# Hydrometallurgical Treatment of EAF Dust by Direct Sulphuric Acid Leaching at Atmospheric Pressure

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## The Issue

The issue dealt with in this research work is the zincferous dust generated in steel plants which use the Electric Arc Furnace technology.

The EAF dust contains heavy metals (Zn, Cd, Pb), it has been classified as a hazardous waste and it is not allowed to be disposed of in the open air.

In Greece, the steel plants generate at full capacity ~35000t/y. As there are no disposal facilities for hazardous wastes, the options available are:

i. To send the dust abroad (Waelz Process).Transportation plus treatment fees amount to at least 140€/t of dust

ii. To build a plant of their own, in Greece, to treat the dust by the Waelz Process. However, this process is economic for annual capacities of at least 100000t.

## The Aim

To develop an integrated, purely hydrometallurgical process to treat the EAF dust efficiently and economically, even for low capacities, based on agitation leaching with dilute sulphuric leaching at atmospheric pressure.

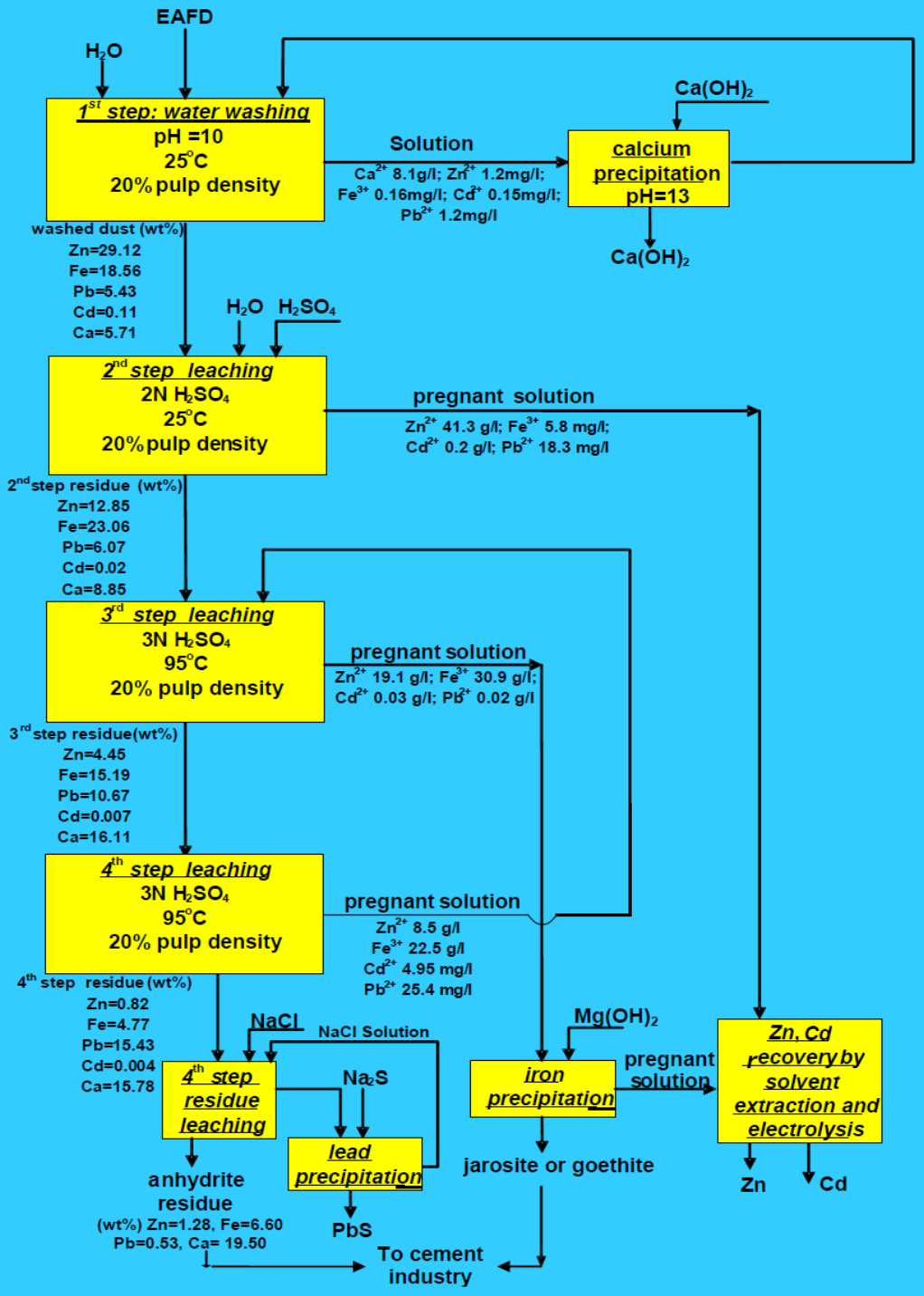
## Chemical Analysis (wt%) of the EAF dust (from Halyvourgiki)

| Element | Content (wt%) |
|---|---|
| Zn | 22.73 |
| Fe | 14.40 |
| Pb | 4.22 |
| Ca | 13.32 |
| Cd | 0.09 |
| Si | 1.45 |
| Mn | 1.00 |
| Mg | 0.70 |
| Cl | 4.75 |
| Na | 1.25 |
| K | 1.61 |

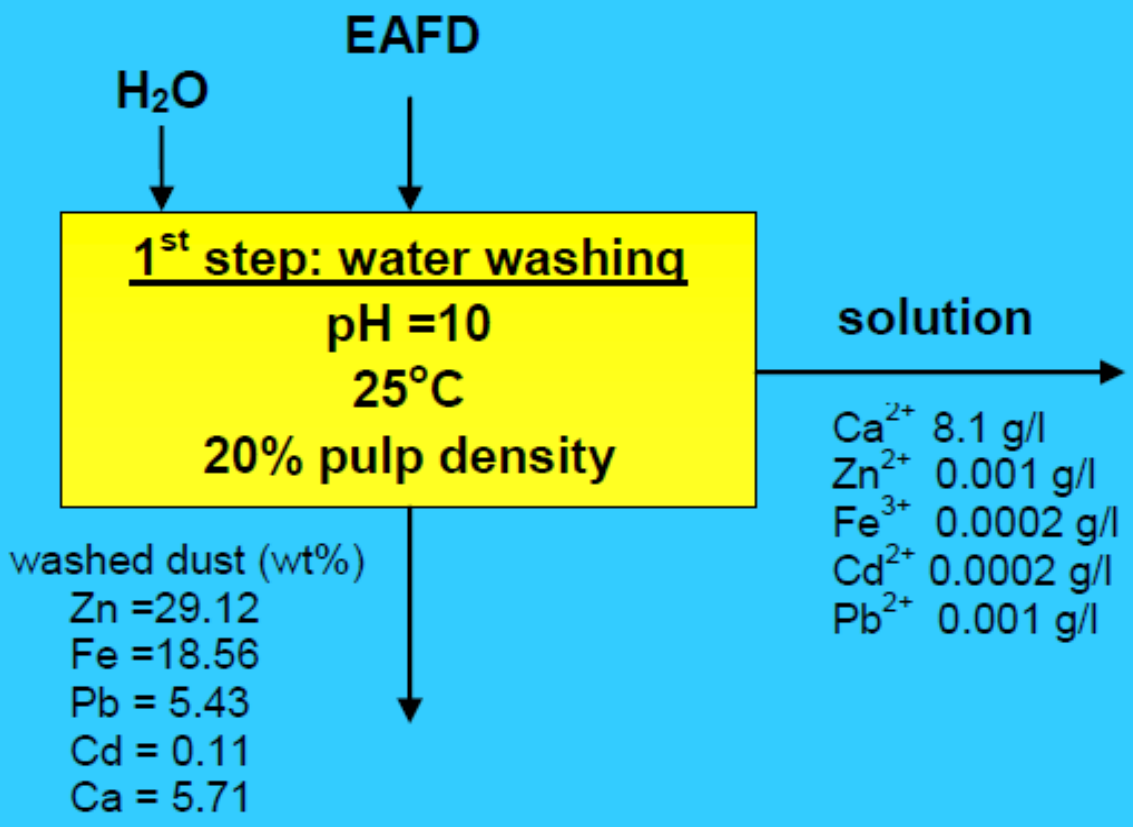
## Main Mineralogical Phases present in the EAF Dust

| | |
|---|---|
| **Zn :** | **$ZnO$** |
| | **$ZnO.Fe_2O_3$** |
| **Fe :** | **$ZnO.Fe_2O_3$** |
| | **$Fe_3O_4$** |
| | **$Fe_2O_3$** |
| **Ca :** | **$Ca(OH)_2$** |
| | **$CaO$** |
| | **$CaSO_4$** |
| | **$CaCO_3$** |
| **Pb :** | **$PbO$** |
| **Cl :** | **$NaCl$** |
| | **$KCl$** |

# Conceptual Flow-sheet of the Hydrometallurgical Process for the Treatment of EAFD



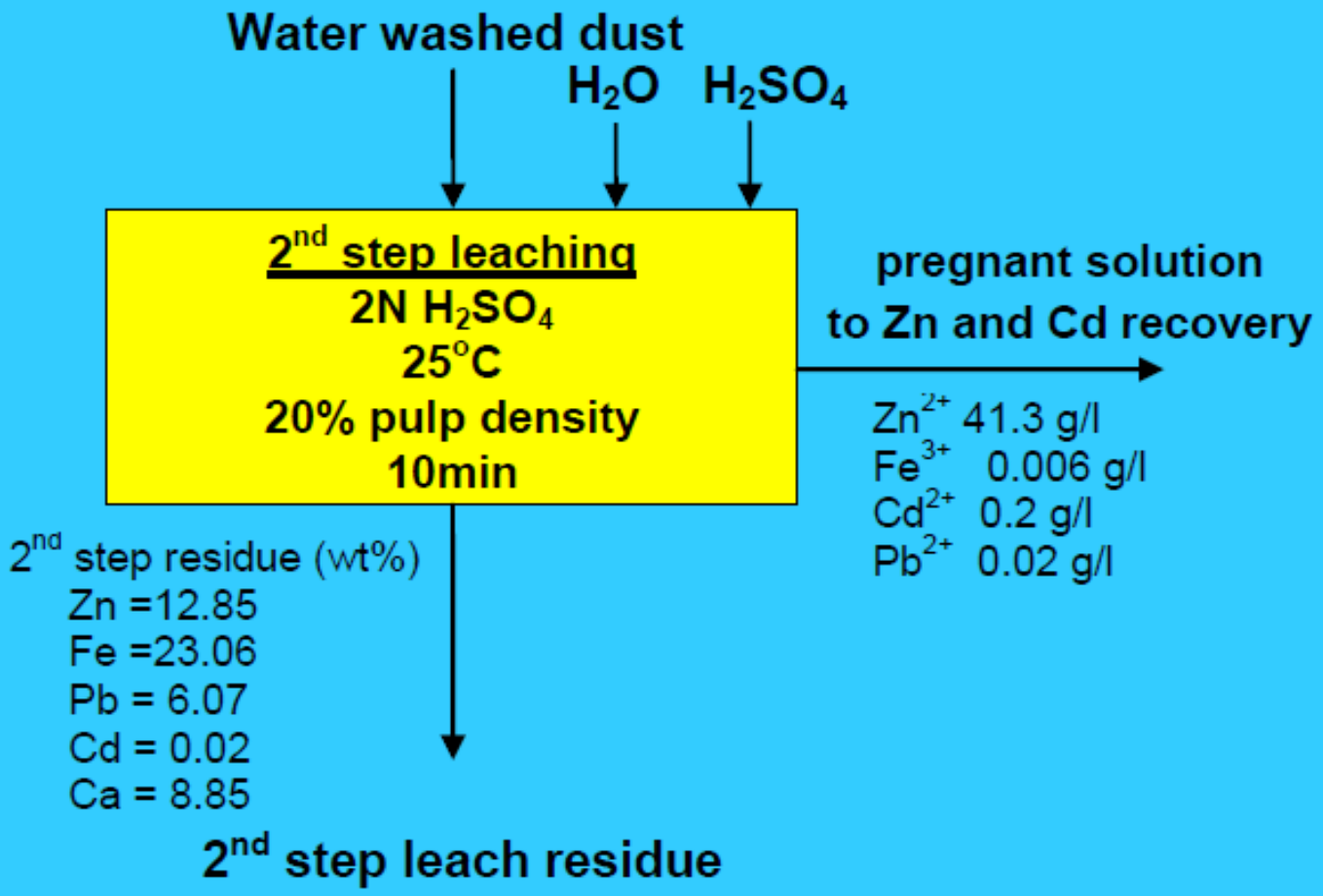
## Water washing of the EAF Dust




## *Conclusions*

- **More than 50% of the calcium present in the dust was leached out without any Zn, Cd, Fe, Pb co-dissolution**
- **Only calcium in the form of free CaO can be washed out with water**
- **Chloride ions were completely removed**

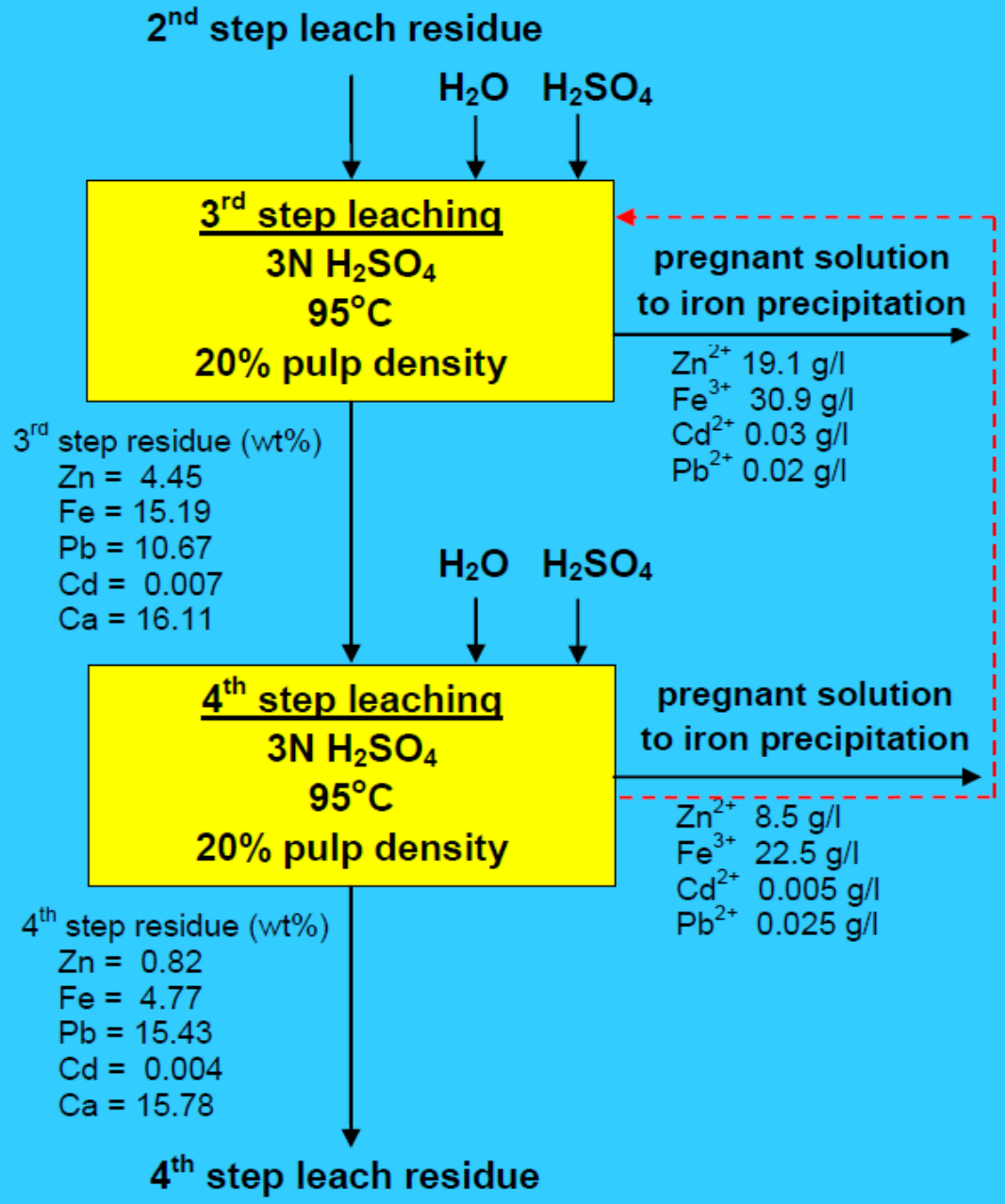
## 2nd step leaching




## *Conclusions*

- Almost complete dissolution of the free ZnO was accomplished
- Zinc and cadmium recoveries were 70% and 90%, correspondingly
- Zn and Cd extraction was absolutely selective against Pb and Fe
- The dry weight of the residue was 67% of the initial dust dry mass

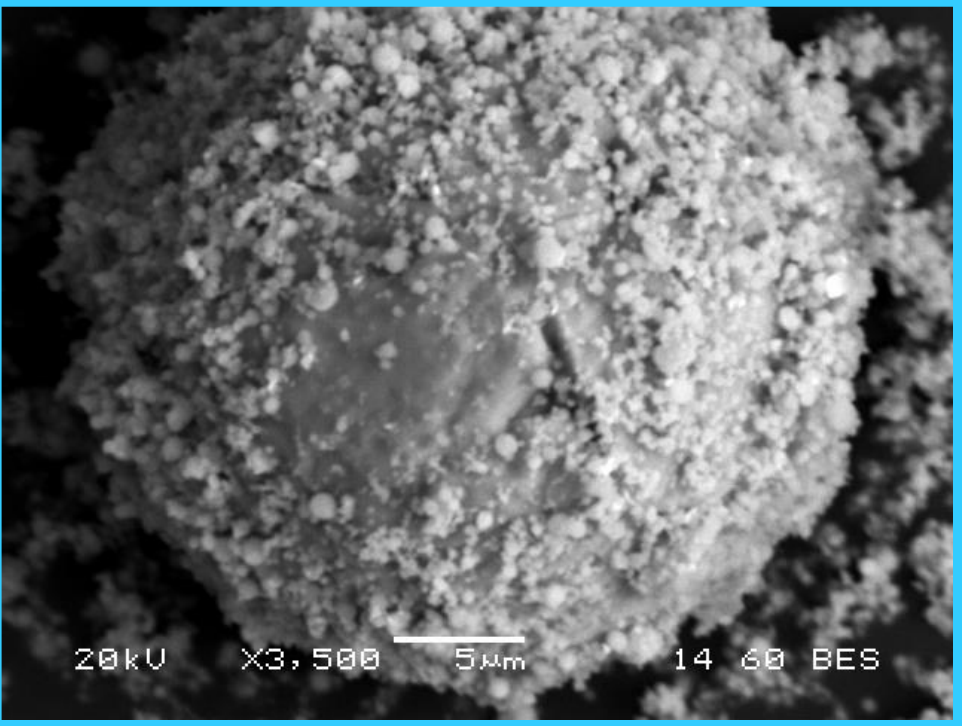
# 3rd and 4th step leaching



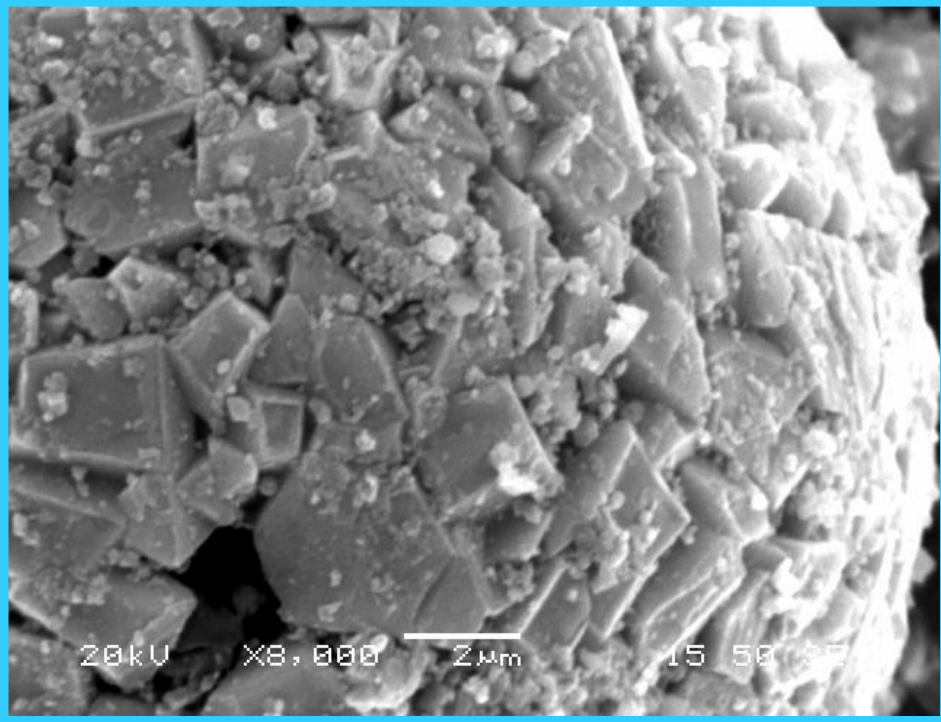

## *Conclusions*

- **Almost all zinc ferrite contained in the dust was dissolved in less than 2h**
- **The overall percent extraction values were 97% for Zn and 97% for Cd**
- **The 4th step leach residue consisted mainly of $CaSO_4$, $PbSO_4$ and $Fe_3O_4$**
- **Its dry weight was approximately 27% of the initial dry mass of the dust treated**

# SEM micrographs of EAF dust during leaching

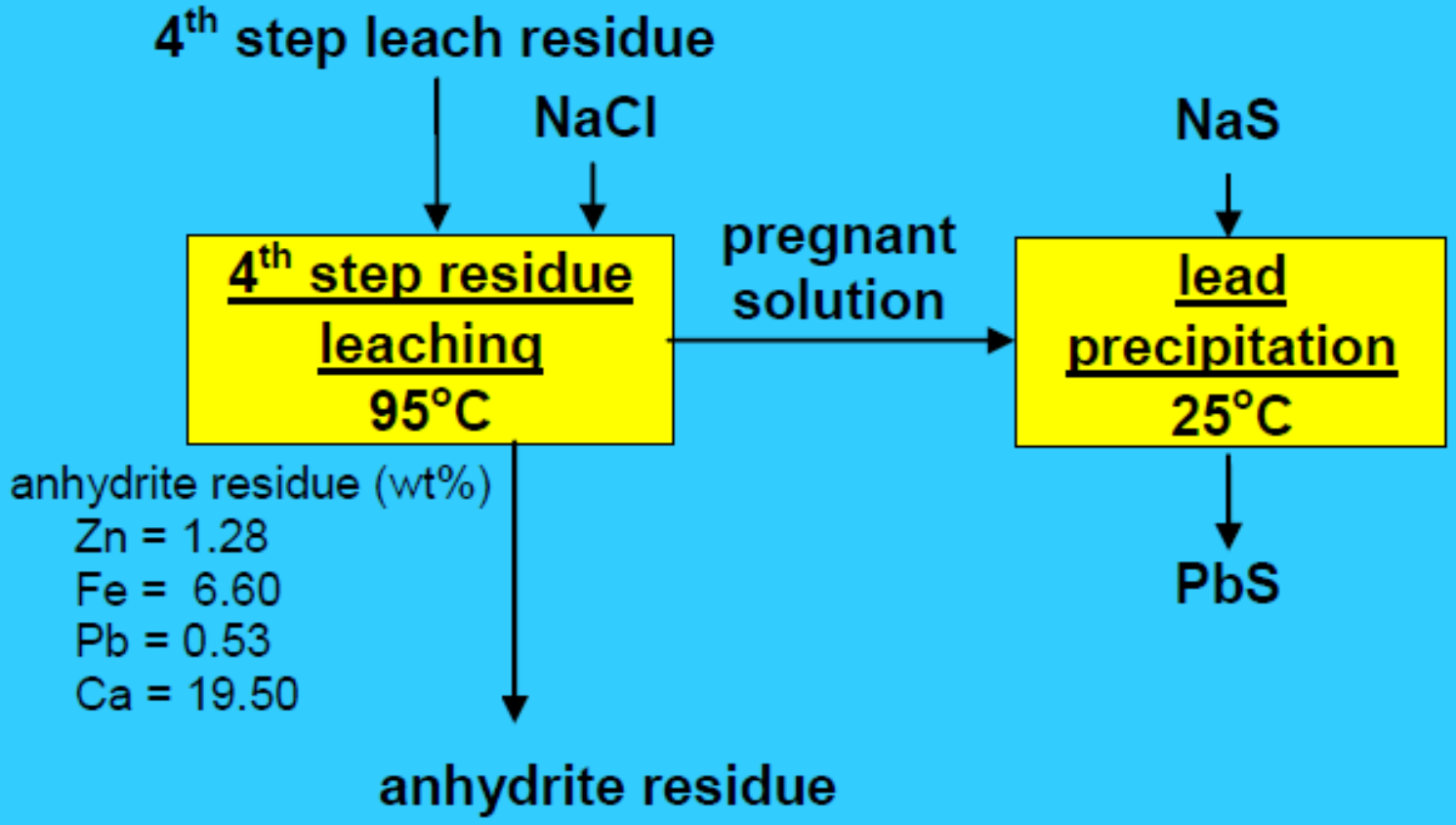



A spherical particle of zinc ferrite with many small grains of ZnO




A zinc ferrite grain in the course of leaching

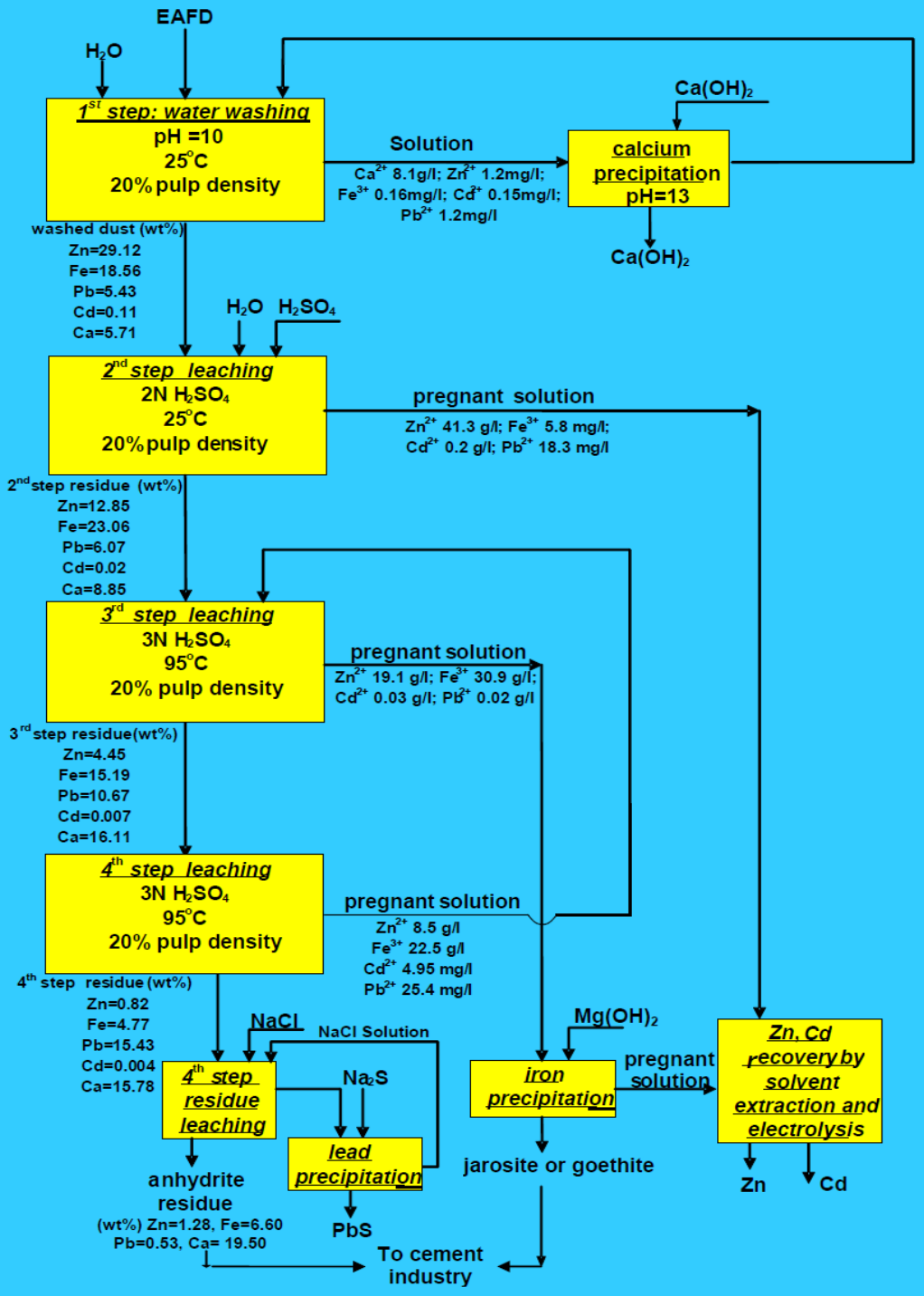
## Lead recovery




## *Conclusions*

- **Lead can finally be recovered as PbS, a saleable product**
- **The final leach residue consists mainly of anhydrite and magnetite and is acceptable as a raw material in the cement industry**
- **This residue was about 20% of the initial dry mass of the dust treated**

# Conceptual Flow-sheet of the Hydrometallurgical Process for the Treatment of EAFD



# General Conclusions

- The proposed hydrometallurgical method, based on direct agitation leaching of EAF Dust with dilute sulphuric acid at atmospheric pressure, is a possible, efficient and zero-waste method for the extraction of useful metals form the dust
- Continuous testing at a small pilot plant scale is a necessary step forward in order to assess its economic feasibility

## Acknowledgements

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