ARREAU Working Group

**Phosphorus**

*Lead: Christian Kabbe (KWB)*
Objectives

**Overall objective:**
- Phosphorus recovery from wastewater
- Including municipal and industrial wastewater (e.g. food industry), not from manure or other biosolids (focus “EIP-Water”)

**Specific objectives:**
- List possibilities for P-recovery and identifying best practice or best available technology (BAT)
- Identifying boundary conditions for BAT, since the local boundaries by infrastructure seems important for implementation

**Tasks:**
- Review of Best Practices considering ecological, economical, political and technical information on BAT
- Communicate the results in and outside of the EIP Water Action Group
**Value Chains**

*End User:* Farmer or fertilizer industry, other industries

*Examples of companies existing from Supplier/Producer to End User:*

- **BWB:** WWTP > Fertilizer (Struvite) > Users
- **Ostara:** WWTP > Fertilizer (Struvite) > Users
- **ICL Fertilizer e.g.:** WWTP > Raw material > Fertilizer > Farmer
Present existing technologies for P-recovery from wastewater

**Full-scale**
- PEARL Struvite
- NuReSys Struvite
- PHOSPAQ Struvite
- AirPrex Struvite
- STRUVIA Struvite
- Grundfos Struvite
- Crystalactor Struvite, CaP
- REPHOS Struvite
- ANPHOS Struvite
- FIX-PHOS CaP/CSH
- P-RoC Struvite/CSH
- EkoBalan Struvite, NPK
- LYSOGEST Struvite
- WASSTRIP Struvite
- Budenheim DCP
- Gifhorn Struvite, CaP
- Stuttgart Struvite

**Demo**
- Stuttgart Struvite

**Lab/pilot**
- Stuttgart Struvite

**Wet sludge and liquor**
- Aqueous phase (dissolved P)
- With enforced P dissolution

**Sludge and sludge ash**
- Acidic digestion/Leaching
- Thermal

**LEACHPHOS**
- P-mineral

**RECPHOS DE**
- P-mineral

**MEPHREC**
- P-slag

**KUBOTA**
- P-slag

**Fert. industry**
- Mineral fertilizer

**EDASK**
- H₃PO₄

**InduCarb**
- H₃PO₄/P₄

**AshDec (Outotec)**
- P-mineral

**THERMPHOS**
- P₄

**ECOPHOS**
- H₃PO₄/DCP

**TetraPhos**
- H₃PO₄

**PYREG**
- P-mineral

www.p-rex.eu
Present map of concretely planned and existing facilities

No replication without demonstration!

https://de.batchgeo.com/map/0f9d56a3aa57a51379a3cb23af27d202

© Kabbe 2015, AirPrex®

www.p-rex.eu

www.ostara.com/sloughUK
100% P load

- grit chamber
- preliminary clarification
- aeration
- secondary clarification
- effluent
- process water
- biogas
- incineration

1. *forced P dissolution*
   - ash after incineration
   - undrained sludge after anaerobic digestion
   - sludge liquor after dewatering
   - direct agricultural utilisation of dewatered sludge

- * ≤ 50% of P load
- ≤ 25% of P load
- > 80% of P load
- 40-90% of P load (solubility, contaminants)

Note:
Difference between precipitation/crystallization and actual separation/harvest
Examples for K.O.-Criteria for other existing technologies

For defining a technology/option as best practice...

1. ... it has to be successfully proven in full-scale
2. ... it has the potential to become successful in full-scale

Examples for K.O.-Criteria for technologies (2.):

- Costs e.g. by demand on chemicals or energy
- No product at the end of value chain (no positive market value)
- Huge amount of waste (by-products) through technology application, which has to be disposed
- Complexity of technology
- Still in pilot-scale, although technology was proven (a) decade(s) ago
Value and Market potential

What products obtained at the end? What cost for WWTP operator? Energy efficient?

- **Sewage sludge** (Case 1, reference): 2-3 €/kg P (equivalent to 120 €/t DS disposal costs)
- **Organic fertilizer** (Case 2, reference): < 5 €/ kg P (equivalent to disposal costs)
- **Struvite** (Cases 3 & 4): 0-5 €/kg P, sludge still needs to be disposed off
- **Phosphoric acid/Fertilizer from ash** (Case 5): 0-1 €/kg P + approx. 10 €/kg P for new mono-incineration if required

Why there is success on the market?

*Recovery-Recycling-processes have synergies with disposal/operation/maintenance/by-product production/energy efficiency etc...*
Summary

- **Objectives:** Phosphorus recovery from wastewater
- **Value Chains:** Sewage (> Raw material) > Fertilizer, Chemicals
- **Existing Technologies:** > 20 but only few market relevant “Best Practices”
- **Tools for assessment:**
  - Results WA 4 of P-REX (EU FP7): Life-Cycle-Assessment, Costs, Risk Assessment, Fertilizing efficiency, Toxicity
  - Results WA 5 of P-REX (EU FP7): Market and legislative analysis, regional case studies, strategy development for implementation
- **Existing Case Studies:** many success-stories in Europe
- **Adding Value** especially through synergies... (energy, nitrogen ...)
Conclusion

There is no one-fits-all-solution
There is a manageable number of best practices

Which of best practices fits best to your plant/region is...

• ...dependent on regulation in your country and on public discussion > regulation can be changed, discussion can be started

• ...dependent on regional infrastructure (e.g. EBPR, incineration, drying capacity, fertilizer industry, agriculture) > first use your existing infrastructure for P-recovery, than think about additional infrastructure for P-recovery (innovation by integration)
Only wisdom applied will shape our future!

but

Think forward, act circular!!!