SUMMARY

DELIVERABLE D.1.1: ENVIRONMENTAL AND ECONOMIC IMPACT ANALYSIS OF THE CURRENT TREATMENT TECHNOLOGIES

Delivery Date: 31/10/2017

The main objective of this deliverable is to analyze the performance of the currently available techniques to treat mining effluents from an environmental and economic point of view. This task aims to set up a benchmark to compare the DEMINE technology with the available options. The environmental impact of the study is assessed by means of the Life Cycle Assessment. It is performed using methodology and criteria established by the ISO 14040 and ISO 14044. The LCA study is made including a complete inventory of all materials, energy and chemicals needed for the construction and operation of the technologies selected. The final disposal and valorization are also included as well as direct and indirect emissions to water, soil and atmosphere.

The technologies selected are Reverse osmosis, Electrodialysis, Electrocoagulation, Wetland and Flocculation. The first tree technologies are studied for both hypersaline and heavy metal waste streams. The other two technologies are studied for heavy metal waste streams.

Several studies have demonstrated the negative effects caused by heavy metals on the freshwater ecosystem structure and functioning. These metals tend to bio-accumulate in aquatic organisms, causing numerous diseases and disorders. In addition to metals, different mining activities such as potash mining, have the potential to increase the total concentration of solid inorganic salts (i.e. salinity) in freshwaters. Salinity affects the ecosystem functioning and reduce the freshwater biodiversity, because ionic composition reaches toxic or sub lethal levels that threatens most of the aquatic organisms.

The environmental analysis shows that recycled metals took into account supposes a reduction of the environmental impact in all of the impact categories (**Table 1**). By the other hand, the metal disposition into a landfill, is the process having a highest impact in almost all of the categories.

Reverse osmosis is the technology with lowest impact on the ecotoxicity impact categories, and so it contributes less to the river and environment pollution through the heavy metal disposal.

Table 1. Comparison of the results obtained for the ecotoxicity and climate change categories.

Technology	Treatment	Ecotoxicity impact categories			
		Freshwater ecotoxicity	Human toxicity	Terrestrial ecotoxicity	Marine ecotoxicity
Reverse Osmosis	Metals	6,00E-02	1,13E+00	2,49E-04	5,54E-02
Electrocoagulation	Metals	4,04E-01	3,15E+00	6,00E-04	3,50E-01
Electrodialysis	Metals	1,02E-01	1,43E+00	2,30E-04	8,90E-01
Wetland	Metals	1,00E-01	1,10E+00	1,60E-04	8,48E-02
Flocculation	Metals	6,05E-02	1,22E+00	2,90E-04	5,55E-02
No treatment	Metals	7,47E+00	3,78E+01	6,66E-23	5,96E+00

Regarding the other impact categories that don't belong to the ecotoxicity ones (**Table 2**), it can be observed that Reverse osmosis is also the most environmentally friendly technology, having the lowest impact in almost all the impact categories together with Wetland and Electrodialysis, that have a similar impact to Reverse Osmosis.

Table 2. impact of the technologies on the impact categories.

Technology	Treatment	Impact categories									
		CC	OD	TA	FE	ME	POF	PMF	WD	MD	FD
Reverse Osmosis	Salts	2,47E-02	4,00E-09	1,33E-04	7,09E-06	1,02E-05	1,00E-04	5,82E-05	4,71E-03	1,10E-03	8,10E-03
	Metals	8,82E-01	9,14E-08	5,25E-04	5,54E-02	3,01E-04	3,42E-03	2,47E-03	5,51E-01	2,29E-01	2,31E-01
Electrocoagulation	Salts	1,17E-01	1,62E-08	7,17E-04	3,82E-05	2,55E-05	4,04E-04	2,64E-04	3,12E-03	6,12E-03	3,36E-02
	Metals	1,31E+01	1,76E-06	8,24E-02	4,31E-03	2,82E-03	4,31E-02	2,92E-02	3,55E-01	6,57E-01	3,63E+00
Electrodialysis	Salts	1,22E-02	2,17E-09	6,90E-05	3,72E-06	2,80E-06	6,06E-05	3,42E-05	4,62E-03	6,90E-04	4,38E-03
	Metals	7,41E-01	8,33E-08	6,94E-03	5,35E-04	2,23E-04	3,29E-03	2,56E-03	5,53E-01	2,30E-01	2,08E-01
Wetland	Metals	7,40E-01	6,67E-08	4,69E-03	3,84E-04	1,78E-04	2,85E-03	1,93E-03	2,80E-01	2,31E-01	1,99E-01
Flocculation	Metals	2,19E+00	1,03E-07	6,97E-03	4,84E-04	2,70E-04	4,88E-03	2,85E-03	8,33E-01	2,51E-01	4,57E-01

For the case of salts impact evaluation, the LCA does not contemplate the ions of the salts in the ecotoxicity categories, and thus, it does not take into account the potential impact caused by salts in freshwater ecosystems.

Table 3. Costs comparison between the technologies.

	Reverse Osmosis[1]	Electrocoagulation[1]	Electrodialysis[1]	Wetland[2]	Flocculation[2]
Investment cost (€)	100.000	150.000	200.000	2.000.000	500.000
Treatment cost (€/m³ wastewater treated)	0,4	15	13,8	0,4	25

[1]Brinkmann, Thomas et al. 2016. Eur 28112 En *Best Available Techniques (BAT) Reference Document for Common Waste Water and Waste Gas Treatment/management Systems in the Chemical Sector*. [2]http://www.itrcweb.org/miningwaste-guidance/technology_overviews.htm

Finally, the economic analysis demonstrates that Reverse osmosis has the lowest investment and operational costs. The investment cost of the Electrocoagulation is the second cheapest, but the operational cost is the second expensive one (**Table 3**).

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