Improvements in copper heap leaching by addition of wetting agents

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Project introduction - improving Cu heap leaching

BASF The Chemical Company

Background:

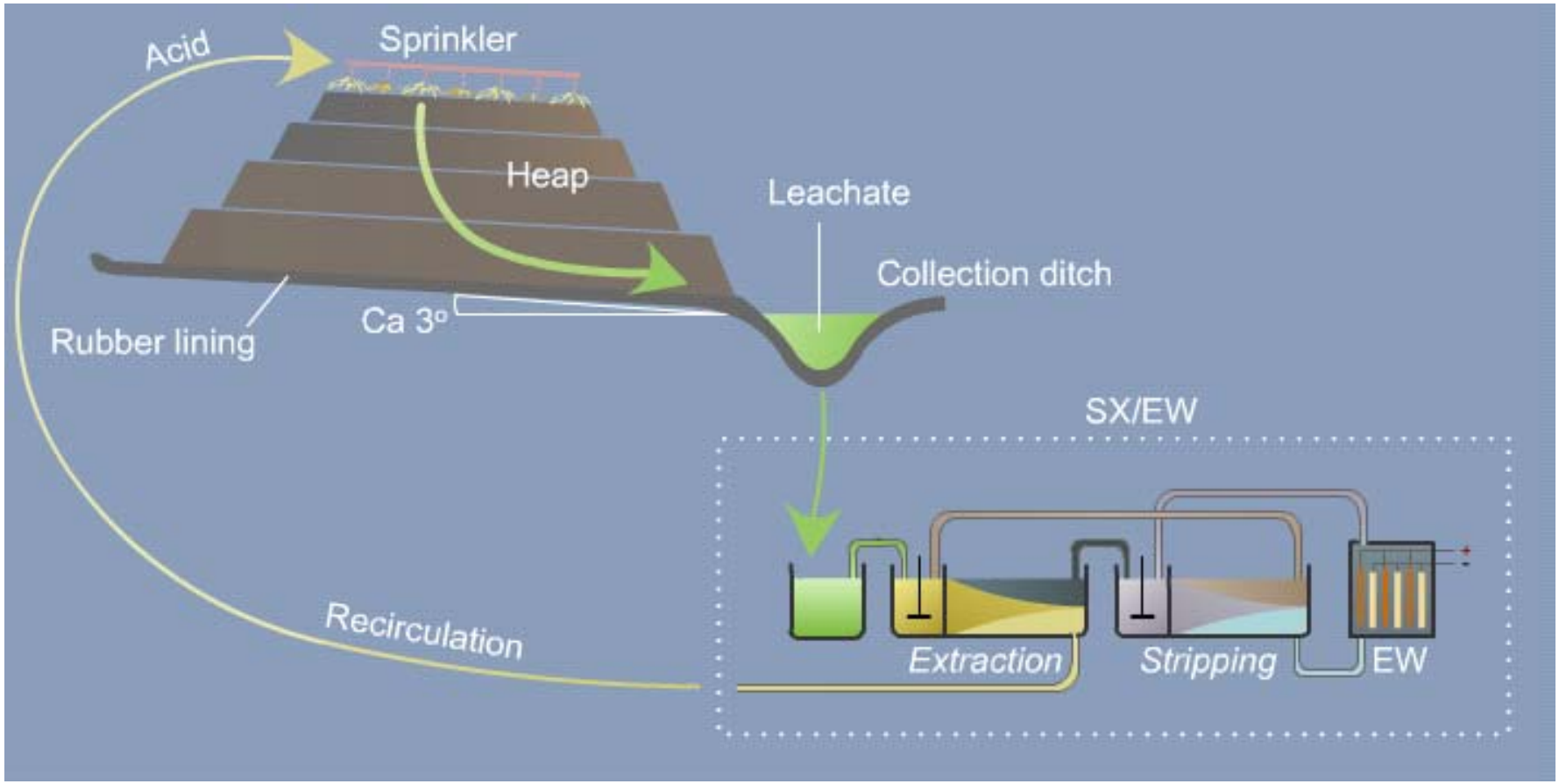
- annually rising demand of copper ⇨ increasing prices
- approx. 20 % of primary world Cu production by heap leaching processes + SX/EW
- so far recovery of conventional heap leaching processes range by 75-80 % of the ore‘s Cu-content during leaching periods of several months

Target:

- Improve productivity (recovery and leaching kinetic)

⇨ **by addition of wetting agents**

Heap leaching of copper ores



- "reactor" volume: 100,000-500,000 t ore
- retention time of solution: 2-7 days
- leaching duration: several months

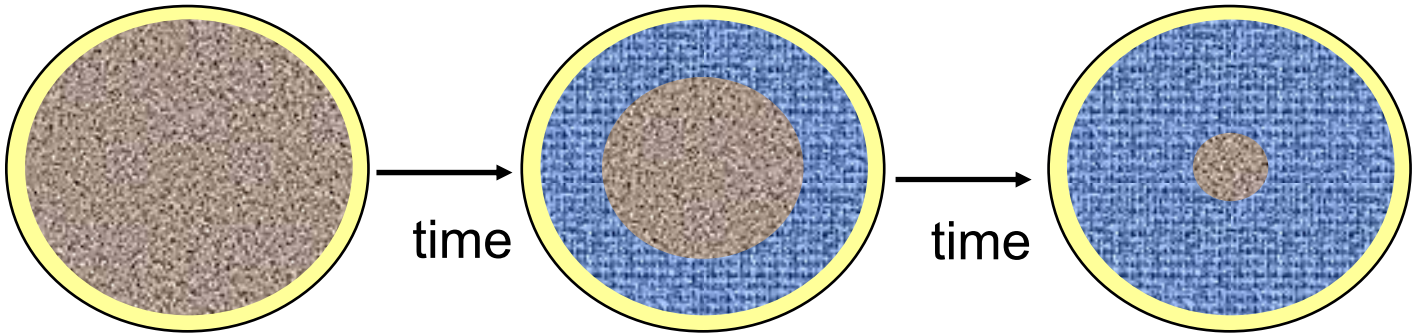
Heap leaching of copper ores

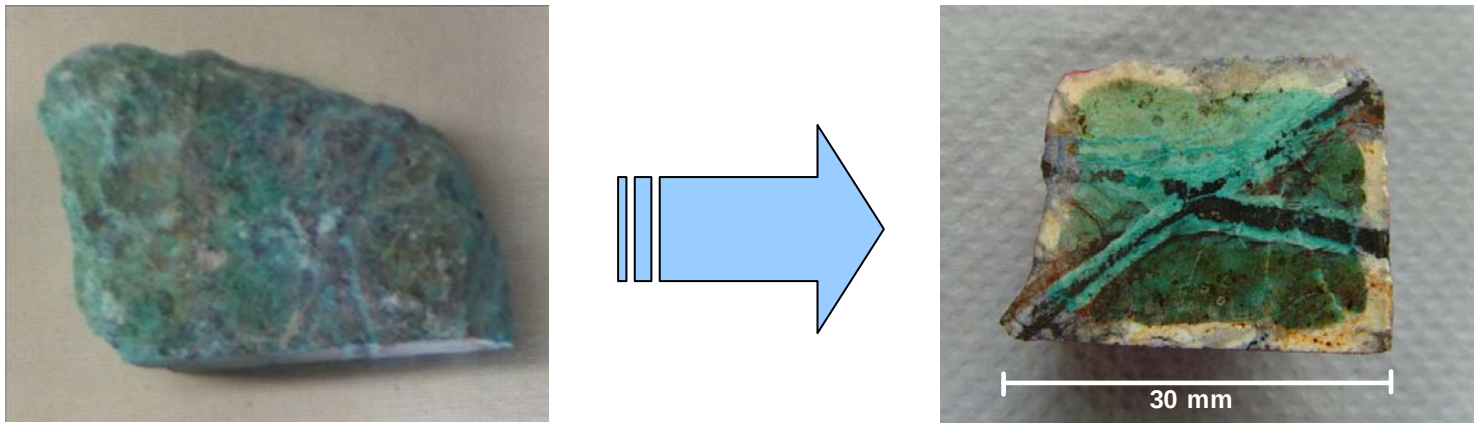
stacker unit

sprinkler system

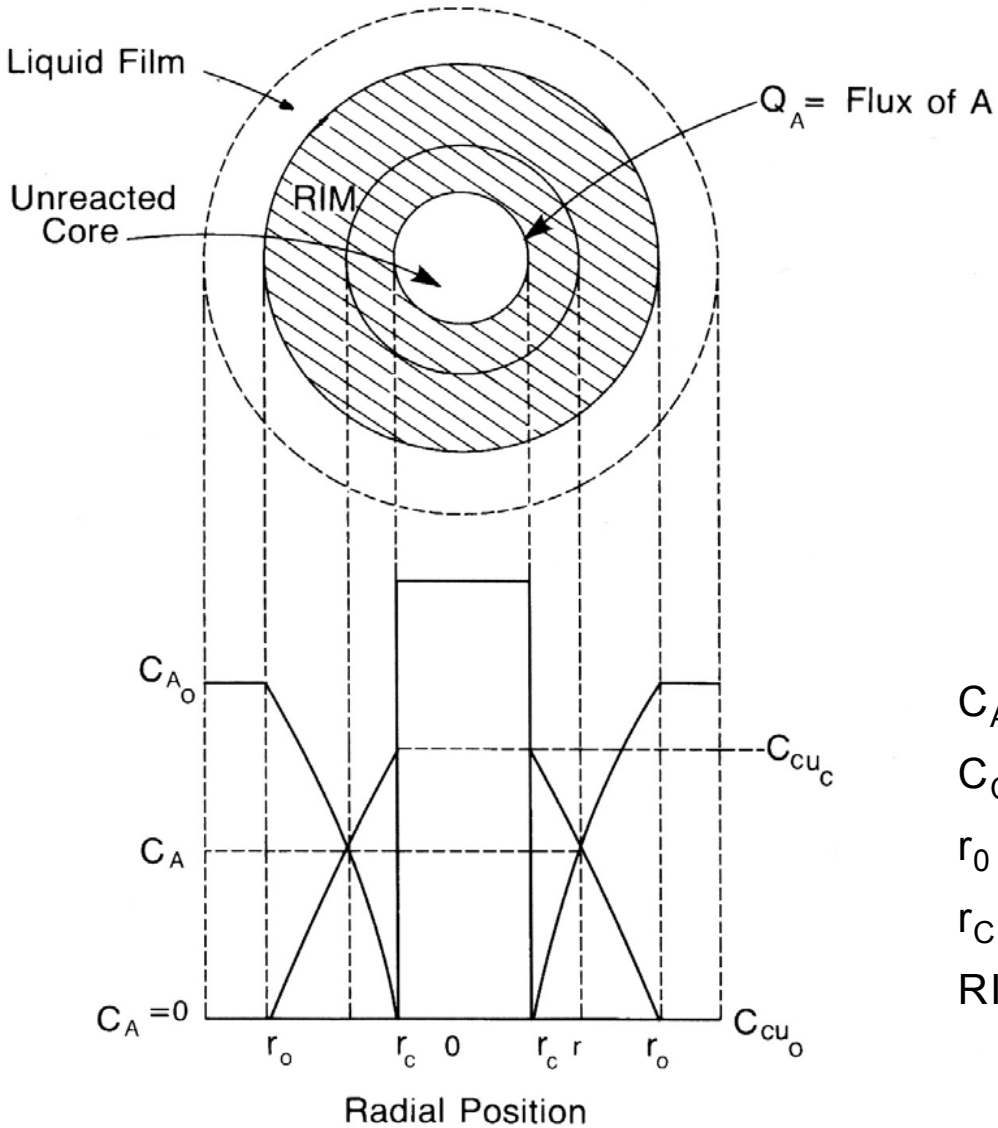
Principles

Model: shrinking core





Leaching model (1)



1st Fick's law

$$\frac{dn_{Cu}}{dt} = A \cdot D_{eff} \cdot \frac{dc_{Cu}}{dr}$$

C_A = acid content

C_{Cu} = leached Cu content

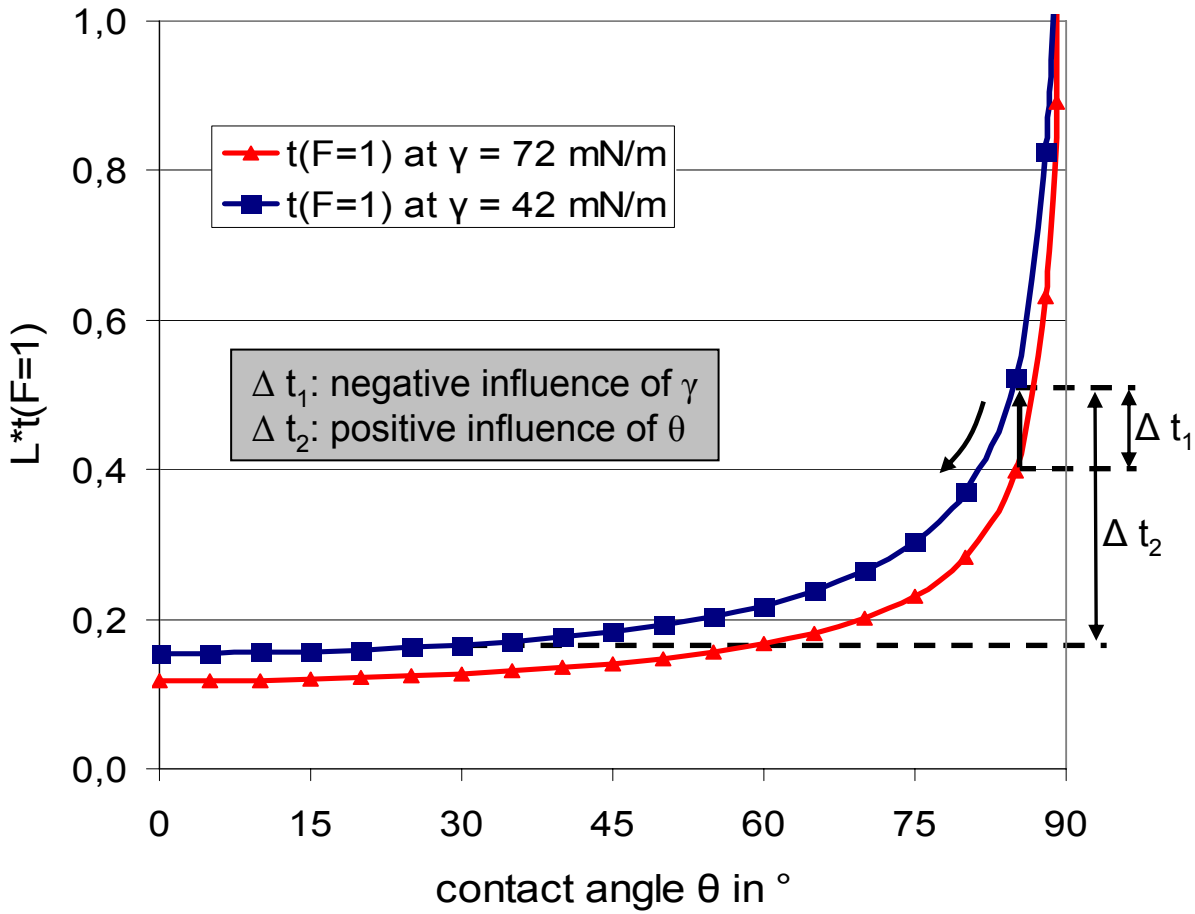
r_0 = starting radius of particle

r_C = radius of unreacted core

RIM = leached core shell

Leaching model (2)

$$t(F=1) = \frac{2 \cdot B \cdot r_0^5 \cdot \tau}{3D \cdot C_{A,0} \cdot n_K \cdot r_K^2} \sqrt{\frac{2\eta}{r_K \cdot t_p \cdot \gamma_L \cdot \cos\theta}}$$



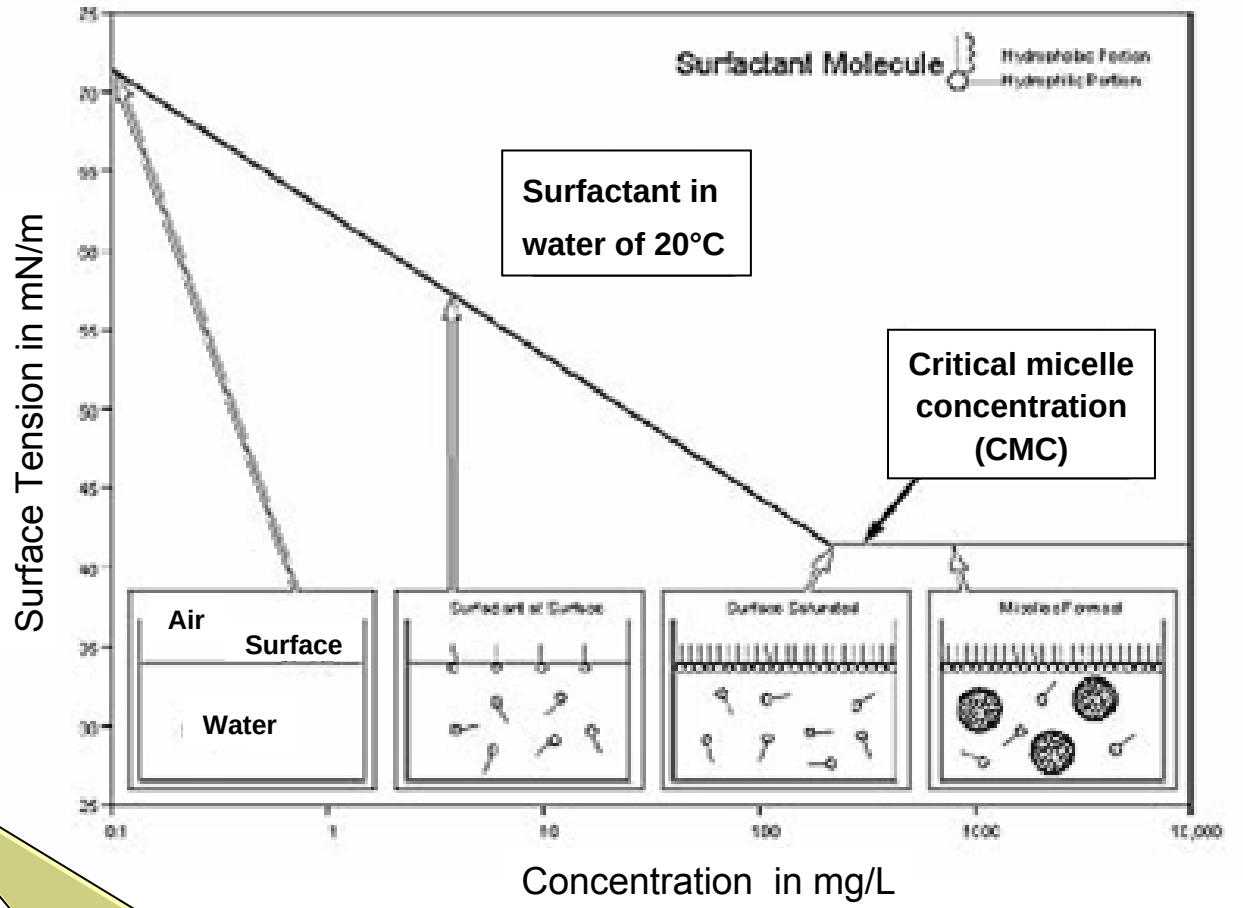
Requirements of wetting agents

By analysis of the previous attempts to introduce wetting agents to leaching processes the following performance profile was developed:

Requirements for heap leaching process:

- good wetting performance at process temperature
- improved capillary penetration of ores
- no negative impact on further processing steps (SX, EW)
- economically acceptable concentration
- stable in leaching solution
- low foaming
- biodegradable / not eco-toxic

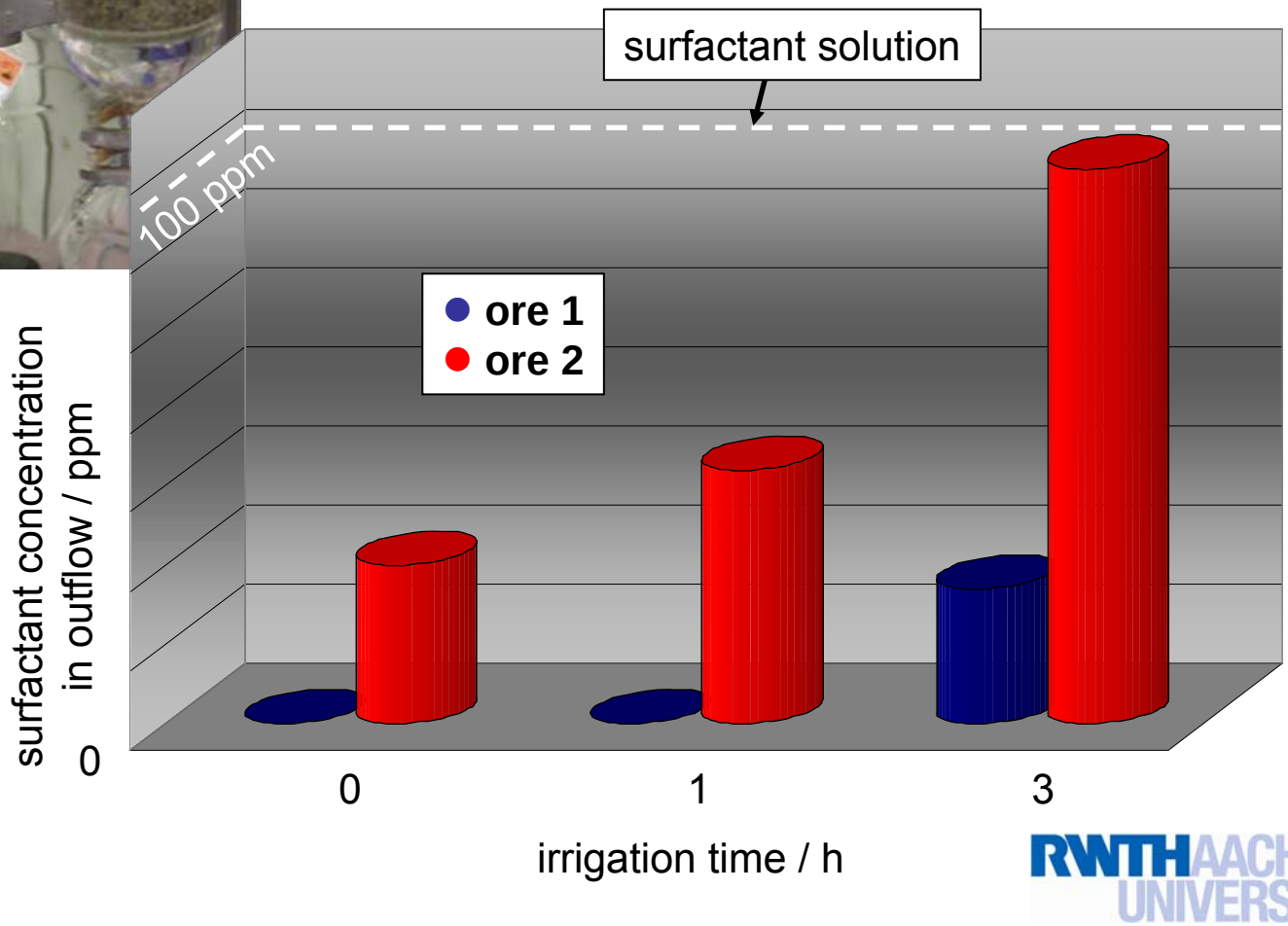
Criteria 1 - surface tension and CMC



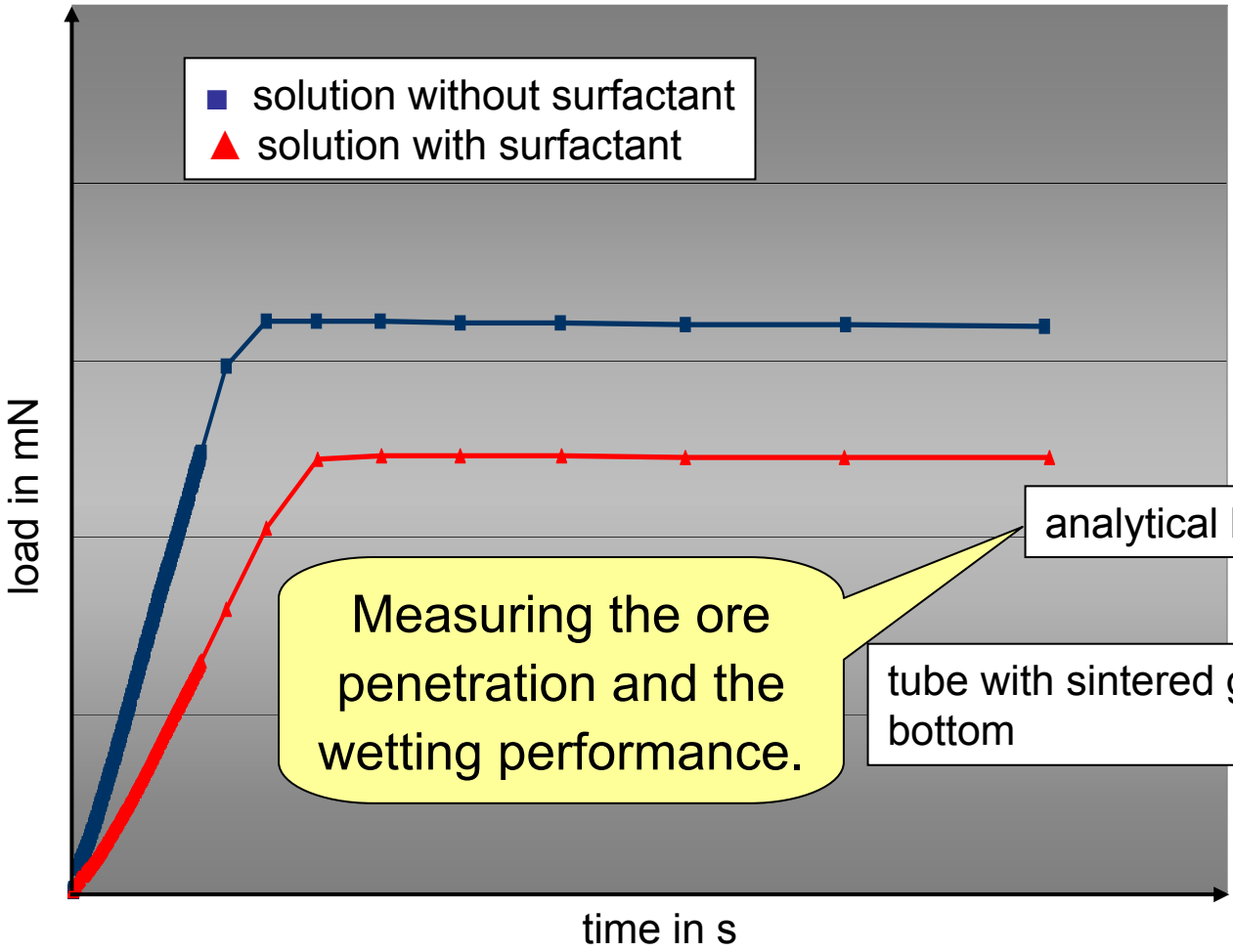
Determination of the optimum dosage concentration.

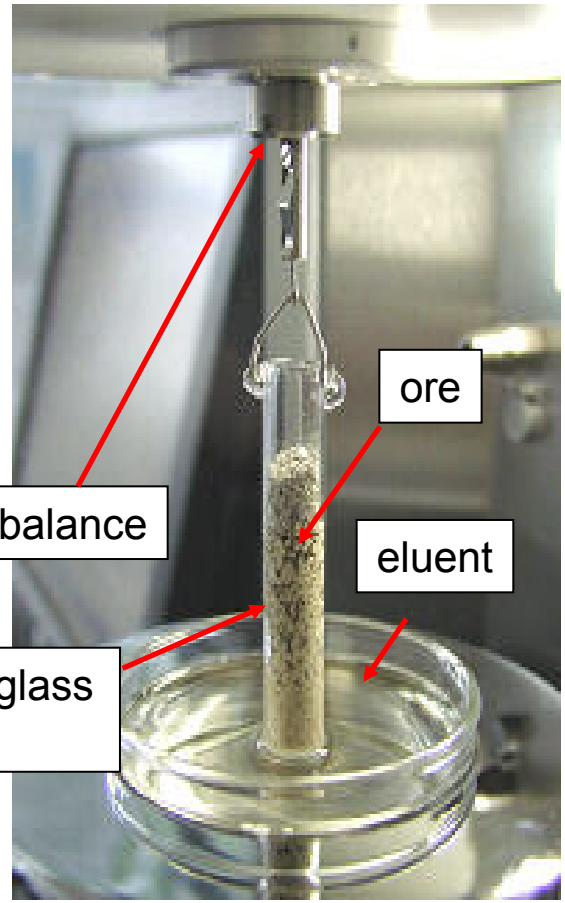
Criteria 2 - adsorption rate

Measuring the adsorption rate by miniature column test.



Criteria 3 – capillary penetration





Column trials at IME

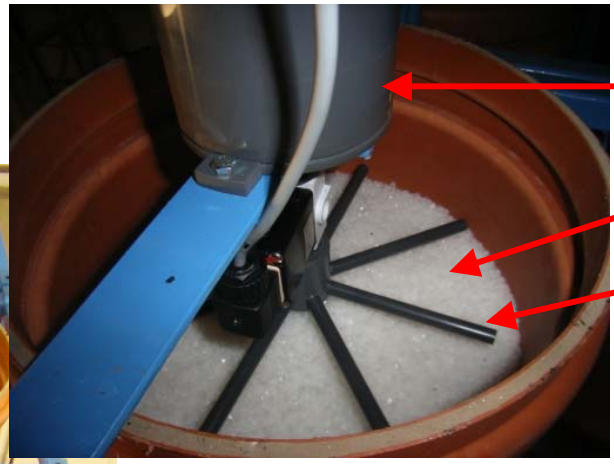
experimental set-up:

- 8 columns, H = 2150 mm, D = 300 mm
- perforated stainless steel base
- filling level: 2000 mm
- volume: appr. 0.14 m^3
- ore weight: appr. 200 kg / column

ore:

- origin: Cerro Colorado, Chile
- particle size: 1 – 30 mm
- Cu-content: 1.05 wt-%

Experimental set up

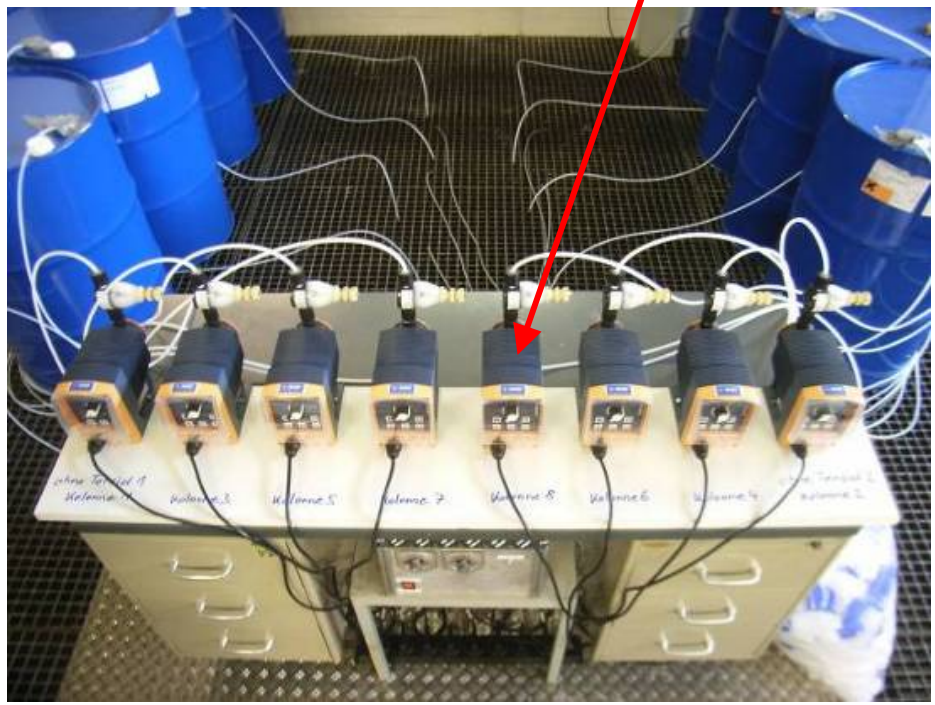


storage vessel

PE granulate

sprinkler

valve timing pumps



Experimental procedure

column	additive	BASF lab No.
1 + 2	blank	-
3 + 4	nonionic surfactant (fatty alcohol alkoxylate)	EVD61549
5 + 6	nonionic surfactant (fatty alcohol alkoxylate)	RD159491
7 + 8	anionic surfactant (alkyl ether sulfate)	EVD63635

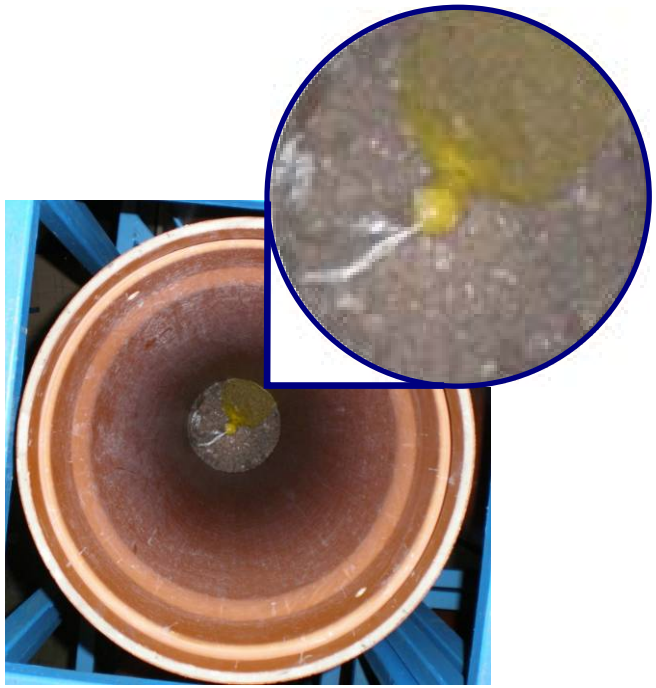
conditions:

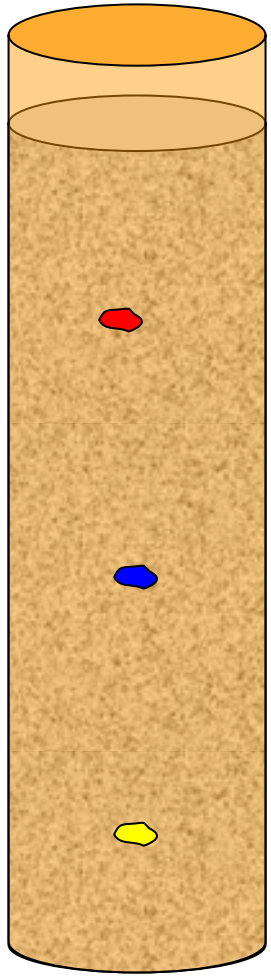
- **test duration:** 4 weeks
- **throughput:** 0.7 l/h column (10 l/h per m^2)

concentrations:

- **H_2SO_4:** 2 %
- **surfactant:** 0.01 %

Determination of adsorption rate with PE nets





total height 215 cm

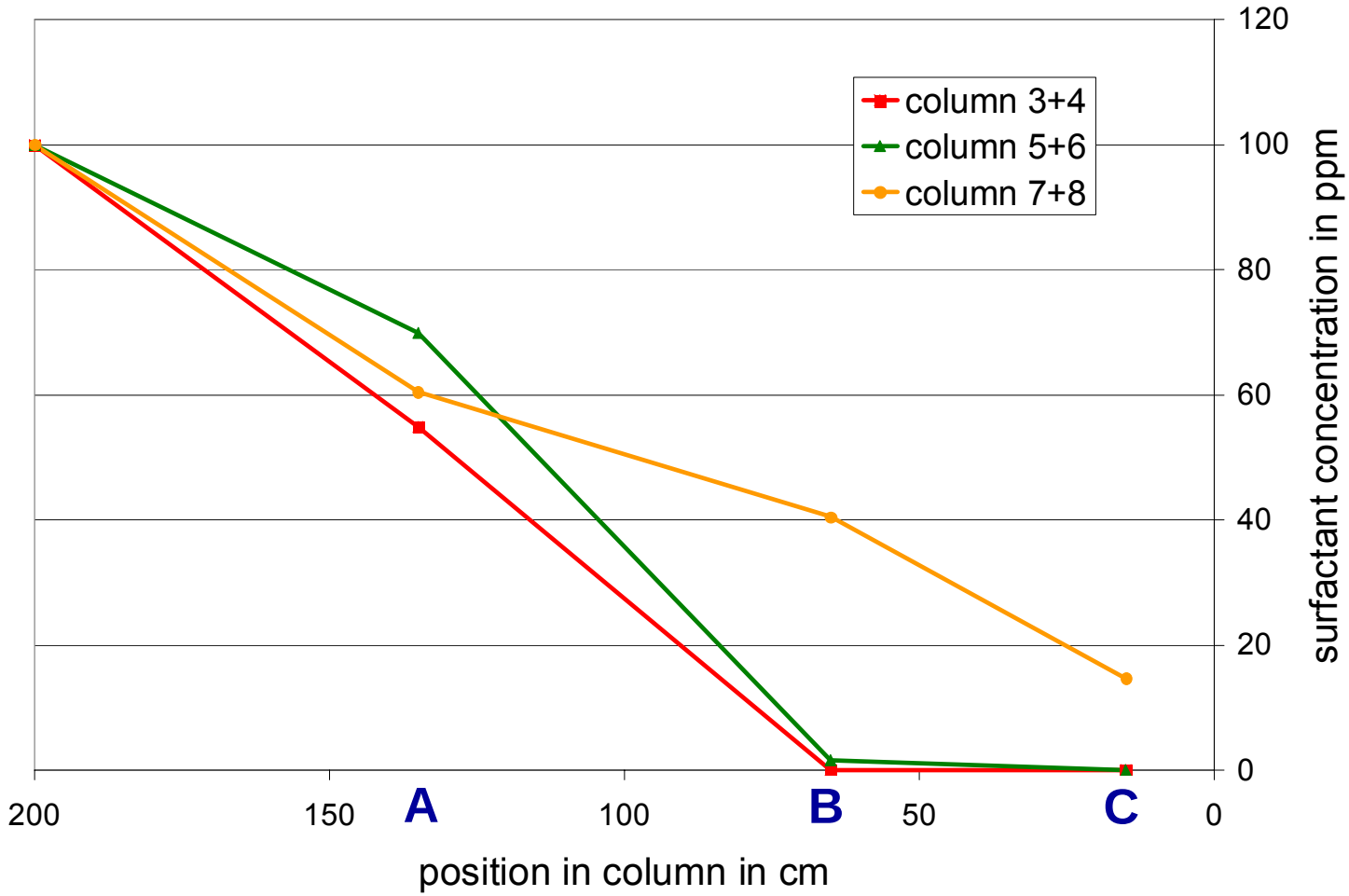
filling level ore 200 cm

sample A 135 cm

sample B 75 cm

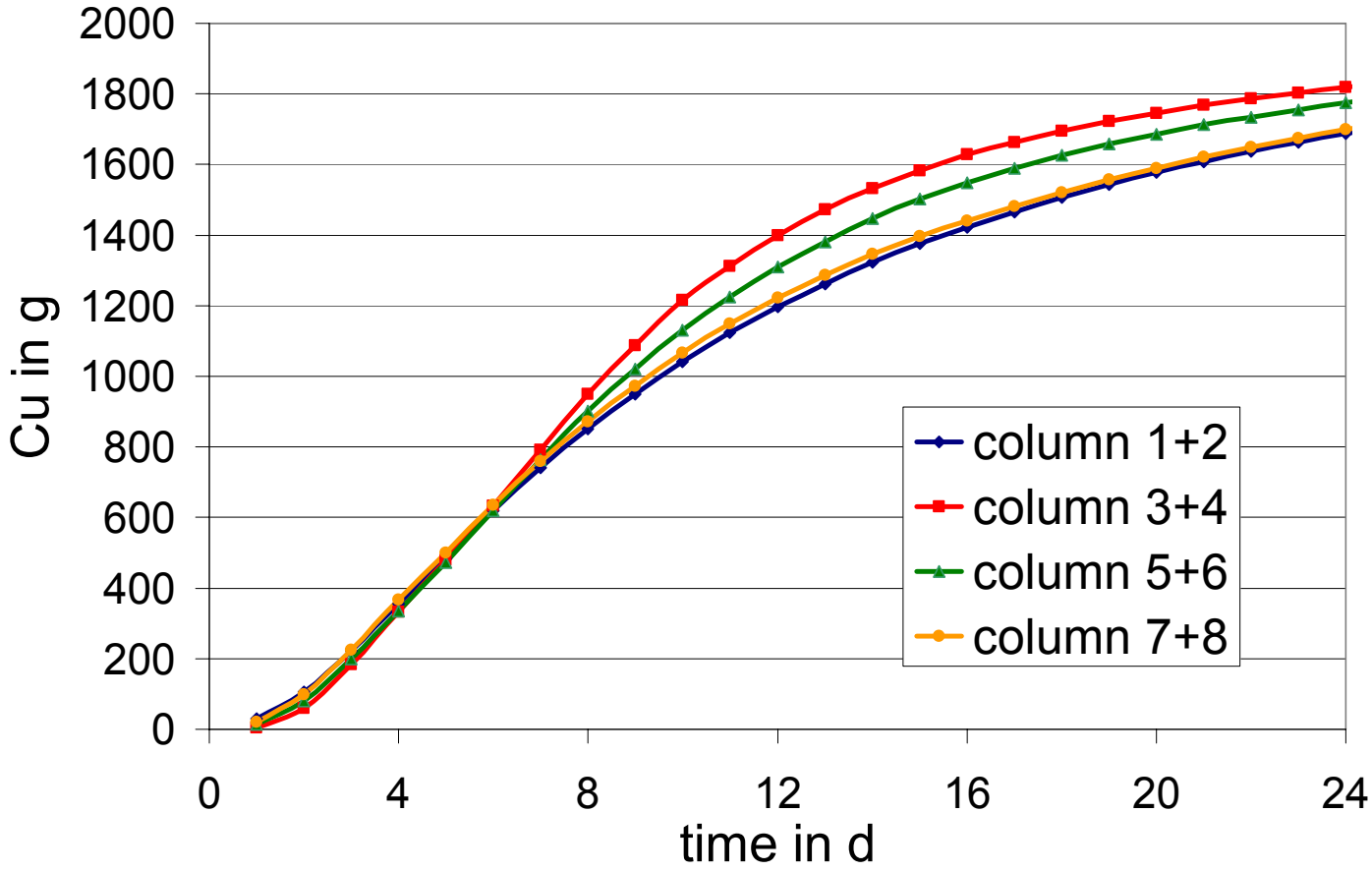
sample C 15 cm

Spreading of wetting agents



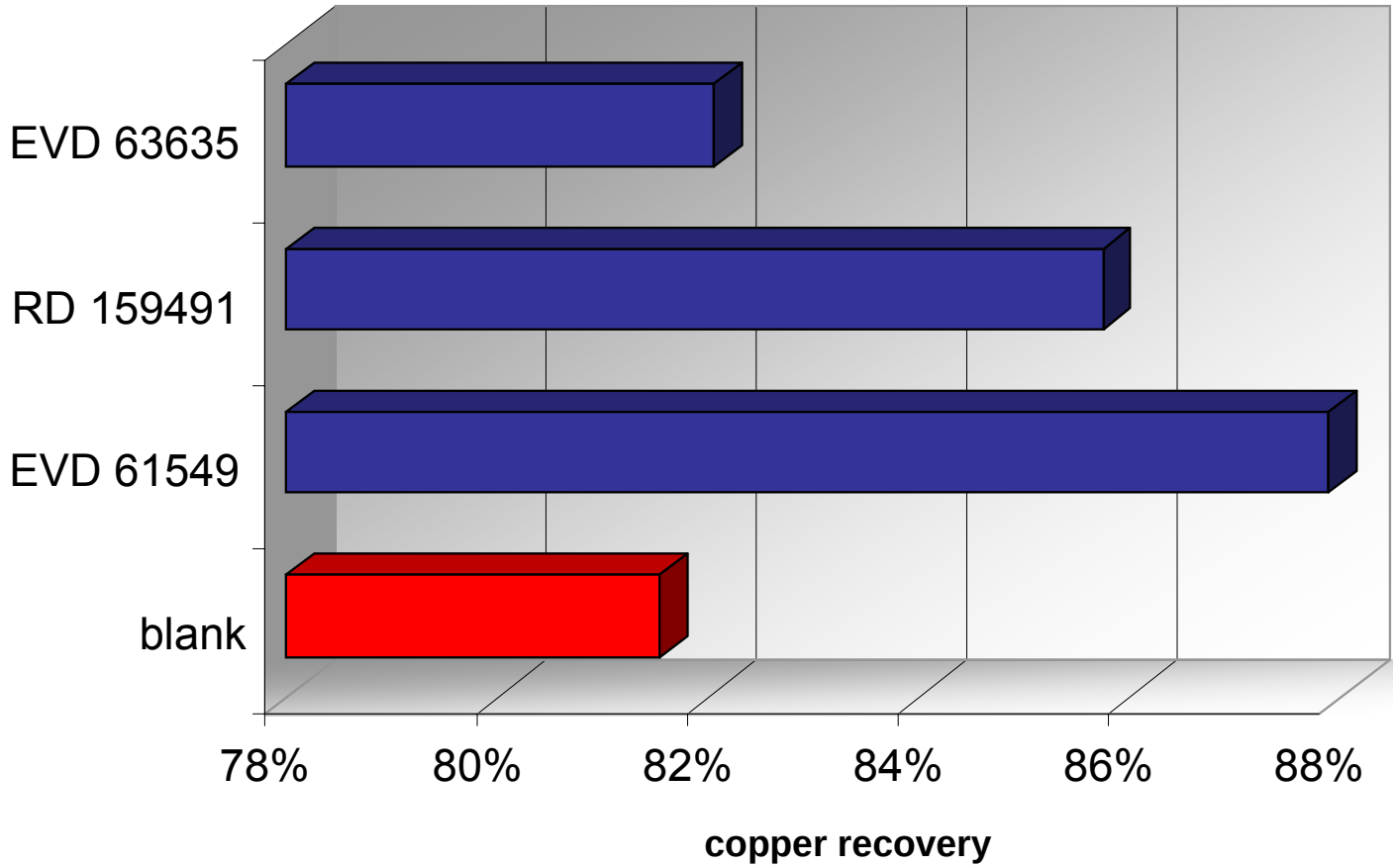
Relatively strong adsorption of all wetting agents

Copper extraction



nonionic wetting agents improve Cu extraction

Copper recovery



improvement of leaching efficiency up to 6 %

Summary and Outlook

Summary:

- proof of concept has been successful:
  - nonionic wetting agents may improve the kinetic of leaching and copper extraction rate
  - still too high adsorption rate for the nonionic wetting agents depending on the ore
  - anonic wetting agents did not achieve a higher extraction rate

Outlook:

- optimization in progress with regard to:
  - wetting performance
  - adsorption rate
  - proof of transferability to other acid leaching technologies e.g. Ni
- new trials are planned in Aachen with improved wetting agents

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Thank you
for your attention.

Ilginize tesekkur ederiz.

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