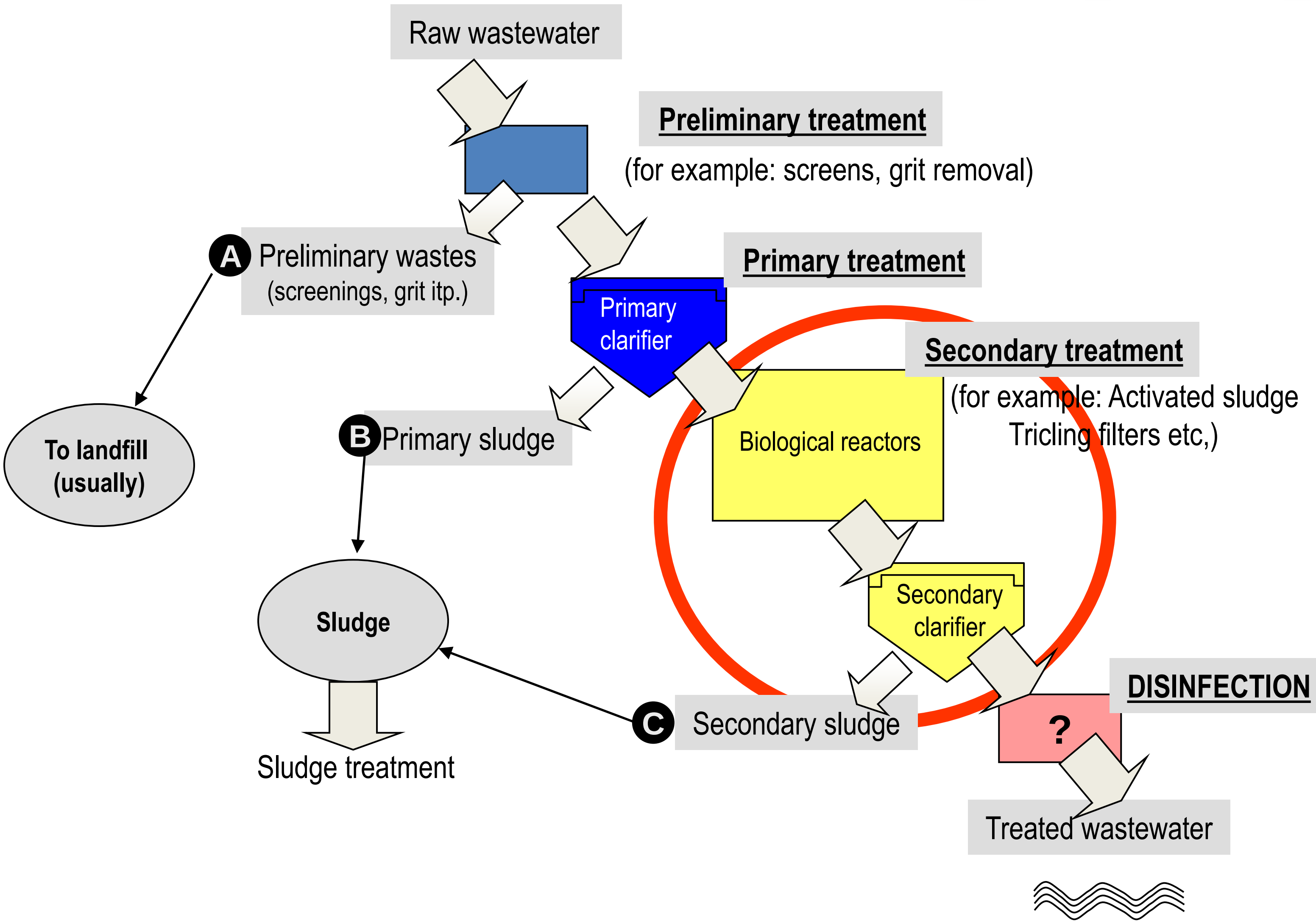
Wastewater Treatment Technology
Lecture 7

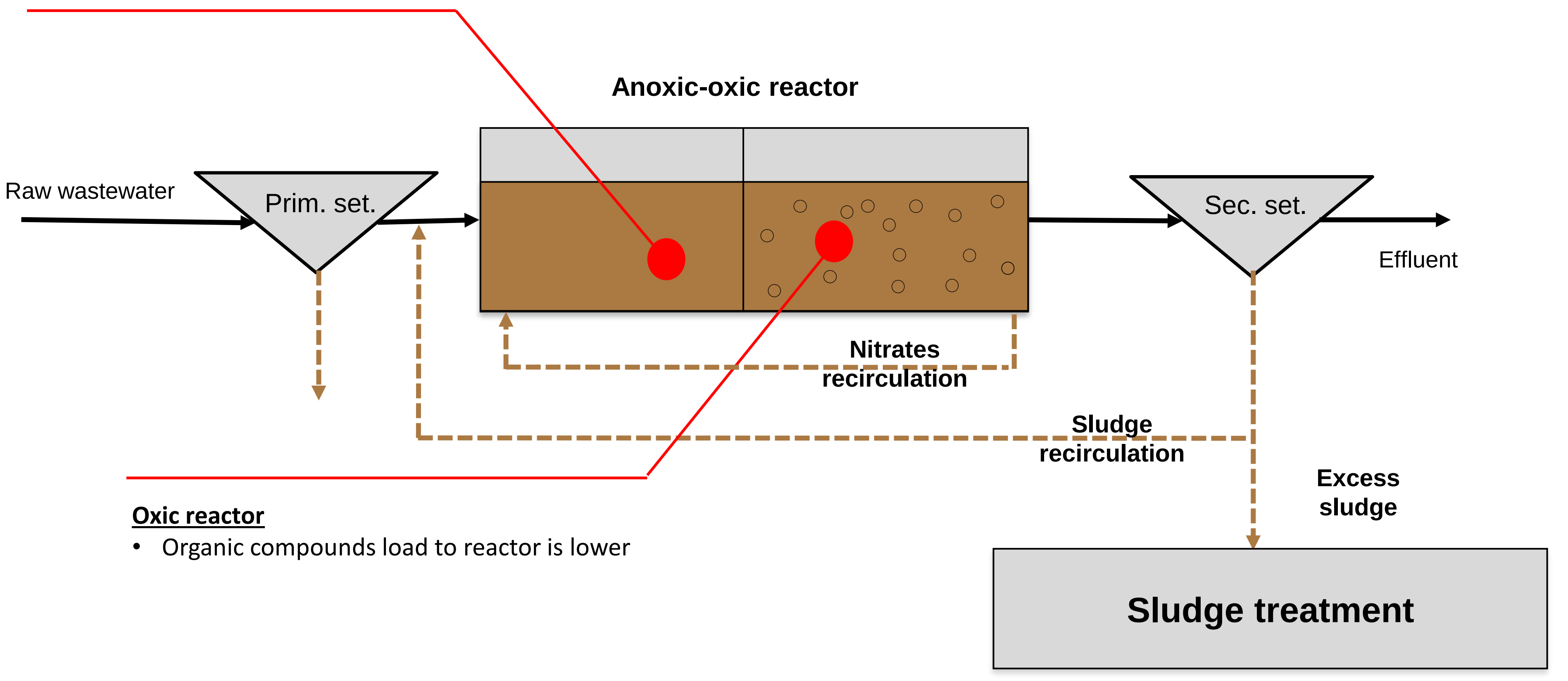
Denitrification – technological aspects

WWTP overall scheme



Oxygen consumption

Nitrates recirculation
- Organic compounds are removed via nitrates rather than oxygen



Oxic reactor
- Organic compounds load to reactor is lower

Oxygen recovery from denitrification

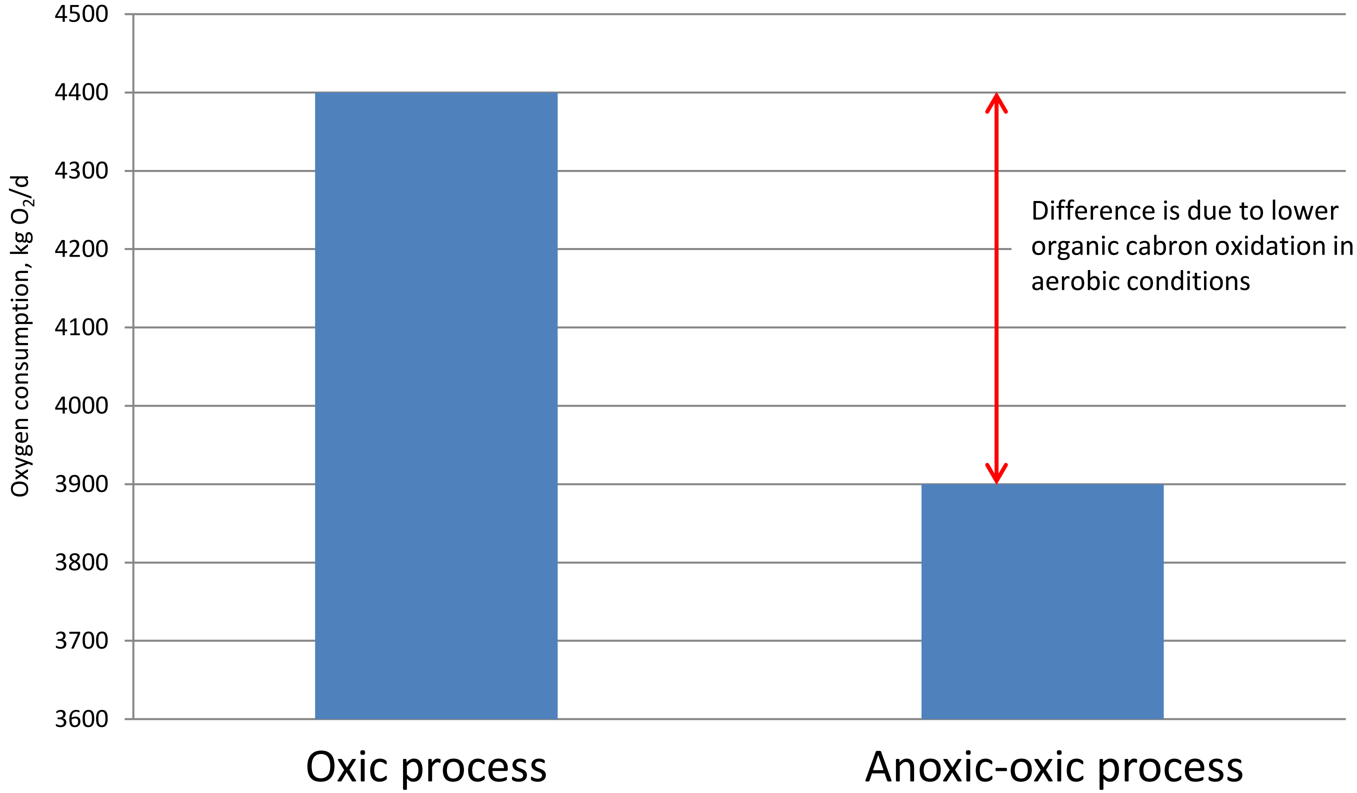
$$Recovery = \frac{Q_{inf} \cdot 2{,}9 \cdot S_{NO_3,\,D}}{1000}$$

Wastewater stream to biological reactor

Stochiometric coefficient g COD/g N-NO_3

Nitrates concentration removed in denitrification

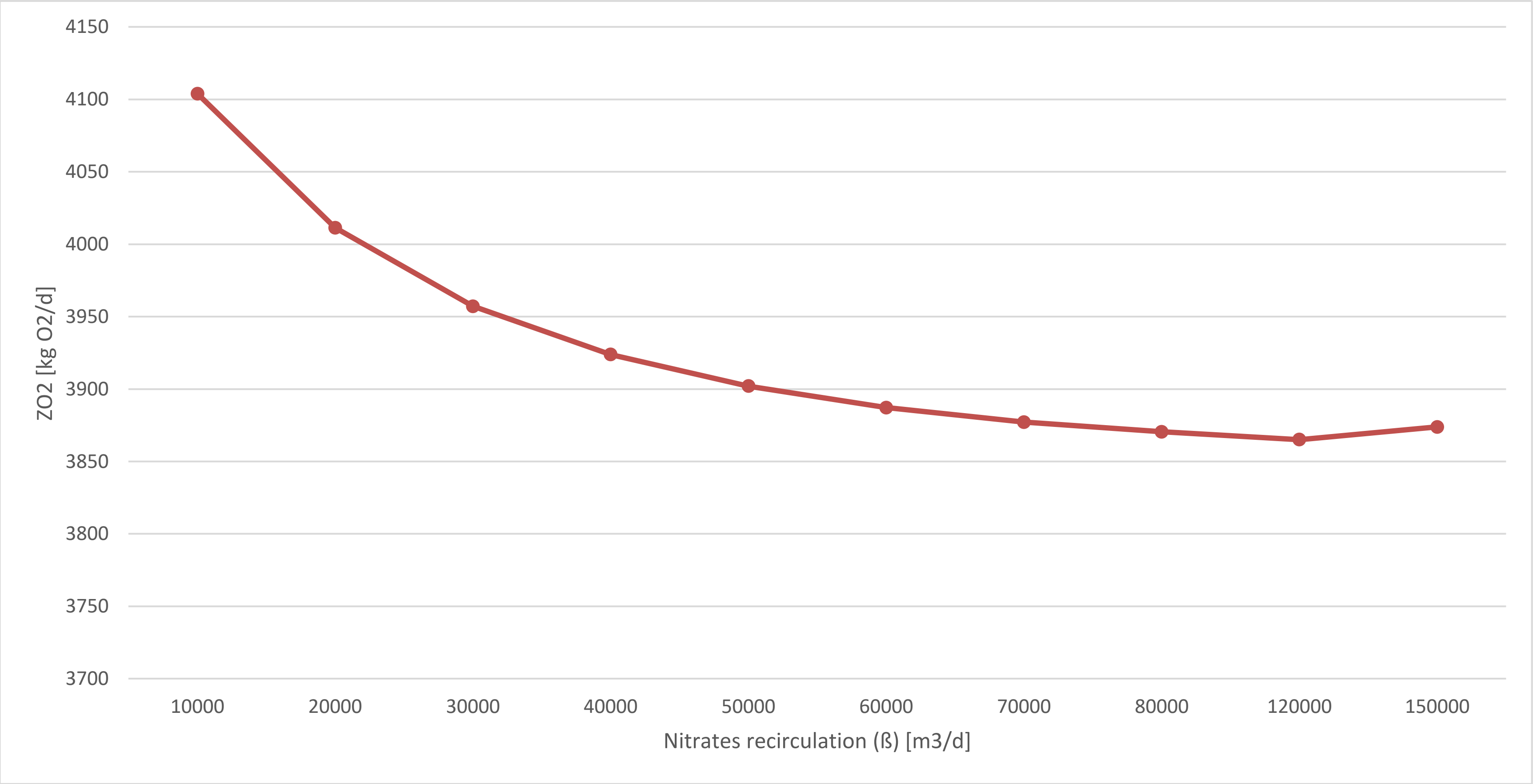
Oxygen consumption



Wasewater flow = 10 000 m^3/d

Typical municipal wastewater

Oxygen consumption

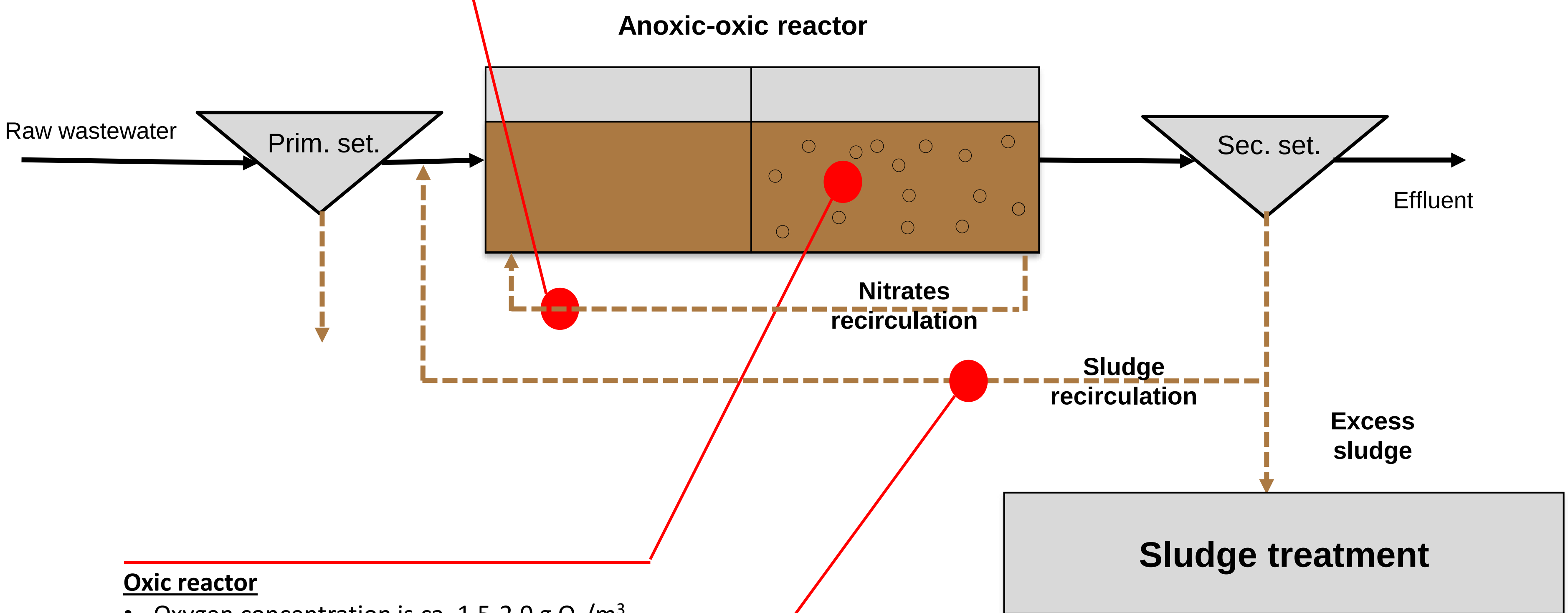


Wastewater flow= 10 000 m^3/d
Oxygen concentration in aerobic reactor: $S_o = 2$ g O_2/m^3
Temperature in biological reactor: $T_2 = 14{,}2°C$
SRT=27 d, SRT_{OX}=13.5 d
Typical municipal wastewater

Oxygen presence in nitrates recirculation

Nitrates recirculation

- Oxygen is present in this stream
- Despite low concentration of oxygen, due to high flow, the mass of oxygen can be substantial



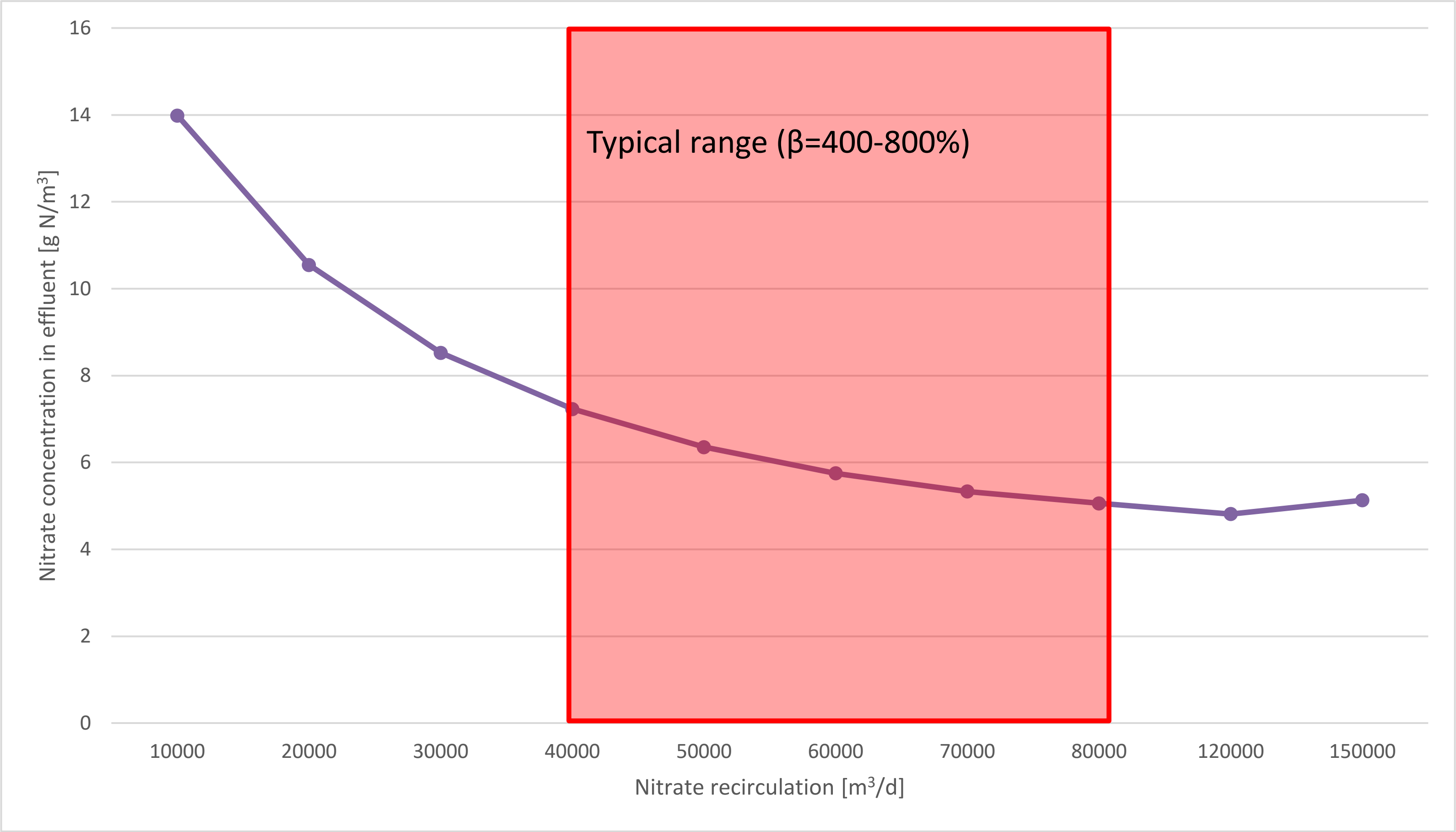
Oxic reactor

- Oxygen concentration is ca. 1.5-2.0 g O_2/m^3

Sludge recirculation

- Virtually no oxygen

Oxygen presence in nitrates recirculation



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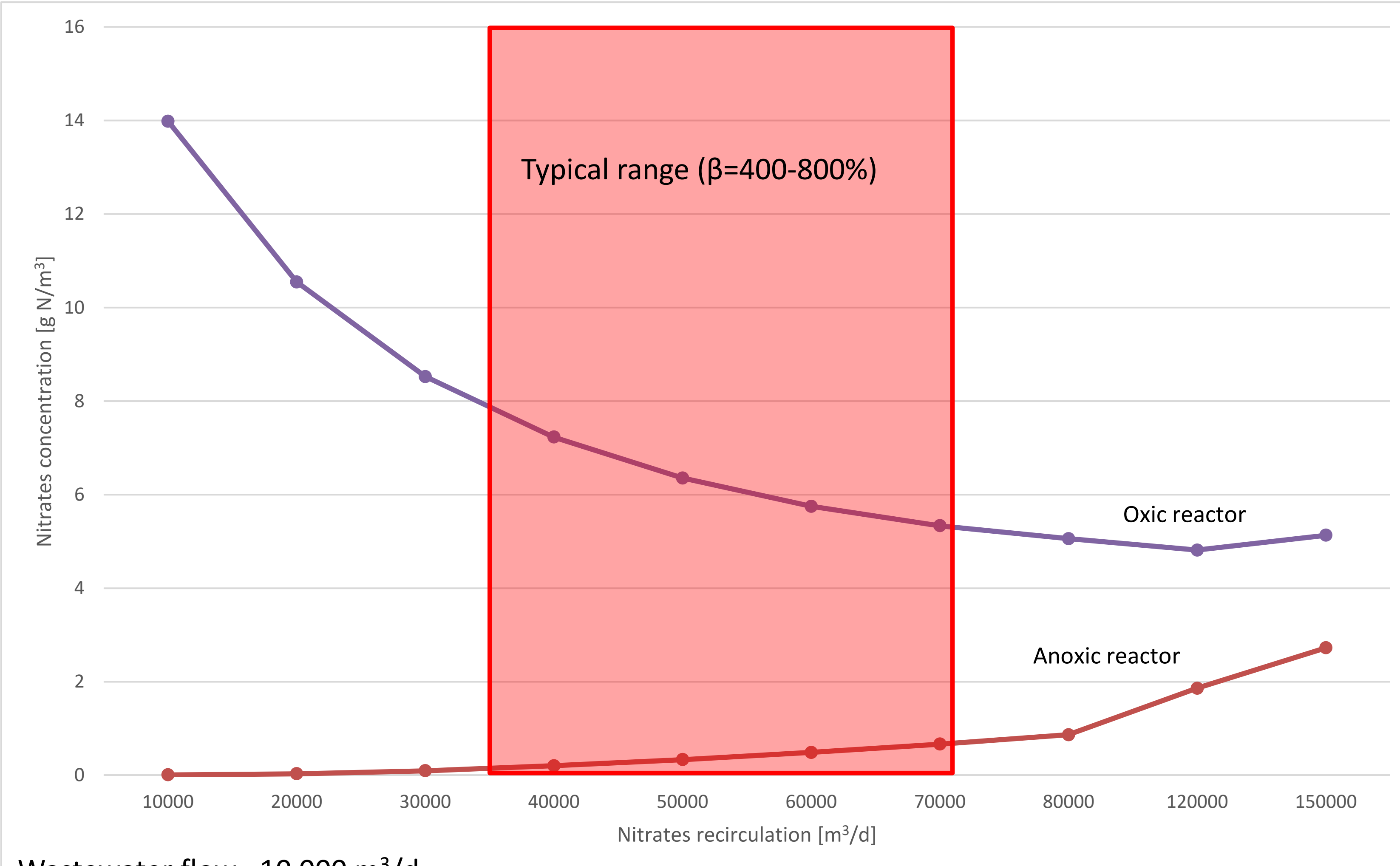
Typical municipal wastewater

Nitrates recirculation versus effluent quality



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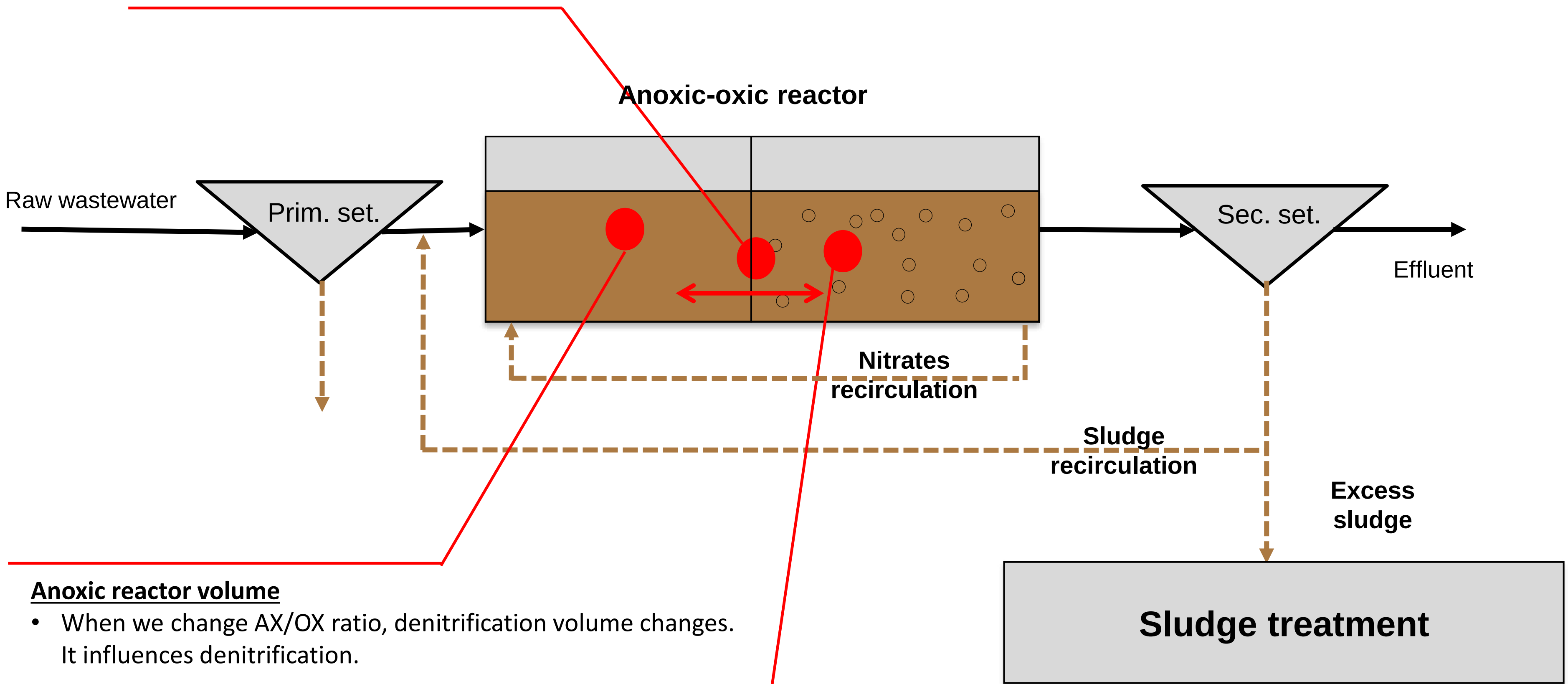
Typical municipal wastewater

AX/OX ratio

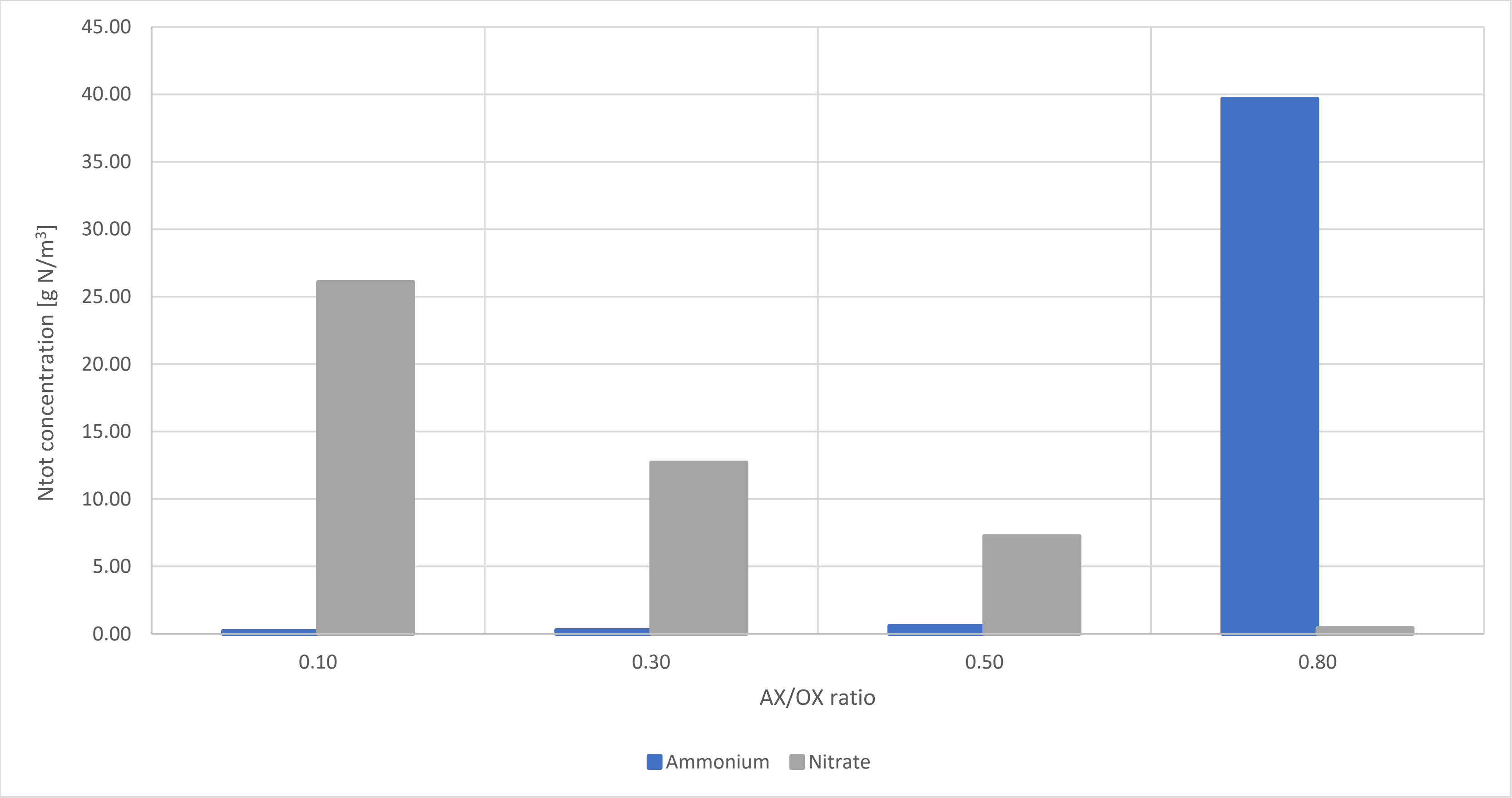
AX/OX ratio
- We turn on/off diffusers to change the OX/AX volume
- If volume of AX goes up then volume of OX go down



Anoxic reactor volume
- When we change AX/OX ratio, denitrification volume changes. It influences denitrification.

Aerobic sludge retention time
- When we change AX/OX ratio, also aerobic sludge retention time changes. It influences nitrification.

AX/OX ratio



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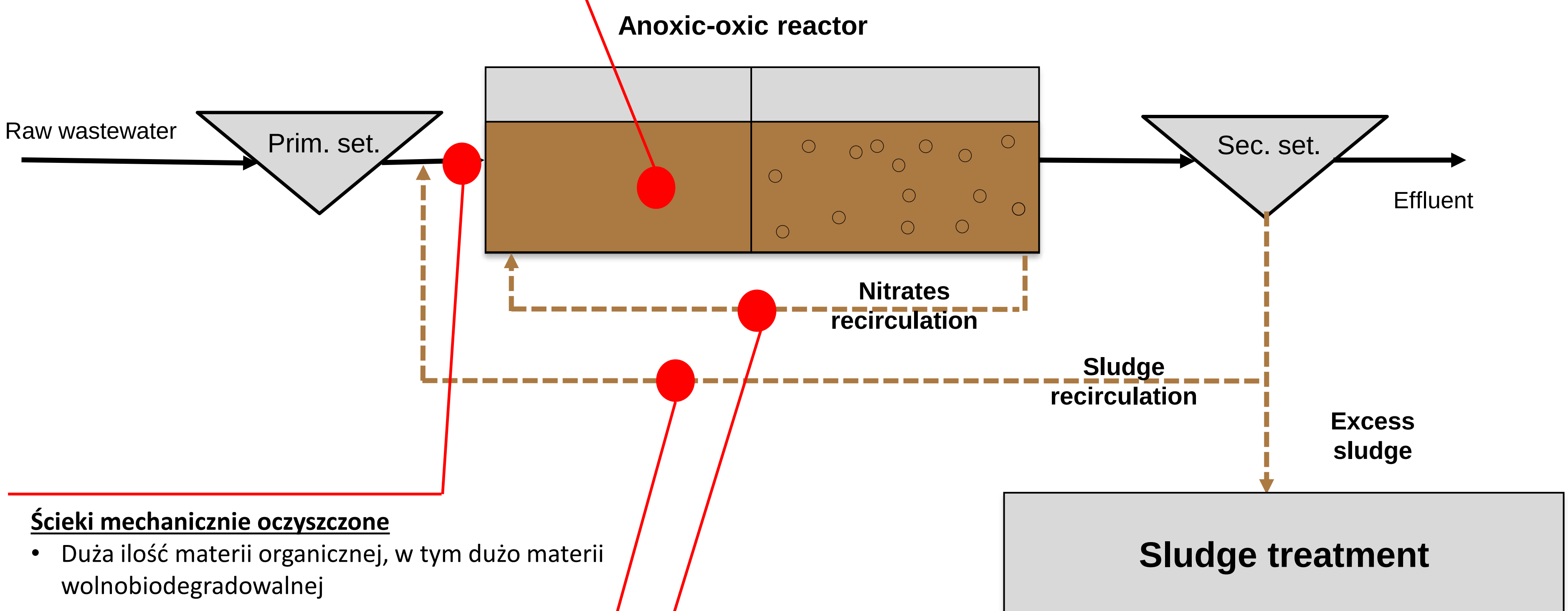
Typical municipal wastewater

Denitryfikacja w oparciu o substraty łatwo i wolnobiodegradowalne

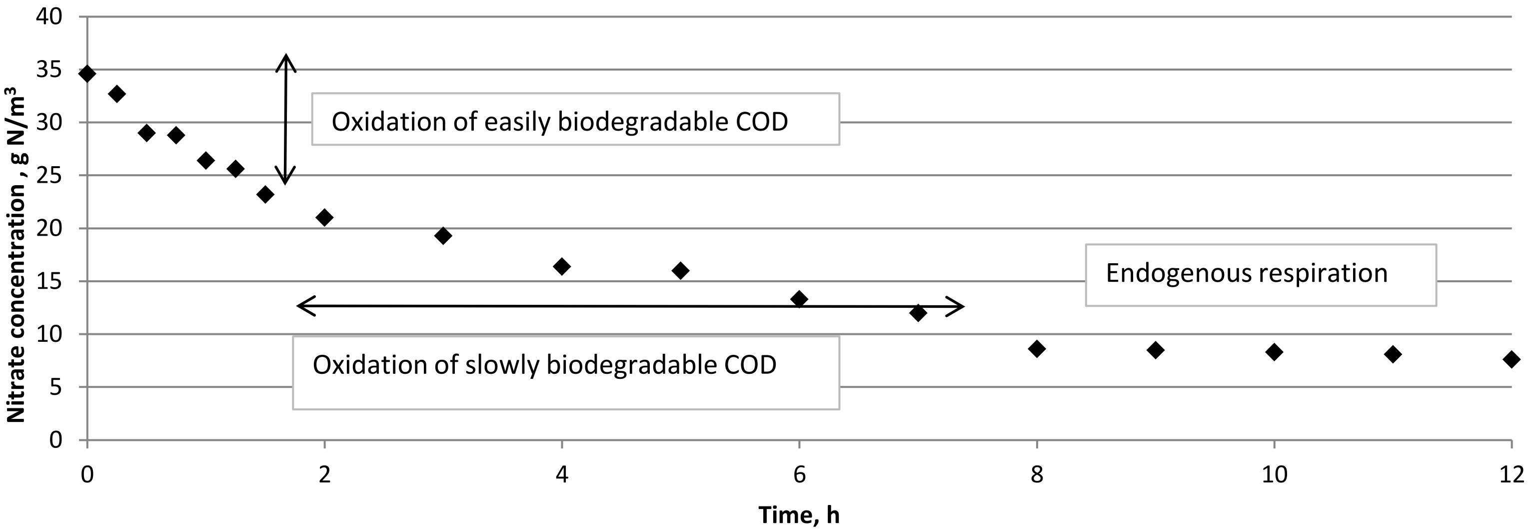
Komora AX
- Najpierw bakterie utleniają związki org. tlenem
- Gdy wyczerpaniu ulegną łatwobiodegradowalne to szybkość denitryfikacji jest limitowana szybkością hydrolizy

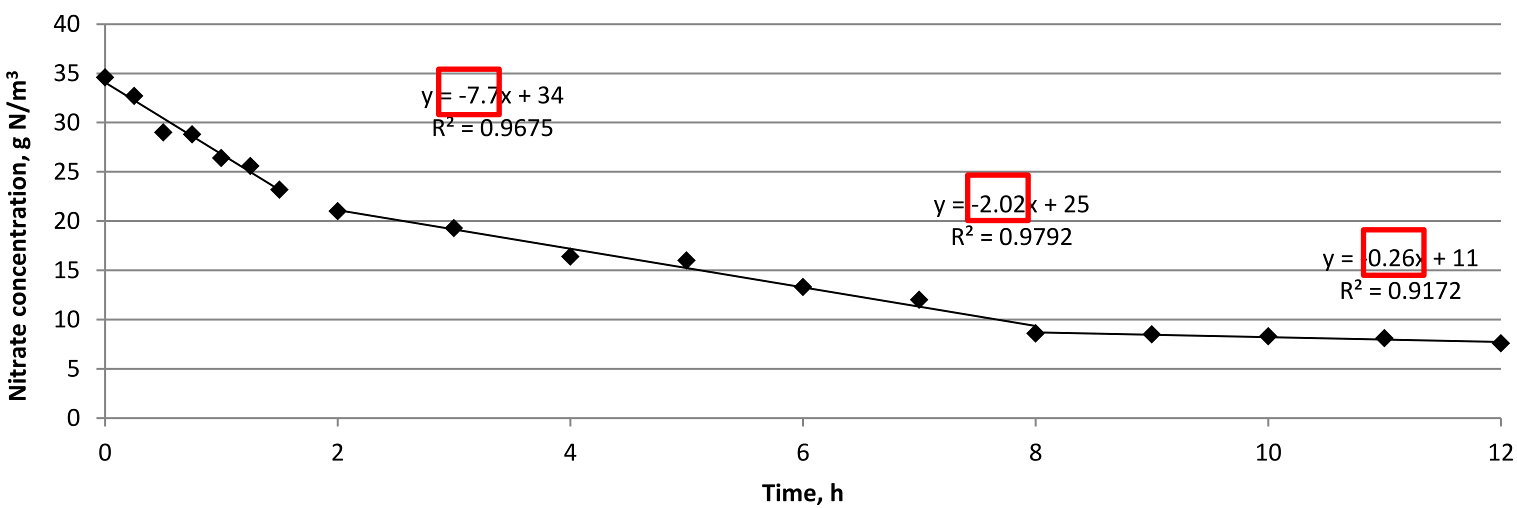


Ścieki mechanicznie oczyszczone
- Duża ilość materii organicznej, w tym dużo materii wolnobiodegradowalnej

Recyrkulacja osadu
- Tylko materia wolnobiodegradowalna

Easily and slowly biodegradable COD vs denitrification





Questions

1. **How does implementing denitrification affect oxygen consumption?**
2. **What effect does the degree of nitrate recirculation have on the nitrate removal process?**
3. **How does changing the volume of the AX chamber affect the effectiveness of nitrification and denitrification?**
4. **Denitrification rate vs the availability of easily and slowly biodegradable substrates?**