ZINC FOR LIFE FACTSHEET

Comparative LCA of Zinc, PVC and Aluminium Gutter and Downpipe Systems

DRAFT

Introduction

Gutters and Downpipes

Gutters and downpipes collect and drain rainwater off of roofs (Figure 1). They are expected to be water-tight and as long-lasting as the building envelope (i.e. several decades). Furthermore, maintenance should be easy, with clogging avoided and painting ideally unnecessary.

Figure 1: *Gutters and downpipes [USE PICS FROM COMMISSIONING COMPANIES]*

Environmental Aspects

Interest in Green Buildings and environmental soundness of building materials and products has increased. Private builders and homeowners as well as public procurement and contractors appreciate or even actively request scientific information about the environmental impacts on a material and product level. Therefore, the International Zinc Association (IZA) commissioned the Dutch research institute TNO to compare the environmental performance of zinc gutters and downpipes with products made from the main alternative materials, aluminium and PVC. In order to consider all relevant aspects, this comparison of different product systems was accomplished by means of a Life Cycle Assessment (LCA).

Life Cycle Assessment

Goal & Scope

The goal of this study was the comparison of the environmental impact of zinc gutters and downpipes made from zinc sheet as produced by *NedZink*, *Rheinzink* and *Umicore (VM Zinc)* with typical alternative products found on the European market.

To this aim, the compared product systems need to have the same function. The function is the drainage of a sloped roof with a minimal pitch of 20° of a reference terraced house with a functional life-time of 75 years. The functional unit is represented by two gutters of 5.46 m each, one downpipe of 5.4 m and one half gutter end per average house. Required accessories of the gutter/downpipe system included supporting hangers, joints and end pieces for the gutter, and hangers and joints for the down pipe. Smaller auxiliaries likes screws, bolts and nuts and the use of tools were not included as the contribution to the environmental impact can be neglected.

Alternatives & Life Cycle

The three basic raw materials used for gutters and downpipes are **zinc**, rigid **PVC** (PVC-U) and precoated **aluminium**. The product system of gutter and downpipe includes the following lifecycle stages:

1. Production of raw materials;
2. Manufacture of gutters, downpipes and accessories;
3. Installation on the building;
4. Use of gutter and downpipe;
5. Demolition;
6. End-of-life (recovery or disposal).

Data & Assumptions

Zinc products have proven to have a lifespan that exceeds 75 years. Gutters and downpipes of PVC and roll-formed aluminium are more recent on the market: for both a lifespan of 30 years was established.

Weathering of the gutters and downpipes takes places due to physical and chemical processes that affect the material surface. Assumptions were made for the run-off of zinc, aluminium and coating due to corrosion. For the PVC system no emissions during the use stage could be estimated.

After 75 years all gutters and downpipes are assumed to be removed during demolition of the house. For PVC and aluminium systems with a shorter life span replacements during this period were calculated. The removed gutters and downpipes can (partly) be recovered, the rest being sent to waste treatment.

Procedures

This Life Cycle Assessment was performed in accordance with the applicable international standards ISO 14040–14044. For the purposes of impact assessment (Table 1), the environmental effect factors for zinc were adapted according to the *Apeldoorn Declaration*. This declaration was made in 2004 by a group of LCA and risk assessment specialists to improve LCA practice: previously, the contribution of essential metals, such as zinc, to ecotoxicity impacts had been overestimated. To overcome this methodological problem, the most recent risk data (Predicted No Effect Concentration, PNEC) for zinc and its bioavailability (Biotic Ligand Model, BLM) were taken into account. For reasons of quality assurance and credibility, a critical review of data and methods of the study was conducted by an independent expert panel.

Table 1: *Overview of the environmental impact categories investigated in this LCA.*

Environmental Impact Category	Abbreviation
Abiotic Resource Depletion Potential	ADP
Global Warming Potential (100 years horizon)	GWP
Ozone Depletion Potential	ODP
Human Toxicity Potential	HTP
Freshwater Aquatic Eco-toxicity Potential	FAETP
Marine aquatic Eco-toxicity Potential	MAETP
Terrestrial Eco-toxicity Potential	TETP
Photochemical Ozone Creation Potential	POCP
Acidification Potential	AP
Eutrophication Potential	EP

Results

The environmental impacts of the gutter/downpipe systems made from the three materials during their whole lifecycles are compared in Figure 2. The zinc system shows the lowest environmental impacts for almost all categories. The only exception is the freshwater aquatic eco-toxicity (FAETP), where PVC is still better.

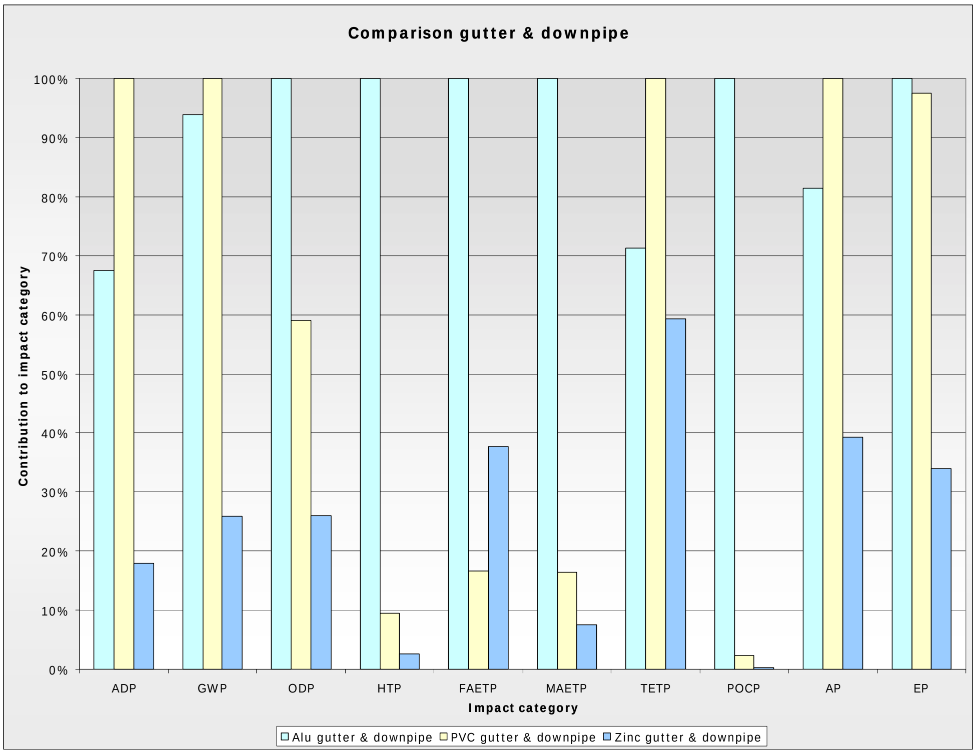

Figure 2: *Comparison of the zinc, PVC-U and aluminium gutter/downpipe systems. The highest score per impact category (see Table 1) has been set to 100%.*

Discussion

The production of zinc and steel hangers contribute most to the environmental impact of the zinc system. As the recycling of zinc at the end-of-life stage avoids the primary production of zinc it shows a beneficial effect. For the PVC system, the production of PVC-U and the manufacture of gutters and downpipes contribute most to the environmental impact. The environmental impact of the aluminium system is dominated by production of aluminium, followed by the manufacture of the gutters and downpipes. The recycling of aluminium at the end-of-life stage reduces this impact considerably, because it avoids the production of primary aluminium.

The freshwater aquatic ecotoxicity (FAETP) of the zinc system is dominated by the release of zinc to surface water during the use phase of the gutters and downpipes. Nonetheless, the zinc system shows a better performance than the aluminium system.

Sensitivity Analysis

In the sensitivity analysis, results were calculated for alternative assumptions or scenarios. For zinc gutters, using heavy hangers instead of light hangers increases the environmental impact of zinc gutters. For PVC gutters, using aluminium hangers instead of PVC hangers, for a longer life span and for a better PVC recycling rate, increases the environmental impact. Conversely, a higher PVC recycling rate decreased the environmental impacts except for ODP, HTP and MAETP. If the life span of the PVC system is increased from 30 to 40 years, only one replacement us necessary over 75 years: this reduced the environmental impact of the PVC system by one third. However, using heavier extruded aluminium gutters with a lifespan of up to 75 years instead of rolled gutters, the environmental impact is rather similar for both types of aluminium gutters for almost all impact categories.

Conclusions

In this LCA study, TNO applied impact factors in accordance with the *Apeldoorn Declaration*: corrected for bioavailablity and using the most recent threshold concentrations from the zinc risk assessment report, this method provides an appropriate assessment of the environmental impacts of zinc emissions, and thus allows for a fair comparison of materials with respect to ecotoxicity.

When comparing zinc, PVC-U and aluminium gutter and downpipe systems, the zinc system has the lowest overall environmental impact. The only exception is the freshwater aquatic eco-toxicity (FAETP), where PVC is still better. The aluminium system has the highest environmental impacts in categories ODP, HTP, FAETP, MAETP, POCP, and EP. The PVC-U system has the highest environmental impacts for categories ADP, GWP, TETP, and AP. Hence, zinc gutter and downpipe systems were found to be preferable from an environmental perspective.