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**SACSESS**  
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*Warsaw, April 23rd 2015*

# Downstream effects of aqueous effluents generated by the EXAm separation process

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➤ EXAm – non concentrated PUREX raffinate ([PF] ~ 10 g/L)

Objectives

EXAm flowsheet studied

Aqueous effluents management flowsheet

Simulation methodology and results

Conclusions

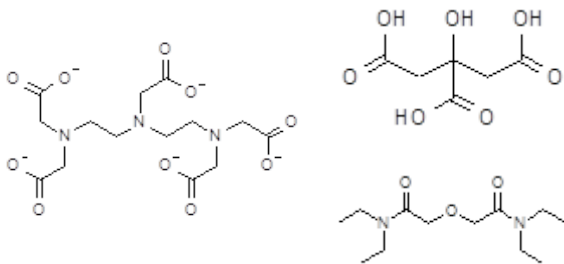
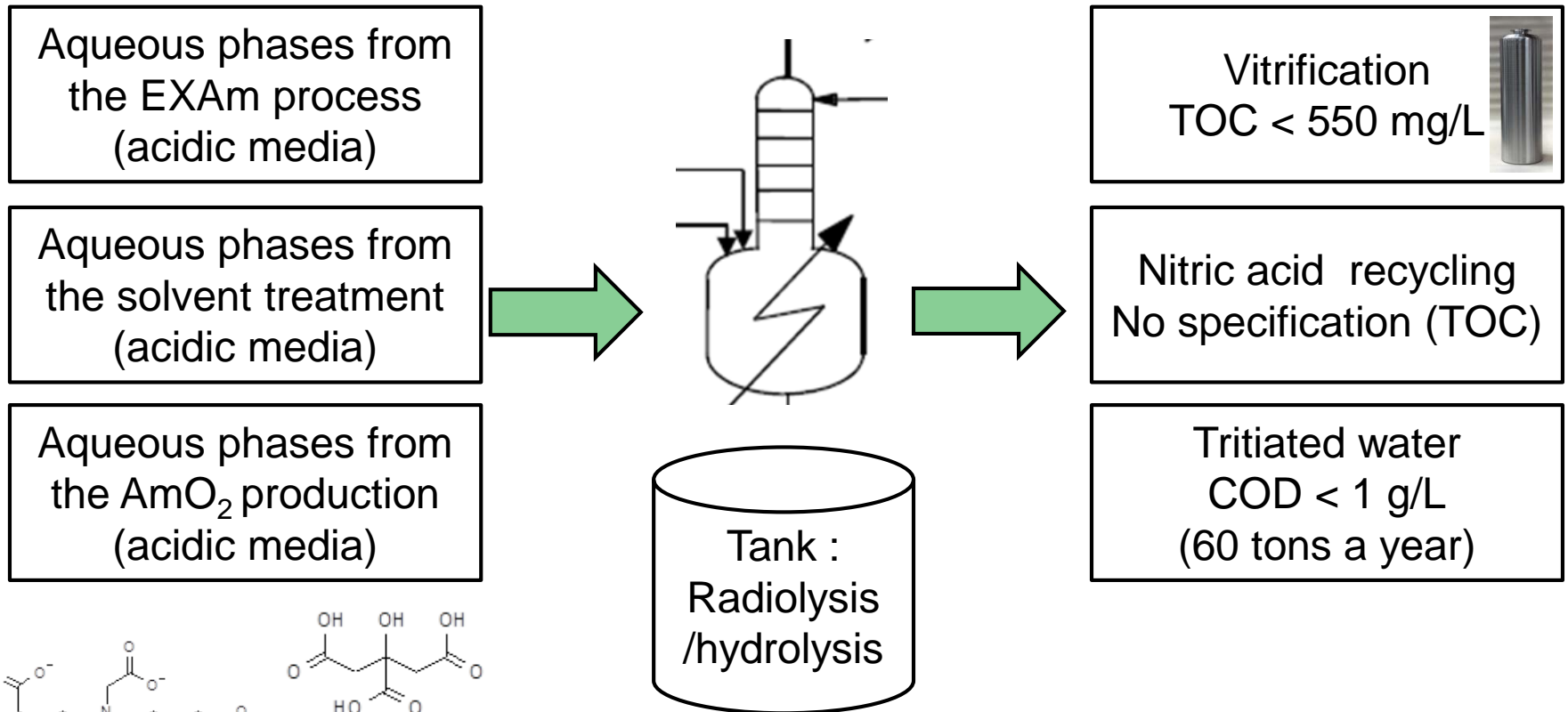
➤ EXAmCO –concentrated PUREX raffinate ([PF] ~ 36 g/L)

Main flowsheet changes

Trends on the impact of a concentrated PUREX raffinate Am separation on aqueous effluents management

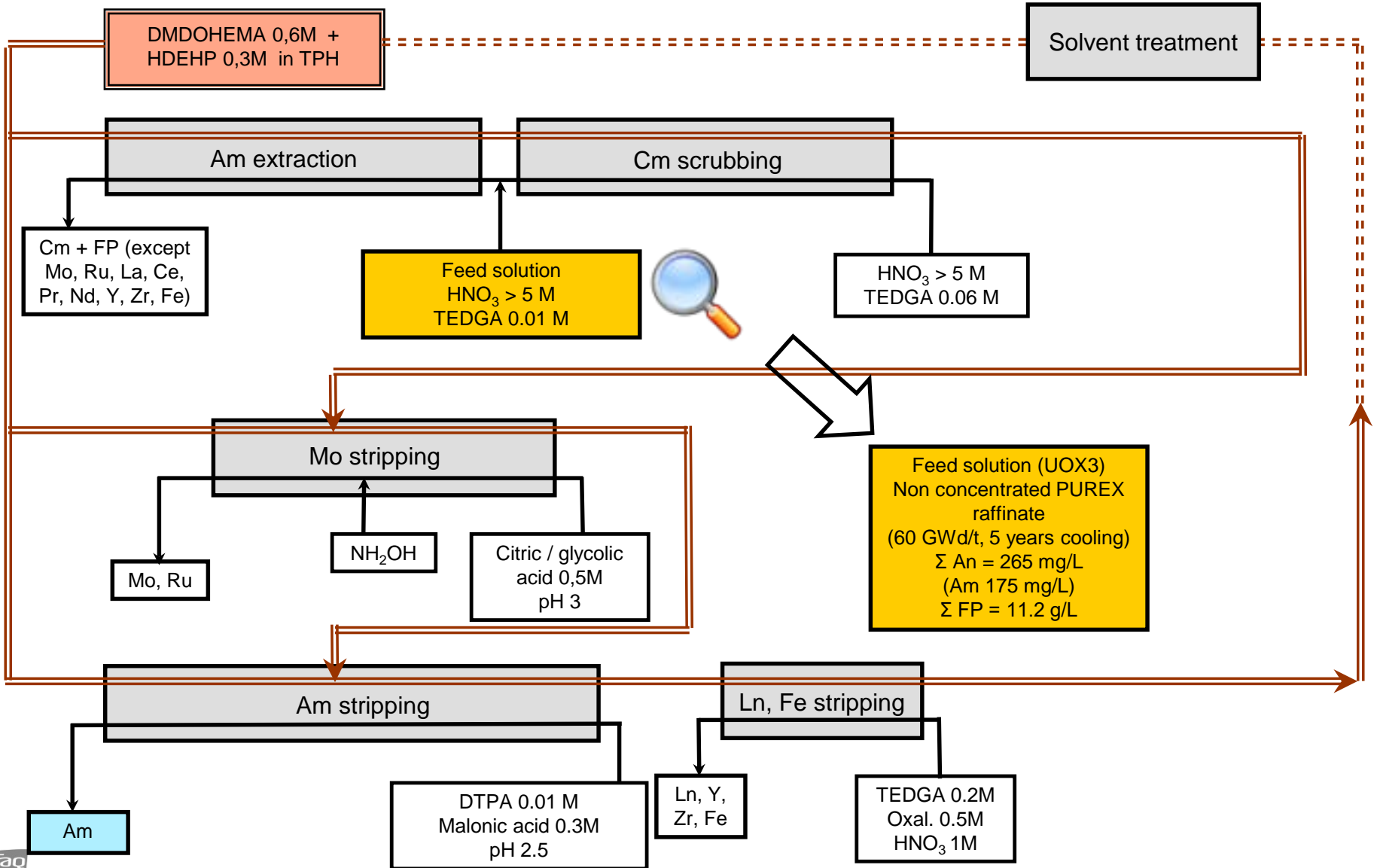
# Objectives

- determine whether the treatment of EXAm reagents meets output specifications

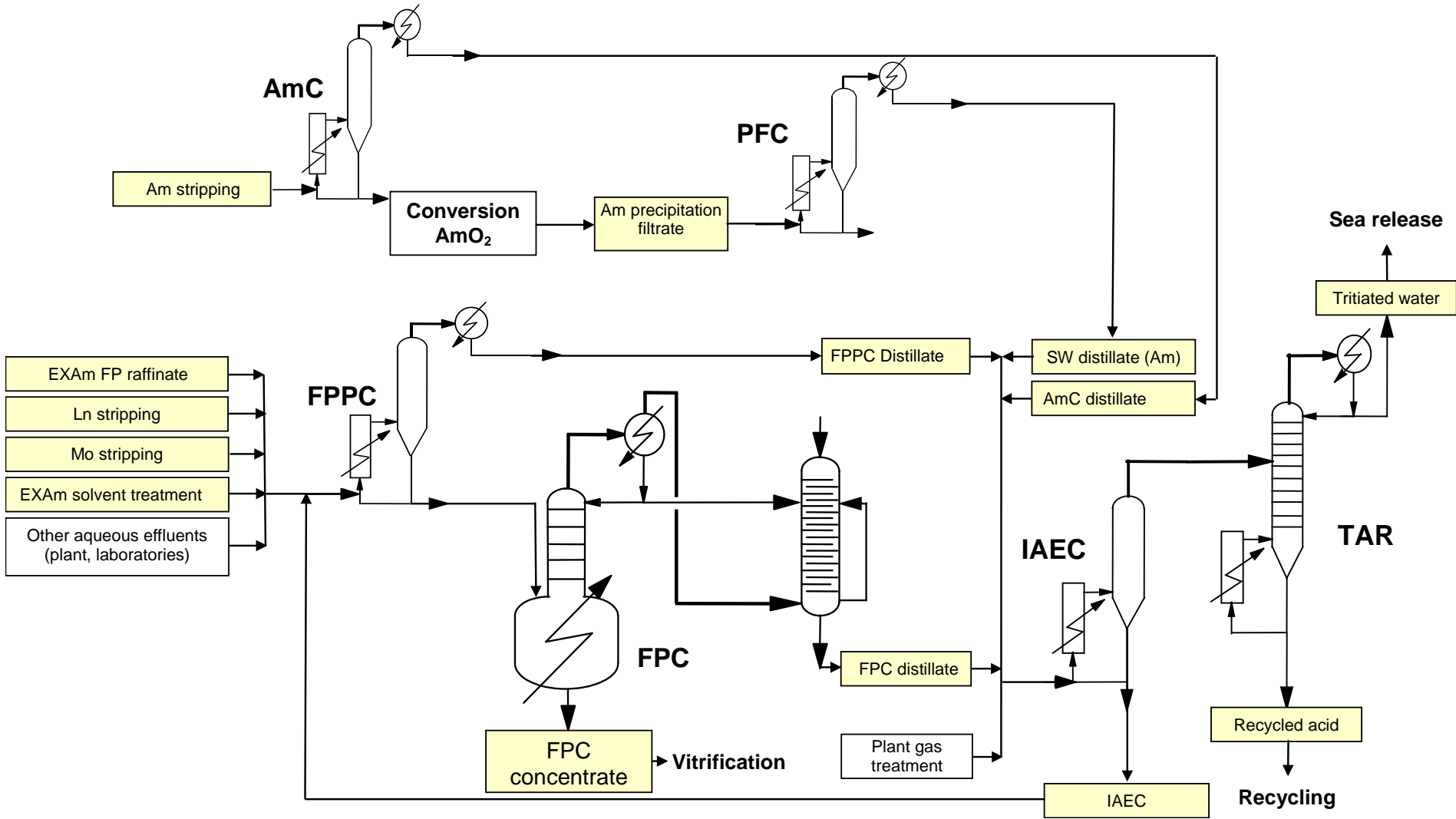


NH<sub>2</sub>OH

# EXAm flowsheet studied



# Aqueous effluents management flowsheet



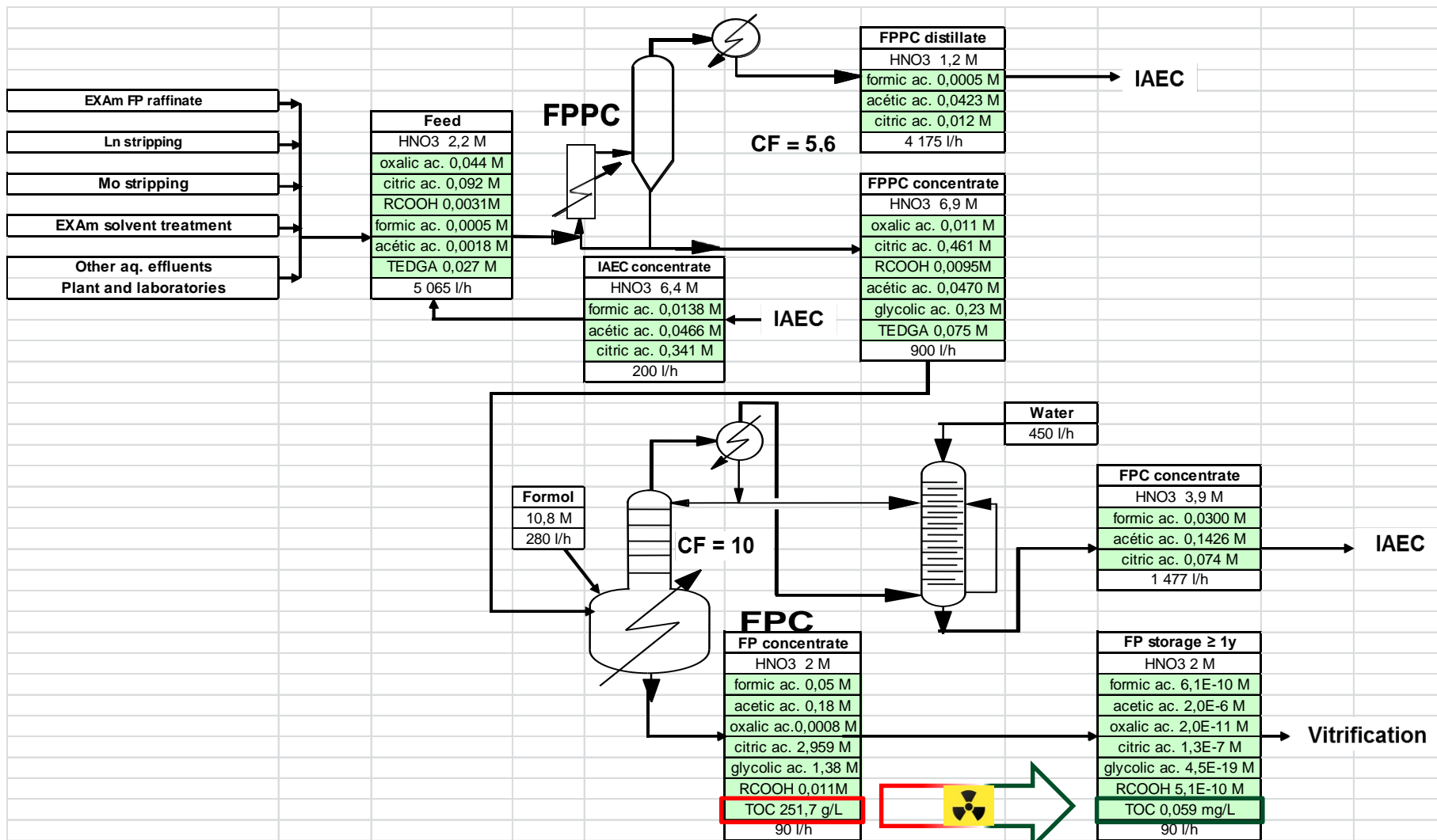
# Simulation methodology

- Distribution to different flows :  $\alpha$  (distillate/ concentrate separation distribution)
- Destruction :
  - TOC =  $\Sigma$  C atoms
  - Chemical molecule  $\rightarrow$  intermediate molecules  $\rightarrow$  CO<sub>2</sub> + degradation product (fewer or no C atoms) (thermolysis, denitration, radiolysis)
  - k = destruction kinetics
  - Grouped destruction sometimes > elementary destruction
  - FP flow : elementary destruction (may be pessimistic)
  - Am production concentration + co-precipitation + filtrate concentration : elementary and grouped destruction
  - Not studied : TEDGA (TODGA data used) + carboxylic acid (propionic acid, butyric acid, Fonet data used)
  - Example of malonic acid :

Phenomena	k	Degradation products
Thermolysis	0	-
Thermolysis + denitration	7.5 h <sup>-1</sup>	Formic / acetic / oxalic / CO <sub>2</sub>
Radiolysis	TOC = 0.00036 kGy <sup>-1</sup> 0.1M HNO <sub>3</sub>	Degradation products + CO <sub>2</sub>



# cea den FP PreConcentration (FPCC) + FP concentration (FPC)

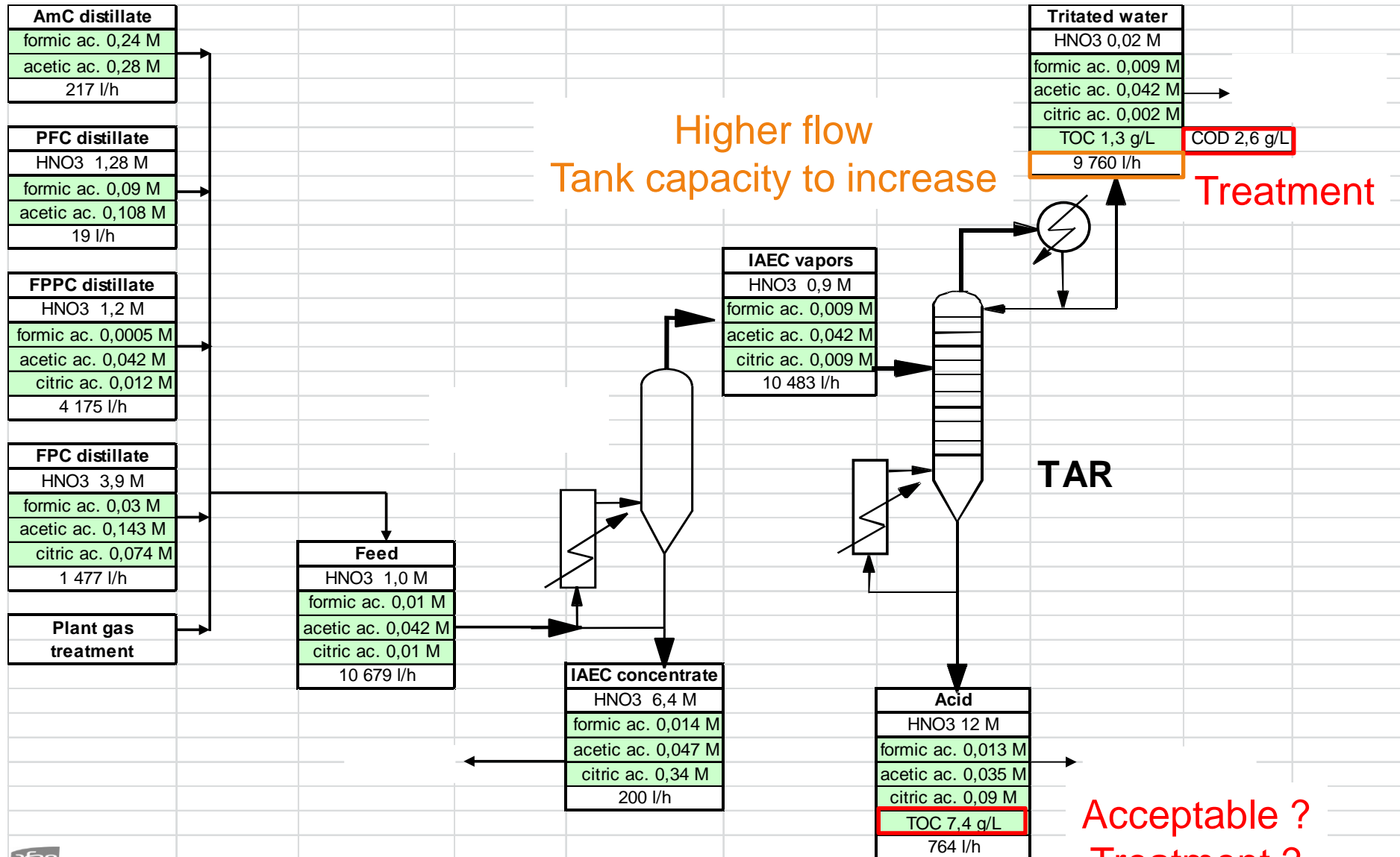


FP precipitate ?  
 TEDGA ≈ 33% TOC

TOC < 550 mg/L  
 (4.5 months)



# IA Effluents Concentration (IAEC) + Tritiated Acid recycling (TAR)



- Nothing prohibitive but :
  - $[TOC]_{\text{vitrification}} < 550 \text{ mg/L}$  due to radiolysis.
  - $[TOC]_{\text{recycled acid}}$  higher than current values (no specification). A treatment may become necessary in case of TOC limitations.
  - $[TOC]_{\text{sea release}}$  higher than current regulatory requirements. A treatment should be studied. Higher capacity tank will be necessary.
- Assumptions to be refined : effect of grouped destructions ? Destruction of TEDGA? Destruction of carboxylic acid?

# EXAm on a concentrated PUREX raffinate (CF = 3.5, [FP] ~ 36 g/L)

- Main changes :
  - HDEHP from 0.3M to 0.45 M.
  - HEDTA added (complexing reagent for Pd)
  - Flow rates adapted to feed solution
  
- 2 flowsheets simulated (with and without TEDGA) with same target performances (2 models but modelling assumptions are not detailed here)
  - TEDGA : Am extraction – Cm scrubbing (40%) + Ln stripping (60%).
  - Models for flowsheet without TEDGA less terminated
  - Same feed solution flow rate (50 mL/h)
  - Higher number of stages compared to flowsheet with TEDGA (162 stages instead of 72)
  - Higher organic and aqueous flow rates compared to flowsheet with TEDGA

# EXAm on a concentrated PUREX raffinate (CF = 3.5, [FP] ~ 36 g/L)

Flow (M/h)	EXAm (with TEDGA)	EXAmCO (with TEDGA)	EXAmCO (without TEDGA)
TEDGA	134.5	152.3	0.0
HEDTA	0 (*)	28.2	48.8
DTPA	2.23	10.0	31.2
NaOH	464.0	804.4	1163.0
HNO3	8723	4761	10966
Citric acid	464.0	132.3	249.9
Malonic acid	66.9	97.0	308.7
Oxalic acid	222.5	235.2	3528

(\*) HEDTA not used yet


# EXAm on a concentrated PUREX raffinate (CF = 3.5, [FP] ~ 36 g/L)

		EXAm (with TEDGA)	EXAmCO (with TEDGA)	EXAmCO (without TEDGA)
Vitrification (FP)	Flow rate (L/h)	90	90	90
	TOC (mg/L)	0.059	0.063	0.008
Recycled acid (12M)	Flow rate (L/h)	764	516	1209
	TOC (mg/L)	7.4	5	4.5
Sea release (tritiated water)	Flow rate (L/h)	9760	4337	13488
	COD (g/L)	2.6	7.0	2.9
	Annual COD (t/year)	121.8	145.7	187.8

- Vitrification (TOC)
  - Meet specification in every case (lower without TEDGA).
  - No significant impact of concentration.
- Acid recycling (TOC)
  - Same order of magnitude, lower with EXACO. A treatment may become necessary in case of TOC limitations (same conclusion as a non concentrated PUREX raffinate).
  - BUT flow rates are significantly different. Removing TEDGA lose the benefit to concentrate feed solution.
- Sea release (COD)
  - Treatment remains a challenge in every case. EXACO with TEDGA closest to annual COD but more concentrated
  - $COD(EXACO \text{ with TEDGA}) > COD(EXACO \text{ without TEDGA}) \sim COD(EXAm)$ . Removing TEDGA lose the benefit to concentrate feed solution.

**Removing TEDGA lose the benefit to concentrate feed solution for acid recycling and sea release. Necessary to find another complexing reagent for Ln stripping.**

**Meeting COD specifications will be the main challenge for aqueous effluents management**



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