures the hydrogen ion ("acidity") concentration of the solution through an electrical potential device in the pH probe.

ALKALINITY RELATIONSHIPS

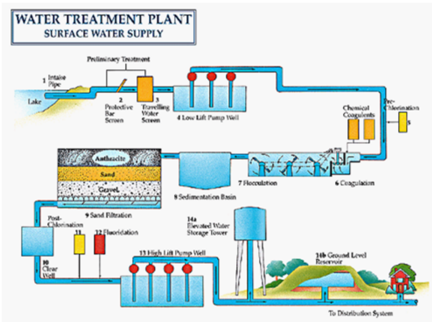
- Alkalinity is a measurement of the buffering capacity of a solution to resist changes in pH due to an acid.
- Alkalinity is measured in terms of “calcium carbonate equivalents” and is calculated based on a titration procedure.

MICROBIOLOGICAL CONTAMINANTS OF CONCERN

- “Heterotrophs”-heterotrophic plate count
- Total Coliforms
- Fecal Coliforms - including E. coli
  - Diseases related to or possibly present with E. coli
- Giardia Lamblia
- Cryptosporidium
- Legionella
- Viruses

LINKS TO TURBIDITY MEASUREMENTS

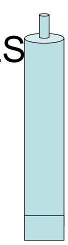
ROD SHAPED BACTERIA- E. COLI



HOW WE KNOW THE DISINFECTION PROCESS IS WORKING.

- Coliform testing
  - State and Federal law requires testing.
  - Number of tests is based of population served.
- Federal Surface Water Treatment Rule
  - Requires all surface water to use a “treatment technique” to remove or inactivate disease causing organisms.

CHLORINE CHEMICALS



- Chlorine, Cl_2 100%
  Gas compressed to liquid
- Calcium Hypochlorite, $Ca(OCl)_2$ 65%
  HTH used in swimming pools
- Sodium Hypochlorite, NaOCl 12% -15%
  Household bleach, 1% – 5 %

Simple vacuum controlled chlorinator

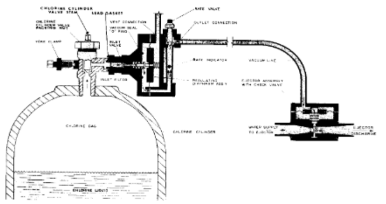


Fig. 7.16 Direct cylinder mounted connection from chlorine gas supply to chlorinator

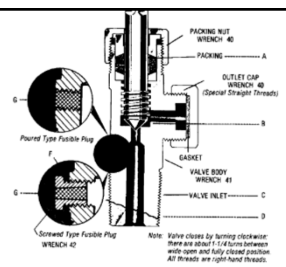
Cylinder valves are a common area for leaks.

Fusible plugs melt at 158 – 165 degrees F

Fusible plugs

150 pound cylinder: **1**

One Ton Container: **6**



TYPICAL VALVE LEAKS OCCUR THROUGH . . .

A - VALVE PACKING GLAND
B - VALVE SEAT
C - VALVE INLET THREADS
D - BROKEN OFF VALVE
E - VALVE BLOWN OUT*
F - FUSIBLE PLUG THREADS
G - FUSIBLE METAL OF PLUG
H - VALVE STEM BLOWN OUT*

*Not shown on above drawing.

Fig. 7.20 Standard chlorine cylinder valve

CHLORINE CHEMISTRY

- Cl_2 + H_2O -> HOCl + HCl
- Which one is the bacteria killer ?
  hypochlorous acid = HOCL "Killer"
- HOCl -> H+ + OCl-
  0…………………7………………..14
  pH
- How does pH affect the disinfection process ?

As pH goes up the amount of HOCl drops off.

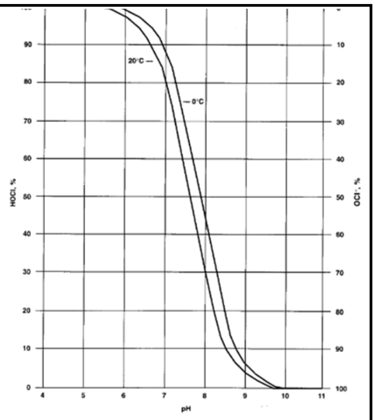


Fig. 7.1 Relationship between hypochlorous acid (HOCl), hypochlorite ion (OCl⁻), and pH

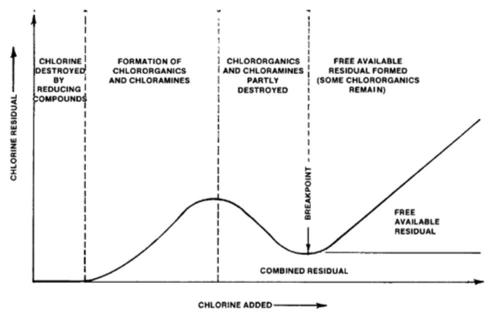
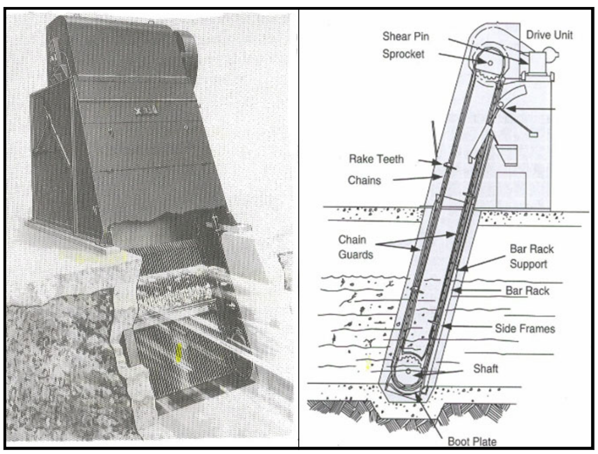


Fig. 7.2 Breakpoint chlorination curve

[10] *Breakpoint Chlorination.* Addition of chlorine to water until the chlorine demand has been satisfied. At this point, further additions of chlorine will result in a free chlorine residual that is directly proportional to the amount of chlorine added beyond the breakpoint.
[11] *Free Available Residual Chlorine.* That portion of the total available residual chlorine composed of dissolved chlorine gas (Cl_2), hypochlorous acid (HOCl), and/or hypochlorite ion (OCl^-) remaining in water after chlorination. This does not include chlorine that has combined with ammonia, nitrogen, or other compounds.
[12] *Chlororganic (klor-or-GAN-ick).* Organic compounds combined with chlorine. These compounds generally originate from, or are associated with, life processes such as those of algae in water.
[13] *Chloramines (KLOR-uh-means).* Compounds formed by the reaction of hypochlorous acid (or aqueous chlorine) with ammonia.

COARSE AND FINE SCREENING

- Coarse-racks/bar screens
- Fine-fixed or moving
- Location considerations
- Hydraulic considerations
  - Velocity
  - Head loss
- Quantity and Quality of Screenings
- Screenings disposal



PHYSICAL TREATMENT TECHNIQUES

- Aeration
- Coagulation
- Sedimentation
- Flocculation
- Filtration

AERATION

- Process used to remove dissolved gases.
- Process to change solids from a dissolved form to a suspended form so they can be removed.

  Example: Fe_2 (Ferrous) to Fe_3 (Ferric)

COAGULATION – PROCESS DESCRIPTION

Adding and rapid mixing of chemical coagulants into the raw water.

The process of adding a chemical or combination of chemicals to neutralize the electrostatic charges on suspended particles in raw water so that they will attract to form larger particles.

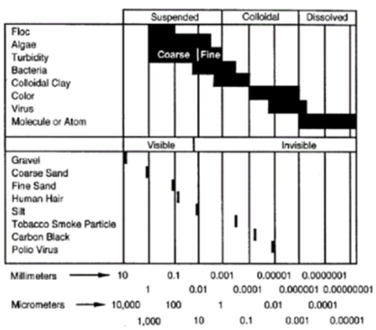


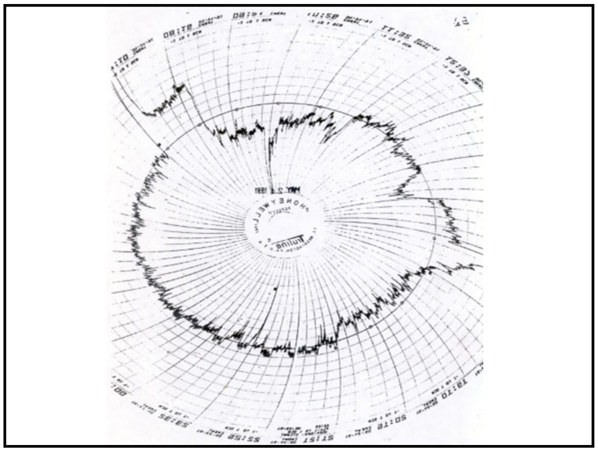
Figure 4-1

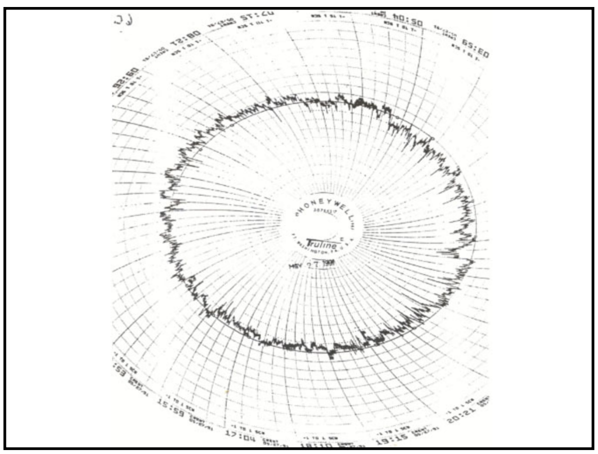
SETTLING RATE FOR SMALL PARTICLES

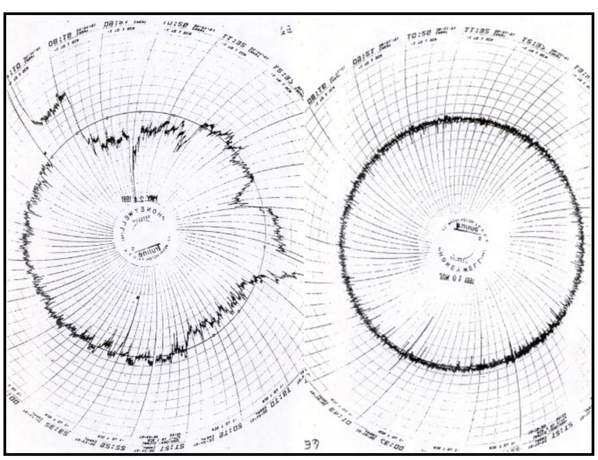
TABLE 4-1 Natural settling rates for small particles

Particle Diameter, *mm*	Representative Particle	Time Required to Settle in 1-ft (0.3-m) Depth
		Settleable
10	Gravel	0.3 seconds
1	Coarse sand	3 seconds
0.1	Fine sand	38 seconds
0.01	Silt	33 minutes
		Considered Nonsettleable
0.001	Bacteria	55 hours
0.0001	Color	230 days
0.00001	Colloidal particles	6.3 years
0.000001	Colloidal particles	63-year minimum

Source: Water Quality and Treatment. *3rd ed. 1971.*







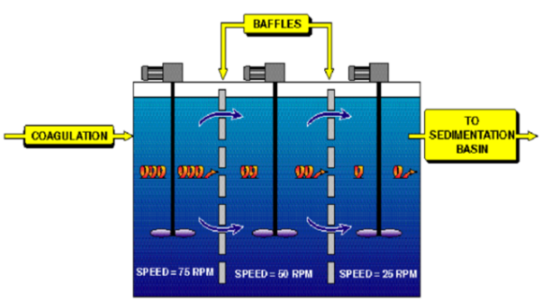
COAGULATION CHEMICALS

- **Alum (aluminum sulfate)**
- **Ferric Chloride**
- **Ferric Sulfate**
- **Polymers (may be used as a coagulant aid)**
- **PACL (polyaluminum chloride)**
- **PAS (polyaluminum sulfate)**

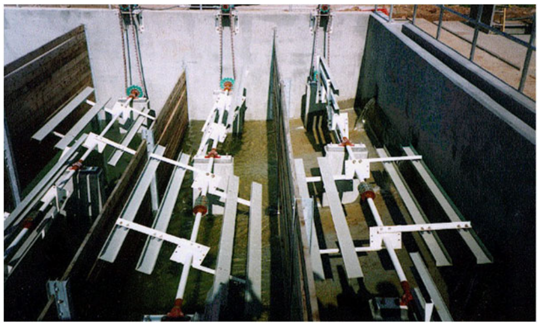
POLYMERS

- Otherwise known as polyelectrolytes, are usually very long strands of molecules that have a repeating compound bonded over and over again.
  - Polyelectrolytes (polymers)
    - cationic polymers (+)
    - anionic polymers (-)
    - nonionic polymers (+/-)

FLOCCULATION EQUIPMENT

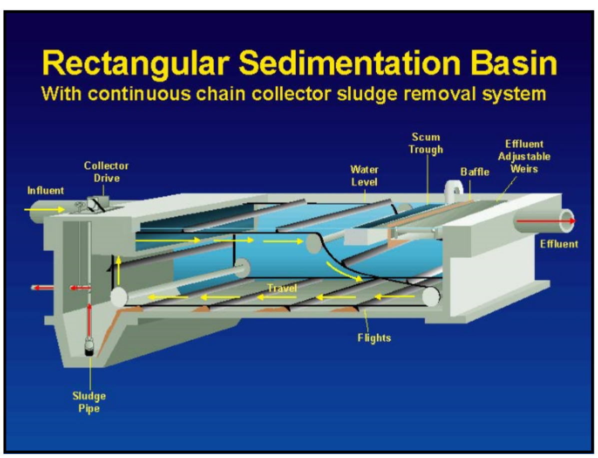


PADDLE WHEEL FLOCCULATORS



BASIC SEDIMENTATION/CLARIFICATION

- Introduction
  - Theoretical concepts
  - Design calculations
  - Clarifier types
- Operation
  - Inspection
  - Recordkeeping
- Maintenance
  - Concepts
  - Frequency
- Troubleshooting
  - Common problems



CIRCULAR SEDIMENTATION BASIN

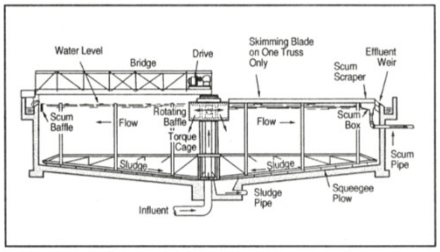
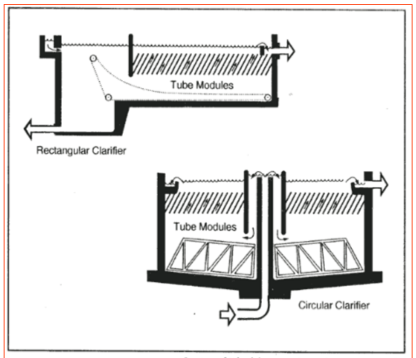


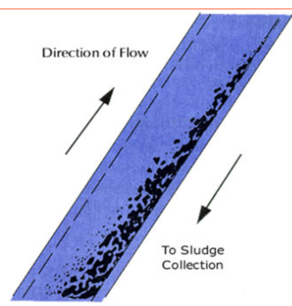
FIGURE 5-5 A typical circular sedimentation basin

Courtesy of FMC Corporation, MHS Division

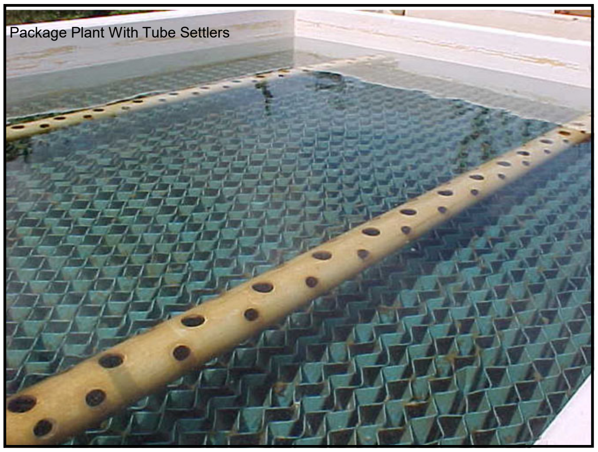
TUBE SETTLERS



Courtesy of Wheelabrator Engineered Systems – Microfloc



COUNTER CURRENT FLOW TUBE SETTLERS

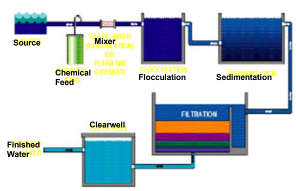

Package Plant With Tube Settlers

FILTRATION

Process Description

- Removal of suspended matter by passing the water through a granular porous medium such as sand, garnet sand, and anthracite coal.

Overall Goal
Turbidity Removal



PROCESS VARIABLES

- **Sedimentation**
  - 75-90% Solids removal
- **Head loss Buildup vs. Solids Capture**
  - Breakthrough (force-through)
- **Filter characteristics**
  - Promote depth filtration
- **Media characteristics**
  - Most important consideration is size and density

FILTRATION THEORY

- Surface straining and depth filtration
- Entrapment
- Adhesion
- Adsorption

THE FILTRATION PROCESS

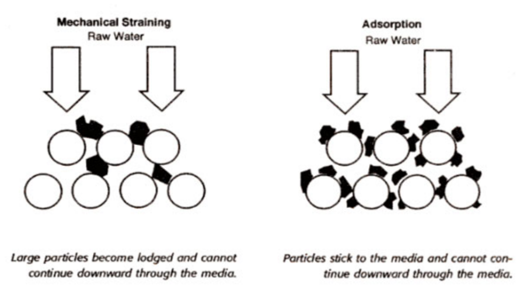
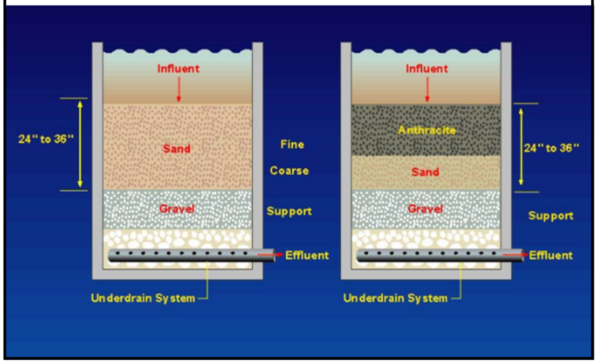


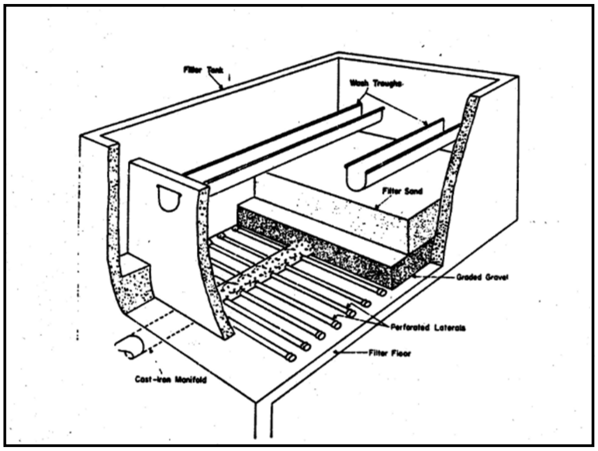
Figure 6-1

FILTER PARAMETERS

- Filter Configuration
  - Gravity, pressure or vacuum
  - Open or closed
  - Single, dual, multi-media
- Media material, size and depth
- Filtration rate (gpm/sq. ft.)
  - Slow, rapid
- Terminal head loss (ft. of water)
- Flow Control
- Backwashing

SINGLE AND DUAL MEDIA FILTERS





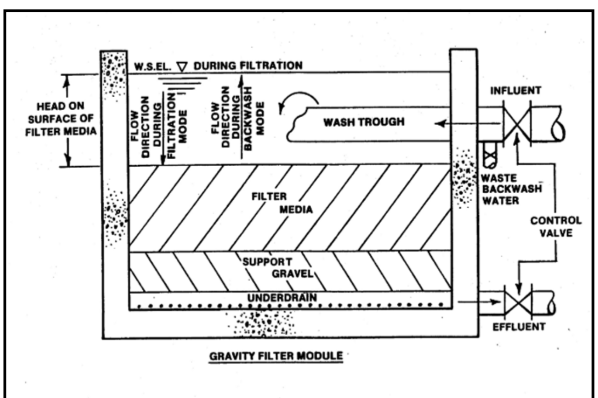


Fig. 6.3 Gravity filter

TYPICAL FILTER RUN

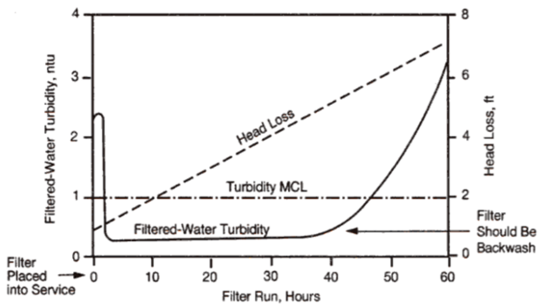


Figure 6-27

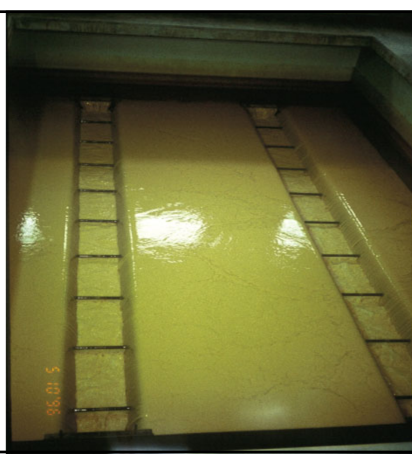
BACKWASHING FILTERS

Even though it takes the least amount of time, backwashing is the most important part of the filtration process!

CLEANING OF FILTERS

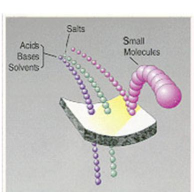
- Manual, semi-automatic or automatic - backwashing
- Factors affecting backwash system:
  - Size, distribution, depth and specific gravity of media
  - Nature of solids removed-principally their adhesion characteristics
  - Type of supplementary cleaning provided

SURFACE WASH SYSTEM



SLOW SAND FILTER

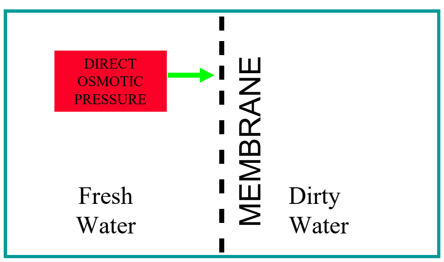
MEMBRANE FILTRATION



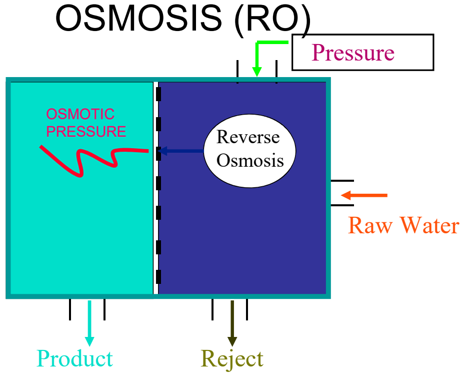
WHAT IS A MEMBRANE?

- Semi-permeable thin layer of material capable of separating contaminants as a function of their physical/chemical properties.
- Despite variations in configurations and types, they are all pressure or vacuum driven except EDR which is electrical potential driven.

PRINCIPLE OF OSMOTIC PRESSURE



PRINCIPLE OF REVERSE OSMOSIS (RO)



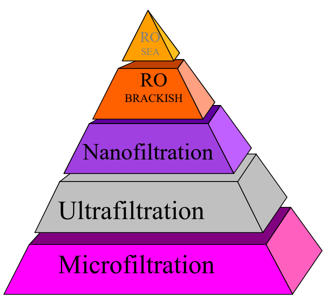
OSMOTIC PRESSURE

- OSMOTIC PRESSURE:

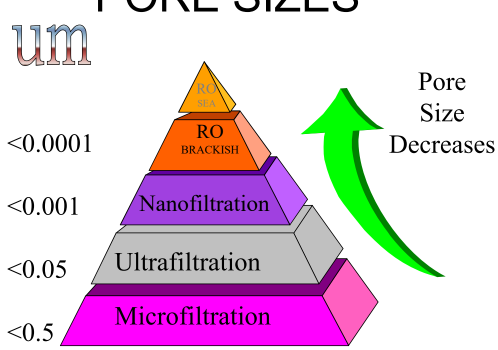
osm pres = 1 psi /100 mg/L OF TDS (divalent rich waters)

osm pres = 1.2 psi /100 mg/L OF TDS (salt NaCl waters)

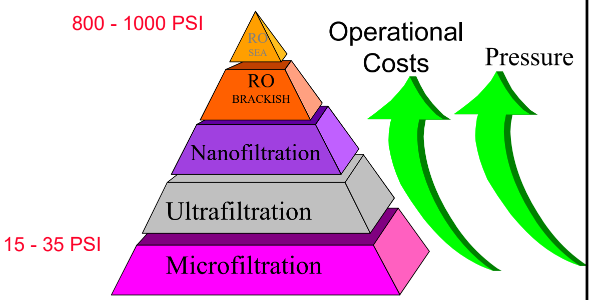
FIVE BASIC MEMBRANE SYSTEMS



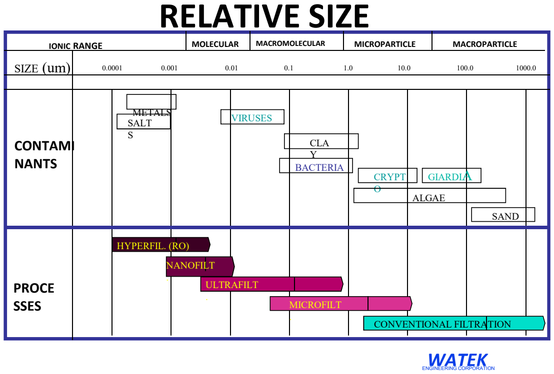
PORE SIZES



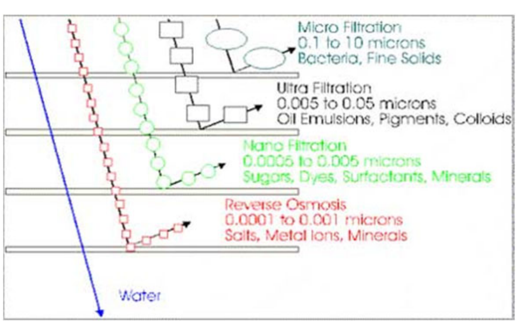
HOW THEY COMPARE



SEPARATION PROCESSES RELATIVE SIZE



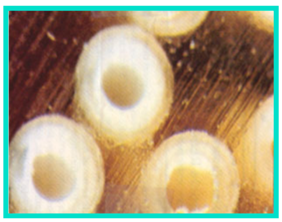
MEMBRANE FILTRATION PROCESSES - TYPES



PACKAGED IN DIFFERENT CONFIGURATIONS

- SPIRAL WOUND
- HOLLOW FIBER
- TUBULAR
- PLATE & FRAME
- CERAMIC & DISCS
- IMMERSED / SUCTION

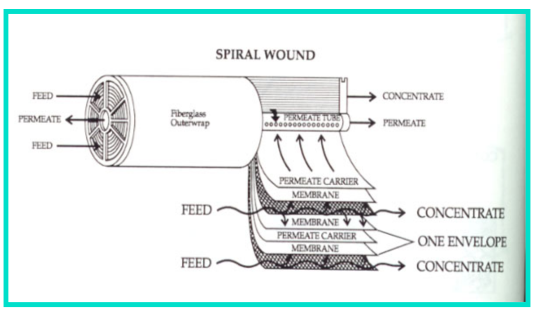
CLOSE - UP VIEW



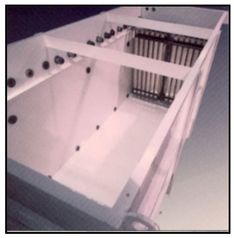
HOLLOW FIBER

SPIRAL WOUND

SPIRAL WOUND SYSTEM

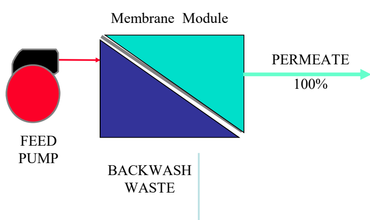


SUBMERGED MEMBRANES ARE THE ANSWER FOR TOUGHER RAW WATERS



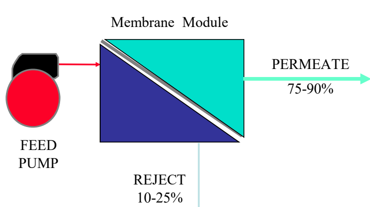
TWO DIFFERENT MODES OF OPERATION

DEAD END WITH FREQUENT BACKWASH

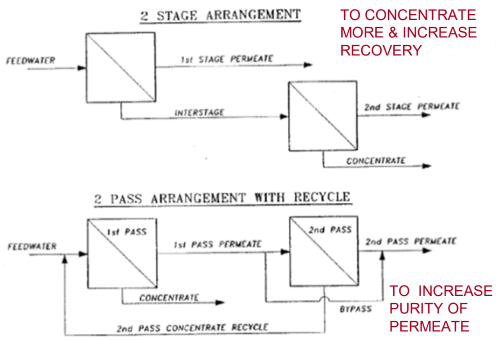


TWO DIFFERENT MODES OF OPERATION

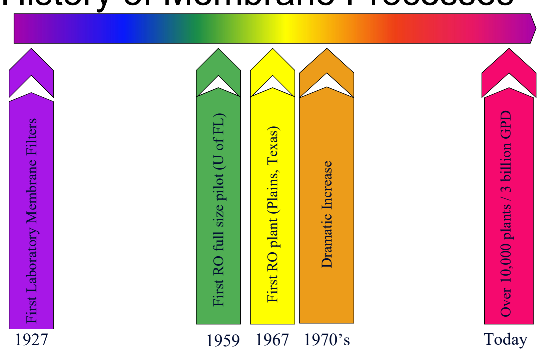
CONTINOUS CROSS FLOW



STAGES & PASSES



History of Membrane Processes

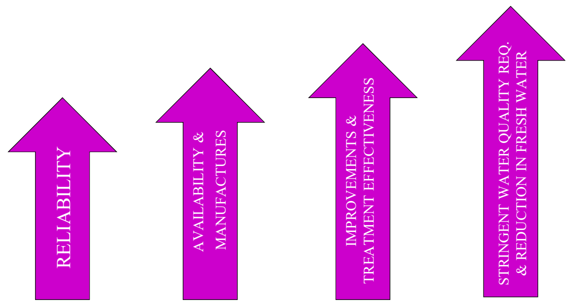


DRAMATIC GROWTH IN 50 YEARS

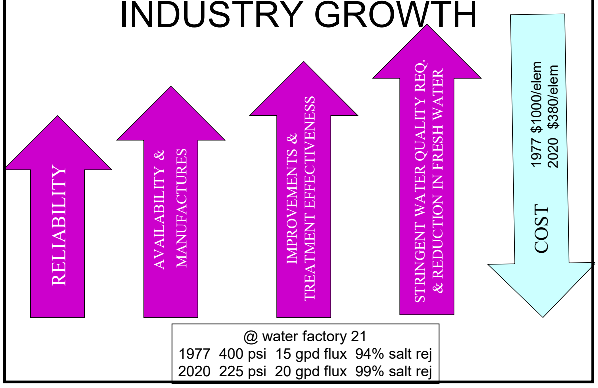
NUMBER OF MEMBRANE PLANTS WORLD-WIDE

- 1970 <10
- 1980 100
- 1990 1,000
- 2020 > 13,000

REASONS FOR DRAMATIC INDUSTRY GROWTH

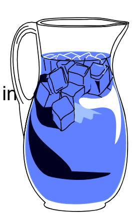


REASONS FOR DRAMATIC INDUSTRY GROWTH



OTHER REASONS FOR GROWTH

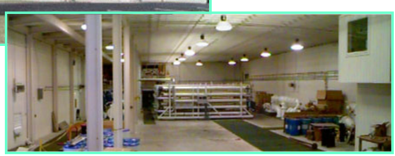
- Fresh water sources long distance away.
- National Security/Conflicts/Independence
- (22 countries depend on others for water)
- Non-Smart Growth. (50% population increase in FL/TX/CA IN next 20 years.)
- Sometimes chosen for small footprint & aesthetics.



CURRITUCK, NORTH CAROLINA

- 0.2 MGD
- EXPAND TO 0.5
- NF SOFTENING
- W/ CONV TO BW RO
- 90% RECOVERY
- 155 PSI

KILL DEVIL HILL PLANT, NC



- 3.0 MGD
- EXPANDABLE TO 8
- FEED TDS: 3,800
- 3 TRAINS

FORT MYERS, FLORIDA

COURTESY OF BOYLE ENGINEERING

- 12 MGD
- EXPAND TO 20
- 3-4 MGD SKIDS
NF SOFTENING
90% RECOVERY
155 PSI, W/BWRO
CONVERSION
PLANNED

UNIQUE FEATURES OF MEMBRANES

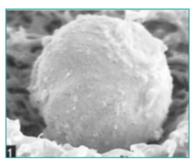
1. IT IS A BARRIER
2. IT IS MODULAR
3. EASY TO OPERATE
4. CAN BE MADE ATTRACTIVE

CHALLENGE TESTS IN MF & UF PILOT TRIALS HAVE SHOWN SUCCESS BEYOND PENDING REGULATIONS

Giardia Cysts

REG: 3 LOGS

CAPABILITIES: 6-8 LOGS

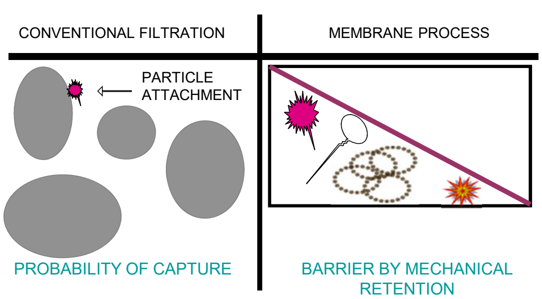


Cryptosporidium Oocysts

REG: 2 LOGS

CAPABILITIES: 6-8 LOGS

COMPARISON TO CONVENTIONAL TREATMENT



PROBABILITY OF CAPTURE — 99.6% CREDIT

BARRIER BY MECHANICAL RETENTION — 99.99% CREDIT

TABLE 5-1 Typical urban water use by a family of four

Type of Household Use	Daily Use: Per Family: Amount of Water Used, *gpd*	*(L/d)*	%	Per Capita Use, *gpcd*	*(L/d per capita)*
Drinking and water used in kitchen	8	(30)	2	2.00	(7.6)
Dishwasher (3 loads per day)	15	(57)	4	3.75	(14.2)
Toilet (16 flushes per day)	96	(363)	28	24.00	(90.8)
Bathing (4 baths or showers per day)	80	(300)	23	20.00	(75.7)
Laundering (6 loads per week)	34	(130)	10	8.50	(32.2)
Automobile washing (2 car washes per month)	10	(38)	3	2.50	(9.5)
Lawn watering and swimming pools (180 hours per year)	100	(380)	29	25.00	(94.6)
Garbage disposal unit (1 percent of all other uses)	3	(11)	1	0.75	(2.8)
Total	346	(1,310)	100	86.50	(327.4)

TYPES OF SAFETY TRAINING NEEDS

- Introduction/Overview of Workplace Safety
  - ideally per group or type of positions.
- Accident Prevention/Awareness
- General Environmental Controls
- Personal/Workplace Hygiene
- "Lifting/bending/twisting"
- Hazard Communication

» more

TYPES OF NEEDS (CONTINUED)

- Personal Protective Equipment (PPE)
- PPE-Respiratory Protection
- Fall Protection
- Fire Protection/awareness
- Means of entry/egress; ladder safety
- General electrical
- Control of Haz. Energy source (L.O.T.O.)

» more

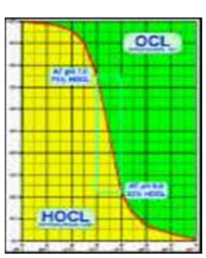
TYPES OF NEEDS (CONTINUED)

- Vehicular safety
- Tools and Equipment-General tips
- Confined Spaces
  - knowledge, use of program, practice
- First Aid/CPR
- Process Safety Management Plan
- Risk Management Plan
- Incident investigation and reporting

EXISTING STRATEGIES

- Some site specific programs.
- Some utility-wide programs.
- In-house.
- Contractual.

REGULATOR (MDE) HOT TOPICS



- LT2ESWTR
- STAGE 2 DBPR.
- GROUNDWATER RULE
- COLIFORM RULE

MORE INFORMATION

- epa.gov
- mde.gov
- awwa.org

SUGGESTED AWWA VIDEOS TO SEE TODAY

- *WE TREAT WATER RIGHT*
- *SOURCE WATER PROTECTION*
- *COAGULATION/FLOCCULATION/ SEDIMENTATION/FILTRATION*
- *PROTECTING AGAINST WATERBORNE DISEASE*
- *FILTER SURVEILLANCE TECHNIQUES*
- *WATER SYSTEM SECURITY*
- *CHEMICAL SAFETY*