

The Activated Sludge Process

**David Jenkins
University of California at Berkeley**

**Operation and Control of Activated Sludge
Processes using Microbiological Analysis**

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Traditional purposes of secondary treatment

- **Remove organics (BOD, TSS) to higher levels than primary treatment**
- **Remove bacteria to higher levels than primary treatment**
- **Remove materials of “sewage origin”**

Additional purposes of secondary treatment

- **Remove ammonia, nitrogen, phosphorus (nutrients)**
- **Remove individual organics**
- **Remove metals**
- **Prepare wastewater for tertiary treatment**
- **Recover valuable resources**

Define activated sludge (AS)

AS is a biological wastewater treatment process carried out by an enrichment culture of microorganisms.

Enrichment cultures

Cultures in which population is determined by the substrate type and the growth conditions.

What does this mean to you ?

**...The designer and the operator
deserve what they get!!**

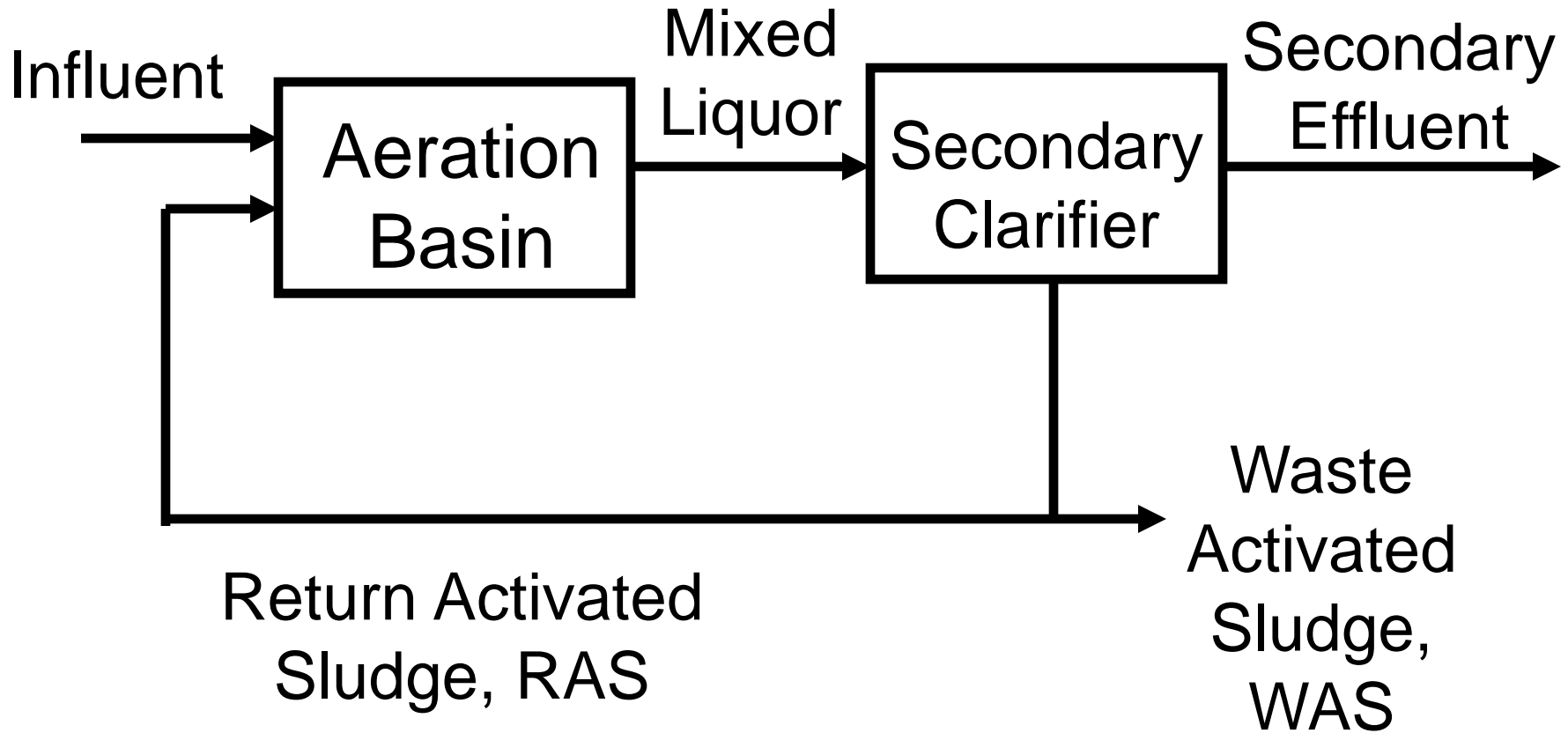
Basic activated sludge process configurations

- **Continuous flow without gravity clarifier**
- **Continuous flow with gravity clarifier**
- **Continuous flow with membrane (MBR)**
- **Sequencing batch reactor (SBR)**

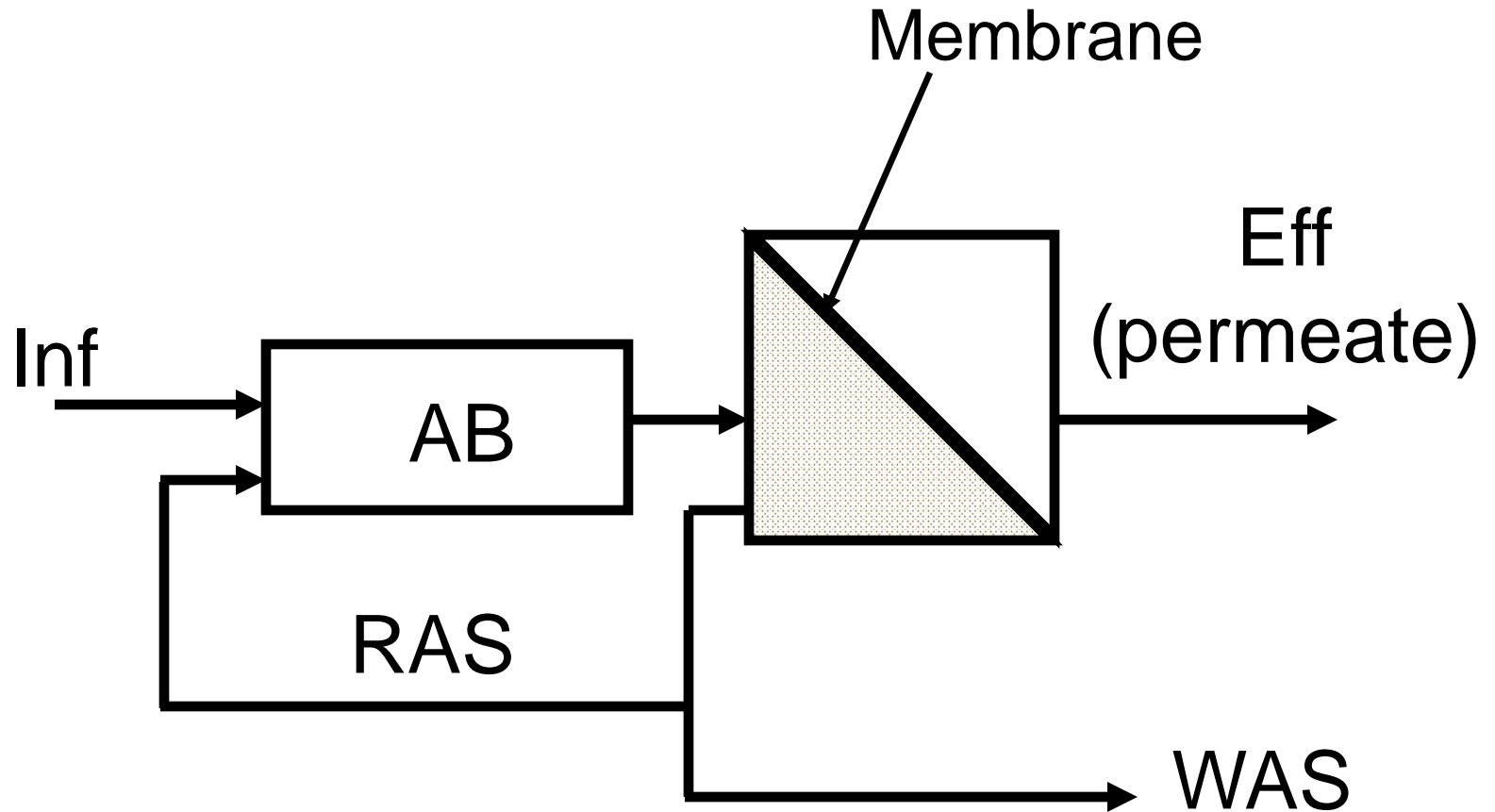
Continuous flow without gravity clarifier (aerated lagoon)



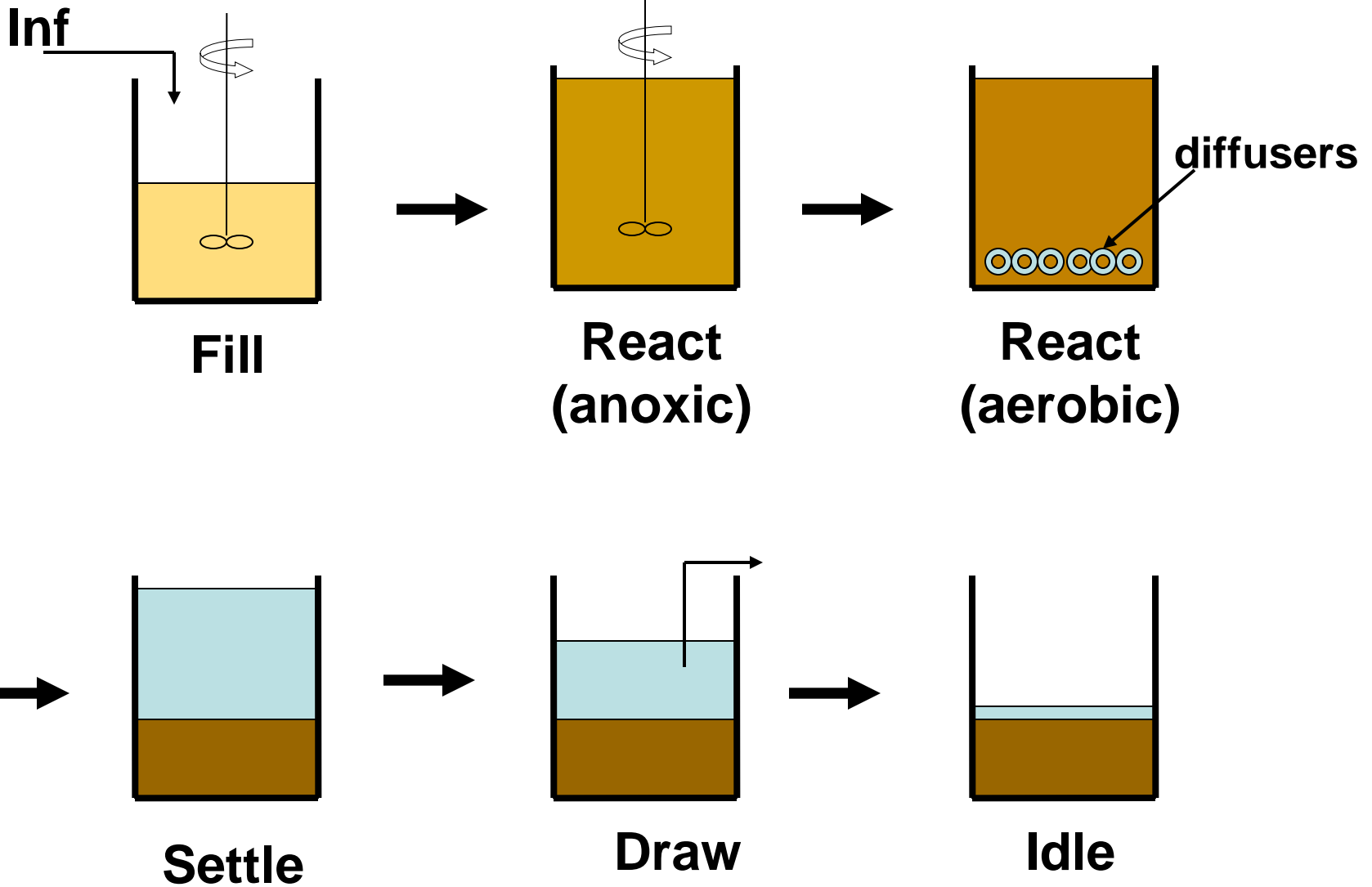
Continuous flow with gravity clarifier



Continuous flow with membrane (MBR)



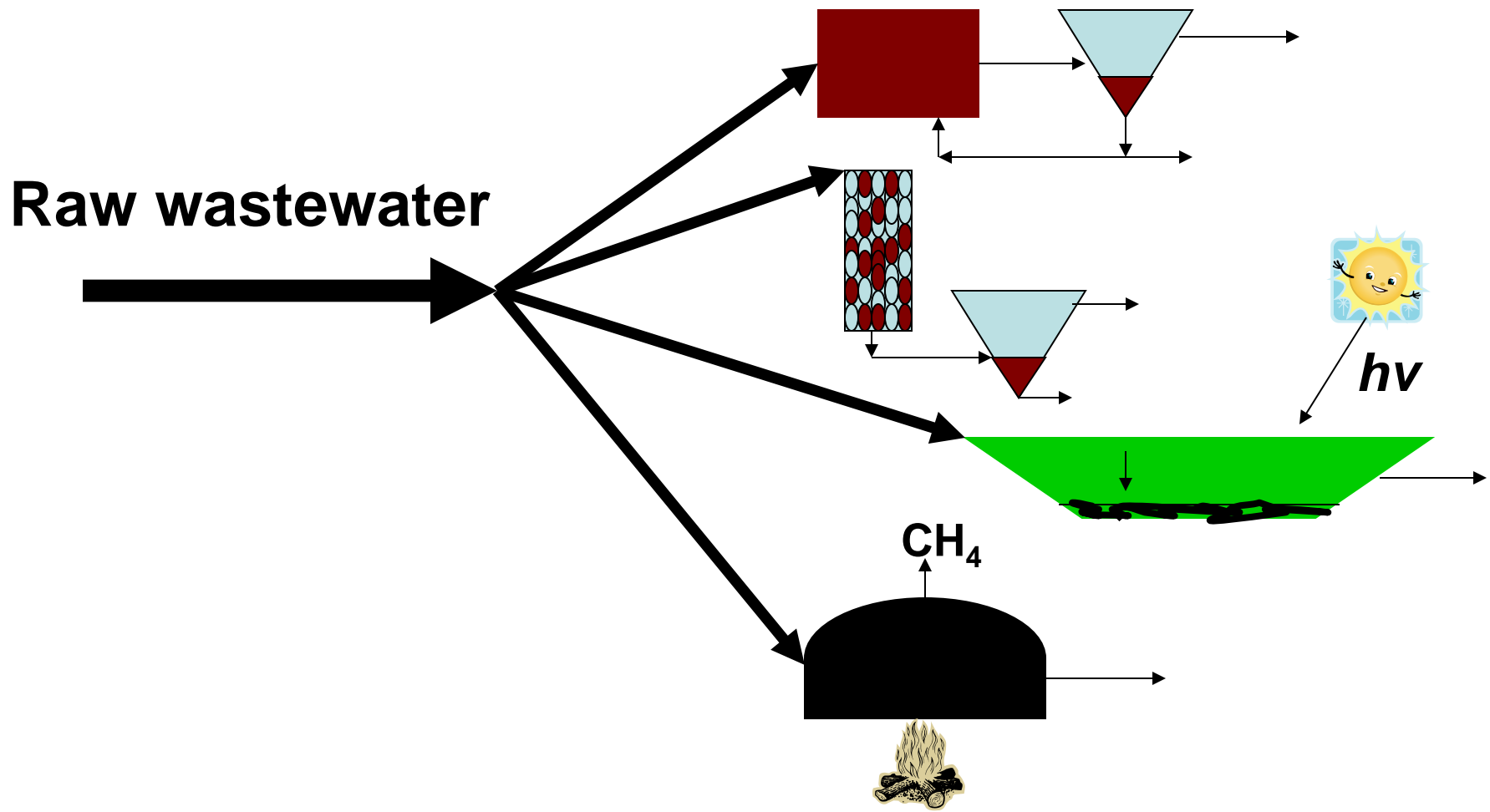
Sequencing batch reactor



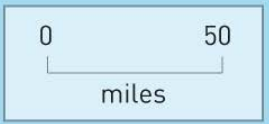


**Made by
enrichment
culture**

Biological wastewater treatment processes as enrichment cultures



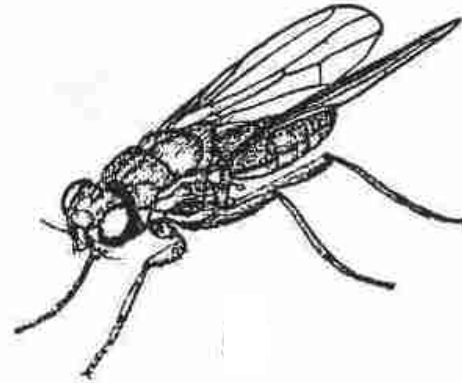
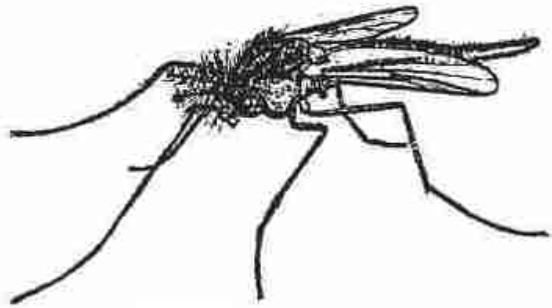
To Berkeley



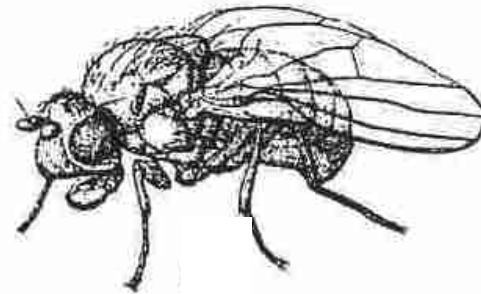
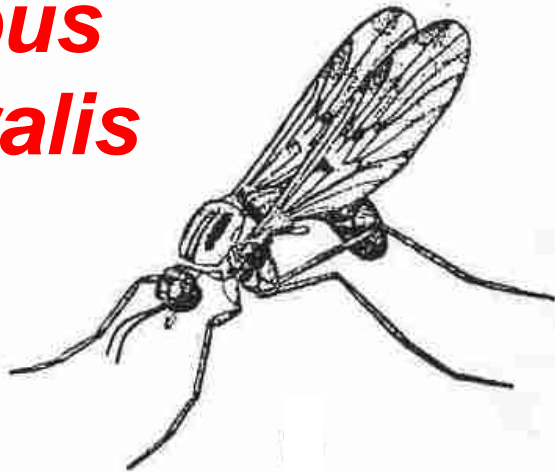
Minworth (1950) - trickling filters as far as the eye can see



“Filter” Flies...All Flies have Larval Stages

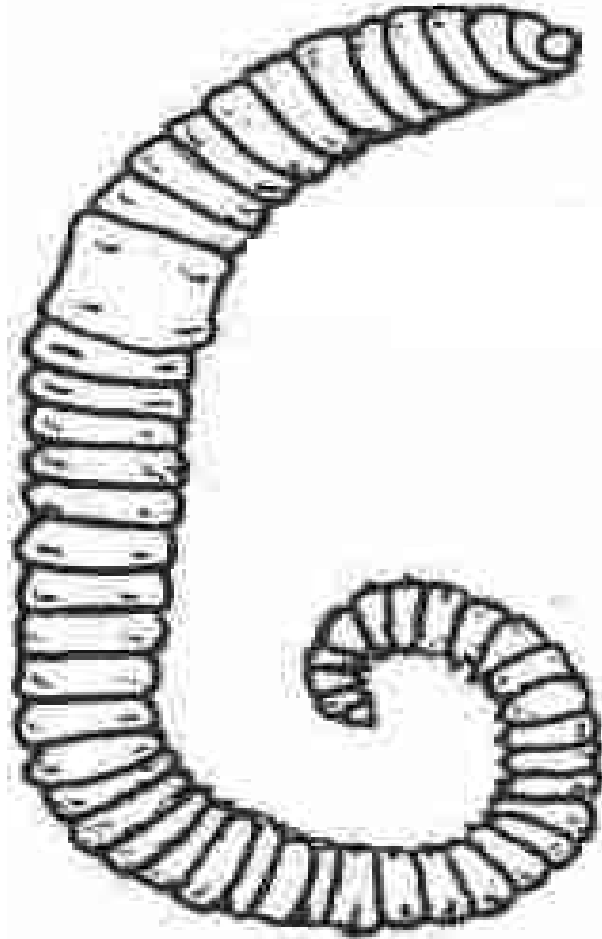


***Anisopus
fenestralis***

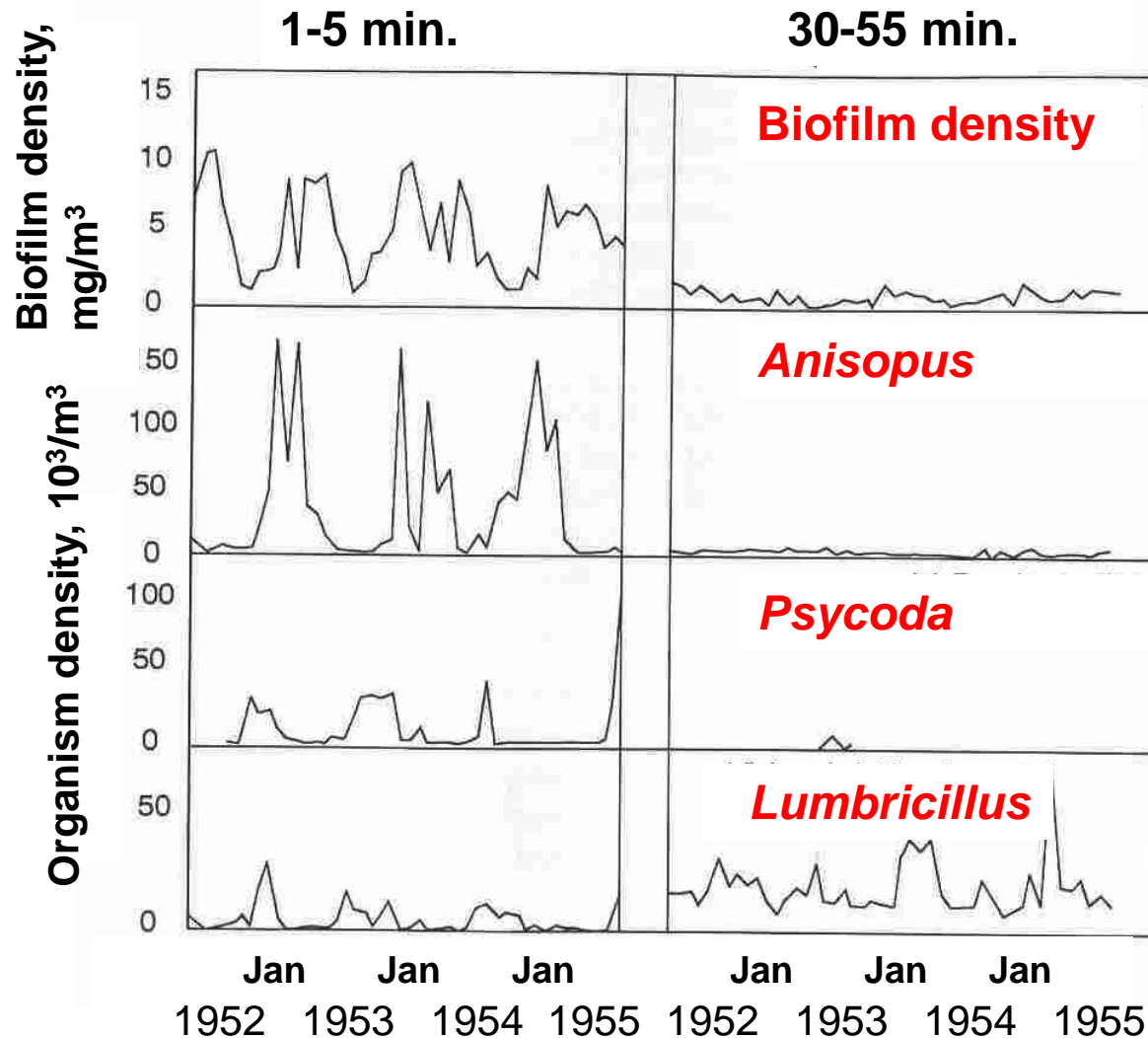


***Psycoda
alternata***

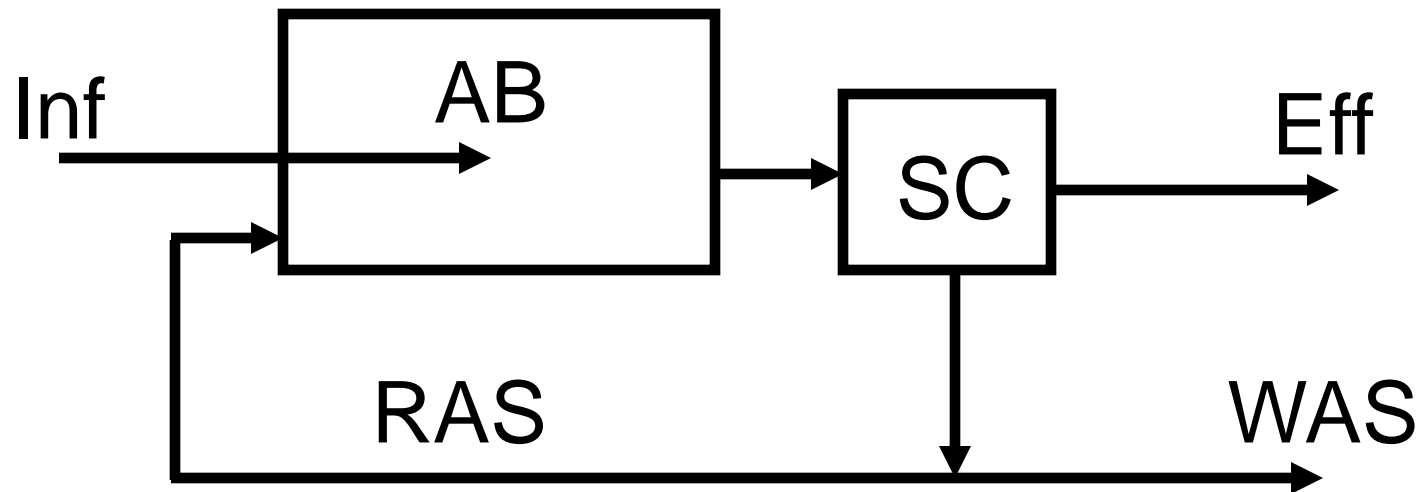
***Lumbricillus* spp...No Fly
Stage...this is the Adult**



Effect of “Periodicity of Dosing” on Populations and Biofilm



Completely mixed activated sludge (CMAS)

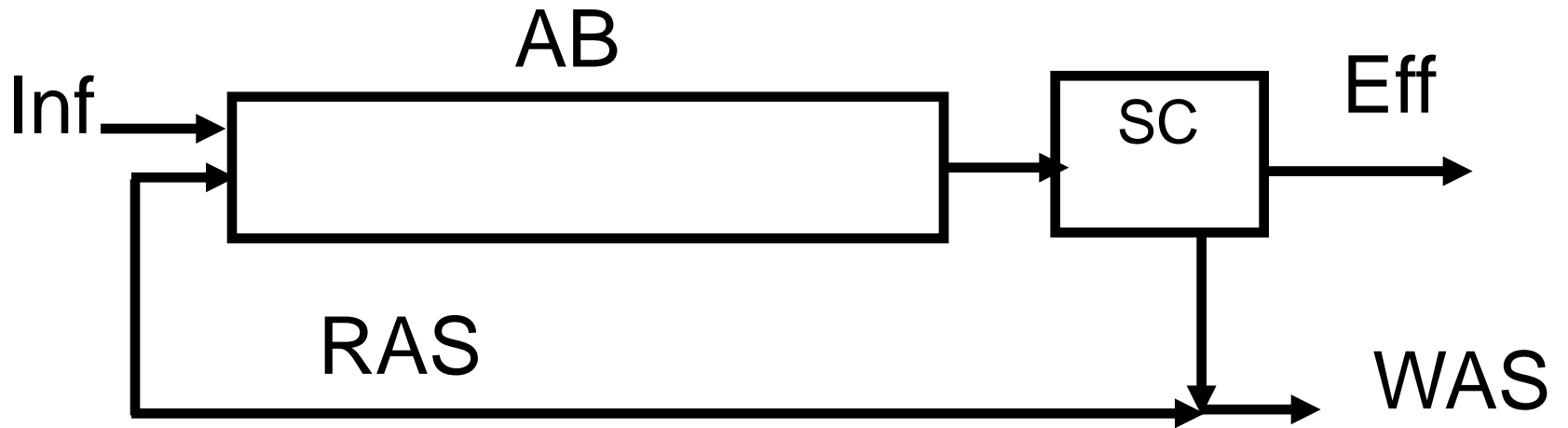


“Plug flow”

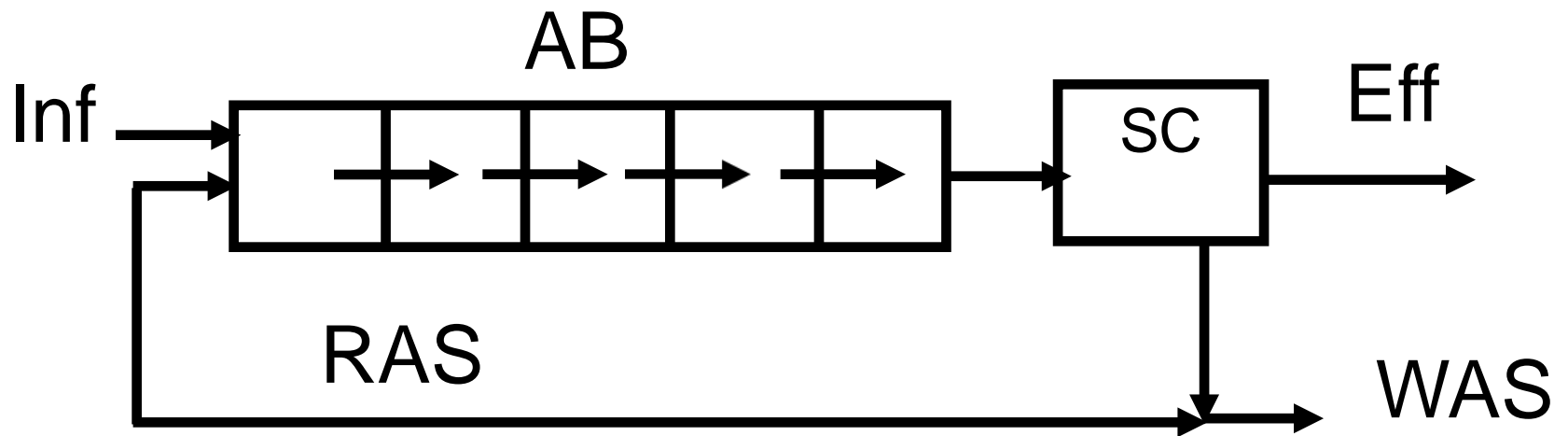
Important note

- True plug flow only exists when there are an infinite number of physical obstructions to flow through a basin.
- Single long “passes” are not plug flow

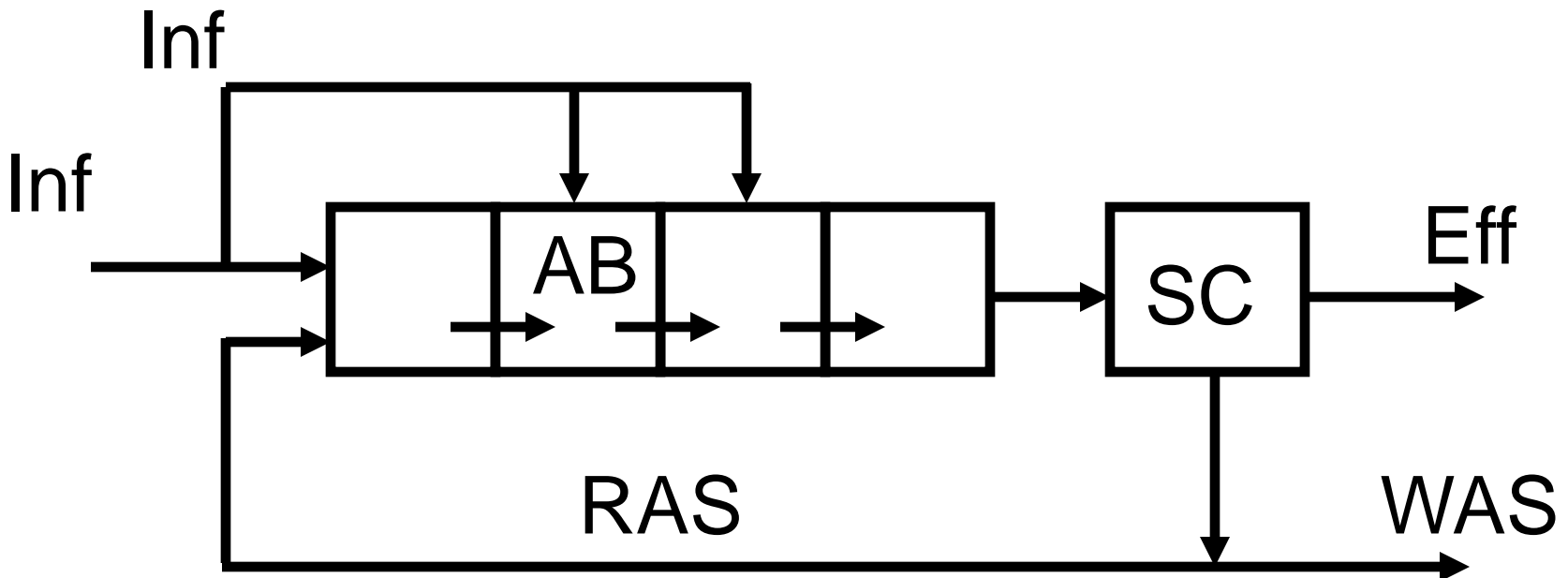
NOT PLUG FLOW



(approaching) “PLUG FLOW”

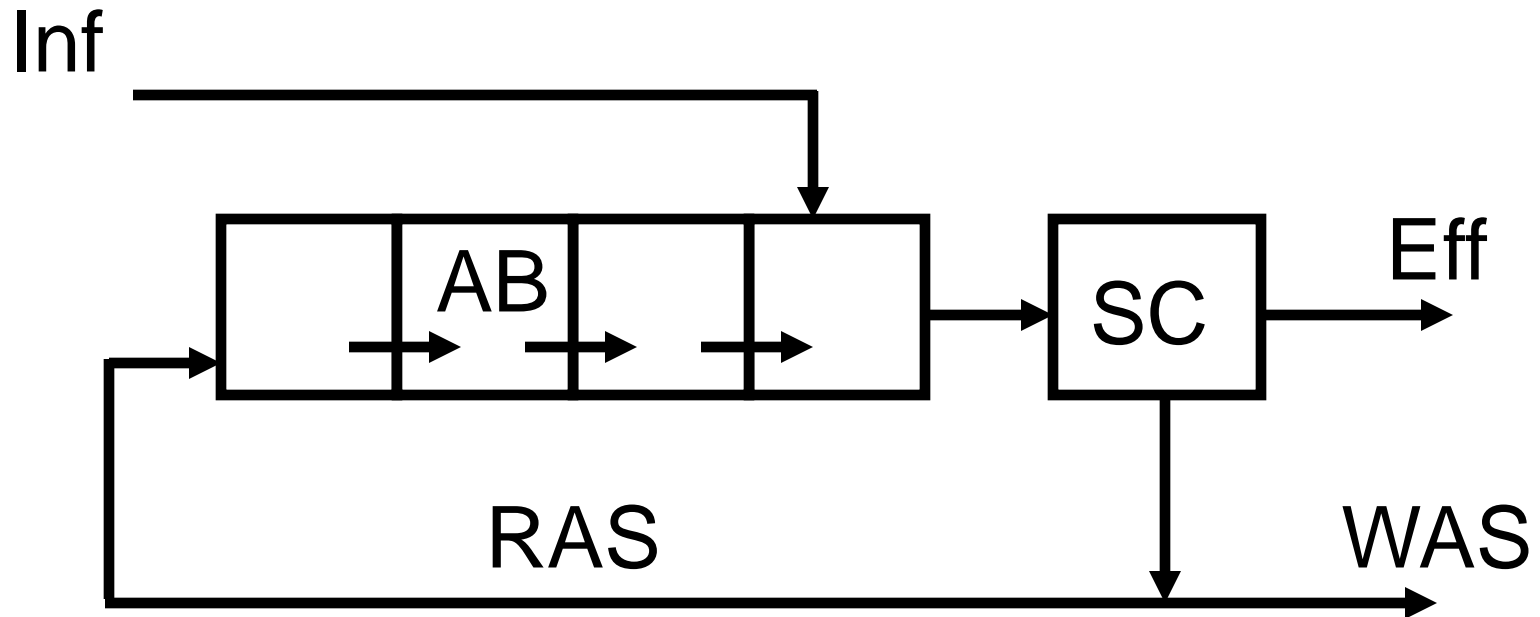


Step-feed activated sludge (Is this “plug flow”?)

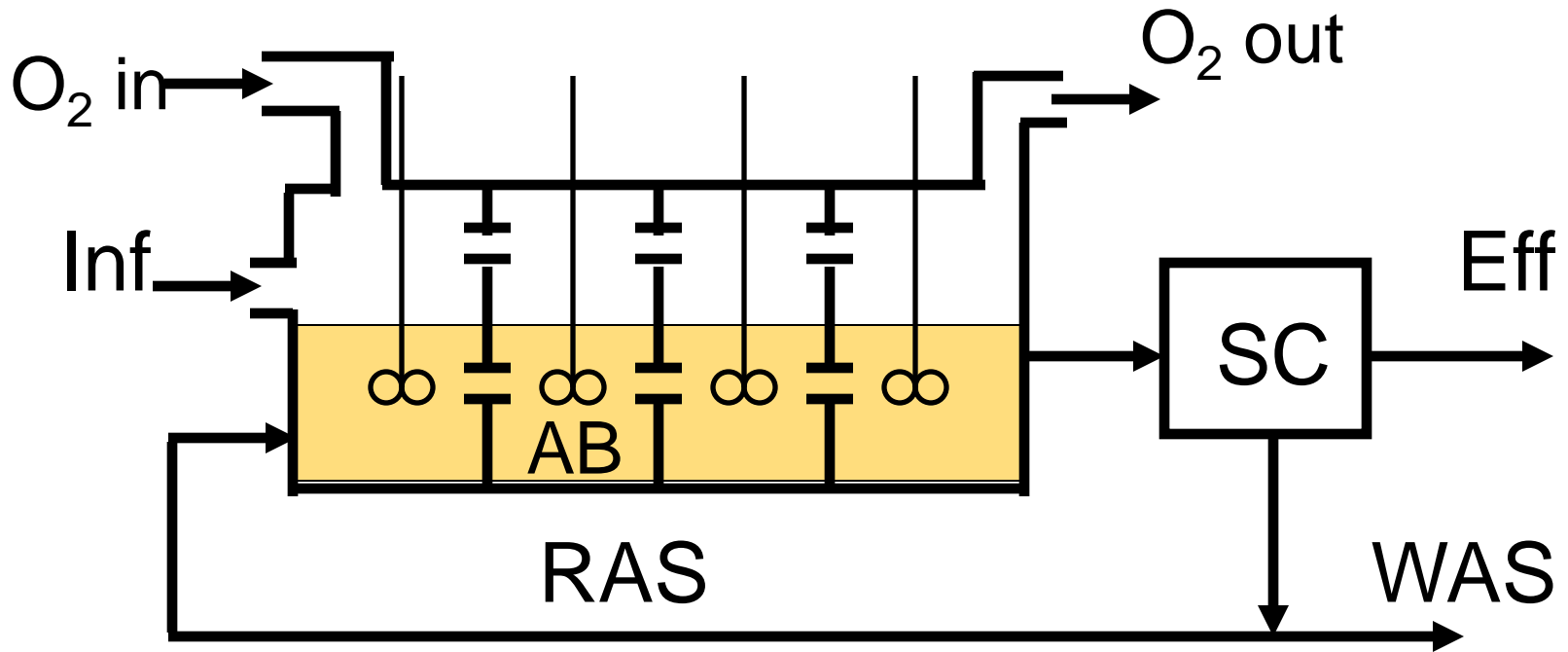


Contact stabilization

(Is this “plug flow”?)

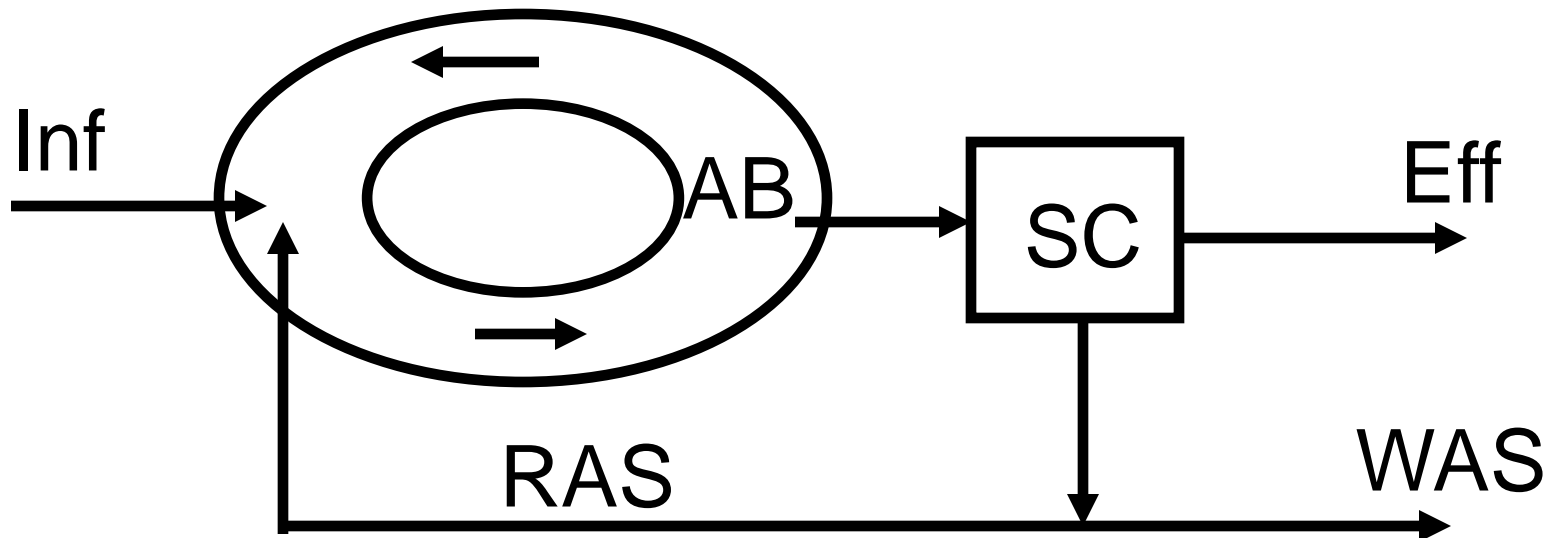


High purity oxygen (HPO) activated sludge (Is this “plug flow”?)

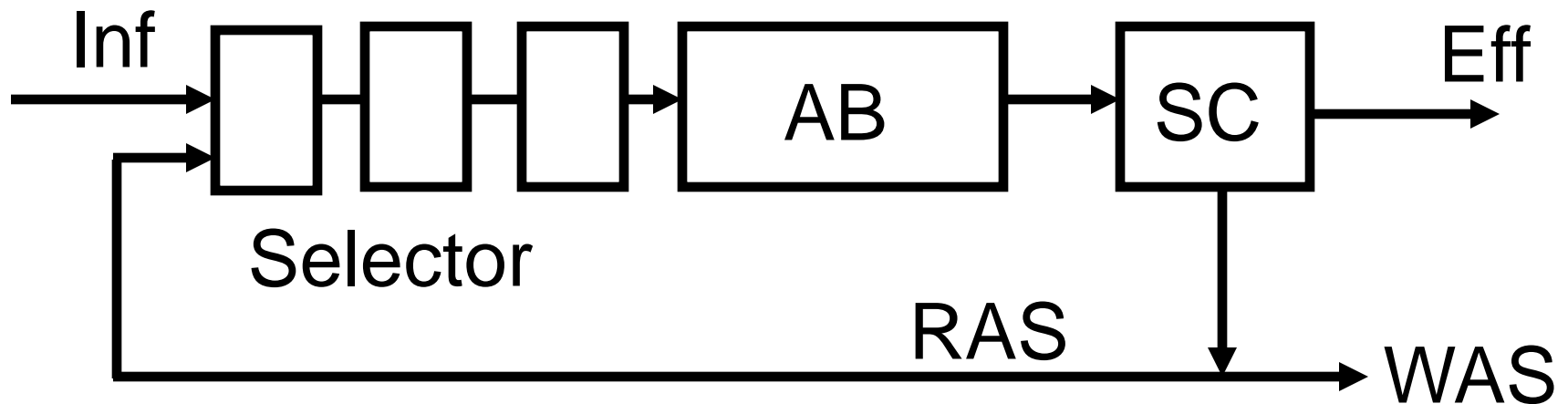


Oxidation ditch

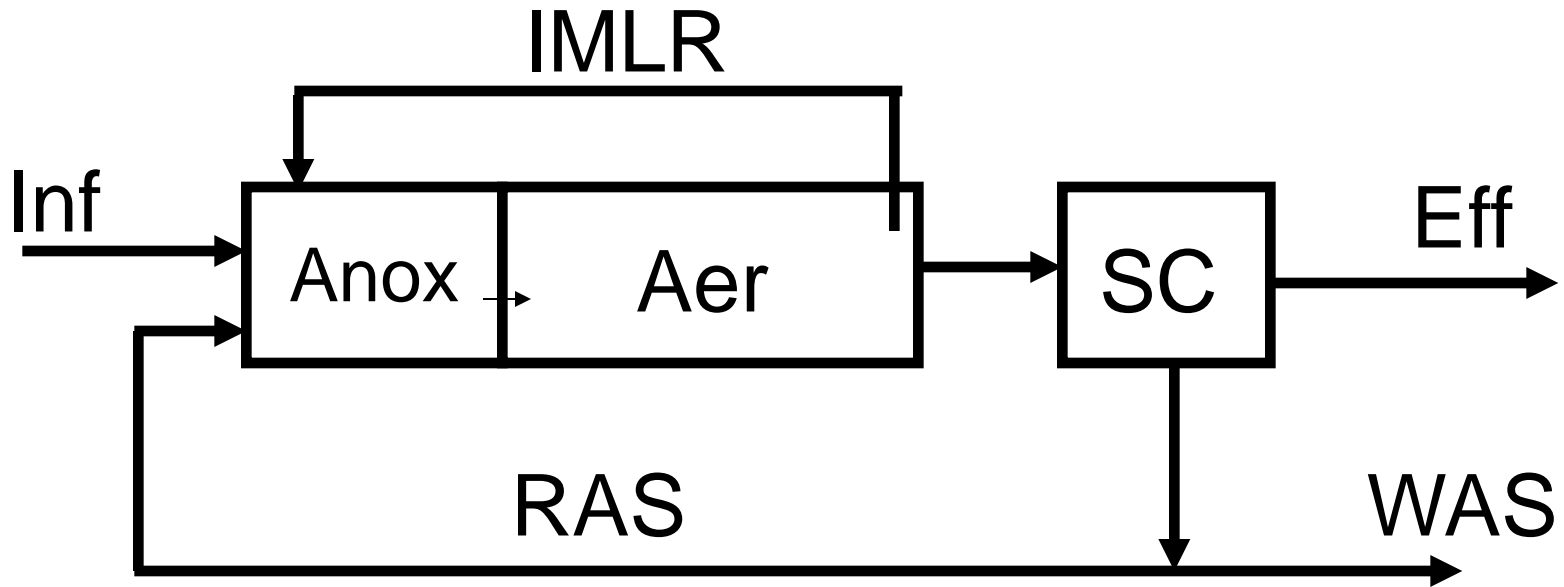
(Is this “plug flow”?)



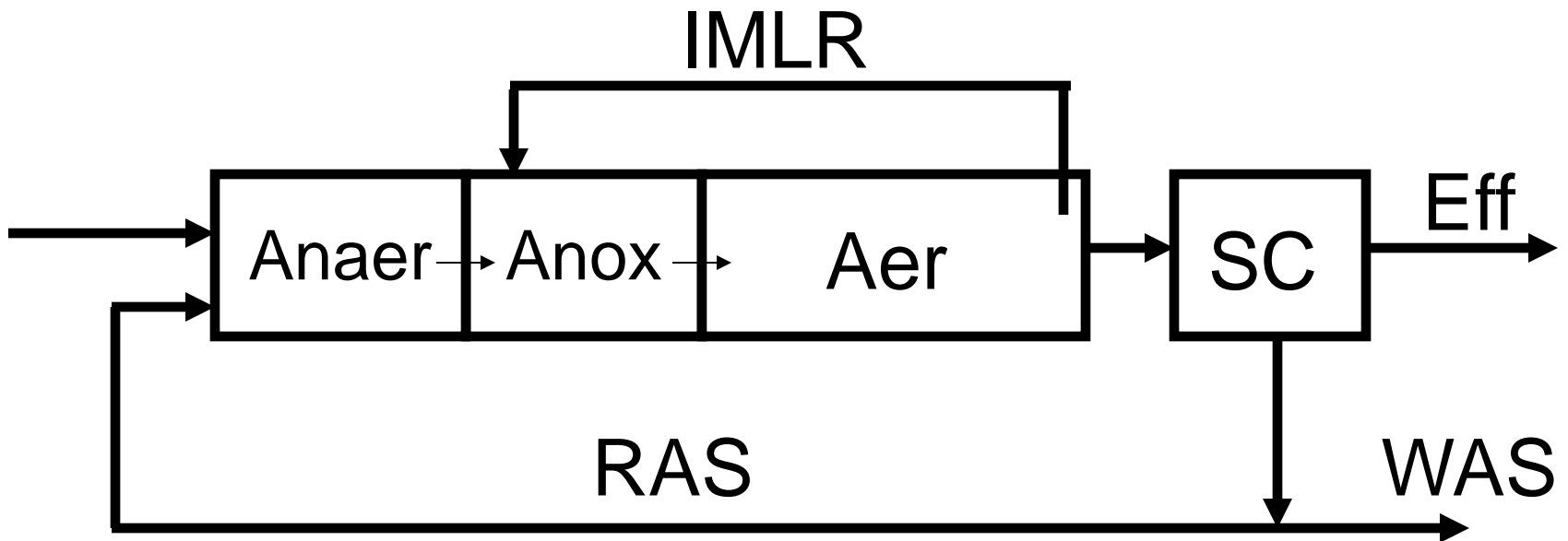
Selector activated sludge (Is this “plug flow”?)



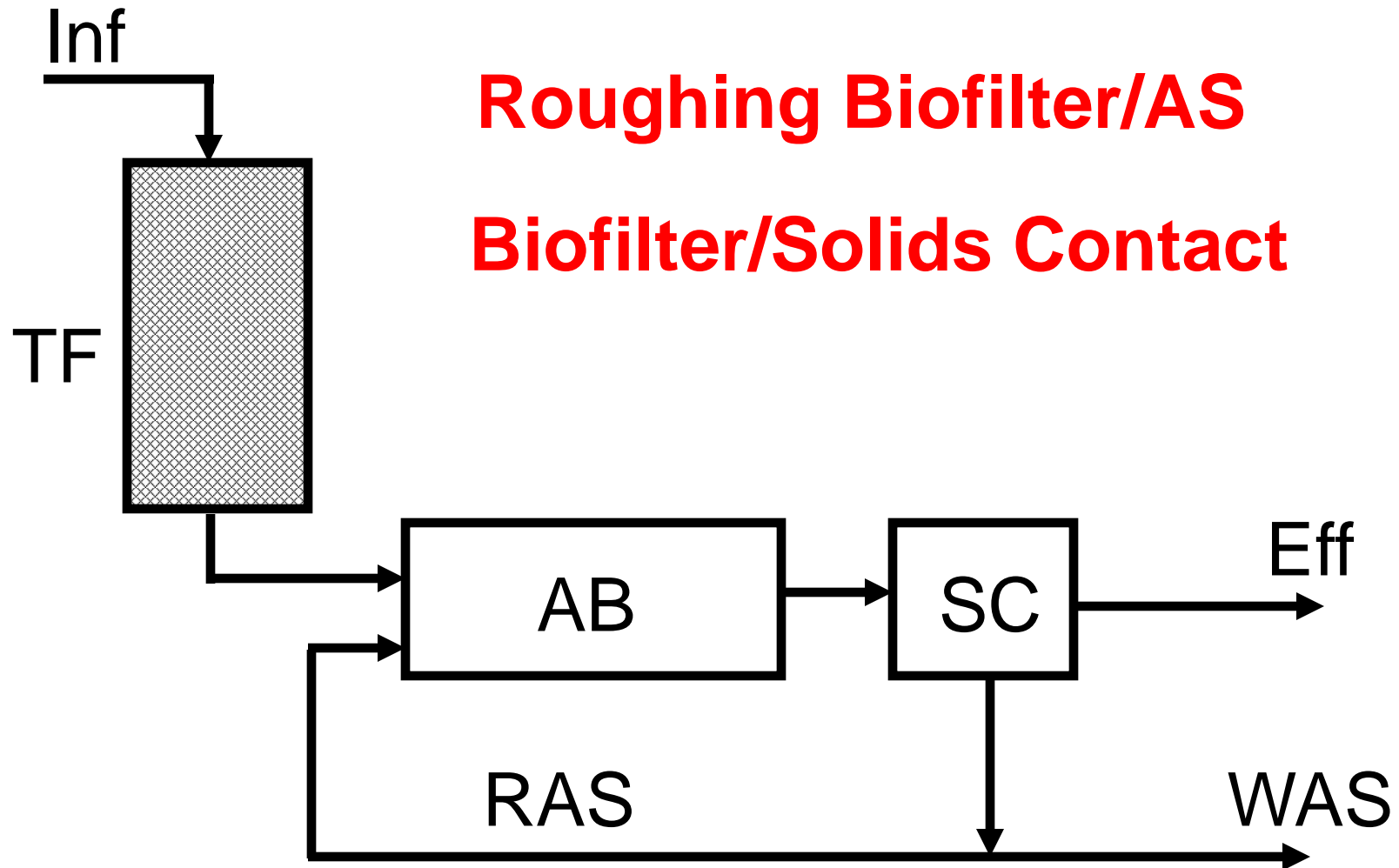
Nitrification/denitrification (N/DN)



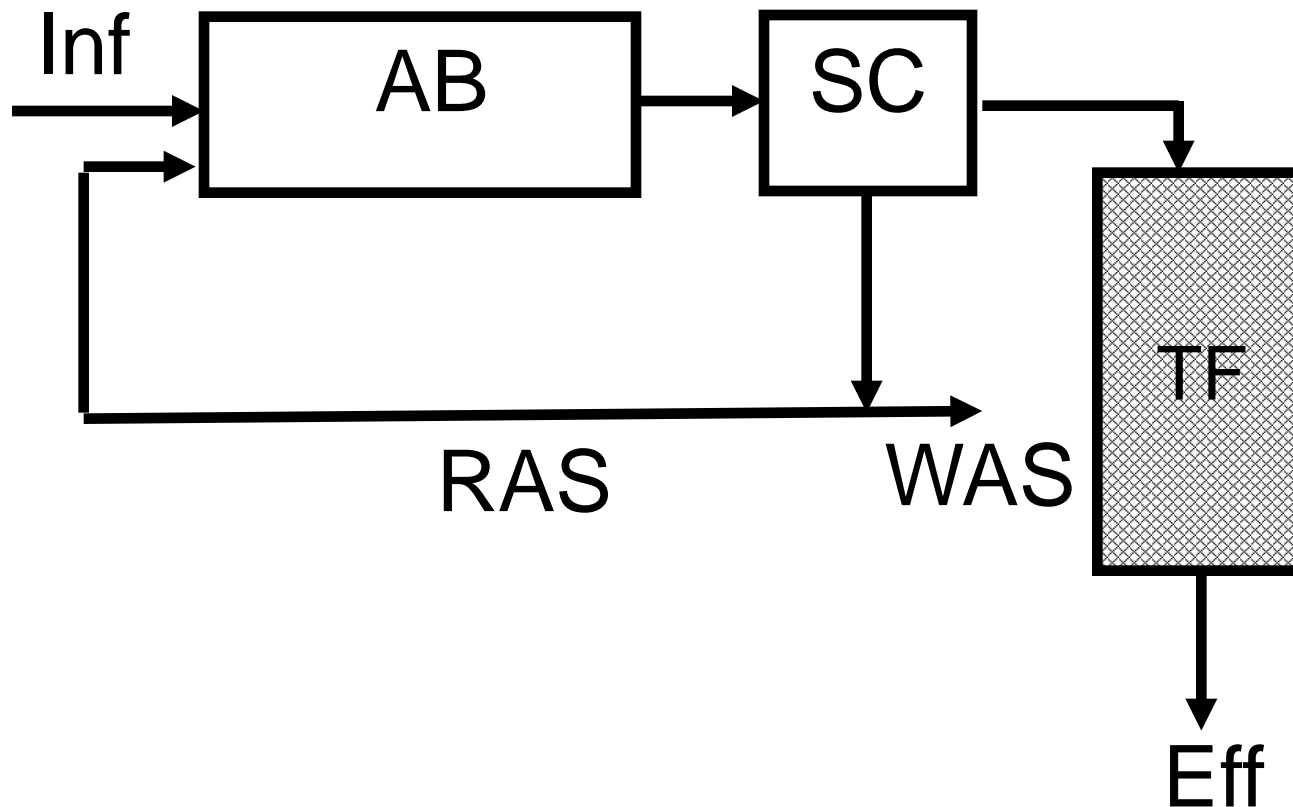
Enhanced biological phosphorus removal (EBPR)



Coupled processes, TF/AS, TF/SC



Coupled processes, AS/TF (typically for nitrification)



Coupled processes, anaerobic digestion/activated sludge

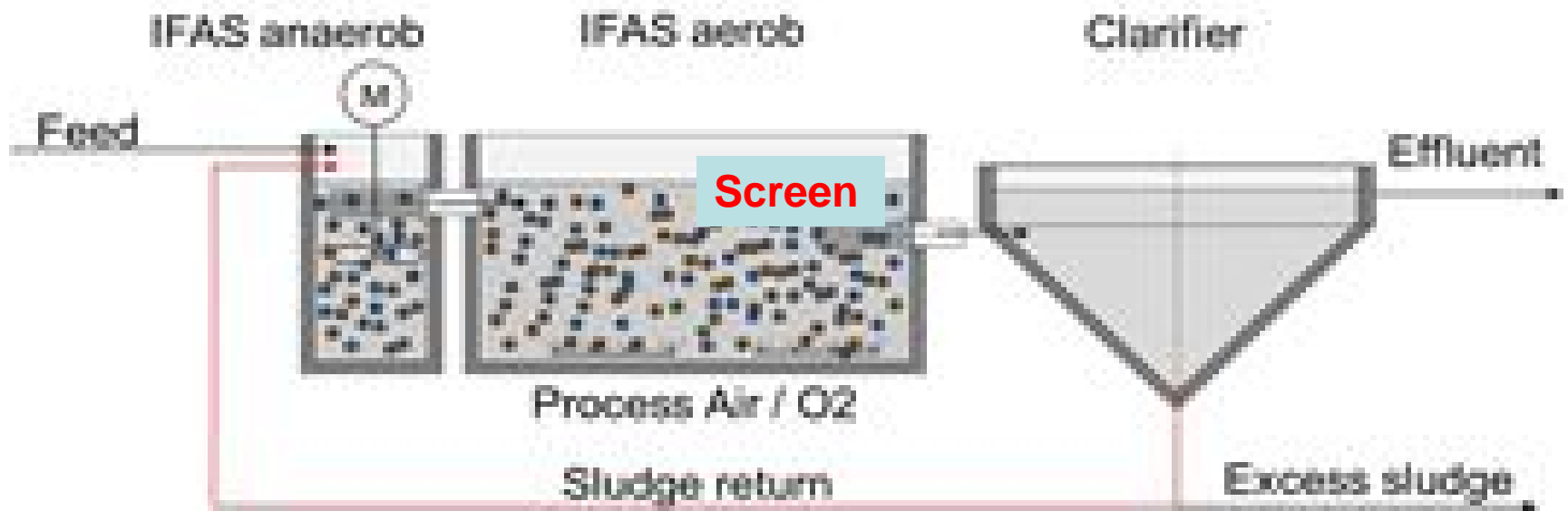
- Used for strong, often nutrient deficient, organic wastewaters... **Why?**

Integrated fixed film/activated sludge systems

- **Both activated sludge and fixed film biomass in aeration basin**
- **Fixed film support media can be either static (fixed) or suspended (moving)**
- **Two process types:**
 - 1. Moving bed bioreactor (MBBR) – incorporates RAS**
 - 2. Integrated fixed film reactor (IFAS) – no RAS**

IFAS

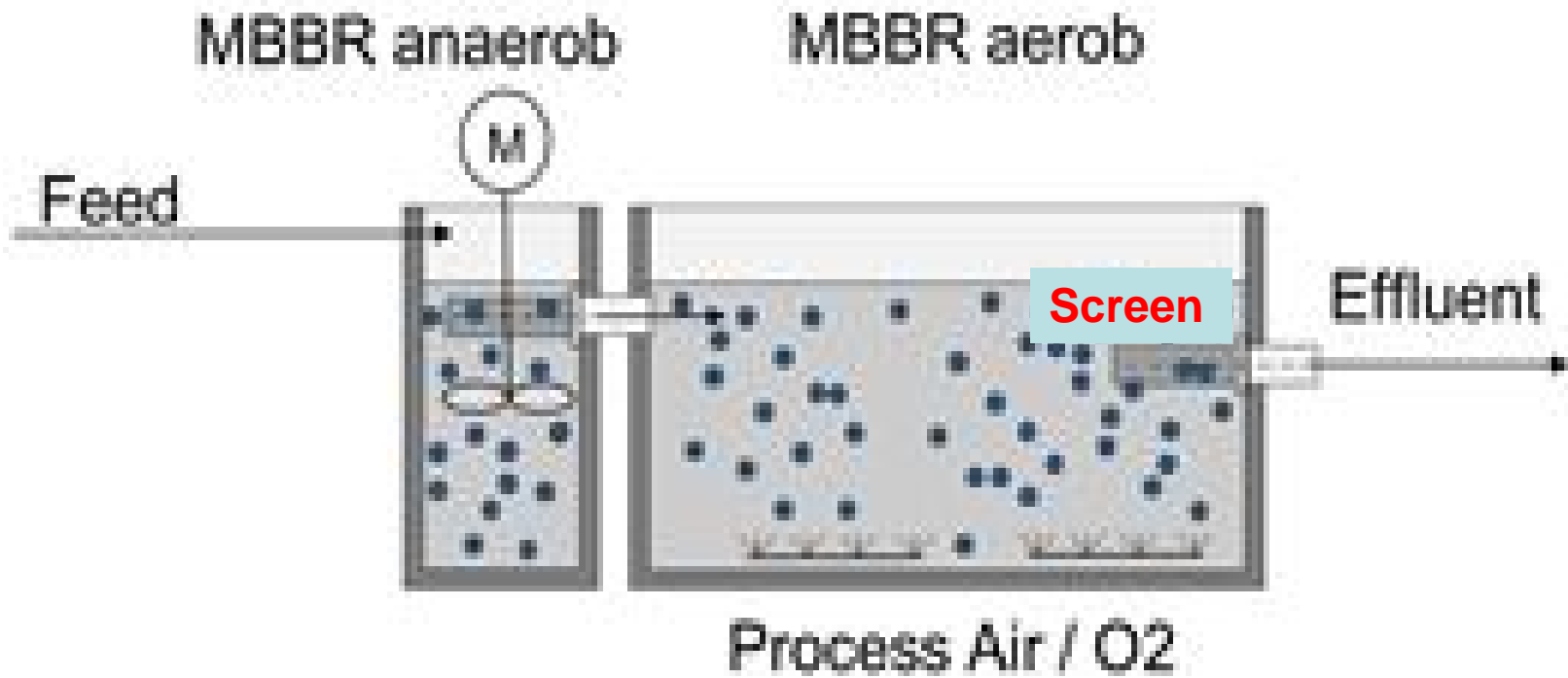
- Carrier
- Activated sludge



MBBR

MBBR (Moving Bed Biofilm Reactor)

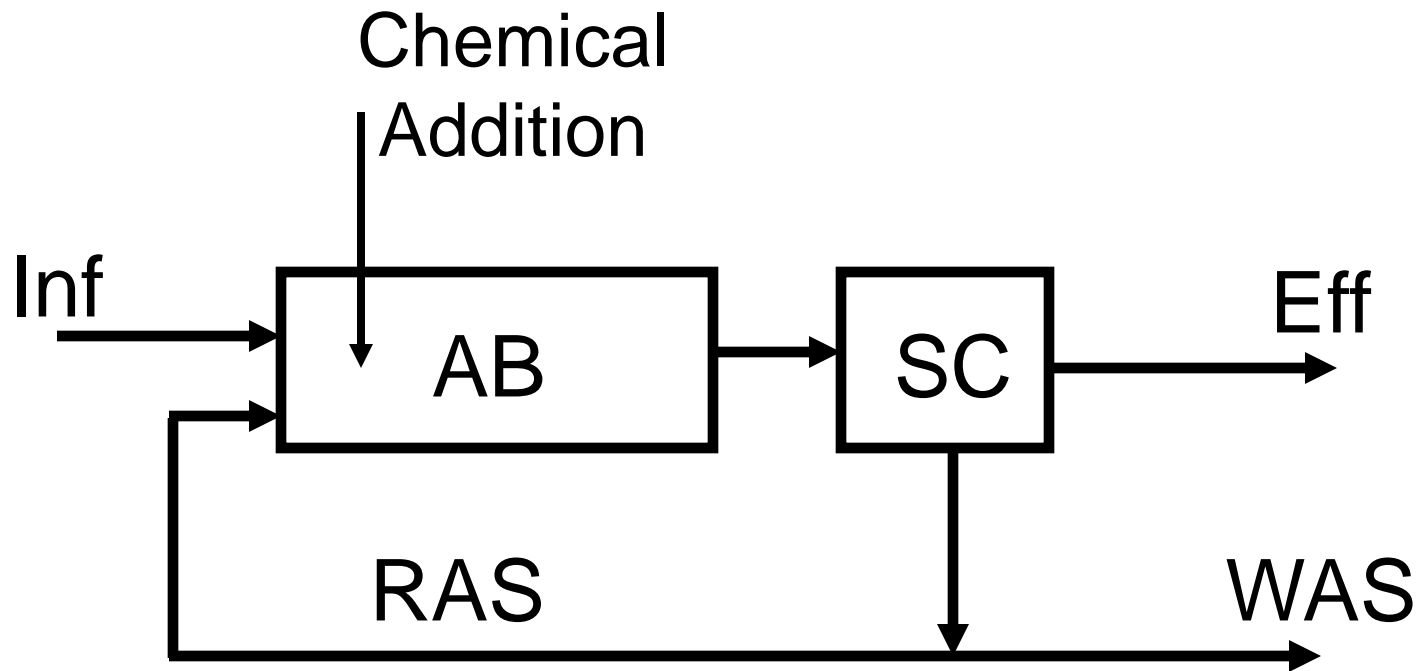
- Carrier



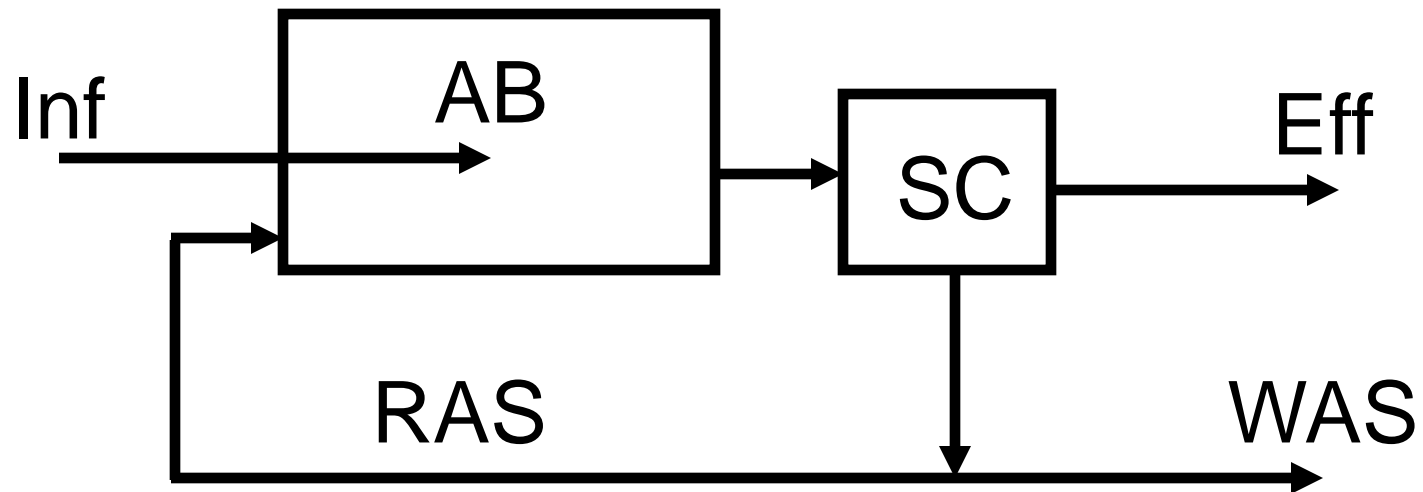
Activated sludge with chemical addition

- **Phosphate precipitation with either iron (ferric) or aluminum salts. e.g. ferric chloride, alum.**
- **Organics removal by powdered activation carbon addition (e.g. PACT process)**
- **Nutrient (N, P) addition for N, P deficient wastewaters)**

Simultaneous precipitation



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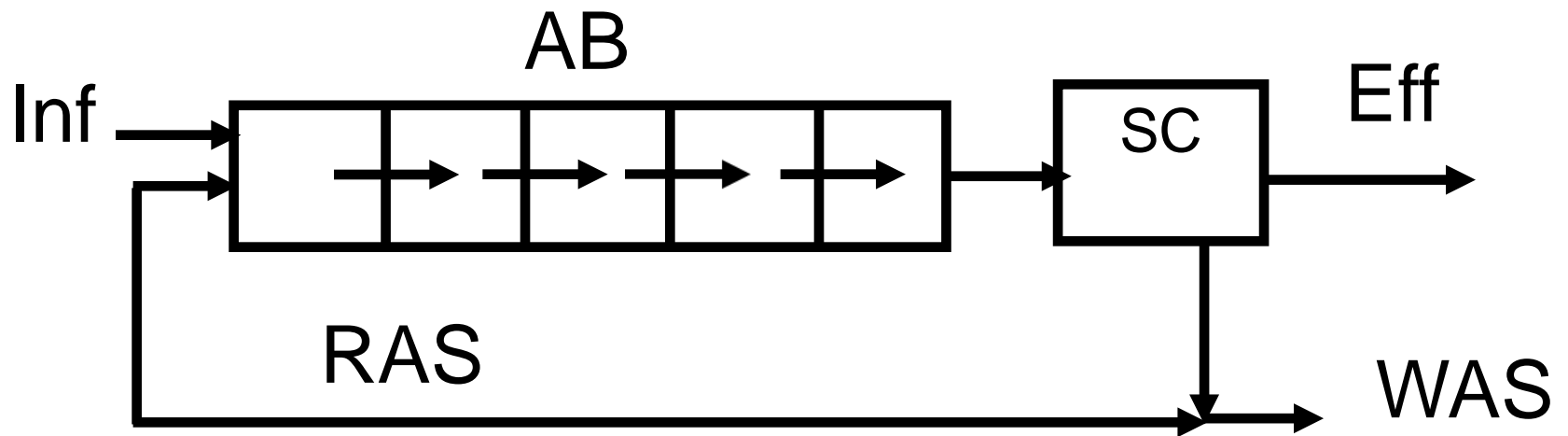


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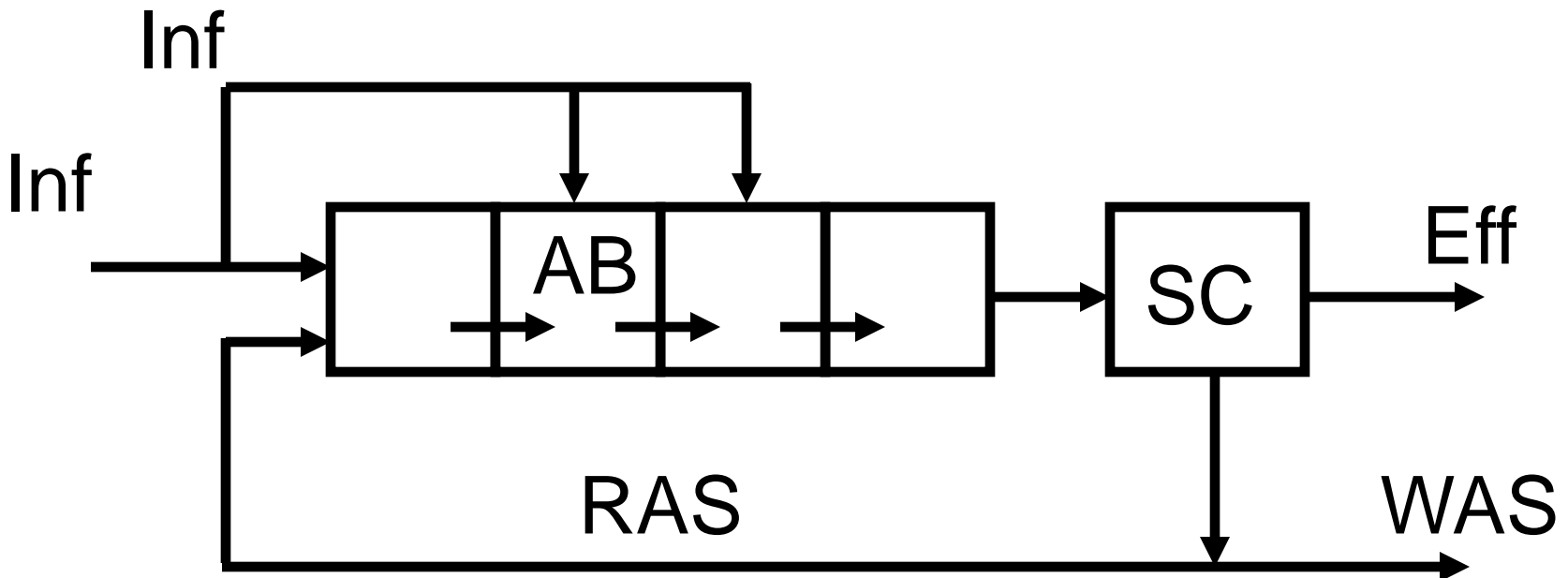
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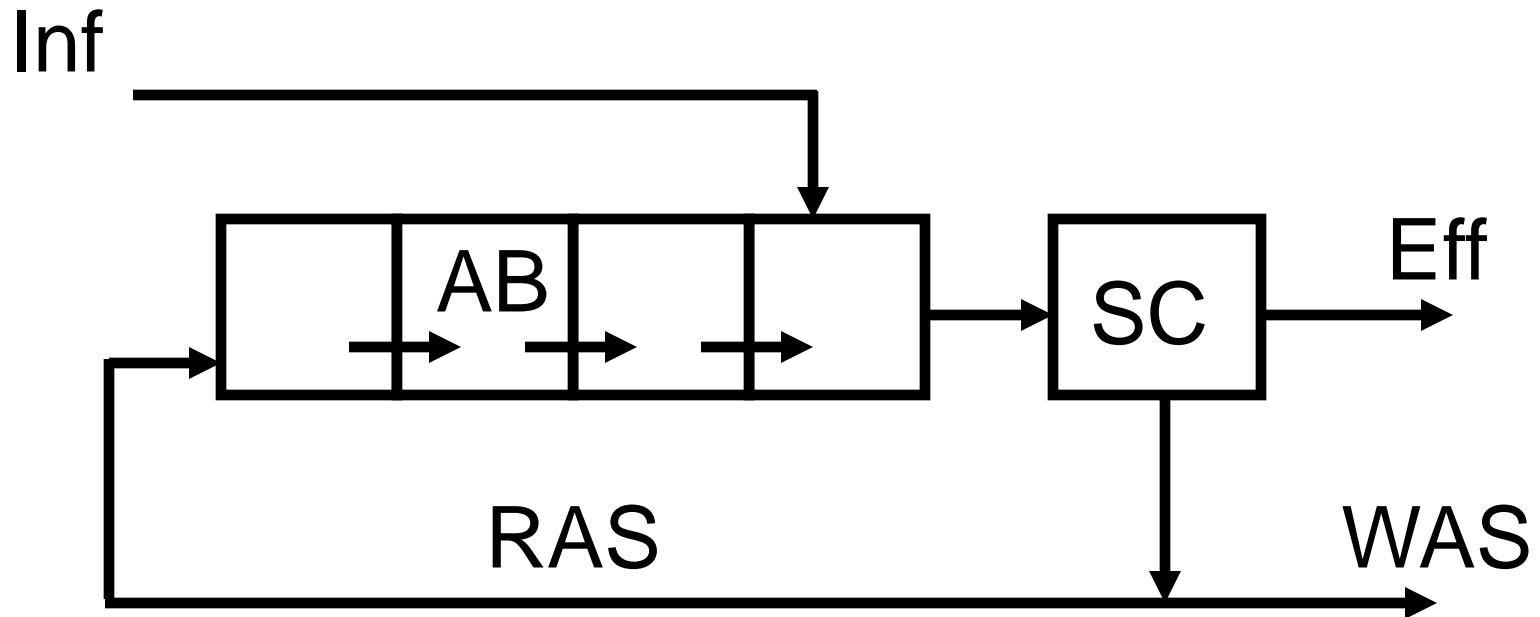


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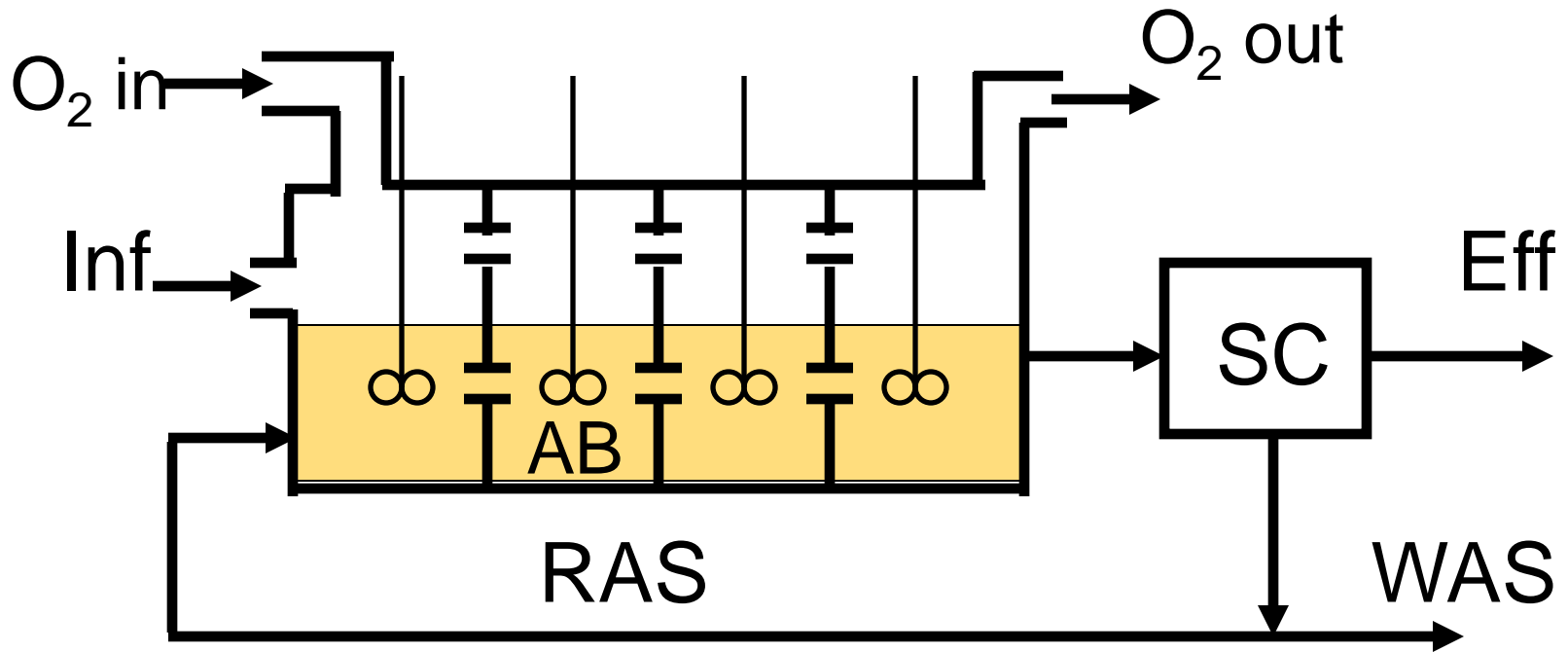


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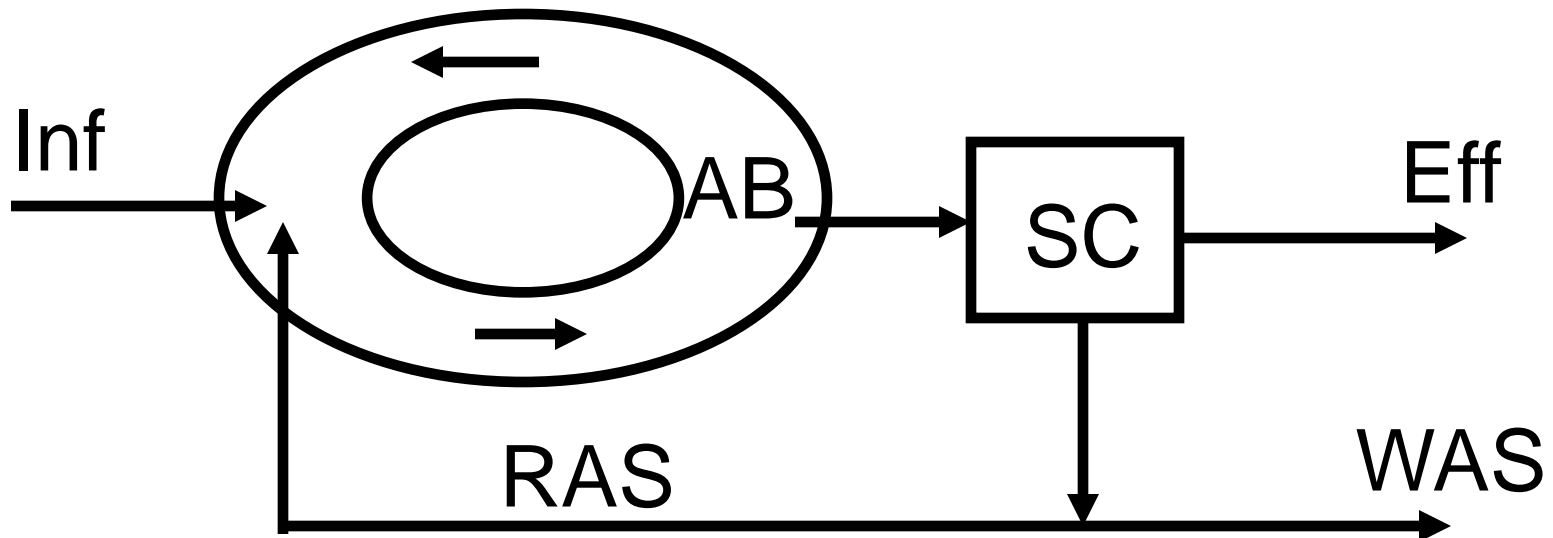
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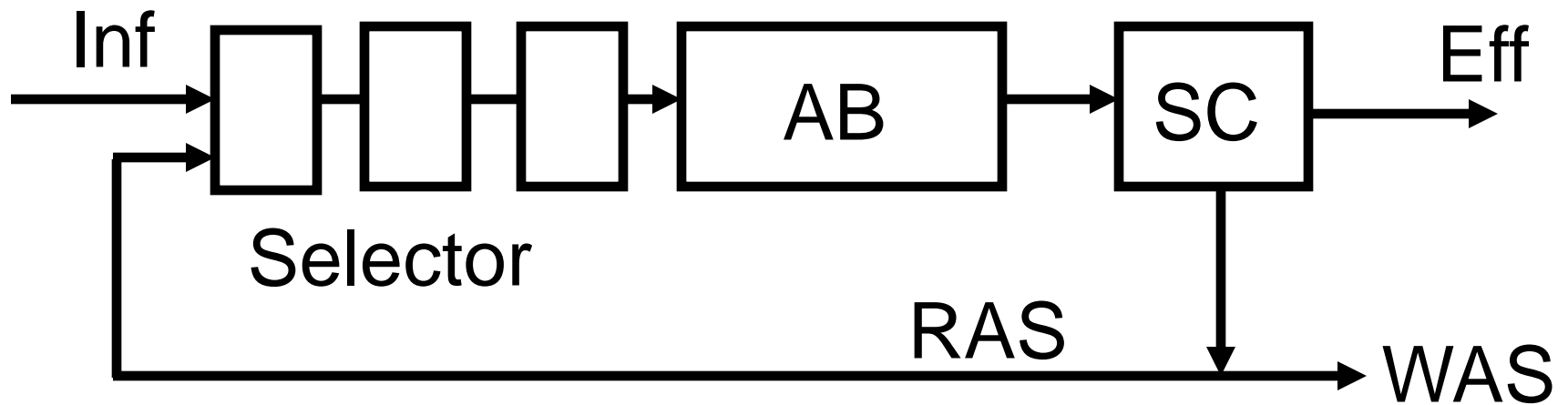
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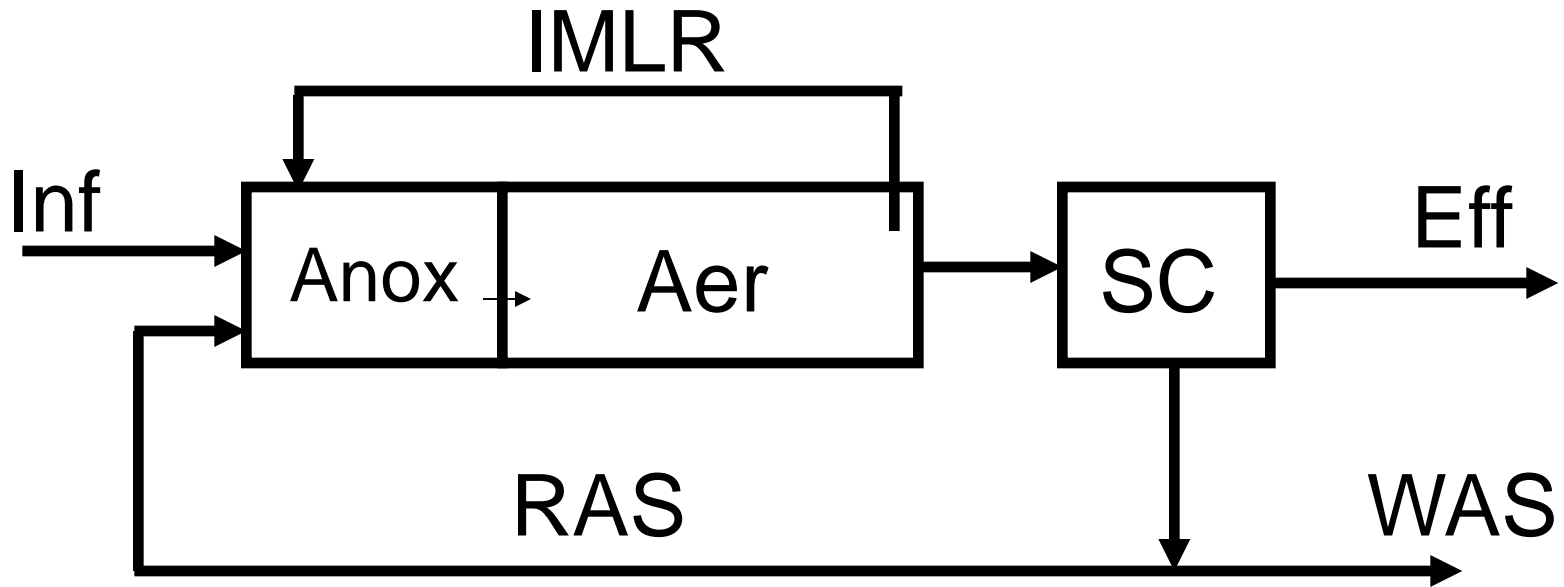
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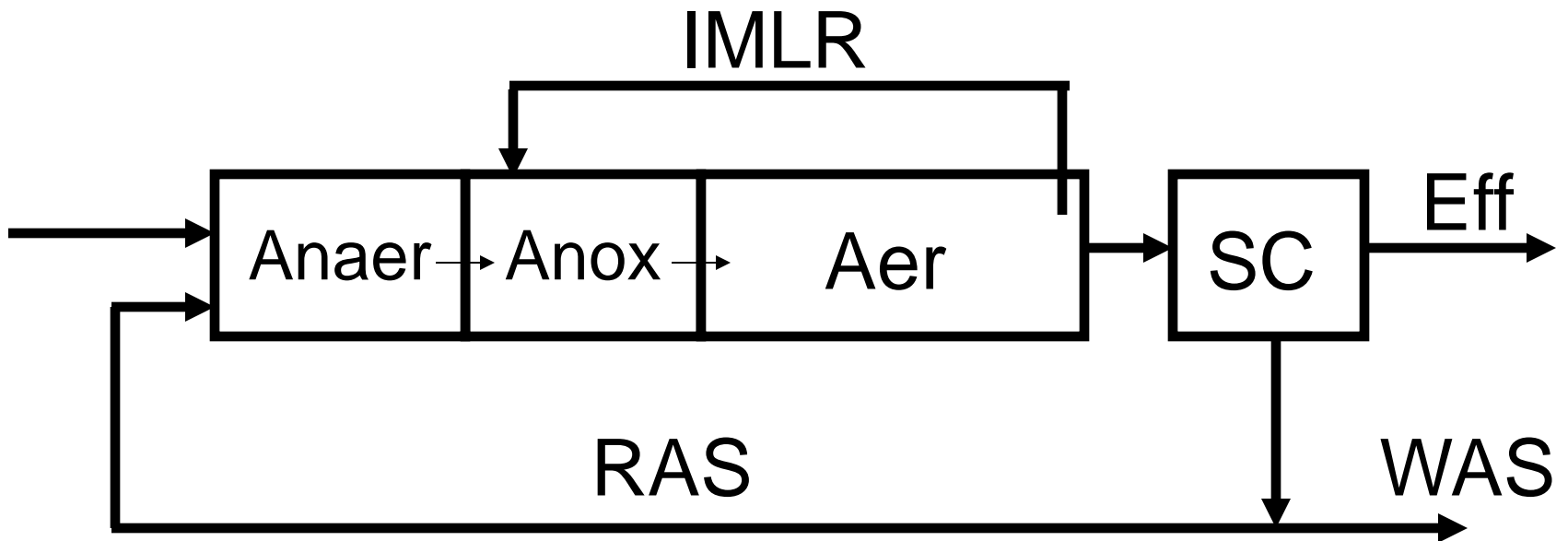
Selector activated sludge (Is this “plug flow”?)



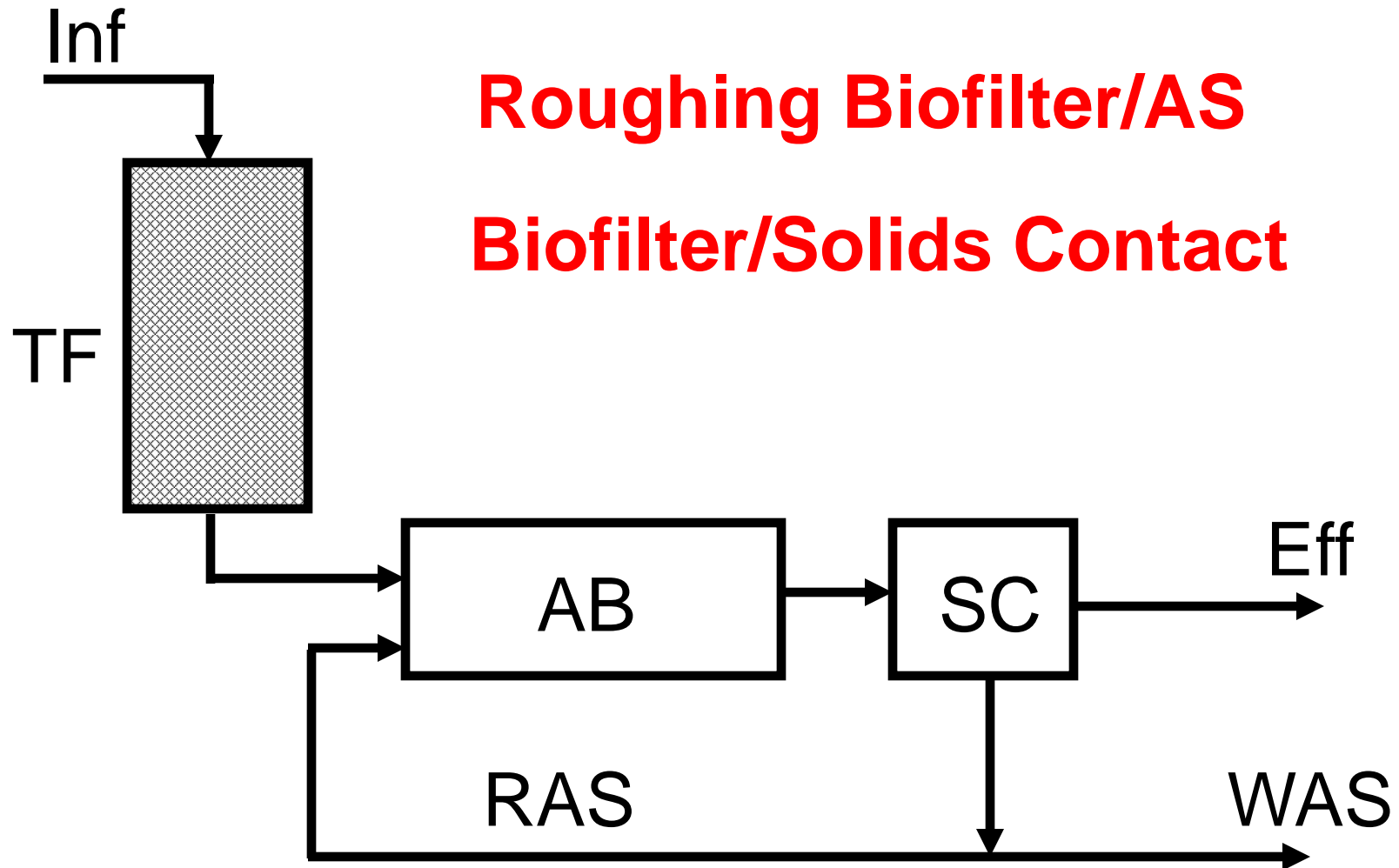
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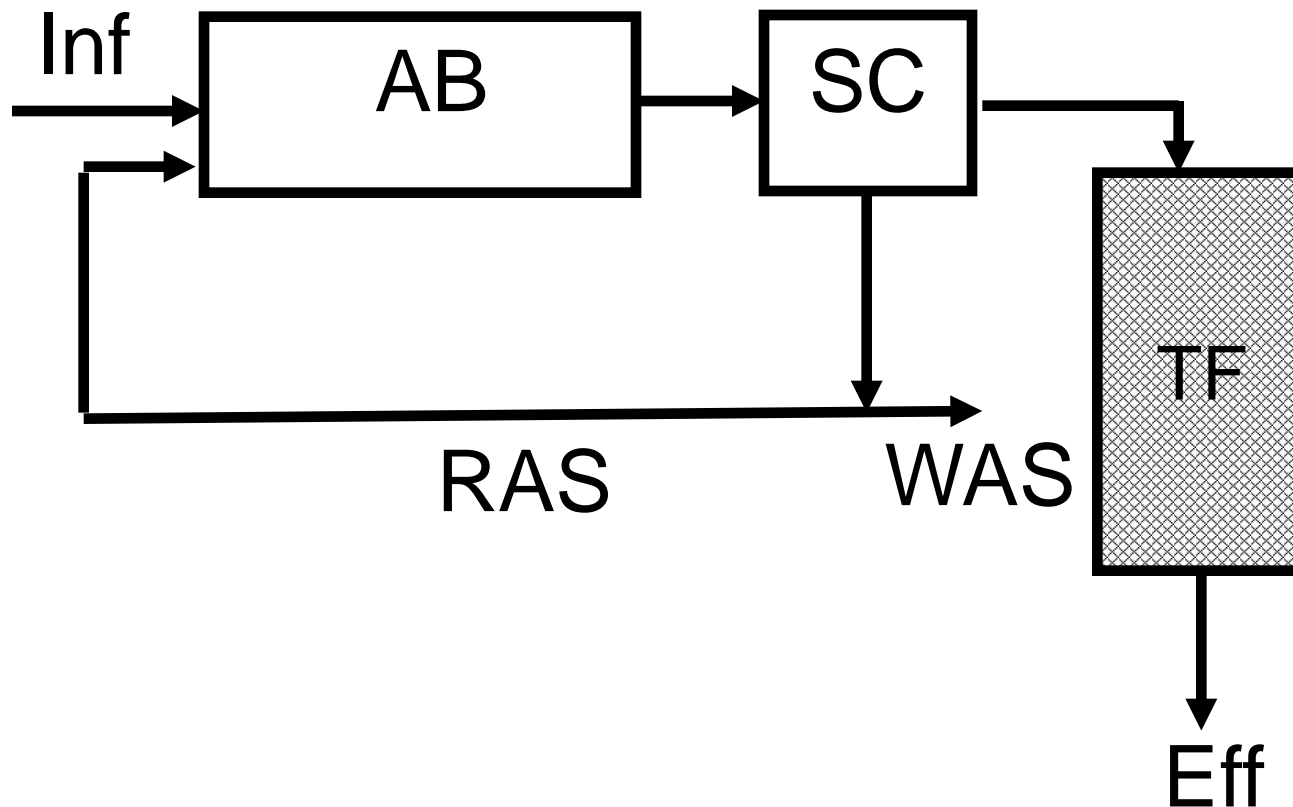
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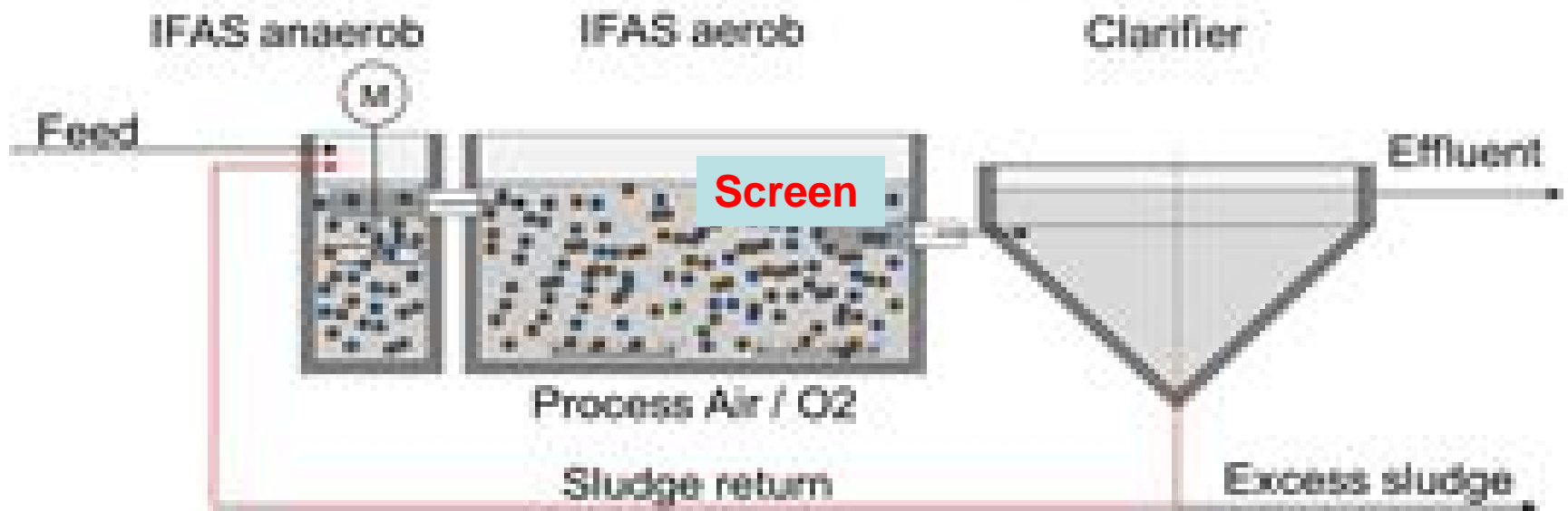
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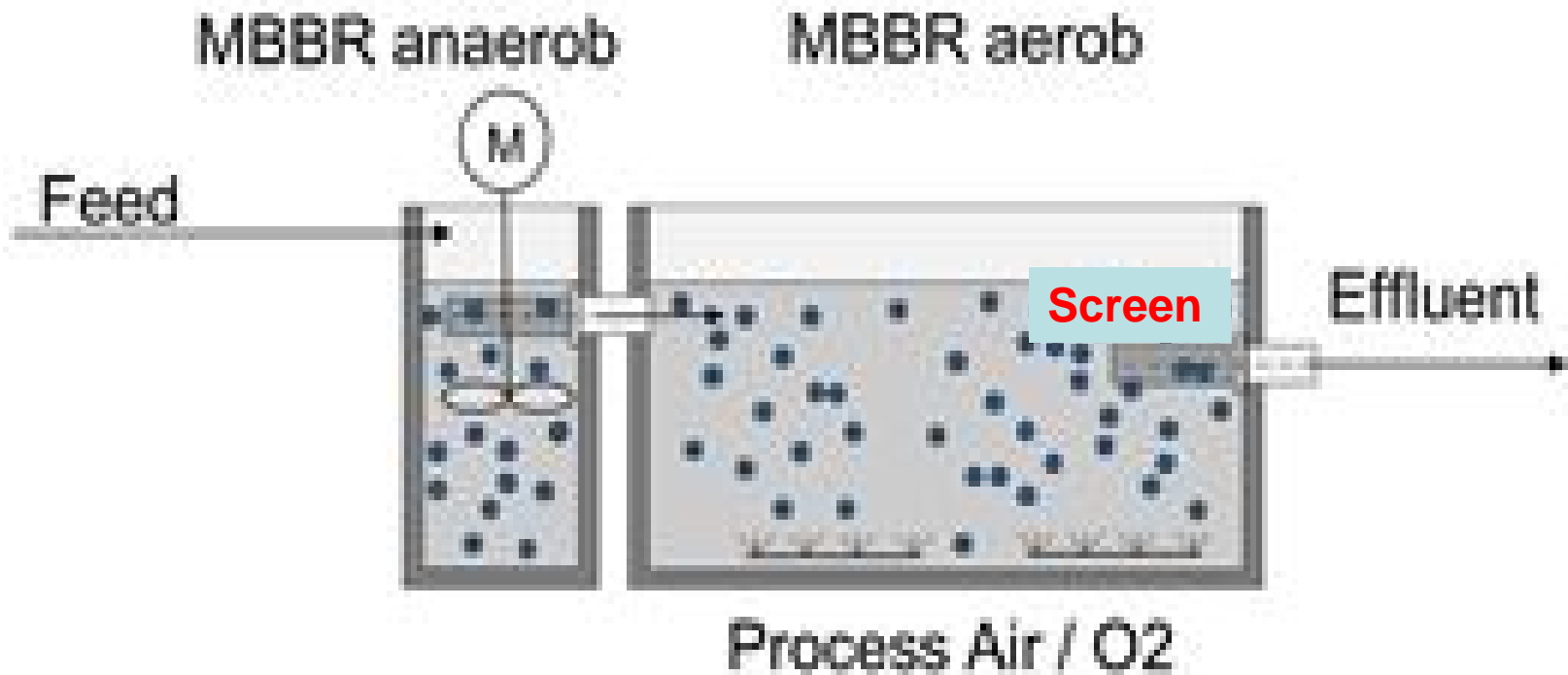
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MBBR

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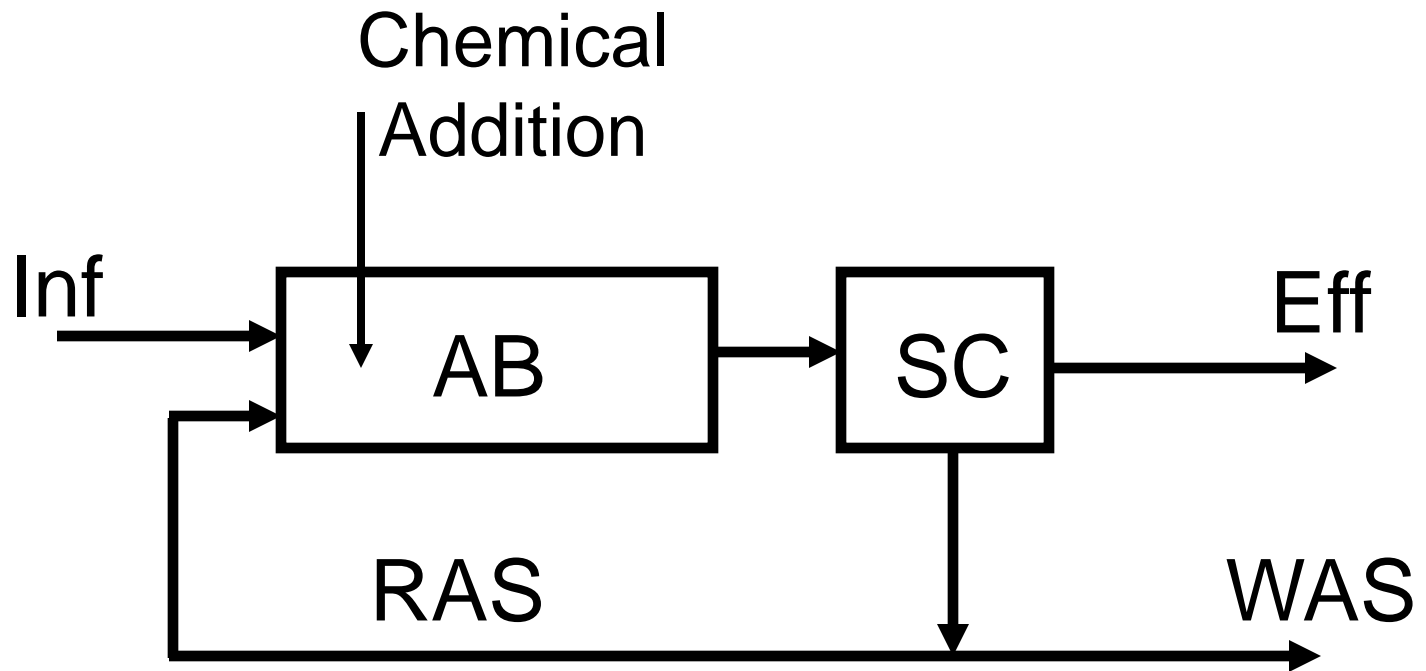
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Simultaneous precipitation



Granular activated sludge

