



NATIONAL UNIVERSITY
OF PUBLIC SERVICE
FACULTY OF WATER SCIENCES
CUM SCIENTIA PRO AQUIS HUNGARIAE!

FINAL EXAM TOPICS

for
**Civil Engineer BSc,
Environmental Engineer BSc**
at

National University of Public Service
Faculty of Water Sciences



2019

BAJA



6500 Baja, Bajcsy-Zsilinszky utca 12-14. | Tel: +36 (79) 523 900
Email: vtk@uni-nke.hu



6500 Baja, Bajcsy-Zsilinszky utca 12-14. | Tel: +36 (79) 523 900
Email: vtk@uni-nke.hu

Civil Engineer (BSc)



6500 Baja, Bajcsy-Zsilinszky utca 12-14. | Tel: +36 (79) 523 900
Email: vtk@uni-nke.hu

WATER UTILITIES

- 1. Structure and design of drinking water distribution networks**
 - functional parts of distribution networks
 - systems with and without elevated tanks, regional distribution networks
 - determination of water demands, demand variations over time and location, parameters of drinking water demand
- 2. Subsurface water intake**
 - types of subsurface water bodies, typical contaminants
 - types of wells, well structures, hydraulic calculation of wells, drawdown curve
 - reservoir and aquifer protection, protective area
- 3. Surface water intake**
 - typical contaminants and their variations over time and location
 - typical intake structures: rivers, lakes, reservoirs
 - selection of water acquisition site location and protective measures
 - screen bars and sieves
- 4. Clarification – thickening**
 - sedimentation process: discrete and hindered settling, thickening curve
 - hydraulic aspects of sedimentation tank
 - sizing of clarifiers, structures and settling tank upgrade
- 5. Coagulation-flocculation**
 - removal of floc size particles, floc destabilization process
 - mixing demand
 - phase separation and process units
- 6. Cake filtration**
 - theory of cake filtration
 - sieves for macro- and micro filtration
 - screens, drum filters
- 7. Filtration in porous media**
 - rapid filtration: pressure and water quality changes along the filter, regulation of filtration rate, filter backwash
 - slow filtration, pressure and water quality changes, operating principles, structural layout



8. **Disinfection**
 - aim of disinfection
 - oxidation by chlorine, breakpoint curve
 - application of chlorine dioxide
 - application of ozone
 - UV disinfection
 - disinfection by-product formation, prevention and reduction
9. **Degassing, aeration, acidity reduction**
 - origin of methane and aggressive carbon dioxide, reduction
 - Henry's law, effect of partial pressure, physical and chemical fundamentals of gas liquid equilibrium, lime-carbonic acid equilibrium
 - structures and equipment for aeration and degassing
10. **Iron and manganese removal**
 - origin of iron and manganese, necessity of reduction
 - fundamental chemistry of iron and manganese removal
 - technologies for iron and manganese reduction
 - treatment of iron and manganese slurry
11. **Arsenic removal**
 - occurrence of arsenic in natural waters
 - necessity of arsenic removal
 - technologies for arsenic removal, placement in process trains, process flow diagrams
12. **Ammonium removal**
 - occurrence of ammonium in natural waters, nitrogen forms
 - necessity of ammonium removal
 - technologies for ammonium removal, placement in process trains, typical block diagrams
13. **Water softening**
 - water hardness, fundamental definitions, aim of softening
 - introduce at least four process for water softening
14. **Hydraulic design of drinking water distribution networks**
 - investigation goals, input data for hydraulic models, utility registers and maps, geodatabases of urban water utilities
 - results and their interpretation
 - execution of hydraulic dimensioning and verification, systems with flowrate and pressure boundary conditions



- 15. Materials, structures and construction of drinking water distribution networks**
 - requirements and legislation of materials for drinking water distribution, common structural loads
 - common pipe materials and designation, fittings and joints
 - structures of water towers, piping layout, maintenance
 - pipe laying methods (earthworks, compaction), verification tests
- 16. Water quality changes in distribution networks**
 - reasons and consequences of water quality changes
 - prevention of water quality deterioration, problem solving methods
 - reduction methods of biological activity in the distribution network
- 17. Construction and functional parts of sewer systems**
 - combined and separated sewer systems
 - main parts of gravity, pressurized and vacuum systems
 - role and technical layout of storm water detention structures
 - leakage testing of sewers (pressurized water and air test)
- 18. Hydraulic calculations of gravity sewers, storm drains and combined systems**
 - common flowrates, wastewater categories, stormwater, infiltration and alien waters
 - design of slope (terrain conditions and elevations, allowed flow velocities), calculation methods based on permanent flow, hydraulic capacity of partially filled and full (pressurized) cross sections
 - determination of storm water flow, rational method
- 19. Structures on sewers and their maintenance**
 - survey of sewer network (geodesy, hydraulics), public utility register
 - diagnostic methods and equipment for sewers
 - structural and surveying structures on sewers, their purpose and application requirements
 - sewer maintenance, flushing, repairing, reconstruction
- 20. Primary (mechanical) wastewater treatment - screens and grit chambers**
 - purpose of screens, screen types, dimensioning of screens
 - grit chambers and grease trap structures and their dimensioning
- 21. Primary (mechanical) wastewater treatment – primary settlers**
 - primary settler structure types and layouts
 - dimensioning of primary settlers, removal efficiency



- 22. Activated sludge process**
- constituents of activated sludge, structure, correlation of recirculation and solid retention time
 - biomass production (Monod and Andrews kinetics)
 - dimensioning based on ATV 131
- 23. Nitrogen removal from wastewater**
- nitrogen forms, mechanisms of nitrogen reduction, required conditions (nitrification, denitrification)
 - necessity of nitrogen reduction
 - possible reactor configurations
 - sidestream technologies (anaerobic ammonium oxidation)
- 24. Phosphorus removal from wastewater**
- phosphorus fractions
 - necessity of phosphorus reduction
 - chemical phosphorus removal and reactor configurations
 - excess biological phosphorus removal and reactor configurations (A/O, A2/O, UCT, etc.)
- 25. Fixed film wastewater treatment**
- properties of fixed film systems, life cycle and transport processes of the biofilms
 - rotating contractors and biofilters
 - moving bed bioreactor systems and their layouts
 - integrated fix film activated sludge systems
- 26. Sizing of aeration systems for wastewater treatment**
- sizing of aerators: correlation between oxygen demand of bioreactors and required airflow (AOTR, SOTR)
 - surface aerators
 - submerged aerators
 - theory and measurement of oxygenation capacity verification, execution of the measurement
- 27. Wastewater treatment in sequenced batch reactors (SBR)**
- properties, dimensioning and operation of SBR systems
 - role of equalizing tanks in SBR processes
- 28. Secondary settlers in wastewater treatment**
- layout, dimensioning principles (hydraulic considerations)
 - sludge volume index, sedimentation curve
 - operation of secondary settlers, duty point analysis



- 29. Sludge treatment in wastewater treatment plants**
- properties of primary and secondary sludge
 - structures and material balance of the thickening process
 - structures, machinery and material balance of dewatering
 - side stream processes for sludge mass reduction (Cannibal, OSA)
- 30. Stabilization of wastewater sludge**
- aim and methods of stabilization
 - process and structures of aerobic sludge stabilization
 - process and structures of anaerobic sludge stabilization
 - biogas production, composition, utilization
- 31. Wastewater sludge utilization and disposal**
- exploitable materials in the sludge
 - process and layout of composting solutions
 - drying and incineration of sludge
 - final disposal of wastewater sludge
- 32. Natural wastewater treatment processes**
- properties of extensive wastewater treatment
 - classification of natural wastewater treatment processes
 - constructed wetland layouts
 - lagoon layouts
- 33. Membrane technologies in water and wastewater treatment**
- principles of membrane separation, pore size, removable materials
 - membrane system setups, layout of membrane units in drinking water treatment
 - membrane materials, production methods
 - maintenance and cleaning of membranes



Environmental Engineer (BSc)



6500 Baja, Bajcsy-Zsilinszky utca 12-14. | Tel: +36 (79) 523 900
Email: vtk@uni-nke.hu

PROTECTION OF ENVIRONMENTAL ELEMENTS AND ENVIRONMENTAL TECHNOLOGIES (A1)

For all specialization

1. Environmental loads and their reduction

- fundamental reasons
- effects and their extents, examples
- environmental elements to be protected
- definition and interpretation of ecosystem
- ecological restoration and nature conservation
- methods for averting harms

2. Aquatic environment and its properties

- biotic and abiotic factors
- occurrence and importance of N and P compounds
- water contaminants and the mechanisms of their effects
- impact of pollutants on water utilization
- natural cleaning processes in surface waters

3. Water quality, quality assessment

- assessment methods, general considerations
- water quality indicators: physical, chemical, hydrobiological parameters
- scope, application and methods of the Water Framework Directive
- classification according to the Water Framework Directive

4. Water quality databases

- information demands
- design of sampling programs
- evaluation and processing of water quality data
- water quality databases

5. Acceptable loading of water bodies

- Correlation between organic load and oxygen balance
- effects on biotopes and biocoenosis
- important correlations of the oxygen balance and its mathematical models
- type of limit values
- penalties and fines for wastewater discharge and environmental loads

6. Point and extensive water contaminations

- main types of pollution
- aim and tools of water quality control
- protection by technological and other methods
- dilution, storage, re-routing, retention
- overview, evaluation and classification of technological and non-technological water quality control methods



7. **Treatment , utilization and disposal of liquid manure**
 - quality and qauntity, environmental impact of liquid manure
 - necessity of treatment, treatment methods
 - disposal possibilities and limitations
 - technological solutions and their common parameters
8. **Waste classification, waste managment frameworks**
 - principles
 - classification of wastes, qualitative and quantitative properties
 - Sampling and evaluation, parameters to be analyzed
 - Waste managment policies and strategies
9. **Collection and transport of solid municipal waste**
 - requirements and tools of collection – pre-treatemnt – transport – storage – administration
 - methods, aim, advantages and disadvantages of selective collection
 - advantages and disadvantages of regional and decentralized waste treatment
 - aim and layout of transfer stations
10. **Physical and chemical waste treatment and disposal**
 - preparation, component separation, phase separation
 - neutralization, coagulation, oxidation, reduction, hydrolisys, electrochemical processes, embedding, solidification
11. **Thermic waste treatment processes**
 - classification, application possibilities and aims of thermic processes
 - advantages and disadvantages of incinertaion plants, furnace types and furnace selection
 - air pollution from waste incineration, reduction methods
12. **Aerobic organic waste treatment processes (composting)**
 - aim, application, influencing factors, advantages and disadvantages of composting
 - composting technologies
 - required measurements and input parameters for the dimensioning of composting facilities, calculation steps
 - aspects of design and operation



- 13. Anaerobic organic waste treatment processes (anaerobic digestion)**
 - aim, application fields, influencing factors of anaerobic digestion
 - advantages and disadvantages of anaerobic digestion of wastes with high organic material content
 - dry and wet digestion technologies
 - required measurements and input parameters for the dimensioning of anaerobic digestion facilities, calculation steps
 - aspects of design and operation
- 14. Municipal landfills**
 - Site selection, different types, and possible layouts of landfills
 - design principles, protection technology, water management and treatment, biogas treatment and utilization
 - recultivation of landfills
- 15. Collection, transport, storage and disposal of hazardous waste**
 - properties of hazardous waste
 - requirements for collection, storage and transport
 - possibilities for temporary and final disposal, operation of facilities
- 16. Fundamental tasks in soil protection**
 - demand for sustained soil fertility
 - protection against erosion, deflation
 - physical, chemical and biological soil improvement methods and tasks
- 17. Irrigation with wastewater, soil as recipient**
 - role of the soil in handling contaminations
 - self-cleaning processes in the soil (physical, chemical, biological), role of the vegetation
 - effect of the most common contaminations on the soil
 - calculation of acceptable contaminant load of soils, dimensioning soil as recipient
- 18. Contaminants in the soil and in the groundwater**
 - transport and transformation of contaminant substances
 - transport and modeling of the reactions
 - typical transport processes
 - methods to restrict contaminant transport
- 19. Point-like contaminations and contamination elimination in soil and groundwater**
 - contaminant sources, common contaminants
 - exploration and localisation of the contamination
 - evaluation based on allowed load, risk assessment, decision support
 - applicable technologies, considerations for technology selection



20. Subsurface oil contamination

- properties of oil contaminations, investigation
- transport of oil in soil and groundwater
- damage assessment, planning of the elimination, in situ and ex situ methods for oil contaminations

21. Air as an environmental element

- contaminants and their sources
- constant and variable constituents
- types of pollutions (point, diffuse)
- effect of pollutants on health and environment
- inorganic and organic contaminant classification with examples
- acid rain development and effect on environment

22. Emission, transmission, immission

- fundamental definitions, emission types and their properties
- determination by measurement and calculation
- principles of emission limits
- contaminant transport in air, influencing factors
- methods for immission determination
- role of background contamination
- green house effect, ozone hole

23. Properties of flue gas emissions

- fuels, common flue gas composition
- determination of flue gas composition (measurement, calculation)
- flue gas quality as a function of burning process parameters (burner, excess air, etc.)
- air pollution from power stations, residential heating, traffic, waste incineration
- methods of air pollution control, active and passive methods

24. Industrial air pollution

- pollution types (dust, chemicals, odour)
- correlation of technology and emission
- active and passive methods to reduce chemical contaminations
- solvent extraction from exhaust gases
- dust removal methods, cyclones, filters, chambers, electrostatic filters, wet processes

25. Common gas purification processes

- NO_x reduction (SNR, SNCR, SCR) process advantages and disadvantages
- SO₂ reduction methods
- combined SO₂ and NO_x reduction methods
- reduction of dioxin emission in waste incineration



- 26. Legal measures of air quality protection**
- legislation goals, principles, limits, and limit determination
 - tools of law making
 - emission register, aim and data collection methods
 - on-line and off-line monitoring and their role
 - important laws and international agreements
- 27. Environmental impact of noise and vibration**
- fundamental definitions, origin of sound and noise
 - spreading of noise and vibration
 - descriptive parameters, characteristic curves, impact on health, limit values and principles
 - legislation regarding noise and vibration
- 28. Noise reduction methods**
- active and passive methods
 - soundproofing and their layout
 - soundproofing of residential buildings, industrial facilities and individual machines
 - reduction of traffic noise
- 29. Environmental impact assessment**
- aim, necessity and methodology
 - listing, localisation, conflicts, solution possibilities, investigation methods
 - impact assessment methods, decision support processes
 - contents and methods of detailed impact assessment, examples
- 30. Environmental monitoring systems**
- data and information demand of environmental monitoring, protocols and methods
 - sampling of environmental elements
 - parameters to be measured
 - design of monitoring network and sampling interval
 - data evaluation
 - environmental databases
- 31. Water management**
- Structure of water management
 - Legislative aspects of water management
 - Permits
- 32. Water balance management**
- Elements of water balance
 - Water bases
 - Hydrological water balance diagrams
 - Water storage – demand relation



33. **European Water Framework Directive**

- Aim, content and execution



WATER AND WASTEWATER TREATMENT SPECIALIZED STUDIES

For water and wastewater treatment specialization

- 1. Structure and design of drinking water distribution networks**
 - functional parts of distribution networks
 - systems with and without elevated tanks, regional distribution networks
 - determination of water demands, demand variations over time and location, parameters of drinking water demand
- 2. Subsurface water intake**
 - types of subsurface water bodies, typical contaminants
 - types of wells, well structures, hydraulic calculation of wells, drawdown curve
 - reservoir and aquifer protection, protective area
- 3. Surface water intake**
 - typical contaminants and their variations over time and location
 - typical intake structures: rivers, lakes, reservoirs
 - selection of water acquisition site location and protective measures
 - screen bars and sieves
- 4. Clarification – thickening**
 - sedimentation process: discrete and hindered settling, thickening curve
 - hydraulic aspects of sedimentation tank
 - sizing of clarifiers, structures and settling tank upgrade
- 5. Coagulation-flocculation**
 - removal of floc size particles, floc destabilization process
 - mixing demand
 - phase separation and process units
- 6. Cake filtration**
 - theory of cake filtration
 - sieves for macro- and micro filtration
 - screens, drum filters
- 7. Filtration in porous media**
 - rapid filtration: pressure and water quality changes along the filter, regulation of filtration rate, filter backwash
 - slow filtration, pressure and water quality changes, operating principles, structural layout



8. **Disinfection**
 - aim of disinfection
 - oxidation by chlorine, breakpoint curve
 - application of chlorine dioxide
 - application of ozone
 - UV disinfection
 - disinfection by-product formation, prevention and reduction
9. **Degassing, aeration, acidity reduction**
 - origin of methane and aggressive carbon dioxide, reduction
 - Henry's law, effect of partial pressure, physical and chemical fundamentals of gas liquid equilibrium, lime-carbonic acid equilibrium
 - structures and equipment for aeration and degassing
10. **Iron and manganese removal**
 - origin of iron and manganese, necessity of reduction
 - fundamental chemistry of iron and manganese removal
 - technologies for iron and manganese reduction
 - treatment of iron and manganese slurry
11. **Arsenic removal**
 - occurrence of arsenic in natural waters
 - necessity of arsenic removal
 - technologies for arsenic removal, placement in process trains, process flow diagrams
12. **Ammonium removal**
 - occurrence of ammonium in natural waters, nitrogen forms
 - necessity of ammonium removal
 - technologies for ammonium removal, placement in process trains, typical block diagrams
13. **Water softening**
 - water hardness, fundamental definitions, aim of softening
 - introduce at least four process for water softening
14. **Materials, structures and construction of drinking water distribution networks**
 - requirements and legislation of materials for drinking water distribution, common structural loads
 - common pipe materials and designation, fittings and joints
 - structures of water towers, piping layout, maintenance
 - pipe laying methods (earthworks, compaction), verification tests
15. **Primary (mechanical) wastewater treatment - screens and grit chambers**
 - purpose of screens, screen types, dimensioning of screens
 - grit chambers and grease trap structures and their dimensioning



- 16. Primary (mechanical) wastewater treatment – primary settlers**
 - primary settler structure types and layouts
 - dimensioning of primary settlers, removal efficiency
- 17. Activated sludge process**
 - constituents of activated sludge, structure, correlation of recirculation and solid retention time
 - biomass production (Monod and Andrews kinetics)
 - dimensioning based on ATV 131
- 18. Nitrogen removal from wastewater**
 - nitrogen forms, mechanisms of nitrogen reduction, required conditions (nitrification, denitrification)
 - necessity of nitrogen reduction
 - possible reactor configurations
 - sidestream technologies (anaerobic ammonium oxidation)
- 19. Phosphorus removal from wastewater**
 - phosphorus fractions
 - necessity of phosphorus reduction
 - chemical phosphorus removal and reactor configurations
 - excess biological phosphorus removal and reactor configurations (A/O, A2/O, UCT, etc.)
- 20. Fixed film wastewater treatment**
 - properties of fixed film systems, life cycle and transport processes of the biofilms
 - rotating contractors and biofilters
 - moving bed bioreactor systems and their layouts
 - integrated fix film activated sludge systems
- 21. Sizing of aeration systems for wastewater treatment**
 - sizing of aerators: correlation between oxygen demand of bioreactors and required airflow (AOTR, SOTR)
 - surface aerators
 - submerged aerators
 - theory and measurement of oxygenation capacity verification, execution of the measurment
- 22. Wastewater treatment in sequenced batch reactors (SBR)**
 - properties, dimensioning and operation of SBR systems
 - role of equalizing tanks in SBR processes



- 23. Secondary settlers in wastewater treatment**
- layout, dimensioning principles (hydraulic considerations)
 - sludge volume index, sedimentation curve
 - operation of secondary settlers, duty point analysis
- 24. Sludge treatment in wastewater treatment plants**
- properties of primary and secondary sludge
 - structures and material balance of the thickening process
 - structures, machinery and material balance of dewatering
 - side stream processes for sludge mass reduction (Cannibal, OSA)
- 25. Stabilization of wastewater sludge**
- aim and methods of stabilization
 - process and structures of aerobic sludge stabilization
 - process and structures of anaerobic sludge stabilization
 - biogas production, composition, utilization
- 26. Wastewater sludge utilization and disposal**
- exploitable materials in the sludge
 - process and layout of composting solutions
 - drying and incineration of sludge
 - final disposal of wastewater sludge
- 27. Natural wastewater treatment processes**
- properties of extensive wastewater treatment
 - classification of natural wastewater treatment processes
 - constructed wetland layouts
 - lagoon layouts
- 28. Membrane technologies in water and wastewater treatment**
- principles of membrane separation, pore size, removable materials
 - membrane system setups, layout of membrane units in drinking water treatment
 - membrane materials, production methods
 - maintenance and cleaning of membrane

