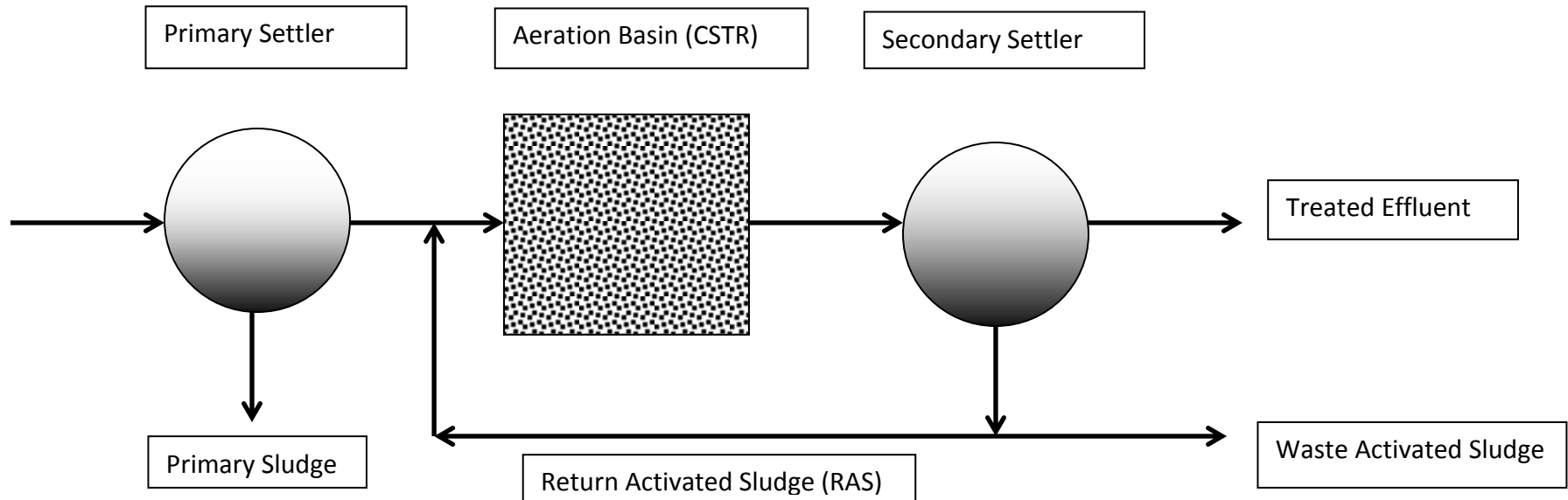


ACTIVATED SLUDGE PROCESS SCHEMATICS

COMPLETELY MIXED ACTIVATED SLUDGE PROCESS



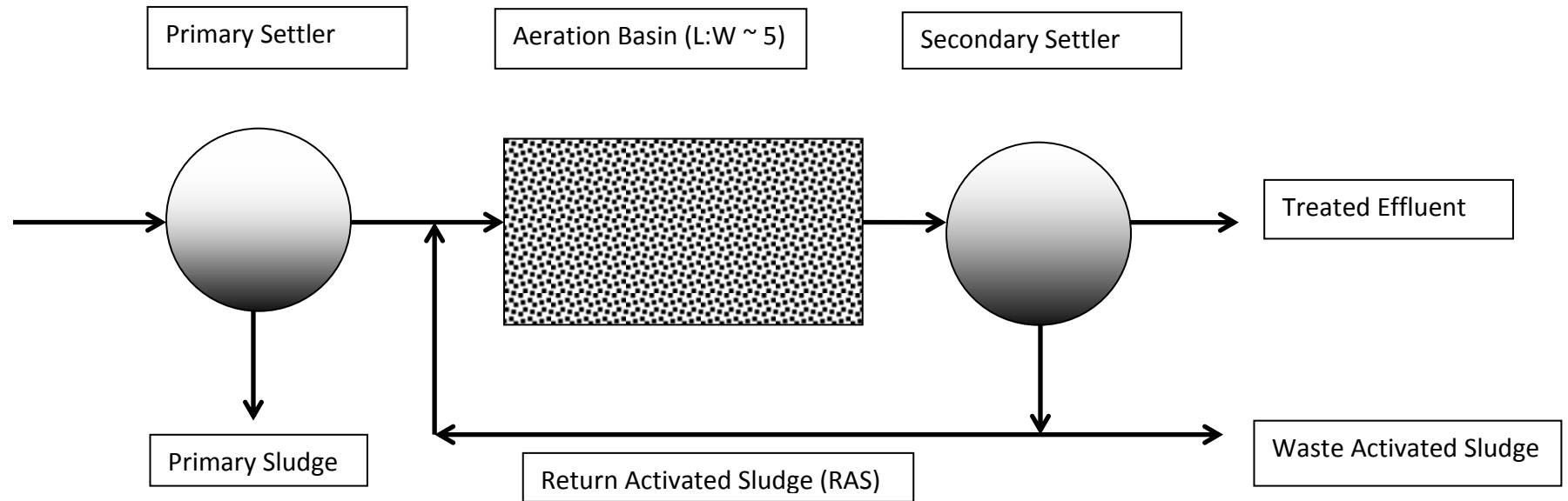
Advantages

1. Allows good nitrification since COD is uniformly low
2. Able to handle peak loads and dilute toxic substances
3. Used in smaller systems, like package plants

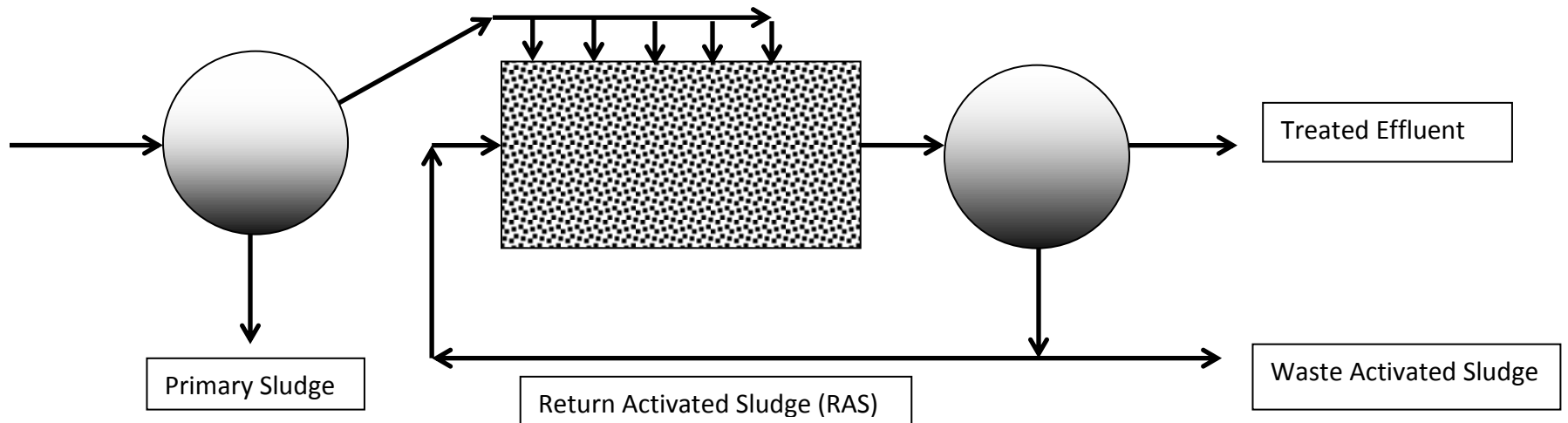
Disadvantages

1. Larger volume, high aeration costs
2. Not much operational flexibility
3. Associated with biomass instabilities like sludge bulking

CONVENTIONAL DISPERSED PLUG FLOW ACTIVATED SLUDGE PROCESS



STEP FEED MODIFICATION



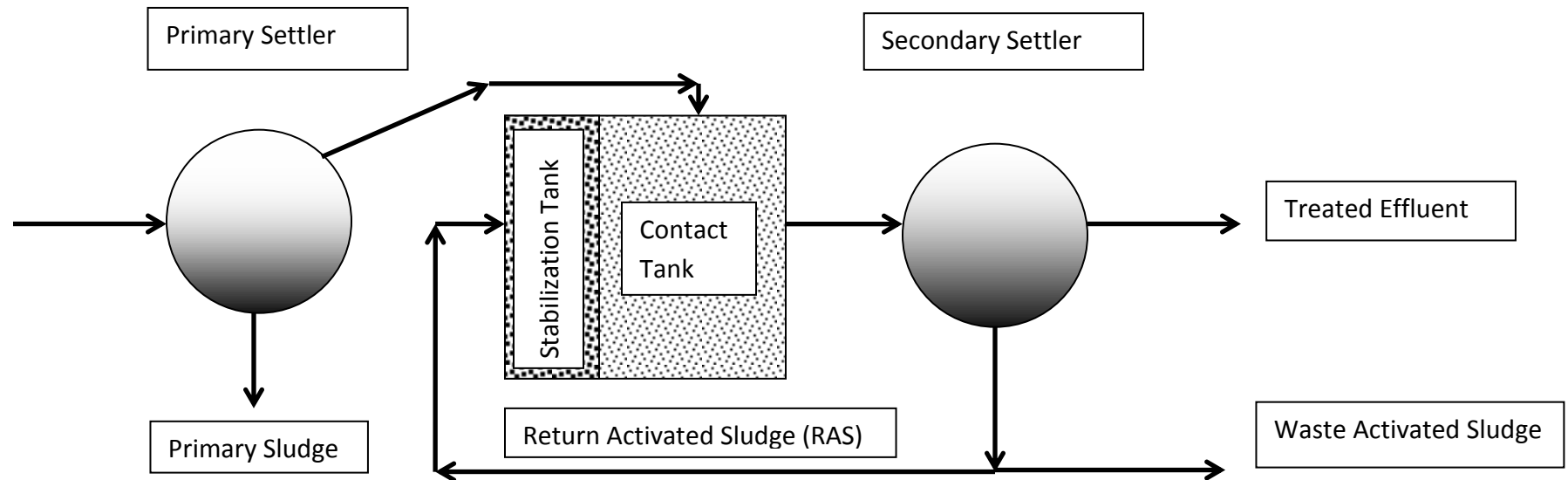
Advantages of Conventional Dispersed Plug Flow Process

1. Allows smaller volume than CSTR
2. Flexible operation, zone aeration, step feeding options, accommodates anoxic and aerobic processes with single biomass for biological nutrient removal
3. Less aeration than CSTR
4. Reduced mixing requirement, per unit reactor volume
5. Better settling characteristics

Disadvantages

1. High oxygen demand in inlet zone – mitigated by step feeding
2. May not buffer peak loads as well as CSTR, although less likely in activated sludge with high biomass
3. Higher construction costs due to serpentine flow in baffled reactor.

CONTACT STABILIZATION ACTIVATED SLUDGE



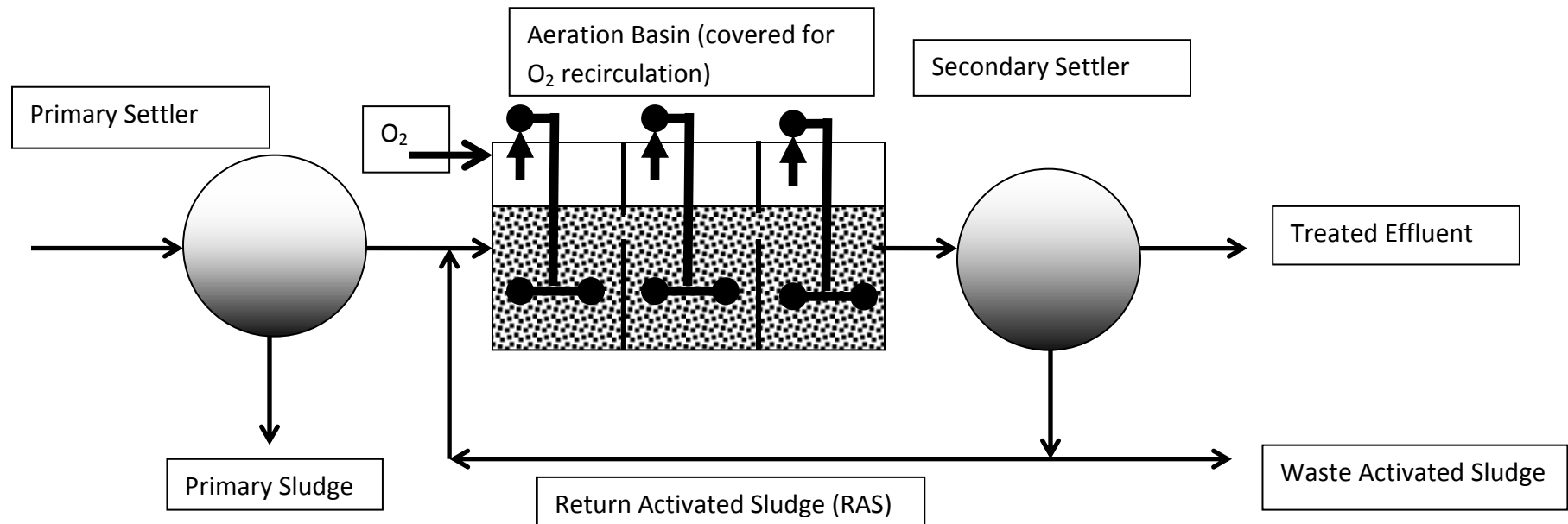
Advantages

1. Reduced aeration requirement with short contact tank residence time
2. Reportedly better settling sludge

Disadvantages

1. Complex operation
2. Possible reduced treatment for soluble contaminants in contact tank
3. Reduced ammonia removal

HIGH PURITY OXYGEN ACTIVATED SLUDGE



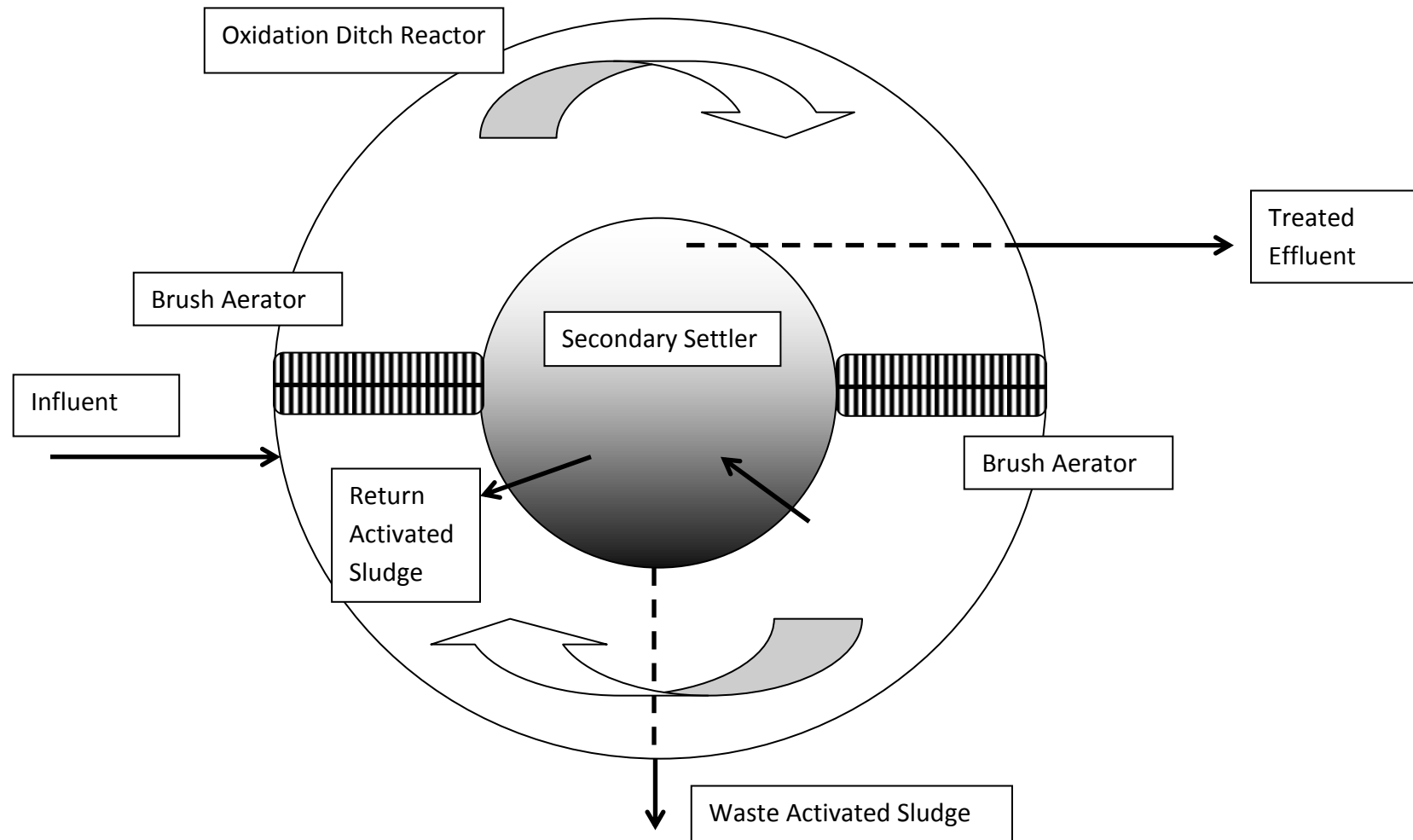
Advantages

1. Five times oxygen transfer rate over air
2. Smaller volume
3. Higher biomass concentration possible, but limited by secondary settler capacity

Disadvantages

1. Very expensive: covered tanks, high energy cost for O₂ generation, gas recirculation equipment
2. Headspace CO₂ accumulation and associated pH drop requires alkalinity addition
3. No flexibility (all aerobic processes)
4. Nitrification is problematic – low pH, short HRT produces high biomass at short SRT
5. Settling problems have been reported

OXIDATION DITCH (EXTENDED AERATION) ACTIVATED SLUDGE PROCESS



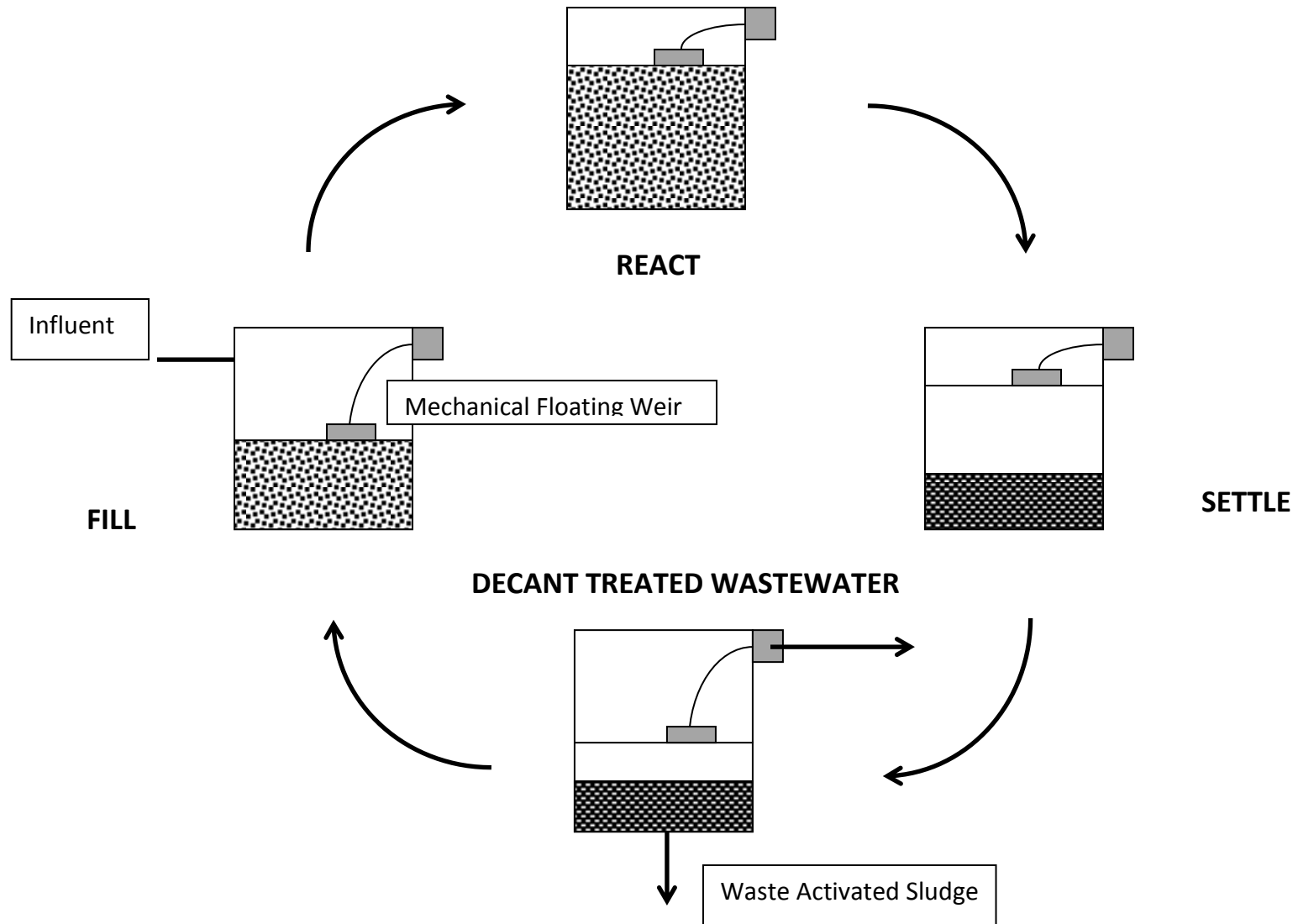
Advantages of Extended Aeration Oxidation Ditch

1. Typically small systems – less than 2 MGD ($5 \text{ m}^3/\text{min}$)
2. Flexible operation with placement and use of aerators – can be used for nutrient removal
3. Very stable process
4. No primary clarifier – simpler sludge handling
5. Good settling characteristics

Disadvantages

1. Long aeration time, larger reactor. Typical HRT > 24 hr.
2. Higher aeration requirement due to typically long SRT
3. Mechanical aeration equipment (rotors, large turbines) required to move water around the channel as well as aerate. Can create zones of high oxygen and add maintenance costs. More recent designs use diffusers for aeration and reduce mechanical requirement.

SEQUENCING BATCH REACTOR (SBR) ACTIVATED SLUDGE PROCESS



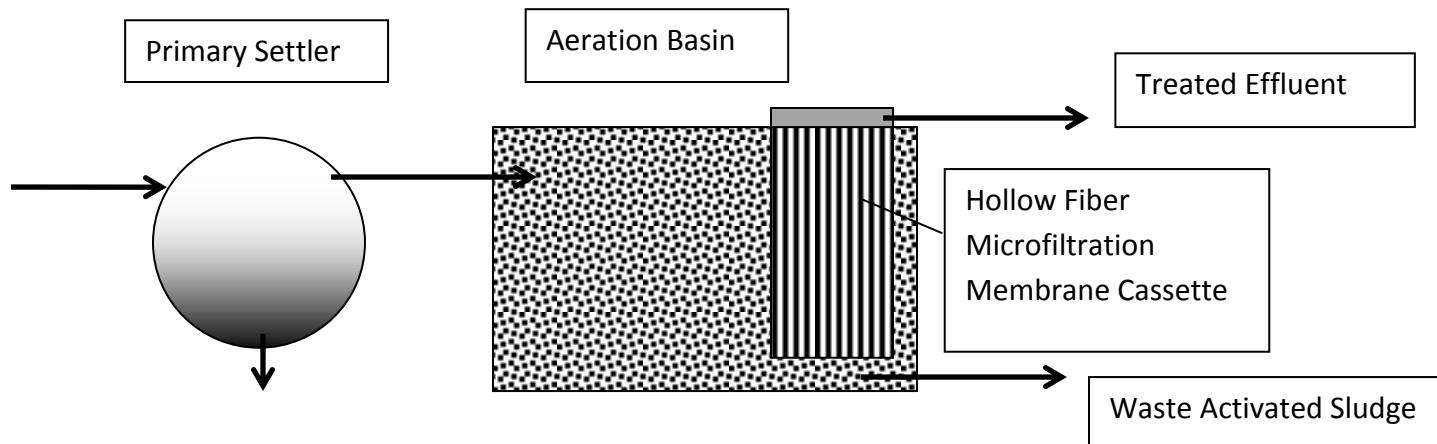
Advantages of Sequencing Batch Reactor (SBR) Process

1. Single tank for reaction and settling (requires two or more tanks for continuous operation)
2. Good settling (quiescent conditions) and no sludge storage
3. Flexible operation, automation possible
4. Typically for smaller plants
5. Often no primary clarifier – easier sludge handling

Disadvantages

1. Special decanting and aeration equipment (can't use diffusers in tank)
2. Need to recycle early decant if solids in weir trough
3. Setting system sequences (fill/decant/reaction times) can be complex, especially if anoxic denitrification is required

MICROFILTER MEMBRANE BIOREACTOR (MMBR)



Advantages

1. No secondary clarifier, virtually no effluent suspended solids, no RAS recycling
2. Maintains high MLVSS
3. Compact footprint
4. Primary clarifier optional

Disadvantages

1. Very high aeration requirements
2. Dual aeration system for mixing and to prevent fouling
3. Time-consuming membrane cleaning procedure
4. High capital costs for membrane system
5. Extra power requirements for vacuum on microfilter
6. Waste activated sludge is not thickened – larger volume to solids processing
7. Broken membranes result in low effluent quality