What companies are asking from researchers?

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AMD – long term problem

- **Acid mine drainage (AMD) is a major environmental problem facing many international mining and mineral industries worldwide.**
- **The leachate from such sites (rich in sulfate, iron, and soluble heavy metals) has the potential to contaminate the ground water as well as the local watercourses. The oxidation of sulfide minerals within mine wastes and workings may continue to release metals into the surrounding environment for decades to millennia.**
- **The characteristics of AMD include low pH, a high concentration of heavy metals and other pollutants, i.e. sulfates, acidity, and sometimes toxic chemicals.**

AMD – methods

The methods used for the control of AMD are classified in three general types:

1. **<u>Preventive methods -</u> to prevent acid generation and chemical leaching of heavy metals by:**

   a) inhibiting the contact of sulfides with either oxygen or water by the use of organic, composite and vegetative covers,

   b) eliminating the oxidation reaction bacteria,

   c) controlling pH using alkaline additives.

2. **<u>Containment methods -</u> to isolate the waste from the environment.**

3. **<u>Remedial methods -</u> to collect and treat the contaminated drainage either by active treatment methods or using passive treatment- engineered wetlands or permeable reactive barriers.**

AMD assessment

These methods are widely applied, but their cost is high.

- **Conventional AMD systems (at active mine sites) - expensive chemicals like lime, caustic soda, etc., which generate voluminous low density sludge. The disposal of this sludge is another environmental problem. It is often expensive both in terms of capital and operating costs.**
- **Passive treatment of AMD – many methods but usually low removal ratio.**

Therefore is necessary to develop of preventive methods that will be both effective in terms of environmental requirements and of low-cost.

Using LCA (Life Cycle Assessment) Analysis, could be beneficial, especially when combined with Environmental Risk Assessment (ERA) and Cost Benefit Analysis (CBA).

AMD in current research

Most of the research for waste area focused on:

- **the impacts to the surficial waters downstream,**
- **the tailings pore water chemistry,**
- **migration and geochemical evolution of contaminant plumes of tailings seepages.**

Less emphasise the geochemistry of the seepage waters.

The rehabilitation strategy for closing a mine and the costs of reclaiming such a site depend strongly on the acid generating potential of the wastes - conventional chemical neutralization and precipitation technology are reliable and effective, but tend to be impractical at abandoned mine sites. New solutions are welcomed.

EU cooperation is needed

Exchange best practice on AMD in European mining sites and promotion of innovative solutions for prevention and remediation is needed.

- Sigma for water project – good practise of cooperation – **www.sigmaforwater.org**
- Sigma is an acronym of *Sustainable InteGral Management Approaches;*
- Project is support from INTERREG IVC programme;
- Period of realisation: 2010-2013;
- 11 members from 8 UE countries;
- **Target:** improvement of water quality by extensive use of existing and newly formed lakes and wetlands also in post-mining area;
- In **Malopolska** there are over 15 post-mining queries which could be transferred into recreation water reservoirs, it depends on both quality of water as well availability of funds for management.

AMD in Poland – ZGH „Bolesław”

ZGH Boleslaw - mining and processing of zinc-lead ores. Gravity-flotation technology of Zn-Pb ore from 2.6 Mln Mg/year generate about 1.5 Mln Mg flotation waste.

Waste is stored at tailing pond, but the water is recycled to the ore treatment process.

There are three tailing ponds:

- Western pond - about 48.5 ha,
- Pond No. 3a - about 23.6 ha,
- pond No. 4 – about 37.4 ha.

ZGH „Bolesław”

Physico–chemical properties of flotation waste
$CaMg(CO_3)_2$ - 77%
FeS_2 - 17% (app. 8% Fe)
ZnS - 0.75% (Zn 0, 5%)
$ZnCO_3$ - 1% (Zn 0.50%)
$PbCO_3$ - 0.5% (Pb 0.40%)
PbS - 0.12% (Pb 0,1%)

KGHM
POLSKA MIEDŹ S.A.

KGHM Polska Miedź - biggest Cu and Ag producer in EU.
ore - 1.92% Cu
concentrate - 17-23% Cu, Ag, Au, Se
metals – Cu, Ag, Au.

Total surface area	**1,394 ha**
Tailings volume	**368 mln m^3**
Water volume	**8 mln m^3**
Water region surface area	**600 ha**
Beaches surface area	**748 ha**
Dam length	**14.3 km**

Element	Excavation Lubin, %	Excavation Polkowice, %	Excavation Rudna, %
SiO_2	68.20	19.63	50.80
CaO	6.96	25.60	13.08
MgO	3.97	3.60	5.53
Al_2O_3	4.63	5.29	4.24
Cu	0.17	0.26	0.21
Pb	0.05	0.025	0.046
Corg	0.24	0.30	0.91

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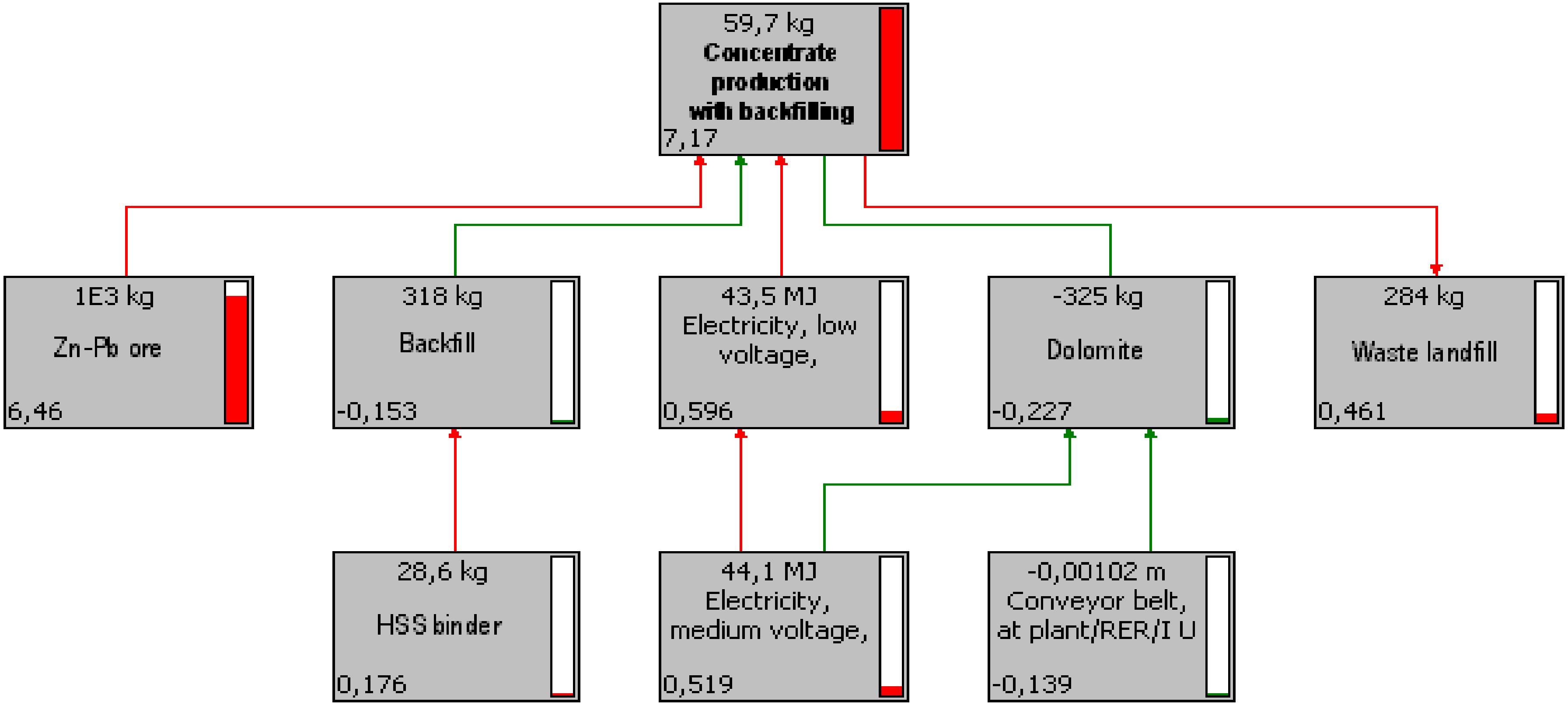
15 Mln m^3 flotation waste per year Horizontal Tailing Drainage Technology HOTdrains™ has been documented during CLOTADAM project (FP5).

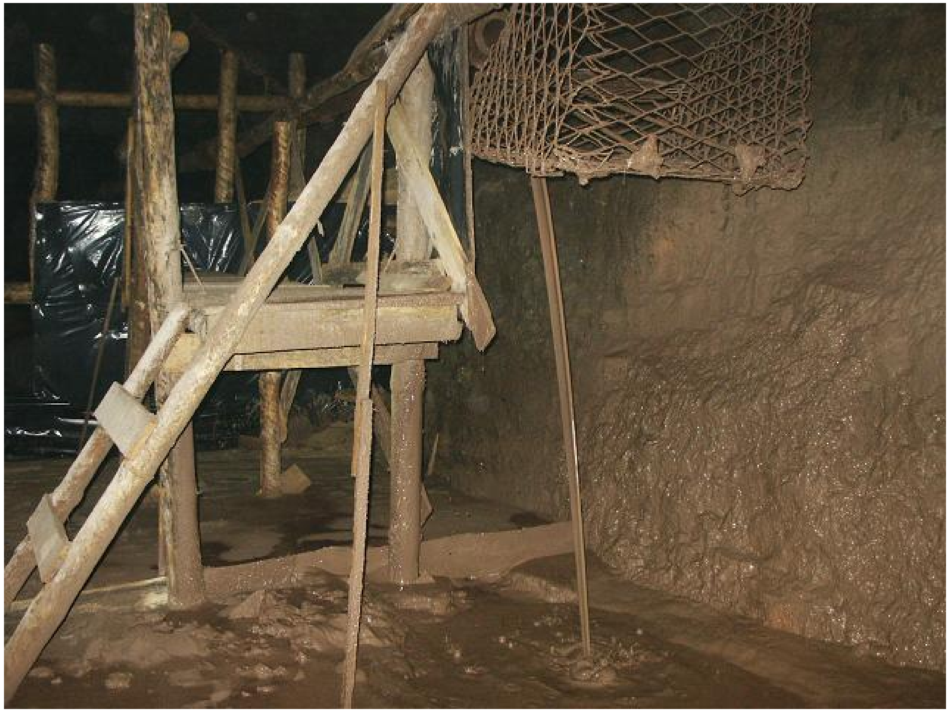
ZG Trzebionka – tailing pond

- **Total surface area 64 ha**
- **Chemical composition of post-flotation tailings: 0,57% Zn, 0,50% Pb, 0,37%ZnO, 0,39%PbO, 1,51% Fe, 34,96% CaO, 15,3% MgO, 0,007 Cd, 0,41% S, ...**
- **Physico-chemical characterisation of water extract (1:10)**
- **Ph 7,8, ChZT 18 mg O_2/dm^3, chloride 4 mg/dm^3, sulfide 75,5 mg/dm^3**

LCA for waste storage – the impulse for backfilling



Trzebionka – backfilling's instalation



LCA for comparison landfilling with backfilling

- **The environmental performance was evaluated by LCA for the concentrate production, assuming that 50% of waste was backfilled and 50% of waste was stored;**
- **Waste backfilling leads to decrease of the overall potential damage of 8.3% (measured in Points, for standard method - 7823 mPt, whereas for backfilling 7173 mPt);**
- **LCA assess the potential environmental effect.**

Conclusions

- **Acid mine drainage (AMD) is a major environmental problem facing many international mining and mineral industries worlwide.**
- **The additional requirements for dealing with environmental issues for mining waste (including AMD, ARD) can create these operations safer, but increase mine site costs.**
- **To identify all environmental aspects the LCA methodology could be applied, whereas for the cost calculation and financial guarantee the Life Cycle Cost could be taken into consideration.**

Thank you for your attention!!!

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