

Technology for Water



ENVIROCHEMIE

Arsenic elimination in industrial wastewater streams

David Londoño; Eva Gilbert

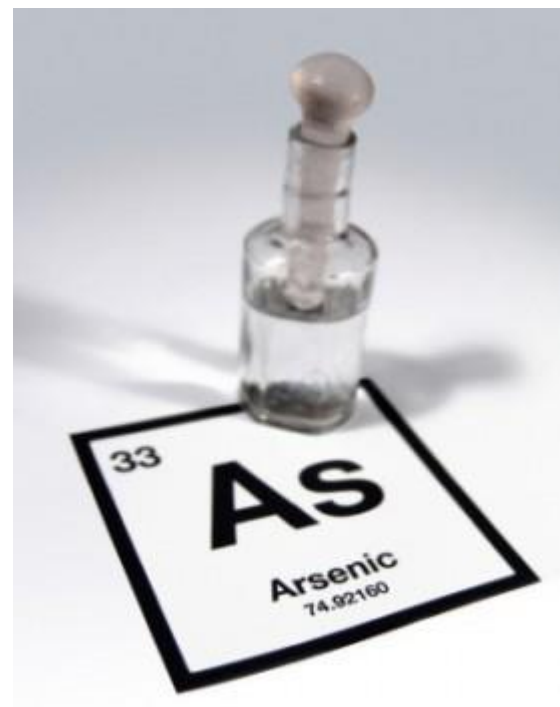


Contents

 Company presentation

 Possibilities for arsenic elimination from industrial wastewater streams

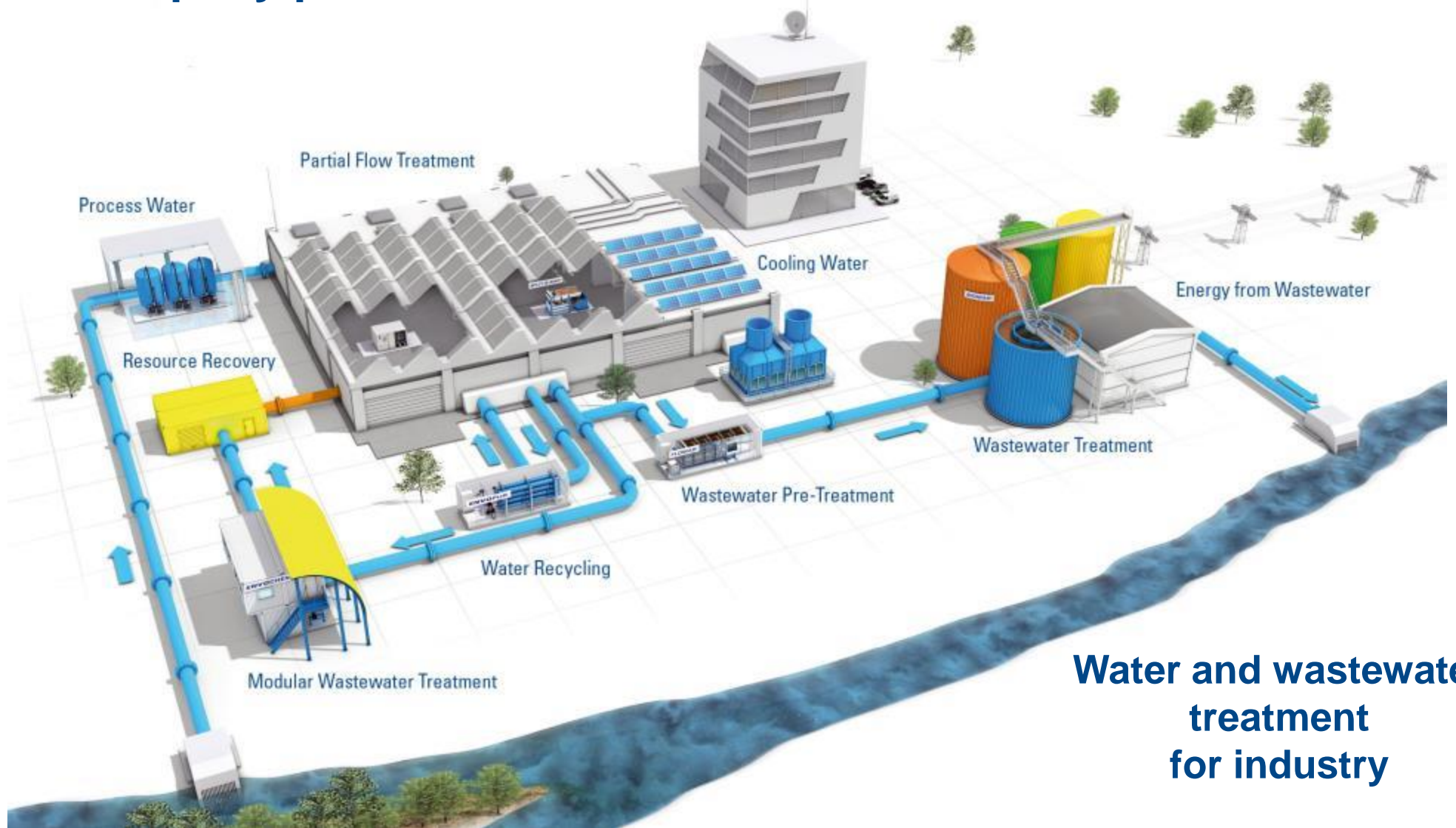
- Classical treatment processes
 - Flocculation/Coagulation
 - Adsorption
- Ionic exchange processes
- Membrane processes
 - Pressure driven
 - Electrically driven 
- Eutectic Freeze Crystallization (EFC) 



Source: Global healing center

 Experiences from EC-Projects

Company presentation – EnviroChemie GmbH



**Water and wastewater
treatment
for industry**

Company presentation – Our services

Planning



Plant engineering



Operation management & contracting



Customer service



Water chemistry



A one-stop service

Possibilities for arsenic elimination

Flocculation/
Coagulation



Adsorption
Ion exchange



As

Membranes



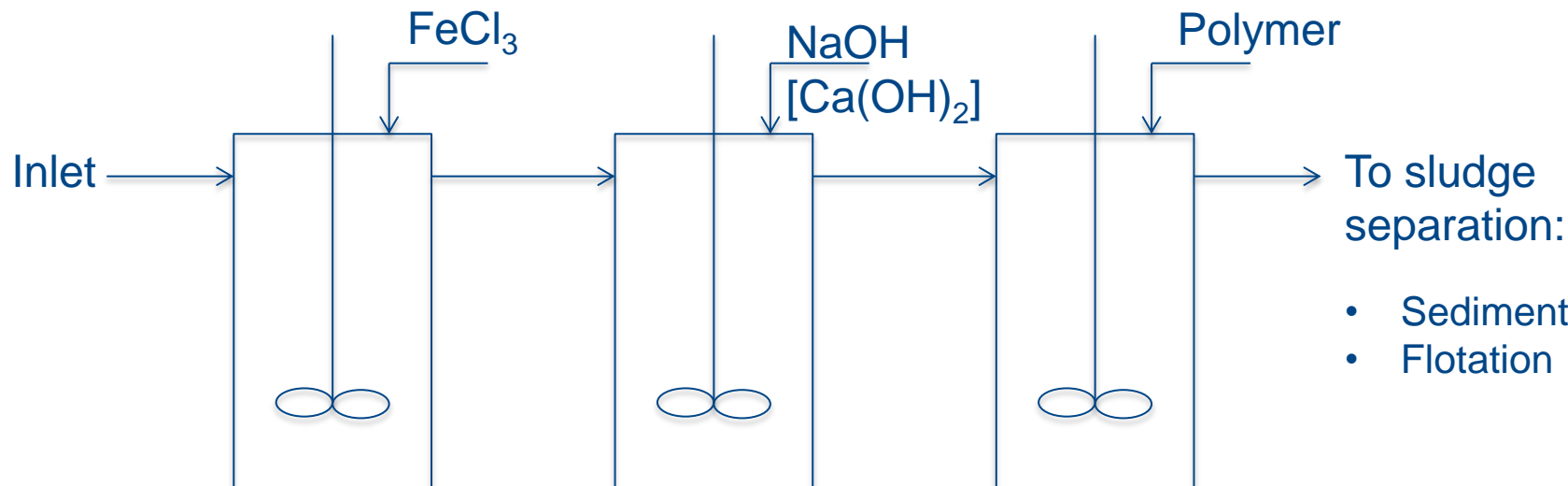
Special
processes



Source: EFC

Flocculation - Coagulation

Classical method for Arsenic elimination



Three mechanisms responsible for the elimination:

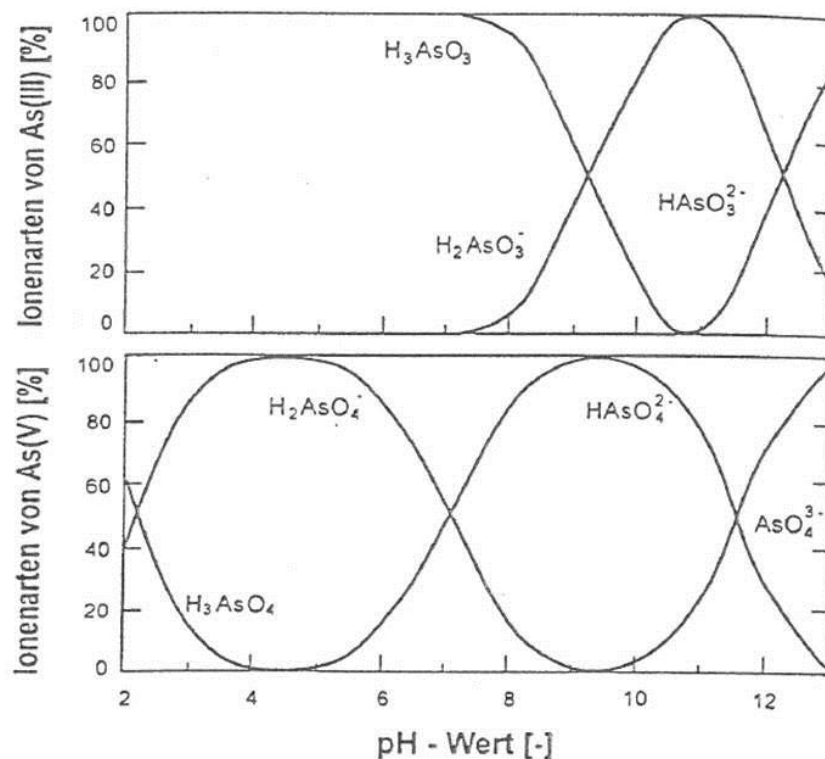
- Precipitation of Iron arsenate
- Coprecipitation
- Adsorption to iron hydroxide

Use of other coagulants is possible

Flocculation - Coagulation

Different elimination grades for different ionic forms of arsenic:

- Arsenites - As(III) – Low separation grades (AsO_3^{3-})
- Arsenates – As(V) - Good separation grades (AsO_4^{3-})



Flocculation - Coagulation

Elimination of As(III) → Pre-oxidation of wastewater necessary



- AOP (O_3 , $\text{H}_2\text{O}_2/\text{UV}$, Fenton reaction)
- Chlorinated oxidants (hypochlorite, chlorine, chlorinated lime)
- Potassium permanganate
- Caroat (Potassium peroxymonosulfate)



Adsorption

 Binding of arsenic to the polar surface of the adsorbent

Activated alumina /
Zeolithe



pH = 5,5 – 6

Only for As(V)

Capacity = 1 – 2 g/kg

Granular ferric hydroxide



pH = approx. 7

Only for As(V)

Capacity = 10 – 15 g As/kg

Granular TiO₂



pH = approx. 7

Only for As(V)

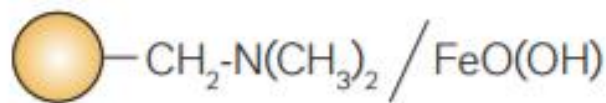
Ion exchange

- Use of strongly basic ion exchanger: Only by absence of other anions (NO_3^- , SO_4^{2-}). Regeneration with NaOH possible



- Arsenic selective ion exchanger:

Hybrid materials: ✓ Polymeric anion exchanger
 ✓ Doped with iron oxide (Goethite – FeOOH)



Source: Lanxess

Elimination of As(III) and As(V) is possible

Membrane filtration

Treatment option for various arsenic bearing sources water characteristics [136]

Source water	Treatment option				Possible treatment
	Filtration alone				
Characteristic	RO	NF	UF	MF ^a	Preoxidation ^b
As speciation					
As(III)	R	PE	NR	NR	R ^a
As(V)	R	R	PE	NR	NR
As size distribution					
Dissolved	R	PE	NR	NR	NR
Particulate	NR	NR	PE	PE	NR
Co-occurrence					
NOM	PE	PE	NR	NR	NR
Inorganic	R	PE	NR	NR	NR

R, recommended; NR, not recommended; PE, possibly effective.

^aRemoval of other arsenic forms possible with ferric coagulants.

^bPreoxidation is considered as a pretreatment.

Source: Shih (2005)

Membrane filtration

Arsenic form	Nanofiltration	Reverse osmosis
As (V)	95 - 99%	Up to 99 %
As (III)	75 – 99 %	Up to 99 %

Drawbacks:

- Higher costs (invest and energy costs)
- Discharge of concentrate

→ NF and RO only for cases when other dissolved solids have to be eliminated (sulfates, nitrates, carbonates ...) or for water recycling purposes

Experiences from EC-Projects

EnviroChemie has acquired experience with arsenic elimination in the following fields:

- Uranium mining remediation sites
- Metal processing
- Glass processing
- Landfill leachates



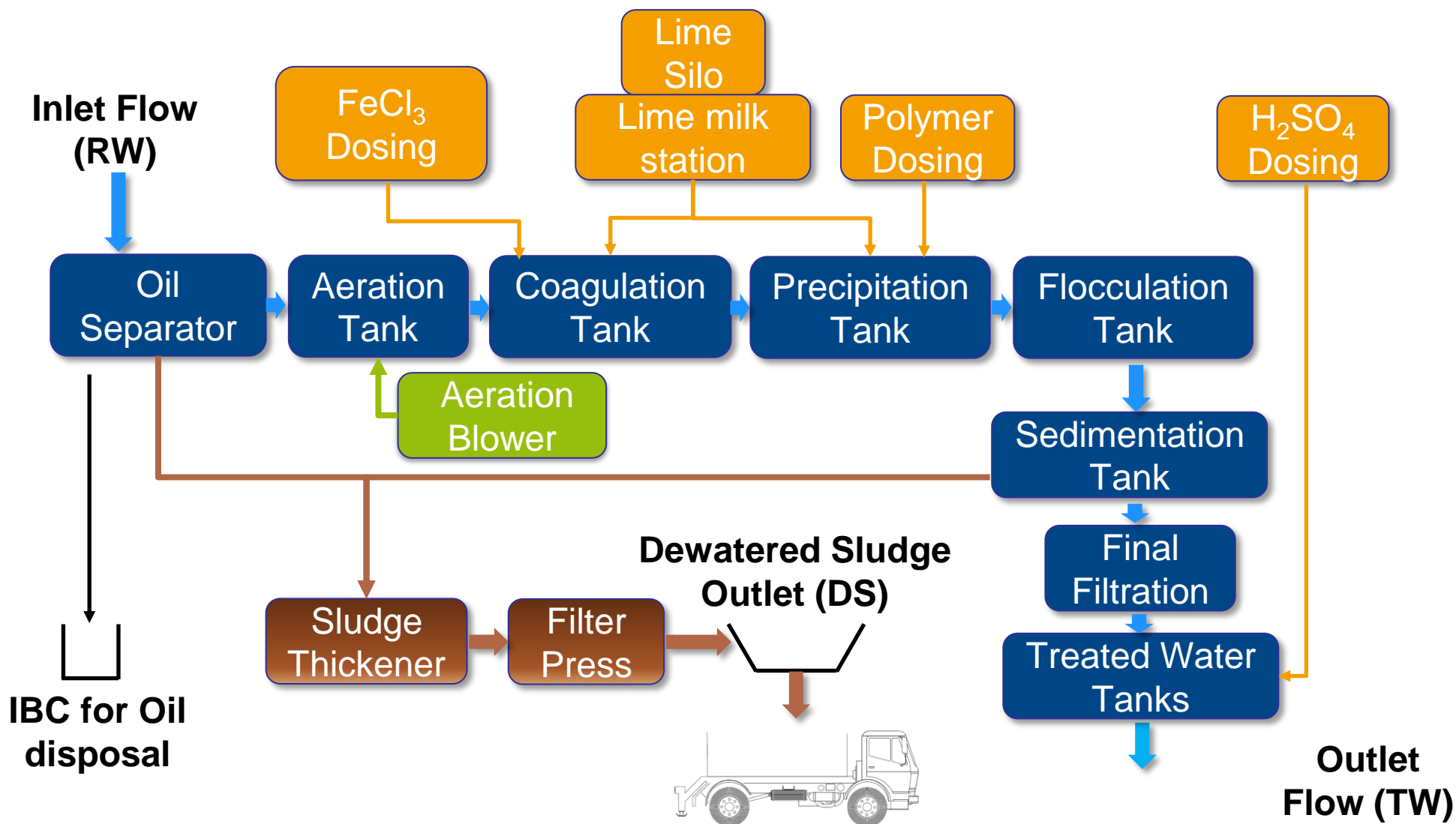
Experiences from EC-Projects

 Rainwater treatment plant for a copper (cathodes) producer in Bulgaria

Wastewater composition

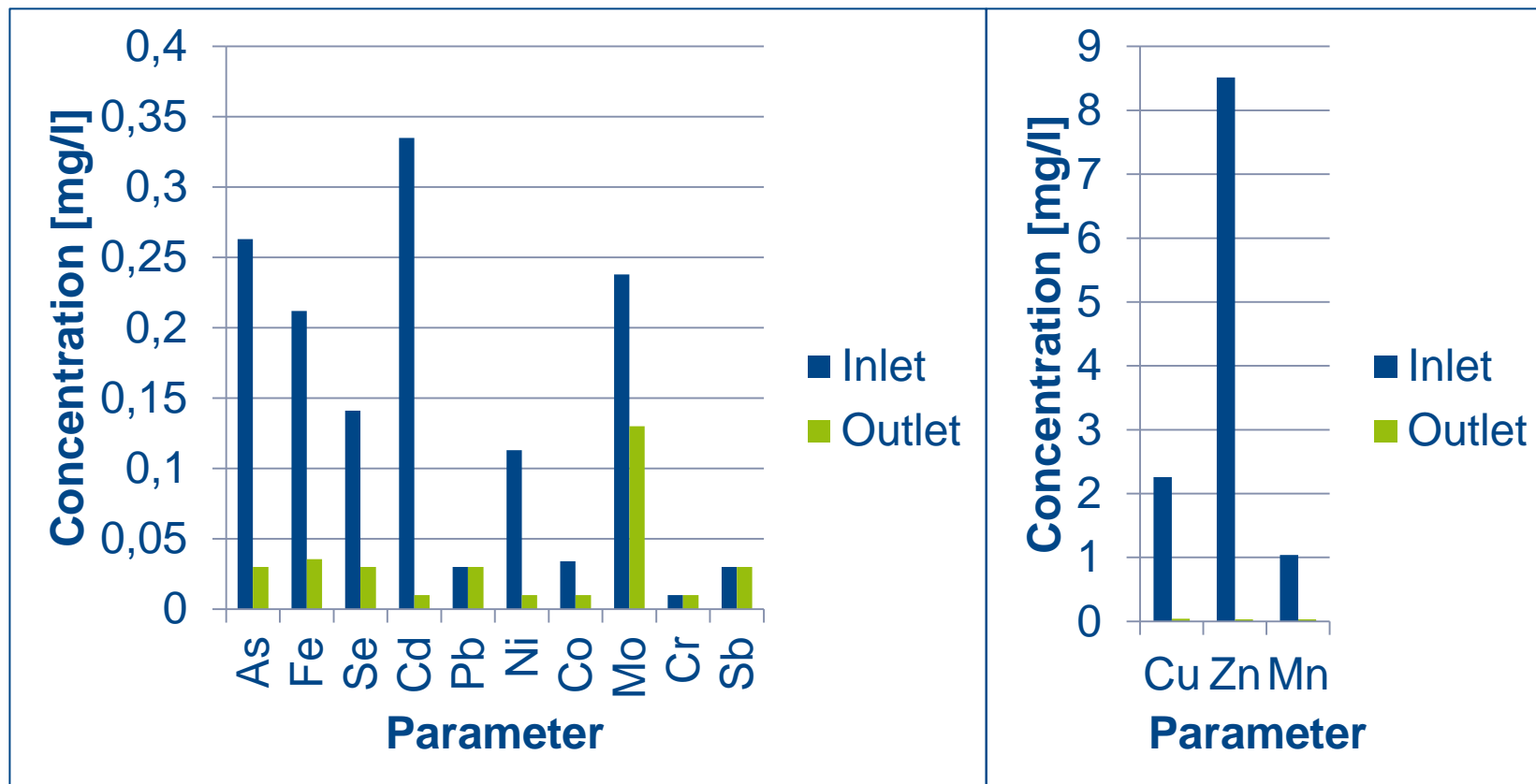
Parameter	Typical composition (extreme values)	Parameter	Typical composition (extreme values)
pH [-]	4,1	Pb [mg/l]	< 0,03
As [mg/l]	0,263 (1,482)	Ni [mg/l]	0,113
Fe [mg/l]	0,212	Mn [mg/l]	1,04
Cu [mg/l]	12,69	Co [mg/l]	0,034
Se [mg/l]	0,141	Mo [mg/l]	0,238
Zn [mg/l]	6,97	Cr [mg/l]	< 0,01
Cd [mg/l]	0,335	Sb [mg/l]	< 0,03

Experiences from EC-Projects



Experiences from EC-Projects

 Achievable results





Thank you for your attention