



NoviSad, 22-23.09.2016

Technology for manufacturing high grade products from excavated landfill plastic

Mait Kriipsalu¹, Aivo Käsner², Arne Saareväli²

¹ Estonian University of Life Sciences; ² Elegro Technology

Background: the site



Background: the site



Kudjape Landfill, Saaremaa island, Estonia

- Mostly municipal waste
- In operation 1970 – 2009
- Estimated volume 200.000 m³
- By law: had to be capped 2013
 - *This particular fact initiated full-scale LFM, co-operation between partners, and research*

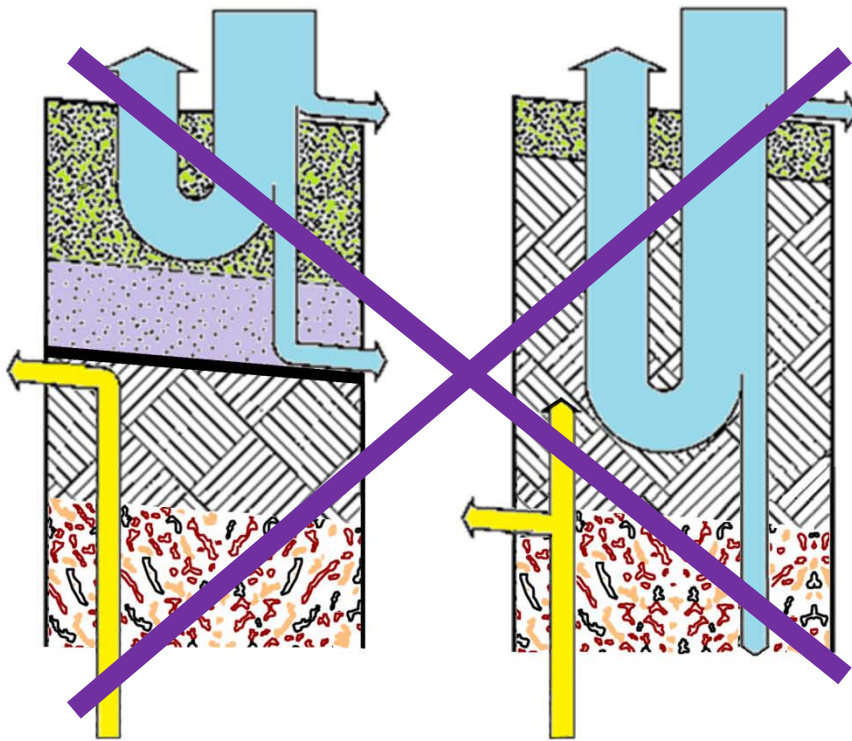


• **Background:** Landfill Mining was a tool for final closure of Kudjape landfill

- Initial closure design of a LF was not agreed by the authority;
 - Plan: egg-shape landfill, covered by 0,5 to 1 m of clay-ish soil
 - Fear of gas → 1,5 m cover layer was prescribed;
 - Sorry, but this amount of cover material was not available.
 - Is it even ethical to force LF to take fragile soil and waste it?
 - Is it OK to dig a hole what the local community did not ask for ☹.
 - What if we take cover material from the landfill?
-

Design of cover layer

Impermeable cover layer



Semi-permeable cover layer



Methane degrades: $\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$

Excavation in progress



We wanted this fraction!

We also got this fraction



**The main objective of LFM was achieved:
methane degradation layer is in place!**



Was there anything valuable that we missed?



Series of experiments with LF resources!



- Waste-to-energy in Tallinn Mass-burn facility

Is waste-to-plastic product possible?



- Waste-to-SRF for Cement factory at Kunda



- Waste-to-oil in Oil Shale industry



Story of mixed plastic recycling in Estonia: Plastrex/Elegro

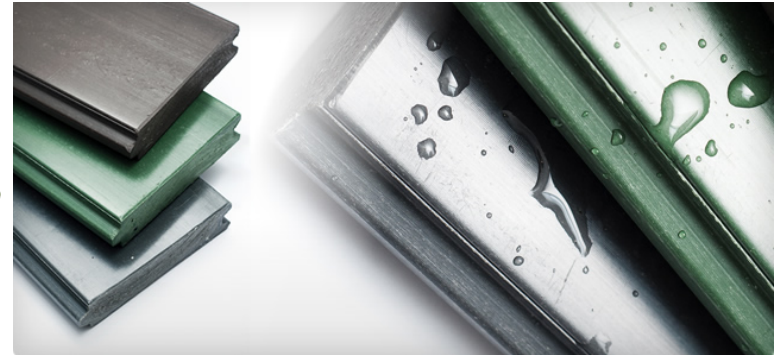
- **Where did the idea of plastic recycling come from?**
 - Plastic Waste is a **Global Problem**
 - Global plastic production reaches **300 million tons** annually
 - Annually approximately **500 billion plastic bags** are used worldwide (more than one million bags per minute).
 - Over the **last 10 years** we have produced **more plastic** than during the whole of the **last century**
 - **Packaging** is the largest end use market segment accounting for just over **40% of total plastic usage**
-



Why Recycling of mixed Plastic Waste is difficult

- When compared to other materials like glass and metal materials, plastic polymers require greater processing to be recycled;
 - **Different plastics do not mix**, which is due to the high molecular weight of their large polymer chains;
 - Heating is not enough to dissolve such a large molecule; plastics must often be of nearly identical composition in order to mix efficiently;
 - When different types of plastics are melted together they tend to phase-separate, like oil and water, and set in these layers;
 - Final product tends to be ugly and not well marketable.
-

Why mixed plastic recycling was selected as business plan?



- Biggest challenge, therefore promising market (hierarchy!);
- Good env. performance: 100% recyclable (endless cycle);
- Good market opportunities: maintenance free product;
- Similar to wood, thus saves wood resources;
- **Two-step production process** was invented;
- Unique **patented** solution for mixed plastic waste recycling.

Plastic Recycling Process

Step
1



Step
2



PlastRex
elegro

Connecting LFM and plastic recycling



Waste was well characterised during 10 day PhD courses at the site





Objectives

- The aim of this study was to investigate if landfill plastic-to-plastic product is possible.
- **Why?** This was not the primary objective in this Project!
 - Objective for a **Company**: landfill plastic is the only waste source that is available/not taken/no competition.
 - Objective for **Science**: landfill plastic-to-plastic product is much higher in hierarchy. We need to know what can be achieved!
 - Sub-objectives:
 - what was the quality of landfill plastic?
 - how much 'product-grade' plastic was in our waste?



Materials & Methods

- Excavated waste was triple-sieved (40 mm), and hand-picked.
 - Requirements:
 - Lightweight packages, preferably PE film;
 - No plastic items, no textile, no leather;
 - No PVC.
 - Minimum four tons had to be shipped to agglomeration, step 1.
 - Various mixtures (LF plastic/raw plastic) to be tested in step 2.
-

Connecting LFM and plastic recycling



Not washed, not shredded, sorted



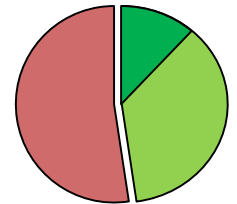
Washed



Final product

Results

- We found that from previously sieved 40-mm coarse fraction it was possible to handpick 24 % as lightweight plastic waste;
 - We need better separation technology.
- Plastic waste had maintained polymeric properties during 6–10 y in LF.
- Impurities and soil was not ‘killer’ concern:
 - Material was heavily abrasive in agglomeration step 1; thin foil unwanted;
 - Impurities were no problem for final production in step 2.
- Pure LF-plastic was not good in production step 2:
 - Agglomerates had to be mixed with fresh mixed plastic waste
 - 50 % share of LFM plastic agglomerates was best



Back to the landfill: this time as a building material!



Other possible markets





Acknowledgements

- Students and their supervisors from Estonia, Latvia, Lithuania, Ukraine, and Sweden for fieldworks and waste sorting, Juris, Gintaras;
- MSc students Kaur-Mikk Pehme, Kaarel Kure and Martti Hoop for waste washing and water treatment;
- Mihkel Paljak and Valdo Liiv from Saaremaa Prügila Ltd, for innovative thinking and strong support; RTS-Infra Ltd, Rein-Erik, Olavi and field staff for daily effort;
- European Cohesion Fund, Estonian Environmental Investment Centre (KIK), and SA Archimedes for funding the project and scientific work;
- Prof William Hogland and Swedish Institute for funding international research project 'Closing the Life Cycle of Landfills - Landfill Mining in the Baltic Sea Region for future'.

*Single objective is unrealistic to justify LFM. Work on multiple objectives!
Let us exploit all valuables and **return the landfill to society in better state.***



mait.kriipsalu@emu.ee

Mixed plastic recycling → <https://vimeo.com/168549390>