Lecture 2: (100 min)

Industrial Waste:

Approach to plant design: From feasibility to process design procedures

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Presentation menu

- Design steps
- Exercise 2
- Q&A

Design steps

1. Engaged by client ▶
2. Agree on Terms of Reference (TOR) ▶
3. Develop waste characterization ▶
4. Develop options ▶
5. Design a selected option ▶
6. Process design ▶
7. Detailed design ▶
8. Appoint contractor ▶
9. Supervise construction ▶
10. Compliance and commissioning ▶
11. Monitoring and performance assessment ▶

Engaged by client

CLIENT FROM

1. Assignment by your employer
2. Recommendation by former clients
3. Recommendation by colleagues
4. Networking

LETTER OF REQUEST

1. Phone call and SMS message is not sufficient
2. Email and letter are preferred
3. Understand the background of the request

Terms of reference

WHAT IS REQUIRED?

1. Objectives of the assignment
2. Motivation
3. Time frame
4. Tasking
   - Level of involvement
   - Detail in design documents
   - Submission to authority?
   - Supervision
5. Costing (if possible)
6. Draft on Memorandum of Agreement (MOA)

Develop waste characterization

WHAT IS REQUIRED OF SYSTEM UPGRADING?

1. Waste load
2. Waste volume
3. Peak and lowest points / trends / patterns
4. Emphasis
    - Waste exceeding the Regulatory requirement
    - Consider reclaim, recycle, reuse
    - Consider using the existing facilities
    - Costing
5. Parameters to design

Develop options

OPTIONS FOR SYSTEM UPGRADING?

1. Treatment (end-of-pipe)
   - Organic removal
   - Nutrient removal
   - Specific contaminants
2. Resource recovery
   - Reclaim – Biogas, materials, water etc
   - Recycle
   - Reuse
3. Carbon credit
4. Tax rebate
5. Other monetary initiatives

Develop options

OPTIONS FOR NEW SYSTEM?

1. Treatment (end-of-pipe)
   - Organic removal
   - Nutrient removal
   - Specific contaminants
2. Resource recovery
   - Reclaim – Biogas, materials, water etc
   - Recycle
   - Reuse
3. Carbon credit
4. Tax rebate
5. Other monetary initiatives

Design a selected option

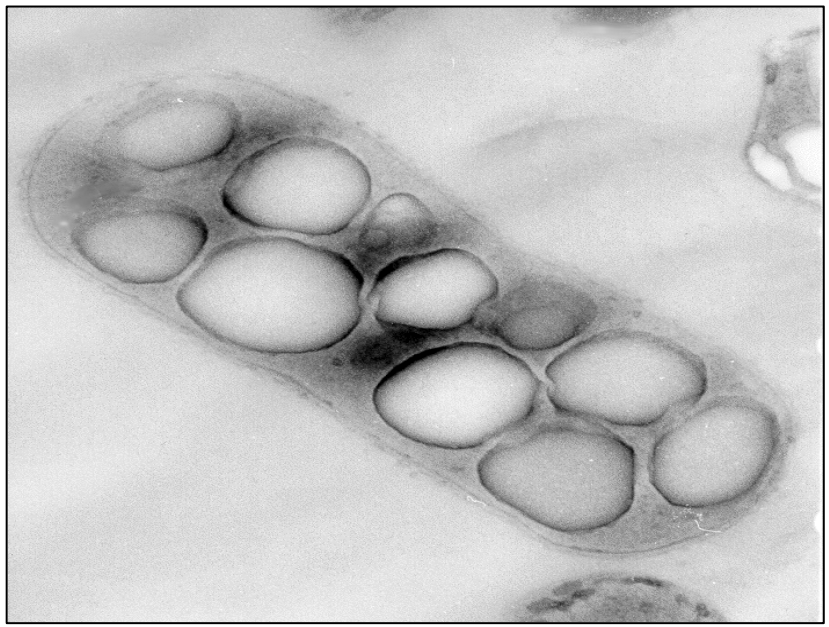
WHAT IS AVAILABLE OPTIONS?

1. Physical treatment
2. Chemical treatment
3. Biological treatment
4. Hybrid

Introduction to bioprocess

- Nature of bioprocess
- Biomass, microorganism
- Substrate, food
- Types of bioprocess
- Engineering parameters of concern
- Design approach
- Instrumentation

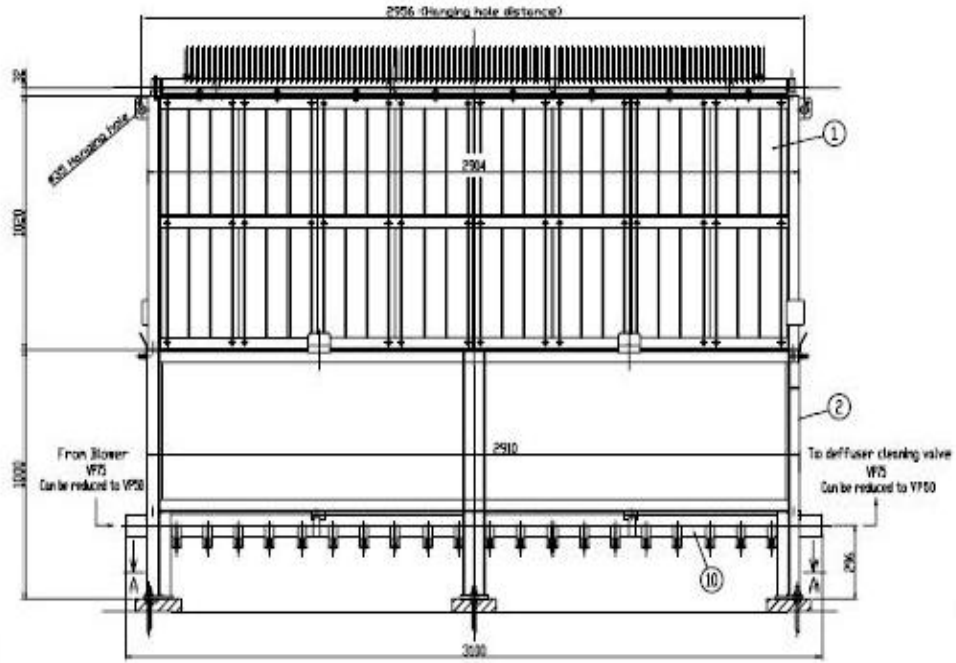
Nature of bioprocess



PRINCIPLE:

Biomass will consume substrates (organic or inorganic materials) from waste materials

Nature of bioprocess



PRINCIPLE:

Biomass will consume substrates (organic or inorganic materials) from waste materials

Electron Transfer in Oxidation

Electron donor	Electron acceptor
Organic materials ▸ Ss ▸ Xs	Heterotrophs
Inorganic materials ▸ Ammonia ▸ Sulfide ▸ Molecular hydrogen ▸ Ferrous ion	Autotrophs

X_S = slowly biodegradable suspended organic matter
S_S = readily biodegradable dissolved organic matter

Electron Transfer in Bioprocesses

Processes	Terminal electron acceptor
Aerobic	Oxygen
Anoxic	Nitrates
Anaerobic	■ Sulfate ■ Organic matters ■ Water ■ Halogenated organic compounds ■ Fe^{3+}

Process selection: Aerobic or Anaerobic?

Aerobic	Anaerobic
■ COD < 3000 mg/l	■ COD>3000 mg/l
■ BOD <2000 mg/l	■ BOD>2000 mg/l
■ Fast biodegradable matters	■ Slow biodegradable matters
■ Low-strength waste	■ High-strength waste
■ Advanced process	■ Pre-treatment process

Biodegradation ⏩ 2 types:

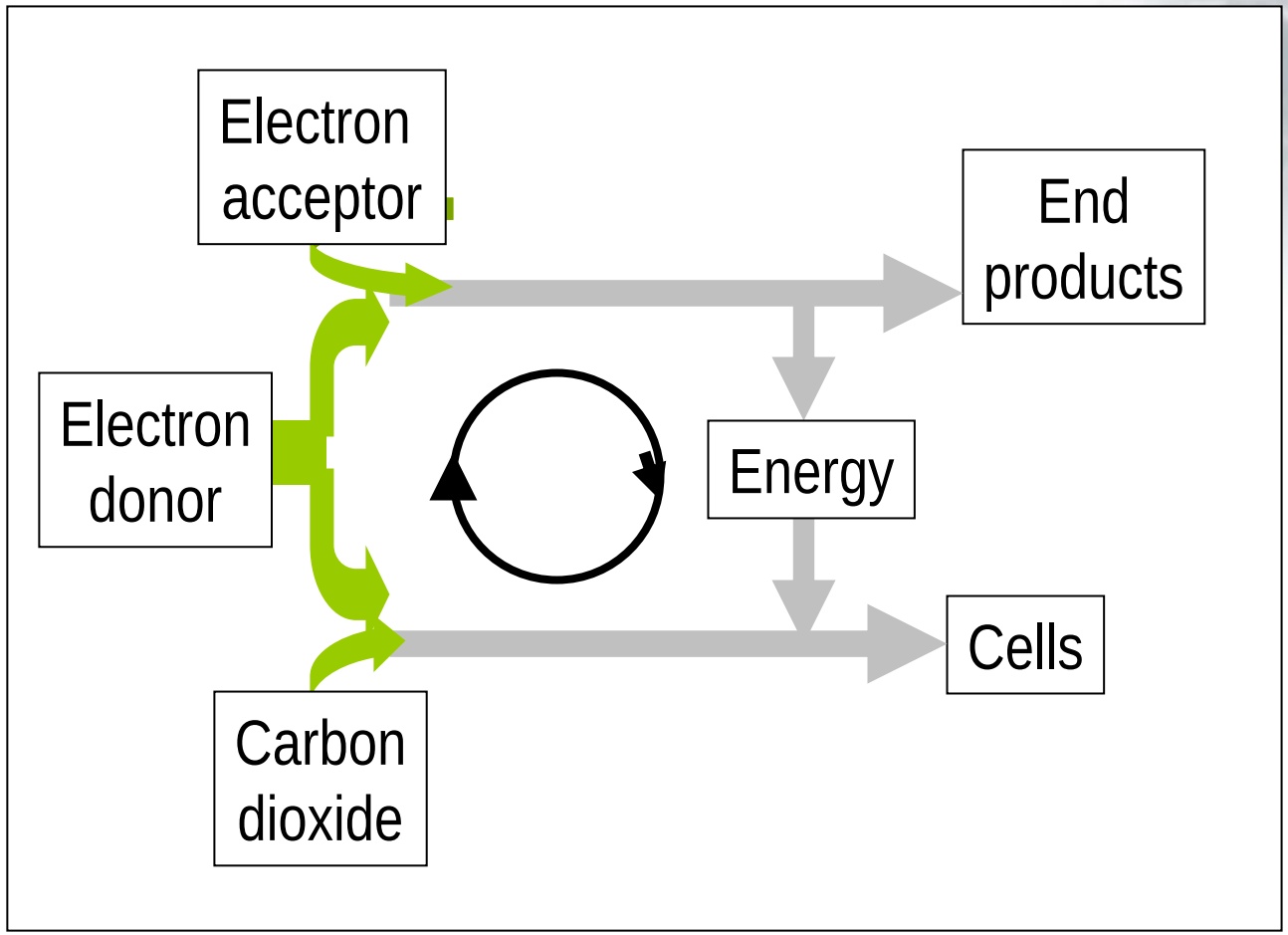
- **Mineralization** ▸ organic compounds are converted by living organisms to minerals (non-organic) end products – MAINLY AEROBIC PROCESS
- **Biotransformation** ▸ Parent organic compounds are not completely mineralized, a portion is converted into other organics – ANAEROBIC PROCESSES

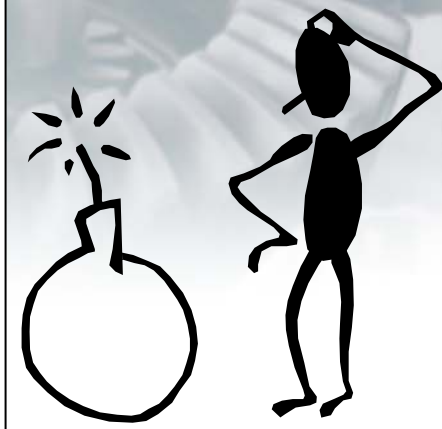
Wastewater treatment system

Aerobic Processes

- Most common
- Suitable for sewage
- Suitable for low-strength industrial wastewater
- Reliable
- Easy to control
- Technology matures
- Many variety
- Cheap???

Biological Oxidation





Biological oxidation an electron donor transmission for energy and transfer of energy for cell synthesis.

Microbial community

• Bioprocess involves complex interaction of mixed bio-populations.

• Growth rates & utilization of substrate is higher in mixed enrichment cultures than in pure cultures isolated from the mixture. In mixed microbial communities, not only are organisms that can initiate catabolism important but so are secondary utilizers.

MICROBIAL CONSORTIUM
Each species serves a vital link in a chain if not web of transformation & mineralization steps, may be necessary for many organic compounds

Wastewater Treatment Systems

Biological Processes

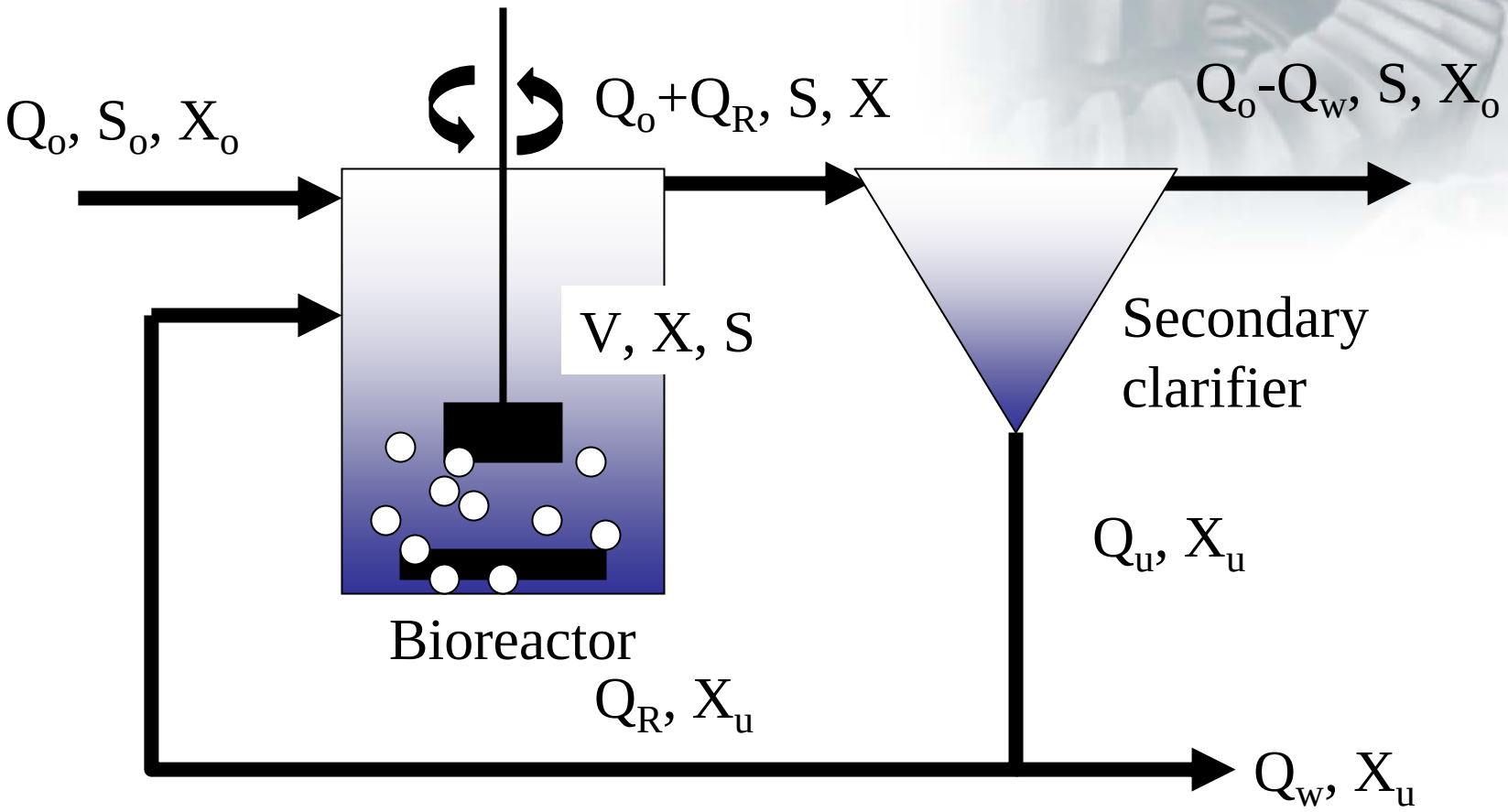
- Activated sludge system
- Biofilm system
- Pond system

- Wetland and natural system
- Hybrid system

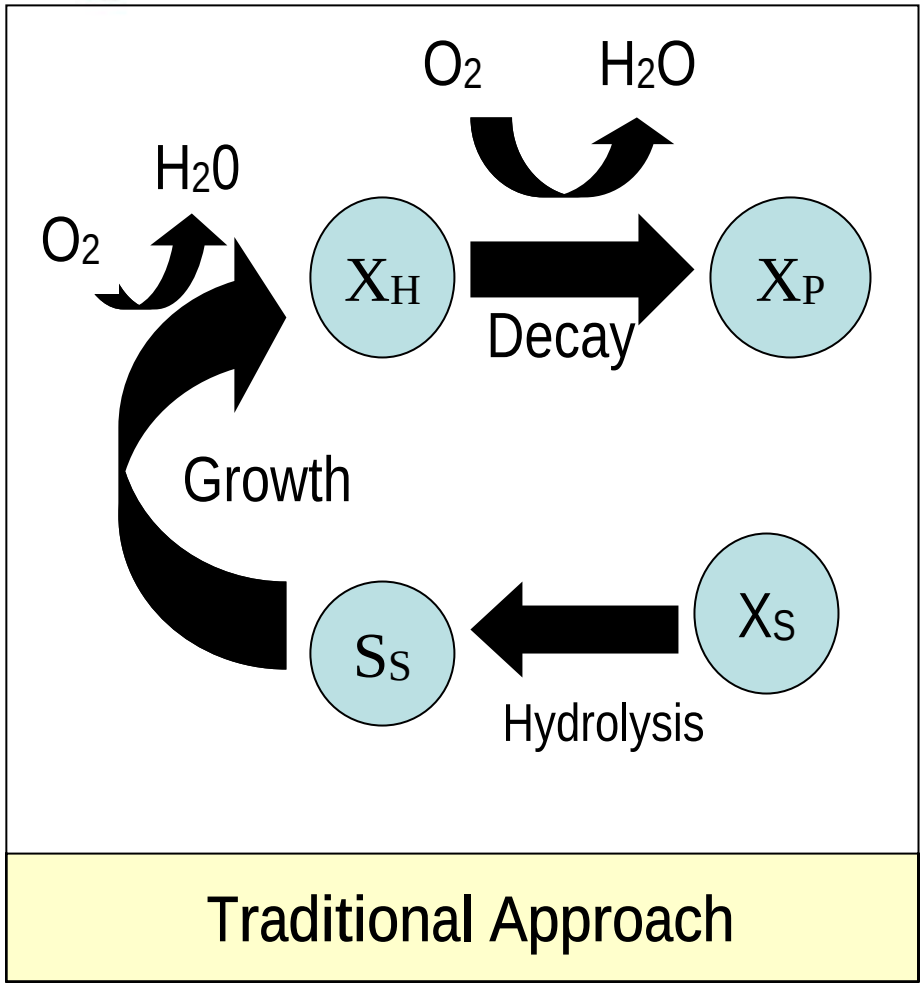
Terminology

Activated sludge	Biofilm	Pond
Biological treatment processes in which the microorganisms responsible for the conversion of organics or other constituents in the wastewater to gases and cell tissue are maintained in suspension within the liquid.	Biological treatment processes in which the microorganisms responsible for the conversion of the organic matter, or other constituents in the wastewater to gases and cell tissue are attached to some inert medium, such as rocks, slag, or specially designed ceramic or plastic materials.	Bioprocess in which the microorganisms responsible for the conversion of organics or other constitutents in wastewater to gases and cell tissue are maintain both in suspension and sludges

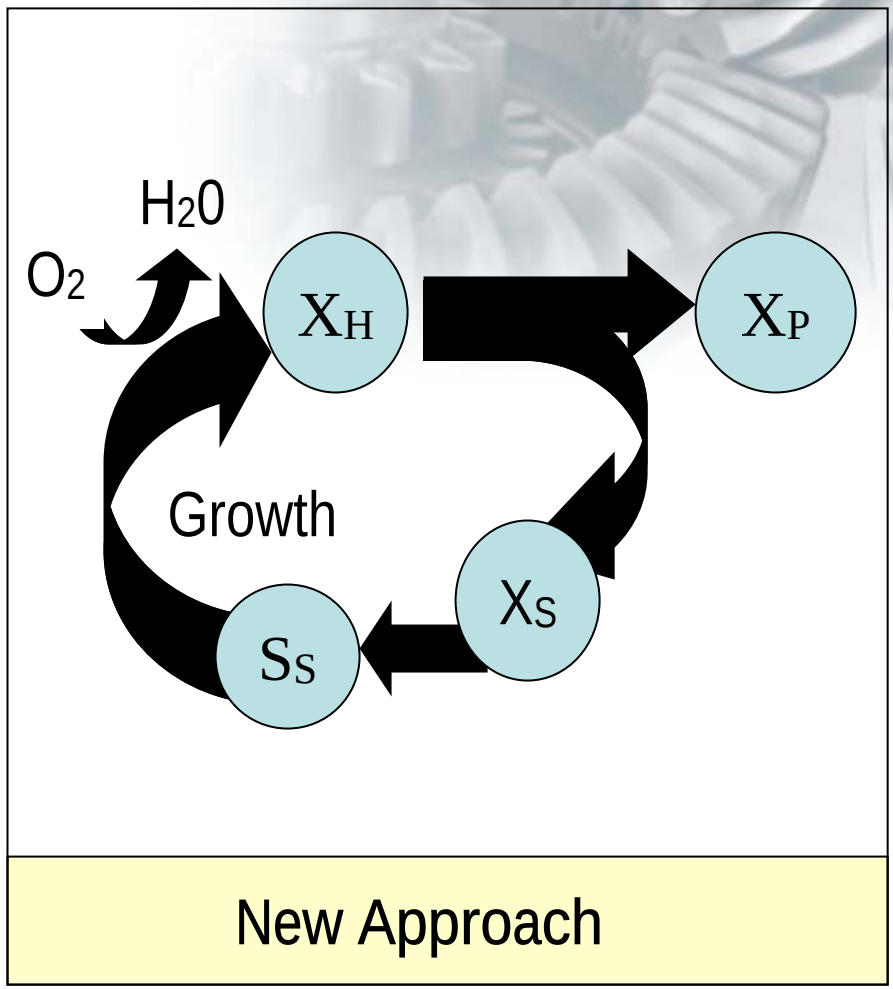
Activated sludge process



Activated sludge design approach



Traditional Approach

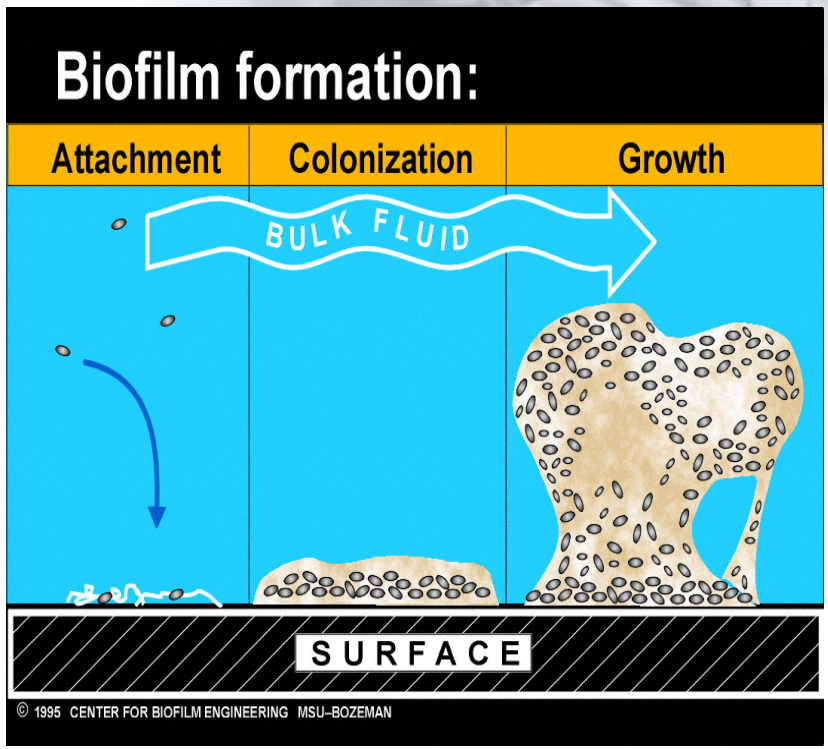


New Approach

Activated sludge systems

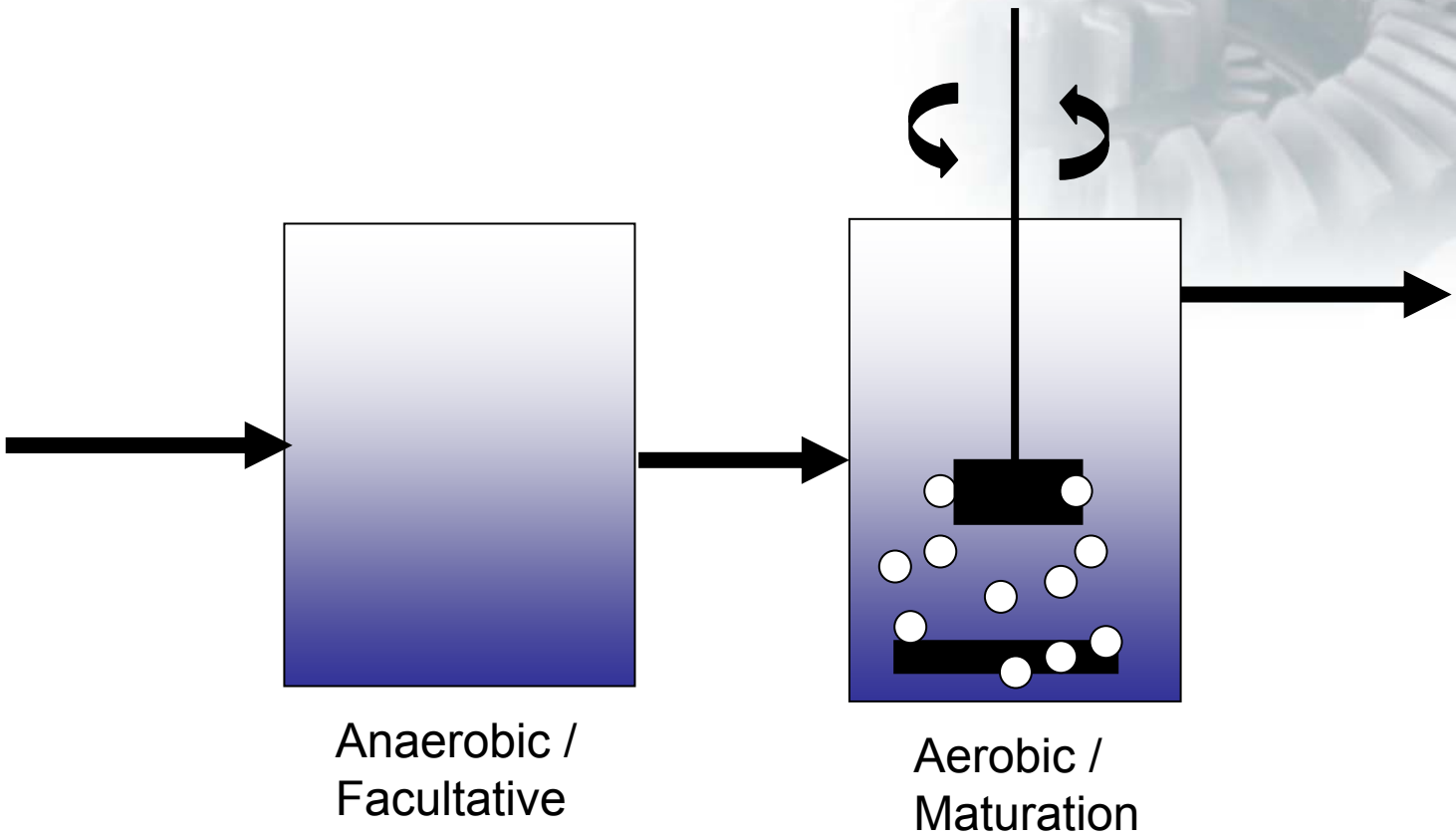
Biofilm processes

- Trickling filter
- Rotating bio. contactors
- Rotating bio. drums
- Fluidized bed reactors
- Upflow Anaerobic Sludge Blanket (UASB)
- Anaerobic fluidized bed



Biofilm processes

Pond system



Pond system

Methane gas generation

Pond system

Aerated Lagoon

Activated sludge plant

Project management & planning

Schedule of Completion for a Design & Build of Treatment Plant

No.	Months	1ST				2ND				3RD				4TH				5TH			
	Weeks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	Detailed Design: Process engineering																				
2	Detailed Design: PID drawing, positioning drawing																				
3	Submission to DOE for & presentation to DOE																				
4	Review of Engineering drawing and design																				
5	Civil Engineering detailed structural design & drawing																				
6	Civil and earth works																				
7	Order and delivery of MBR units																				
8	Mechanical installation																				

Project Management & Planning

Schedule of Completion for a Design and Build of Treatment Plant

No.	Months	6th				7th				8th				9th				10th			
	Weeks	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
7 cont.	Order and delivery of MBR units																				
8 cont.	Mechanical installation																				
9	Commissioning of MBR System																				
10	Documentation O&P Manual																				