SPECIAL ARTICLE ON

SUSTAINABILITY OF PVC Pipes AND FITTINGS THROUGH LIFE CYCLE MANAGEMENT

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For mechanical recycling, the recycled PVC can be used as input materials in other PVC processes (become secondary raw materials) which helps reduce amount of fresh/virgin raw materials needed. These secondary raw materials are considered as avoided input in other processes where they are used, and thus, yield benefits in terms of less energy consumption and environment impacts.

The results of the study are separated into 2 parts: cradle-to-gate (up to PVC resin) and cradle-to-grave (whole life cycle, including end-of-life). For environmental performance, only global warming potential (GWP) and energy consumption are chosen to present in this article. In addition, due to the limited space, only the results of the 55 mm. pipe and fitting are presented since the results of the 18 mm. pipe and fitting show the same trend. Figures 2 (a) and (b) show the results of global warming potential (GWP) in kg CO_2 equivalent per kg resin and energy resources consumption in MJ per kg resin. In these figures, the results are also compared with Thailand National LCI database (2006) (1) and other international databases (2-5).

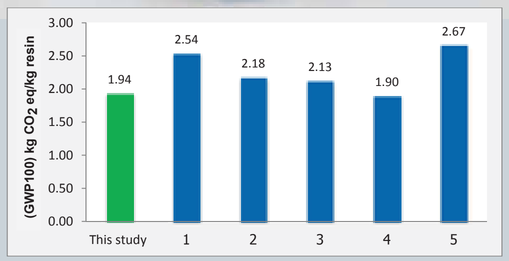

Figure 2(a). GWP of PVC resin (kg CO_2 equivalent/kg resin)

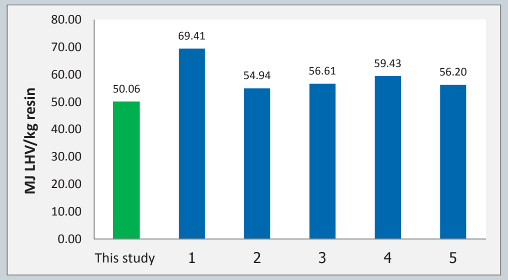

Figure 2(b). Energy resources consumption of PVC Resin (MJ/kg resin)

1. PVC-S National LCI Database Thailand (2006);
2. PVC (S) I (of project IDEMAT 2001) – Delft U. of Technology;
3. PVC suspension A (of project industry data 1997);
4. Polyvinylchloride, suspension polymerised, at plant/RER U (of project Ecoinvent unit processes) – International Database 2006;
5. Polyvinylchloride resin (S-PVC), suspension polymerization, production mix, at plant RER (of project ELCD) – European Life Cycle Database 2007.

It can be seen that the GWP of PVC resin is 1.94 kg CO_2 eq/kg resin and the energy resources consumption is 50.06 MJ per kg resin. When compare to the present data in the Thailand National LCI database for PVC (2006 data), the environmental performance of PVC resin obtained in this study (2011 data) has shown to be much better both in GWP and energy resources consumption. The GWP of PVC resin is 24% lower than the 2006 value and the energy resources used is about 28% lower than the 2006 value. In addition, both GWP and energy resources consumption are lower than the values reported in international databases.

Next we evaluate the whole life cycle of PVC pipes and fitting which extends from the resin production to cover pipe and fitting processing and end-of-life. The results of GWP and energy resources consumption of the base case are shown and compared with other scenarios (1-8, see Table 1) as shown in Figures 3(a) and (b), respectively.

Table 1. Scanario Analysis for End-of-Life Management

Scenario	End-of-life treatment (%)		
	Mechanical recycle	Landfill	Incineration
Base case	30	67	3
1	100	0	0
2	0	100	0
3	0	0	100
4	50	50	0
5	70	30	0
6	75	25	0
7	80	20	0
8	90	10	0

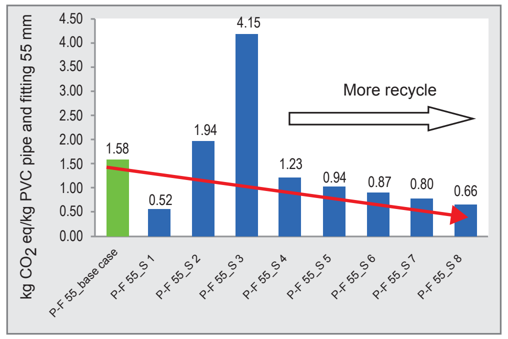

Figure 3(a). GWP of PVC pipes and fittings for various end-of-life scenarios

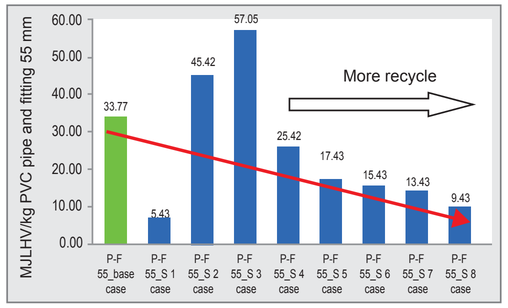

Figure 3(b). Energy resources of PVC pipes and fittings for various end-of-life scenarios

The results clearly show that end-of-life management has shown to be very important factor affecting the whole life cycle performance of PVC pipe and fitting in both energy and environmental aspects. Scenario with 100% recycle of PVC (scenario 1) has shown to be the best one which gives lowest GWP and energy consumption whereas scenarios with incineration (scenario 3) and landfill treatment (scenario 2) are shown to be unfavourable end-of-life management for PVC products such as pipes.

The most important results from this study can be seen from the comparison between scenarios 4-8 and the base case. It is obvious that by increasing recycling portion of PVC pipe and fitting (from 30% in the base case to 90% in scenario 8), the environmental performance of PVC pipes and fittings can be significantly improved as we can observe as high as 50% reduction of the environmental impacts from the base case scenario.

For full report please download at
http://www.aseanvinyl.org/information-center/category/20-pvc-sustainability-forum-2013

"PVC is the most Sustainable, Environment-Friendly and Safe-to-Use Commodity Plastic in The ASEAN Community."

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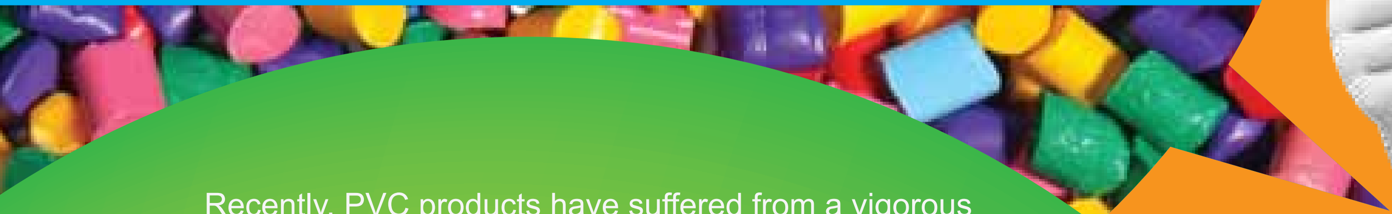
Polyvinyl chloride (PVC) is a widely used plastic which has matchless versatility.

For number of years, it has effectively replaced wood, paper and metal in several applications. An ideal example is PVC pipes that have been progressively replacing conventional pipes like cast iron and cement pipes for various important applications such as water supply, irrigation, buildings and drainage systems in household/town/city/rural. PVC pipes are the most widely used all over the world on account of their most favorable balance of properties. PVC pipes are light in weight, rates for use under pressure, easy to install, low frictional loss, low on maintenance cost, and have low frictional loss.



Recently, PVC products have suffered from a vigorous campaign of opposition to the use of PVC from environmental groups resulting in widespread belief that PVC is inherently damaging to the environment and to human health. As a result, effective tool such as life cycle assessment or LCA has been used to evaluate environmental impacts of PVC products. Several LCA studies conducted internationally have shown that PVC products are typically no better or worse than the alternatives across a wide range of environmental and health risk assessments. Especially, studies in US and Australia have concluded that in the case of pipe, PVC pipe is typically advantageous environmentally.

In Thailand,

there has been several developments towards sustainability both in government and industrial sectors. In recent years, green initiatives and regulations have been launched by Royal Thai Government. National companies such PTT and SCG as well as SMEs in various industries have also been very active in practicing sustainability tools such as LCA, Eco-design, Eco-label and Eco-efficiency. Realizing the importance role of PVC products towards sustainability, ASEAN Vinyl Council (AVC) has worked with a research team at the Petroleum and Petrochemical College (PPC) on LCA study of PVC pipes and fittings in Thailand in order to make them become more environmental friendly.

The study aims to use LCA to evaluate the life cycle environmental performance of PVC pipes and fittings in terms of energy consumption, global warming, other relevant impact categories and to investigate different end-of-life management of PVC in order to minimize overall environmental impacts. 18 mm. and 55 mm. PVC pipes are selected in the study and their production data (2011) are collected from the 3 largest manufacterers in Thailand (Thai Pipe Industry Co., Ltd., Nawaplastic Industries Co., Ltd. and Advanced Pipe Co., Ltd.). The scope of the research covers the entire life cycle based on cradle-to-grave approach, including raw materials, monomer and resin production, processing, usage and end-of-life as shown in Figure 1. The input data including raw materials and chemicals usages, energy consumption and utilities and the output data including emissions to air, water and soil are collected and analyzed by using LCA software, SimaPro 7.0, with Eco-Indicator 95 and CML 2 baseline 2000 methods to quatify the environmental burdens in various impact categories.

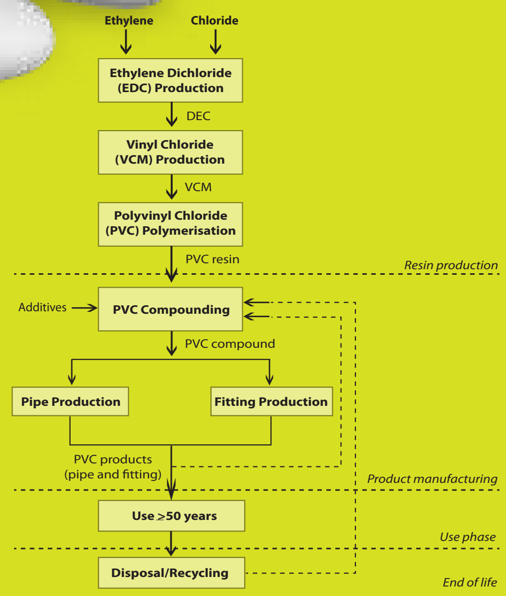


Figure 1. System Boundary of LCA Study

For use phase, it is divided into installation, maintenance and removal. Installation and removal are assumed to be all done manually with simple tools such that there are no environmental burden and no waste from these processes. The service period of PVC pipes is assumed to be 50 years with no maintenance required. For end-of-life, several scenarios are created in order to simulate different end-of-life management of PVC pipes and fittings based on three disposal technologies: landfill, incineration and mechanical recycle as shown in Table 1. The results are then compared to the base case which is assumed to represent the current situation in Thailand.