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PEX Hot & Cold Water Supply System Life Cycle Assessment

According to EN ISO 15875 for European Single-Family House

Consumer awareness of environmental friendly products and low environmental impact materials has increased over the last decade. This is a positive trend and it will become stronger in the future. Decision makers in the building industry are demanding transparent and objective methods on how to select the solution with the lowest environmental impact.

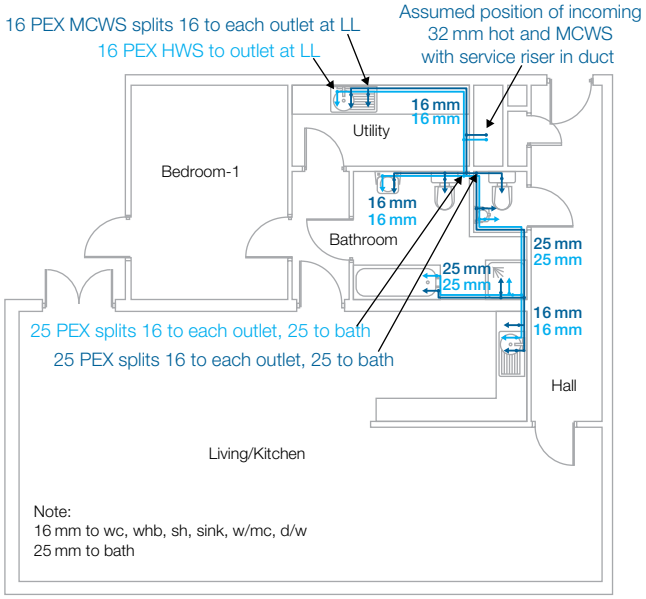
An example of an objective tool used to quantify the potential environmental impacts of products, product systems, processes or services is LCA (Life Cycle Assessment). It can be used to evaluate several product alternatives that meet the same technical and functional requirements.

This paper is a summary of an LCA study (from cradle to grave, consistent with ISO 14040 and ISO 14044 series) that was performed by VITO (Flemish Institute for Technological Research) under the authority of TEPPFA (The European Plastic Pipes and Fittings Association). This analysis outlines the various environmental aspects that accompany different pipe systems, from the primary extraction of raw materials up to and including the end of life (EoL) treatment after their reference service life time.

Set Up

The function of the PEX (cross-linkable polyethylene) hot and cold water pipe system is to supply a typical residential single-family apartment with hot and cold drinking water. The functional unit has been defined as the environmental impacts (calculated per year) related to the pressure supply and transport of hot and cold drinking water, from the entrance of a well-defined apartment to the tap, by means of a PEX hot and cold drinking water pipe system installation supplying a 100 m² apartment, incorporating a bathroom, separate WC, kitchen and washroom (considering the reference service life time

Figure 1: Floor plan of a typical European single-family home



of the pipe system to be aligned with the 50-year service life time of the apartment). See Figure 1.

All data relates to the existing situation in Europe, using existing production techniques. As much as possible, the data represents modern state-of-the-art-technology. As such, Europe in the period 2000-2008 is considered as the geographical and time coverage for these data.

The used data are consistently reported and critically reviewed, so that they can be easily reproduced. If in this document one refers to “a pipe system”, this means the pipe system representing the average at the European level, and not one specific pipe system. Calculations of the amounts of PEX pipes, polyphenylsulfone (PPSU) fittings and brass fittings (needed per 100 m² of apartment) are based on a consensus within the AG Building. See Table 1.

Table 1: PEX hot and cold water pipe system components in relation to the functional unit

PEX Pipe System	Apartment 50-Year Lifetime [Average in kg/100m^2]	Excluding Pipe Left Over [Average in kg/FU]	Including Pipe Left Over [Average in kg/FU]	Average PEX Pipe Left Over During Installation (1%) [kg/FU]
PEX pipe	8.086	0.16172	0.1633372	0.0016172
PPSU plastic fittings	0.769	0.01538		
Brass fittings	1.485	0.0297		

Table 2: Results of the LCA for the PEX hot and cold water pipe system (expressed per functional unit)

Impact Category	Abiotic Depletion	Acidification	Eutrophication	Global Warming	Ozone Depletion	Photochemical Oxidation
Unit	kg SB-eq	kg SO_2-eq	kg PO_4-eq	kg CO_2-eq	kg CFC-11-eq	kg C_2H_4-eq
Total LCA contribution	0.00998	0.00736	0.00075	0.93869	0.00000008	0.00039

There are several environmental indicators which are typically used in an LCA to describe the potential effect on the environment. For the TEPPFA project VITO uses the different environmental impact categories presented in the draft documents prepared by Technical Committee CEN/TC 350 *Sustainability of Construction Works*. A graphical representation is shown in Figure 3 for each indicator of the functional unit. Some more explanation of each indicator:

- **Abiotic depletion (expressed as Sb equivalences)**
  The extraction of minerals and other non-living materials that can lead to exhaustion of our natural resources.
- **Acidification (expressed as SO_2 equivalences)**
  Acidic emissions, such as sulphur dioxide and nitrogen oxides, from manufacturing processes that harm our soil, water supplies, human and animal organisms, and our ecosystem.
- **Eutrophication (expressed as PO_4 equivalences)**
  The result of over-fertilization of water and soil by human activity, speeding up plant growth and killing animal life in lakes and waterways.
- **Global warming (Expressed as CO_2 equivalences)**
  The insulating effect of greenhouse gasses in our atmosphere. Greenhouse gasses are a major contributor to global warming, affecting our health and that of the ecosystem in which we live.
- **Ozone layer depletion (expressed as CFC-11 equivalences)**
  The depletion of the ozone layer in the atmosphere caused by emissions of chemical foaming and cleaning agents allowing the passage of greater levels of UV from the sun. Ozone layer depletion can cause skin cancer and can reduce crop yields.
- **Photochemical oxidation (expressed as C_2H_4 equivalences)**
  The photochemical reaction of sunlight with hydrocarbons and nitrogen oxides that leads to atmospheric pollution such as chemical smog that affects our health, food crops and ecosystem.

The results of the LCA for the PEX hot and cold water pipe system, expressed per functional unit, can be found in Table 2.

Data Compared to Other Systems

To better understand the relevance of the environmental profile of the PEX hot and cold water pipe system, a comparison was made with a full copper solution for the same functional unit. At the same time, some sensitivity analyses were made to evaluate the influence of increasing the amount of recycled material for the copper system on the total environmental profile of the copper hot and cold pipe systems. The graphical result can be found in Figure 2. The data shows that a plastic system is contributing to less environmental burden compared to a full metal system.

Figure 2: LCA for the PEX hot and cold water pipe system

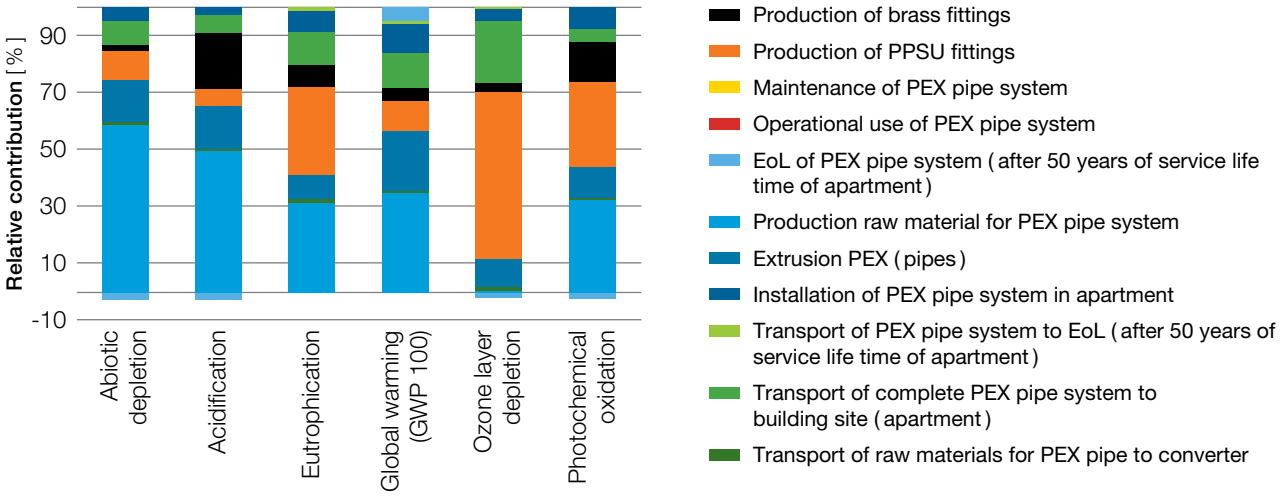
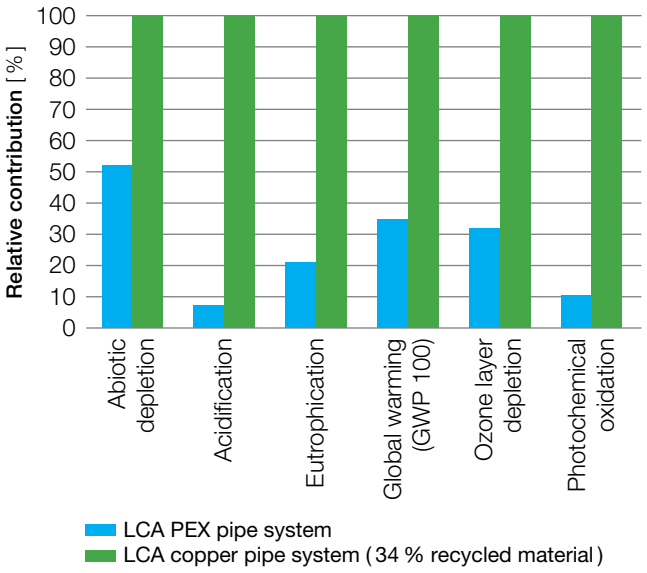


Figure 3: Environmental impact of PEX pipe system vs. copper pipe system



Summary

Objective methods and tools exist to compare the environmental impact from several product systems that can be used in the building industry. The data generated in this study show the advantage of using PEX plastic systems as a hot and cold water supply for a representative European single-family house. Efforts in technology can further reduce the environmental impact and are being promoted by various players within the industry. The government can speed up this process by defining global regulations based on technological input.

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