Deliverable D 1.2

Stationary product-like industrial demonstration plant

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This deliverable contains the description of the full-scale, stationary plant that was realized within the HydroWEEE-Demo project. The plant is in Relight's site and can treat fluorescent powders from disused lamps and cathode ray tubes; the same equipments could be used to treat other types of waste by means of the hydrometallurgical processes developed inside the HydroWEEE-Demo project.

Fluorescent powders contain important elements, especially rare earths such as yttrium, europium, terbium and the installed plant allows to recover them like oxalates. The amounts of the final products are in the range 0.25-0.35 kg/kg of powder

The stationary plant can treat 600 kg/batch of initial materials thus the capacity is 132 tons per year, considered to be processed in one shift (8 h) for 220 days/year.
1. Plant construction

The stationary plant was realized in according to flowsheet reported in previous deliverable D1.1 “Report on the detailed functional specifications for industrial – like stationary plant” (Figure 2.1: Flowsheet of the industrial –like stationary plant).

The main equipments of the stationary plant are:
- Leaching reactor, R01
- Filter press for leaching suspension, FP101
- Recovery reactor, R02
- Filter press to recover final products, FP102
- Wastewater treatment section with reactor R103 and filterpress FP103
- Air treatment section with a fun, a scrubber SC1 and dust collector with baghouse

The plant also is equipped with compressor for air system devices, electrical and PLC panels. The reagent’s tanks and the storage tanks are placed in the site. The leaching reactor has a volume of 6.5m³ and working with initial 15% of pulp density around 600 kg/batch of initial material could be treated.

The construction of the plant started in October 2013 and in January it was completed. The first tests have also been performed.

The following photos report the construction’s phase.

![Figure 1: Installation of the supports for the stationary plant- Relight’s site](image1.jpg)

![Figure 2: Transport and mounting of one reactor- Relight’s site](image2.jpg)
Figure 3: Particular of filterpress- Relight’s site

Figure 4 shows two viewports of the complete stationary plant.
The stationary plant is managed by PLC that permits the constant monitoring of every step of the process, through the remote control of the main indicators (temperature, pH,
pressure, etc.). For example Figure 5 reports two images of graphical interfaces operation’s controls for set up and for the reactor R01.

Figure 5: Control display for set up of the plant and for R01 – stationary plant
2. Hydrometallurgical Process and Capacities

The stationary plant is designed to treat especially fluorescent powders from lamps and CRTs. These wastes are rich in rare earths like yttrium, europium, terbium that can be recovered. The Figure 6 reports the simple flowsheet for lamps' hydrometallurgical process.

![Diagram of hydrometallurgical process](image)

**Figure 6: Simple block scheme for lamps' process**

The same process could be adopted to treat CRTs. Important developments of the treatments were carried out, respect to process reported in deliverable D1.1, for example purification step was deleted for both schemes. Hence the main operations are:

- **Leaching**: the initial material is dissolved with acid at $T < 80^\circ\text{C}$ and at the end of reactions the rare earths and other metals are in solution. The suspensions are filtered with filterpress and the solid waste are disposed instead the solutions go in the reactor in which oxalic acid is added.
- **Recovery of rare earth oxalates**: a mixture of rare earths' oxalates is recovered by precipitation after addition of oxalic acid and filtration.
- **Wastewater treatment**: the residual solutions are treated with lime solution to remove sulphates, phosphates, oxalates and traces of metals. After treatment the water could be recycle for the various phases of the processes.

The final products, as said before, are a mixture of the rare earths’ oxalates.
Considering the useful volume of the leaching reactor (R1) and 15% pulp density to carry out the dissolution of the materials the capacity for batch is around 600 kg/cycle. This means that for year around 132 T can be treated (220 day/years) considering a batch/shift. This capacity could be increased if the number of cycle rises per shift.
The amounts of rare earths' oxalates are 0.32 kg/kg initial lamps and 0.27 kg/kg initial CRTs.

3. Conclusions

The deliverable reports the main developments regarding the construction of stationary plant in Relight’s site and the last optimizations of the hydrometallurgical processes to recover rare earths from fluorescent materials. The plant is actually finished and it has been tested with the first preliminary tests.
At the moment the inputs for the industrial installation are fluorescent powders from lamps and CRTs. The first are the results of spent fluorescent lamps mechanical treatment that provide shredding, mechanical separation, aspiration and filtration by an active carbon filter.
The CRTs' powders are the results of treatment of CRT TV and monitors. These devices are dismantled manually to isolate the cathode ray tubes. Then the tubes are cut by specific machines that detach in controlled atmosphere the panels glass from the funnel glass. The fluorescent materials are removed from panel glass by an aspirator, it goes in a separate waste flow and used for material recovery.
All these pretreatment are realized in Relight's site.

The stationary plant is managed by PLC that permits:
- The constant monitoring of every step of the process, through the remote control of the main indicators (temperature, pH, pressure, etc.).
- The control of potential situations of "risk" and immediate action by the automatic safety system
- The minimization of operations from the operators, with a considerable reduction of risks to health and safety of the operator.