Partial nitritation + anaerobic ammonium oxidation (anammox)

**CONCEPT**
- Totally autotrophic bioprocess for the removal of nitrogen

**TARGET**
- Treatment of wastewaters with high nitrogen and low organic contents targeting N-removal efficiencies close to 90%

**ADVANTAGES (with respect to conventional nitrification-denitrification)**
- Reduction of both oxygen needs (60% less than nitrification-denitrification) and sludge production
- Does not need organic carbon for denitrification, which is optimal for treatment of anaerobic digestion effluents
- Does not produce nitrous oxide, a powerful greenhouse gas
- The possibility of working with higher nitrogen loading rates

**CHALLENGES**
- Anammox biomass retention inside reactors is difficult due to the low growth rates of these bacteria

New anammox bacteria
- Novel microorganism *Candidatus* “Brocadia caroliniensis”
- Isolated from an animal waste treatment facility in North Carolina, USA

Anammox immobilization techniques

**Entrapped biomass**
- 1.4-L continuous stirred tank reactors (CSTR) packed with pellets (25% v/v)
- Use of polyvinyl alcohol (PVA) as gel carrier to make the pellets
- Preparation of gel pellets of about 3-5 mm
- Nitrogen loading rates (NLR) of 0.45 to 1.65 g N L⁻¹ d⁻¹ (40-d start-up)
- Synthetic feed (71 ±14 mg NH₄-N L⁻¹, 90 ±12 mg NO₂-N L⁻¹)
- Nitrogen removal rate of 0.05-0.55 g N L⁻¹ d⁻¹

**Attached biomass**
- 10-L continuous upflow reactor
- Use of polyester non-woven biomass carrier
- Flow rate of 60 L d⁻¹ and NLR = 1.74 g N L⁻¹ d⁻¹ (350-d)
- Synthetic feed (131 ±13 mg NH₄-N L⁻¹, 152 ±13 mg NO₂-N L⁻¹)
- Nitrogen removal rate of 1.48 g N L⁻¹ d⁻¹ with 85% efficiency

**Self-immobilized biomass**
- Bench-scale automated unit coupling partial nitritation (PN) and anammox processes
- Use of sequencing batch reactor (SBR) technology
- Biomass: nitrifying activated sludge and suspended-granular anammox sludge
- Treatment of swine wastewater with 1400 ±36 mg NH₄-N L⁻¹ and low biodegradable organic-C (1625 ±129 mg COD L⁻¹)
- PN stage produced a good quality effluent, with a NO₂-N:NH₄-N ratio of 1.4 ±0.3 (70-d)
- Measured conversion rates in the anammox reactor of up to 1.34 g N L⁻¹ d⁻¹