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Resource Efficiency and Carbon Footprint Minimization in Manufacture of Plastic Products

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Efficient resource management, waste prevention, as well as renewable resource consumption promote sustainable production and lower greenhouse gas emissions to the environment when manufacturing plastic products.

The paper presents the analysis of the efficiency of resources and the potential of carbon footprint minimization in manufacture of plastic products by means of implementation of wood-plastic composite (WPC) production. The analysis was performed using life cycle assessment and material flow analysis methodology. To devise the solution for better management of resources and minimization of carbon footprint, the environmental impacts of polyvinyl chloride (PVC) and WPC wall panels through their life cycle were assessed, as well as the detailed material flow analyses of the PVC and WPC in production stages were carried out.

The life cycle assessment has revealed that carbon footprint throughout life cycle of 1 kg of WPC wall panel is 37 % lower than those of the same weight of PVC wall panel product. Both products have a major impact on the environment during their production phase, while during this phase WPC wall panel has 35 % smaller carbon footprint and even 47 % smaller during disposal stages than those of the PVC wall panel.

The results of material flow analysis have shown that recycling and reuse of production spoilage reduce the need of PVC secondary resources for PVC panels and primary WPC resources for WPC panel production.

For better resource efficiency, the conceptual model of material flow management has been proposed. As WPC products are made of primary WPC granules, which are imported from abroad, the model suggests to produce the WPC granules at the company using collected PVC secondary materials (PVC stocks). It would lower environmental costs and environmental impact, increase the efficiency of resources, and diminish dependence on suppliers.

Keywords: *wood-plastic composite, polyvinyl chloride, carbon footprint, material flow analysis, life cycle assessment*

1. Introduction

Climate change and global warming are internationally recognized as current issues, driving negative effects on humanity, and being mainly caused by greenhouse gas (GHG) emissions generated both from industrial and anthropogenic activities (Radu et al., 2013).

The three greenhouse gases (carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) have increased in the atmosphere since pre-industrial times (defined as beginning in the year 1750), and this increase is the main driving cause of climate change. The increase in CO_2, CH_4 and N_2O is caused by anthropogenic emissions from the use of fossil fuel as a source of energy, and from land use and land use changes, in particular agriculture (IPCC, 2013).

Total GHG emissions caused directly or indirectly by an individual, organization or product expressed as CO_2-eq or CO_2e are named carbon footprint (Carbon Trust, 2012). Carbon footprint is one of the indicators of sustainable development which are used to monitor the EU Sustainable Development Strategy. At the current rate of reduction, the EU target is to reduce greenhouse gas emissions by 20 % lower than the 1990 level by 2020 (Eurostat, 2013).

Over the last 100 years (1906 - 2005), global temperature has increased by 0.74 °C. The global sea level has risen by 17 cm during the 20th century, in part because of the melting of snow and ice from many mountains and the polar regions. More regional changes have also been observed, including changes in the Arctic temperatures and ice, ocean salinity, wind patterns, droughts, precipitations, frequency of heat waves, and intensity of tropical cyclones (EPA, 2012).

In order to achieve our target of planetary warming with maximum 2 °C rate, a decrease in GHG emissions of 5.1 % annually by 2050 is required. In 2011, this rate was 0.7 %, while the average, starting from 2000, is 0.8 %. The reduction target was not reached during the last period, on the one hand because of the increasing emissions in emerging countries and, on the other hand, due to insufficient involvement of other countries in the achievement of the objectives materialized in uncertain policies at national and international levels, in reduced efforts for low emissions technologies, and even in a decline in the renewable energy field (PricewaterhouseCoopers, 2012).

Plastics industry is a potential polluter of GHG emissions. Plastic resins are made from derivatives of petroleum and natural gas. The first step in plastics manufacture is the acquisition of derivatives from refined petroleum and natural gas, which results in energy and non-energy GHG emissions from the extraction and refining of petroleum and natural gas. The petroleum and/or natural gas are then transported to plastic manufacturers, and it results in transportation of GHG emissions. The plastic resins are then made into products through various processes, such as extrusion blow molding, and injection molding, where GHG emissions are generated as a result of energy consumption (EPA, 2013).

In the second half of the 20th century, plastics became one of the most universally-used and multipurpose materials in the global economy. The plastics industry has benefited from 50 years of growth with a year on year expansion of 8.7 % from 1950 to 2012. In 2012 the quantity of global plastics production totalled 241 million tons. Europe produced 49.2 million tons in the same year, and 39.4 % of the demand was attributable to the packaging sector. Building and construction are the second largest application sector with 20.3 % of the total European demand (PlasticsEurope, 2013).

In addition to GHG emissions, another main problem in the plastic sector is waste streams. Plastic is non-renewable, non-degradable material in the environment. The materials used in the production of plastics are cellulose, coal, natural gas, salt, and crude oil. Therefore, plastic is directly dependent on fossil fuel.

Turning waste into a resource is an aim the European plastics industry is committed to achieve to improve the efficiency of European resources. Achievement of this goal is impossible, when 38 % of plastic waste is still going to landfill. As such, landfill is a major barrier that must be eliminated for an ambitious goal to be reached. Recycling and energy recovery are both complementary and necessary to achieve the zero plastics to landfill by the 2020 goal. Since energy recovery is non-existent in Lithuania, recycling is one of the sustainable options in waste prevention (PlasticsEurope, 2013).

In exchanging non-renewable resources into renewable, one of the alternatives is the usage of bioplastics and bionanocomposites in various applications, such as packaging, durable goods, electronics, etc. The usage of renewable resources based plastics can lead to the reduction in energy consumption and greenhouse gas emissions in certain applications (Reddy et al., 2013). Currently, the bioplastics market is coming out of its infancy and is capturing the plastics market at a growth rate of 30 % annually (Shen et al., 2009).

In order to reduce an impact on the environment, another alternative to minimize primary plastic consumption and promote renewable resources usage is to integrate wood chips/ dust/ powder into plastic products. Wood-plastic composites (WPC) are widely used in the USA, the most common type of such panels are produced by mixing wood flour and plastics to produce a material that can be processed similar to 100 % plastic-based products (Wechsler et al., 2007). China's WPC industry is the second largest in the world after the USA. It is forecast that China will reach 33 % of the global WPC production by 2015, while Europe will reach about 9 % of it (Eder et al., 2013).

In 2012, a new innovation in Lithuania was implemented by a plastic manufacturing company, which started a new practice, namely, the production and sale of WPC decking, fencing, and cladding. WPC is composed of two compounds: plastic and woodchips, as well as various additives governing the properties of this material. WPC products are fireproof, timeless, and resistant to humidity, cold, mould, and fungus. Moreover, they do not fade in the sun and are not damaged by timber pests. As well as this, products are recyclable and reusable (InoWood, 2012). Products have already got interest in local and foreign market. By implementing a new WPC product the company sustains its competitiveness and promotes reduction in an environmental impact.

Since there are not many researches on environmental sustainability and environmental benefits of WPC technology and products, the goal of this study is to analyze the resource efficiency and carbon footprint minimization potential in a plastic products' manufacturing sector by implementing WPC production. The objectives of the study are: 1) to assess and compare the environmental impact of PVC and WPC products throughout their life cycle; 2) to analyze all the materials flows in the production stage of the PVC and WPC, 3) to find the solution of the better resource management, eco-efficiency, and carbon footprint minimization.

Analysis was performed using the data received from the company manufacturing plastic products.

2. Research methodology

2.1. Life cycle assessment of PVC and WPC wall panels

Life cycle assessment (LCA) is a methodology to quantify the potential environmental impacts associated with product, process, or activity throughout product's life cycle. The LCA study of PVC and WPC was carried out following the procedure and recommendations indicated in the European standards series – ISO 14040-14044 (ISO 14044 2006). In accordance with the standards, the LCA analyses were performed in the following main steps:

1. Definition of the goal and scope of the study; identification of functional unit and system boundaries.
2. Life-cycle inventory analysis.
3. Life-cycle impact assessment and interpretation.

1. The goal of the LCA was to evaluate and compare the environmental burdens associated with production, use, and disposal of PVC and WPC wall panels. The functional units of 1 kg of PVC wall panel with packaging and 1 kg of WPC wall panel with packaging were determined. The analysis of environmental impact was carried out throughout the whole life cycle (production, use and disposal) of the products: PVC and WPC wall panels. The production part represents information about all materials and energy related to the analyzed product. The use phase includes products' transportation from their manufacturing place to customers. Finally, the disposal phase represents information about the management of the waste (when products become waste).

2. A most important step in the LCA studies is to collect the inventory data for building the life cycle inventory. High quality data are essential to reliable evaluation. Data for this research were collected from different sources. The system inventory data for production of PVC and WPC products were taken by on-site measurements in the company. Other inventory data for the background system were obtained from the Eco-it software database (PRé, 2013).

Polyvinyl chloride as the main material (about 90%) is used in the production of PVC wall panels. Additives, such as antioxidants, stabilizers, UV rays filters are also needed, which constitute 10 % of the product. Additives ensure product's stability, durability, and resistance to ultraviolet radiation. As the software for life cycle assessment did not have anything equivalent to these additives, they are not included in the production phase.

The two main materials used in WPC wall panel production phase are polyvinyl chloride and wood chips, which constitute 35 and 55 % of the product, respectively. As well as in PVC wall panel, WPC product consists of 10 % of additives, but the additives were not included in this assessment for both PVC and WPC products due to their non-existence in the used software. In addition, an assumption has been made that the additives are of a similar chemical composition in both products and their environmental performance is similar, too. Therefore, for the impact assessment of PVC product, 100 % of polyvinyl chloride material was taken into account, and for the WPC – 40 % of polyvinyl chloride and 60 % of wood chips materials were assessed. In both PVC and WPC products alkyd paint and packaging of LDPE were used.

3. In order to determine and compare the impact of PVC and WPC wall panels on the environment throughout their cycle, and to define significant environmental aspects, analysis was carried out using the ECO-it software. ECO-it calculates the environmental load and shows which parts of the product's life cycle (production, use or waste disposal) contribute most.

The environmental impact measure unit used in this study is carbon footprint, which is the overall amount of carbon dioxide and other greenhouse gas emissions emitted during the product's life cycle. This measure is expressed in equivalent kilograms of carbon dioxide (CO_2-eq) and represents global warming potential as an impact category in environmental assessment during the life cycle.

2.2. Material flow analysis in production of PVC and WPC wall panels

Material flow analysis (MFA) is a systematic assessment of the flows and stocks of materials within the system, which is defined in space and time. It connects the sources, the pathways, and the intermediate and final sinks of a material. MFA can be controlled by a simple material balance comparing all inputs, stocks, and outputs of processes. The MFA method is a practical decision-support tool in resource, waste, and environmental management (Rechberger et al., 2004).

Material flow analysis contains the following main steps:

- Identification of system space and time boundaries.
- Selection of the materials (goods or substances);
- Identification of significant flows, sinks and processes.
- Identification of mass flows, sinks and concentrations.
- Total assessment of material flows and sinks;
- Schematic representation and interpretation of the results (Staniškis et al., 2010).

The material flow analysis was performed for PVC and WPC separately. The conceptual model of the eco-efficient material flow management was also suggested. The data for the material flow analysis comprised average annual data that were obtained by on-site measurements in the company.

The results are represented using software STAN (subSTance flow ANalysis), which performs MFA according to the Austrian standard ÖNORM S 2096 (MFA – application in the waste management) under consideration of data uncertainties (TU WIEN, 2012).

Having built a graphical model with predefined components (flows, subsystems, system boundaries, and text fields), the known data (mass flows, stocks, concentration, and transfer coefficients) with corresponding physical units can be either entered or imported for different hierarchical layers (good, substance, energy) and time periods. A graph of the model is shown as *Sunkey* diagram (i.e. the width of a flow is proportional to its value) (Cencic et al., 2008).

3. Results and discussion

3.1. Environmental life cycle assessment of PVC wall panel

Figure 1 illustrates the environmental life cycle assessment results of a PVC wall panel. The graph shows that the value of carbon footprint throughout the whole PVC life cycle is 4.6 kg CO_2-eq, where the greatest impact on the environment occurs in a production stage – 3.4 kg CO_2-eq, followed by a disposal stage – 1 CO_2-eq. During the use phase an environmental impact is made, while the product is transported and distributed to customers. Therefore, the use phase impact on the environment is the least of all phases, thus in the further analysis it will be not considered.

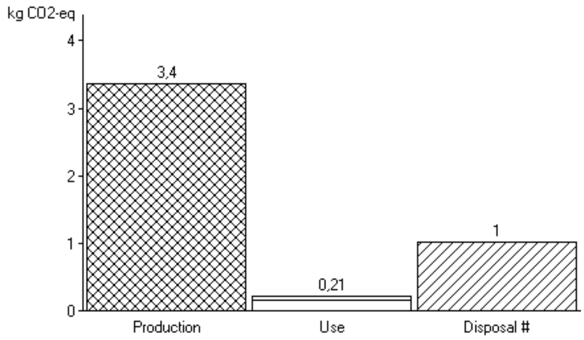

Fig. 1. Environmental impact of PVC wall panel in production, use, and disposal stages

As the biggest environmental impact of all life cycle is made in a production stage, the latter is divided into separate materials and the impact on the environment is studied more in detail (Fig. 2.).

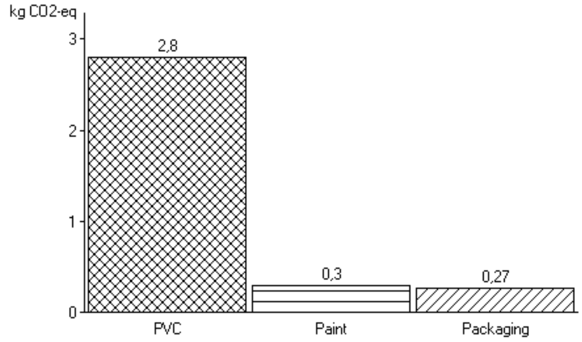

Fig. 2. Environmental impact of PVC wall panel in a production stage

The greatest environmental impact (83 % of the total one) is made by a product's component – polyvinyl chloride. The other components, paint and package, used in a PVC wall panel production stage contribute less to the impact of the whole production stage – 8.9 and 8.1 %, respectively (Fig. 2.).

There are several waste management ways in a disposal phase: recycling, incineration, and landfill. When PVC wall panels become waste, they can be recycled and reused repeatedly. However, they get into municipal waste containers and then are disposed of in landfills. The results of a disposal stage are shown in Figure 3.

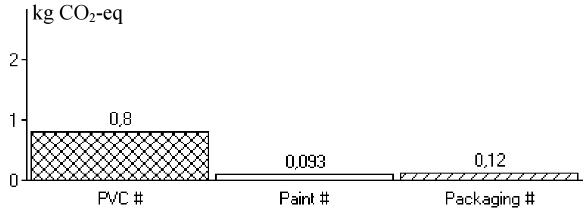

Fig. 3. Environmental impact of PVC wall panel in a disposal stage

Figure 3 shows that carbon footprint of PVC disposal is 0.8 kg CO_2-eq, and it covers 80 % of the total disposal stage impact.

In improving the environmental performance of a product, the carbon footprint of polyvinyl chloride in production (2.8 kg CO_2-eq) and disposal (0.8 kg CO_2-eq) stages can be identified as a significant environmental aspect.

3.2. Environmental life cycle assessment of WPC wall panel and its comparison with PVC impact

Wall panels of wood-plastic composite are made of primary WPC granules, which are imported from abroad. Figure 4 illustrates results of WPC wall panel environmental life cycle assessment.

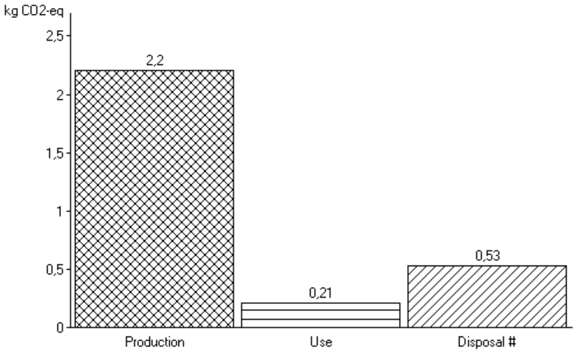

Fig. 4. Environmental impact of WPC wall panel in production, use, and disposal stages

Figure 4 presents that the carbon footprint value throughout the all life cycle of a WPC product is 2.9 kg CO_2-eq, where the production stage has the greatest contribution – 2.2 kg CO_2-eq (76 % of the total impact). As well as in PVC wall panel environmental assessment, the use stage of a WPC wall panel has the least impact, and in further analysis it will be not considered.

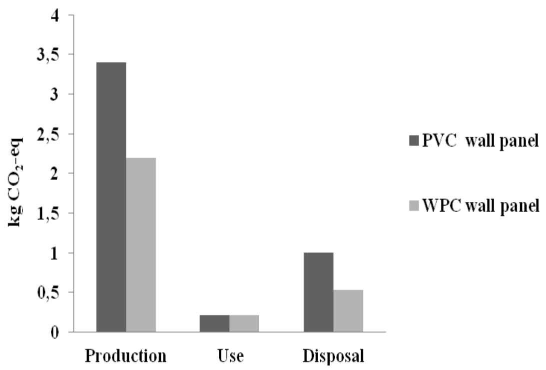

Fig. 5. Comparison of the impacts of PVC and WPC products during life cycle

Comparing the impact of all life cycle of both PVC and WPC products (Fig. 5.), it is identified that the carbon footprint of WPC wall panel is 37 % smaller than that of PVC wall panel. During the detailed analysis of separate life cycle stages (production, use, and disposal), it is assessed that the production and disposal stages of WPC wall panel contribute less (35 % and 47 %, respectively) to global warming than PVC wall panel. The use stage remains equable, because the conditions of products transportation and distribution to customers were the same.

The production stage of WPC wall panel is divided into separate materials and carbon footprint is calculated in detail (Fig. 6).

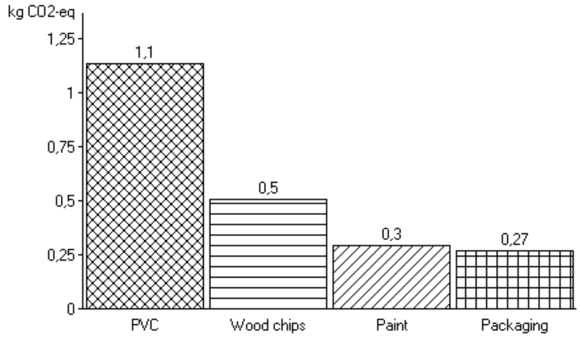

Fig. 6. Environmental impact of WPC wall panel in production stage

The diagram (Fig. 6.) shows that polyvinyl chloride has the greatest impact on the environment (1.1 kg CO_2-eq). Although the amount of wood chips is 20 % greater than PVC, the impact of wood chips on the environment is 2.2 times lower than that of polyvinyl chloride. The paint and packaging make up to 13.6 and 12.3 %, respectively, of the total environment impact in a production phase.

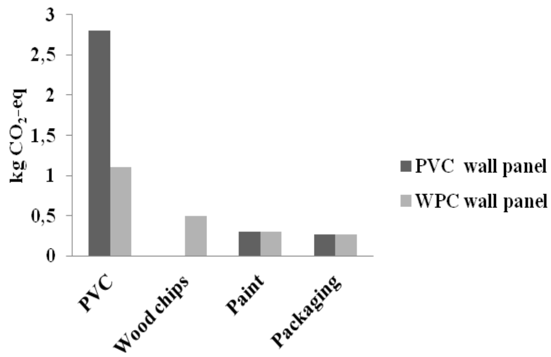

Fig. 7. Comparison of impact of PVC and WPC products in production stage

The comparison of the carbon footprint value in a production phase of both PVC and WPC products is represented in Figure 7. Looking at the results it is evident that by reducing the amount of PVC from 1 to 0.4 kg, the impact on the environment is reduced up to 60 %. In this stage 23 % of the total environmental impact is contributed by wood chips. The amount and the composition of paint and packaging used in both PVC and WPC wall panels are the same and have the same environmental impact.

Further, the disposal stage is analyzed. Both PVC and WPC wall panels can be recycled and reused in the new products manufacturing process. Due to irrelevant consumers' information about the recycling potential of wall panels after their usage, they get into municipal waste containers from which they are disposed of in landfills. The results of the disposal phase are represented in Figure 8.

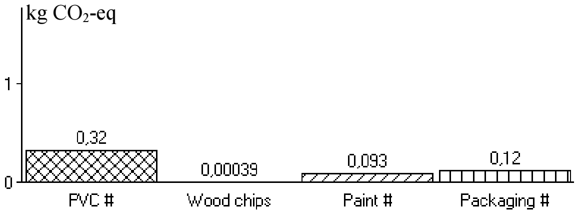

Fig. 8. Environmental impact of WPC panels in disposal stage

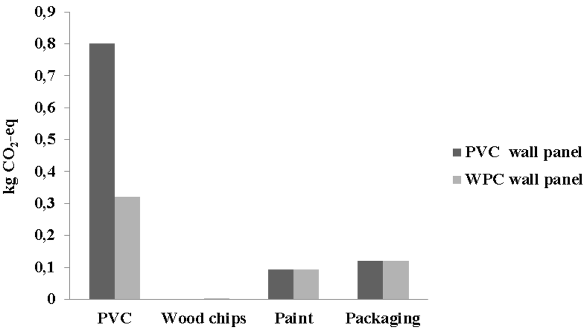

Fig. 9. Environmental impact of PVC and WPC products in disposal stage

Carbon footprint value of the WPC wall panel in a disposal phase is 0.53 kg CO_2-eq, i.e. 47 % lower than that of PVC wall panel. Figure 8 identifies that polyvinyl chloride has the greatest impact contribution (0.32 kg CO_2-eq) in a disposal stage, and the lowest impact belongs to wood chips (0.00039 kg CO_2-eq).

Summarizing the life cycle analysis of both PVC and WPC products it could be concluded that WPC technology has 37 % lower carbon footprint. Manufacturing of wood-plastic composite products instead of polyvinyl products promotes the resource efficiency, reduces non-renewable resources (plastic) usage and disposal in landfills. Thus, the impact on the environment and greenhouse gases emissions are minimized.

3.3. Results of PVC material flow analysis

Material flow analysis is based on the data of the company producing plastic products. This company develops both PVC waste collecting, its recycling, and production of PVC profiles, wall panels from secondary PVC raw materials.

Material flow analysis makes it possible to develop and improve distribution of materials in a production stage, and also to identify significant points or actions that could be accepted as a good practice.

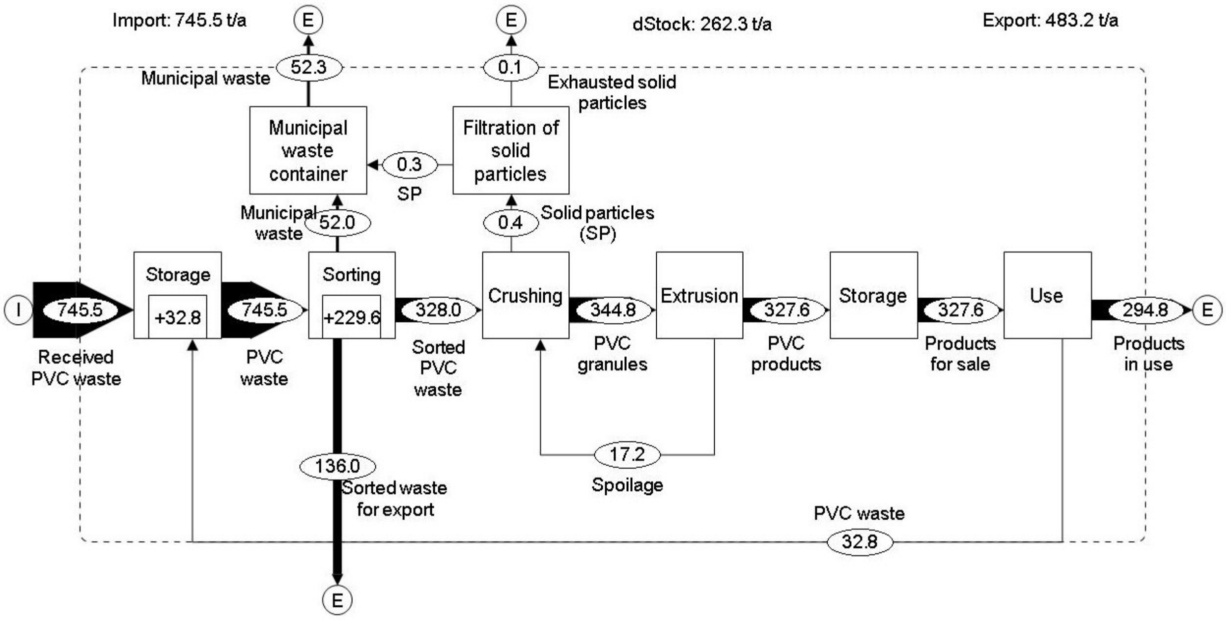

Fig. 10. Flow diagram of polyvinyl chloride

Figure 10 presents the diagram of PVC flows in production of PVC wall panels. It shows that the spoilage is directed to crushing, i.e. preparing of raw materials. Reuse of the spoilage reduces the need for sorted PVC waste supply for crushing to produce the same amount of the final product. In this way it is possible to save PVC materials for the next year operations.

The analyzed company collaborates with the companies of the construction sector, which use PVC products, get PVC waste and return it back to the manufacturing, in this case our analyzed, company. Therefore, the part of used products (in this case 10 %) is directed to PVC waste storage. As a result, a stock of +32.8 tons per year is generated, which ensures constant PVC waste augmentation.

The results show that the input of the system is 745.5 tons per year and the output is 483.2 tons per year. Consequently, the rest of 262.3 tons forms a stock (unused raw materials). This stock is a proper PVC resource, which remains in the company for follow-up operations.

3.4. Results of WPC material flow analysis

In 2012 the analyzed manufacturing company started producing new products made of primary WPC granules. The WPC products include terrace boards, fences, and wall panels for both internal and external cladding. Using the accounting data, the diagram of WPC flows is shown below (Fig. 11.).

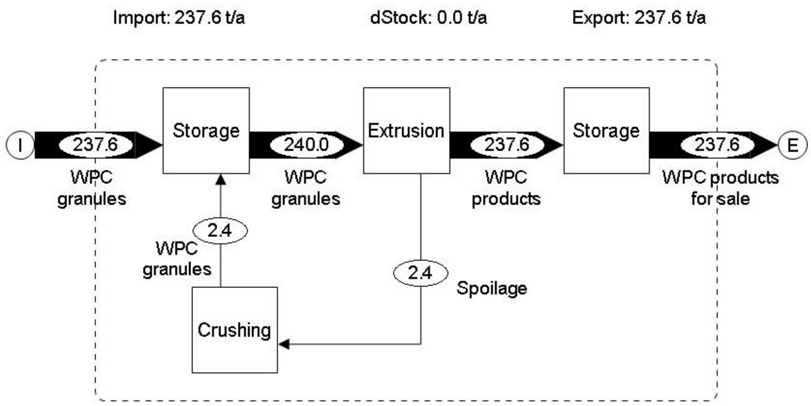

Fig. 11. Flow diagram of wood-plastic composite

The flows of wood-plastic composites in production of WPC wall panels are similar to PVC flows, because the spoilage (1 %) is directed to the crushing process for recycling and reusing of WPC materials in further operations. Thus, the need for primary WPC granules is reduced for producing the same amount of the final product. Results show that the input and output of the system are equal i.e. 237.6 tons per year. This is due to the fact that during the analyzed period the planned amount of WPC granules were used in a manufacturing process and products were sold, therefore no stock was formed.

3.5. Summary of material flow analysis

In the manufacture of PVC products 5 % of waste is formed, which is recycled and reused for new production. In this way, the company reduces the amount of primary raw materials needed either for obtaining the same quantity of products, or for keeping the materials in storage for the following next year operations.

In Lithuania there are a number of companies which recycle, granulate, and produce plastic products for local and foreign markets. As a result, there is a big competition among them in buying up plastic waste. Consequently, the threat emerges for the future prospects due to dependence on a supplier of plastic waste.

To sum up, when developing PVC recycling and reuse of secondary raw materials, primary resources are economized, and waste disposal in landfills is reduced. Moreover, the company has developed an attitude towards an industrial ecology conception. PVC waste coming from construction companies becomes raw material important in the PVC wall panel production. However, there are also negative aspects of the company activities. The biggest concern is poor quality of products due to many-times-recycled waste, which becomes less suitable raw material. Therefore, it affects the quality of a final product. In addition, the company is dependent on PVC waste suppliers and it is difficult to have a constant PVC waste supply. Moreover, increased demand for plastic waste causes bigger competition among waste management companies.

In order to win the market competition, the analyzed company has launched an innovative and promising branch of producing WPC terrace boards, wall panels, fencing. It is an alternative to PVC wall panels, as WPC granules are composed of both polyvinyl chloride, which ensures excellent performance and durability, and wood fibers, which give aesthetic and attractive image.

Currently, WPC products are manufactured from primary resources and reuse of waste. This allows the company to reduce the demand for primary raw materials for the same amount of production and to avoid waste. Nevertheless, WPC granules have positive and negative aspects. One of the advantages is that there is no need to collect, store, and recycle waste for its reuse preparation. It determines the company to avoid waste transportation, sorting, cleaning, and other processes; no additional utilities are needful, no inappropriate waste for reuse is generated. One of the disadvantages is that granules are to be imported from abroad and this causes a negative impact on the environment and additional transportation expenses. Another issue is dependence on the WPC granules suppliers, who at any time may stop providing their products or raise their prices.

3.6. Conceptual model of material flow management

Having studied the material flow analysis, it could be said that more rational usage of stocks should be realized in a conceptual model of material flow management. Due to a limited scope of PVC products manufacture, a large amount of PVC waste stays for the next year use. Assessing that in production of WPC products primary WPC granules are used, a suitable suggestion would be to produce these granules by themselves using the collected PVC raw materials.

Production of wood-plastic composite granules consists of the following processes:

1) Mixing and granulating of polyvinyl chloride, wood flour/ chips/ powder and necessary additives (stabilizers, UV filters, antioxidants, etc.) with twin screw extruders; 2) molding with a single extruder.

To ensure better granulation all the components have to be crushed into fine powder. Consequently, PVC and wood waste have to be directed to a special crusher and then to an extruder. Production of WPC granules ensures rational stock usage, independence from primary WPC granules suppliers, environmental costs, and reduction of an indirect impact on the environment due to transportation. This practice may also have a negative aspect, which appears during the granulation process, when the plastic and wood ratio has to be precisely chosen. This is of great importance in ensuring high quality and compliance products.

In the studies where technology of WPC granules is described the concrete wood-plastic ratio is not specified. Entirely the percentage ranges of the components of purchased WPC granules are taken into consideration. The ranges are: PVC – 20-50 %, wood flour – 50-80 %, additives – 10 %. With respect to these ranges, the ratio was chosen: PVC – 35 %, wood flour – 55 %, additives – 10 %. A suitable mixture of the materials will take a lot of material losses and energy resources, even so, the desired results will be reached experimenting and developing the ratio and technology.

Illustrating the conceptual model of material flow management, the combined and improved material flow analysis is represented in Figure 12.

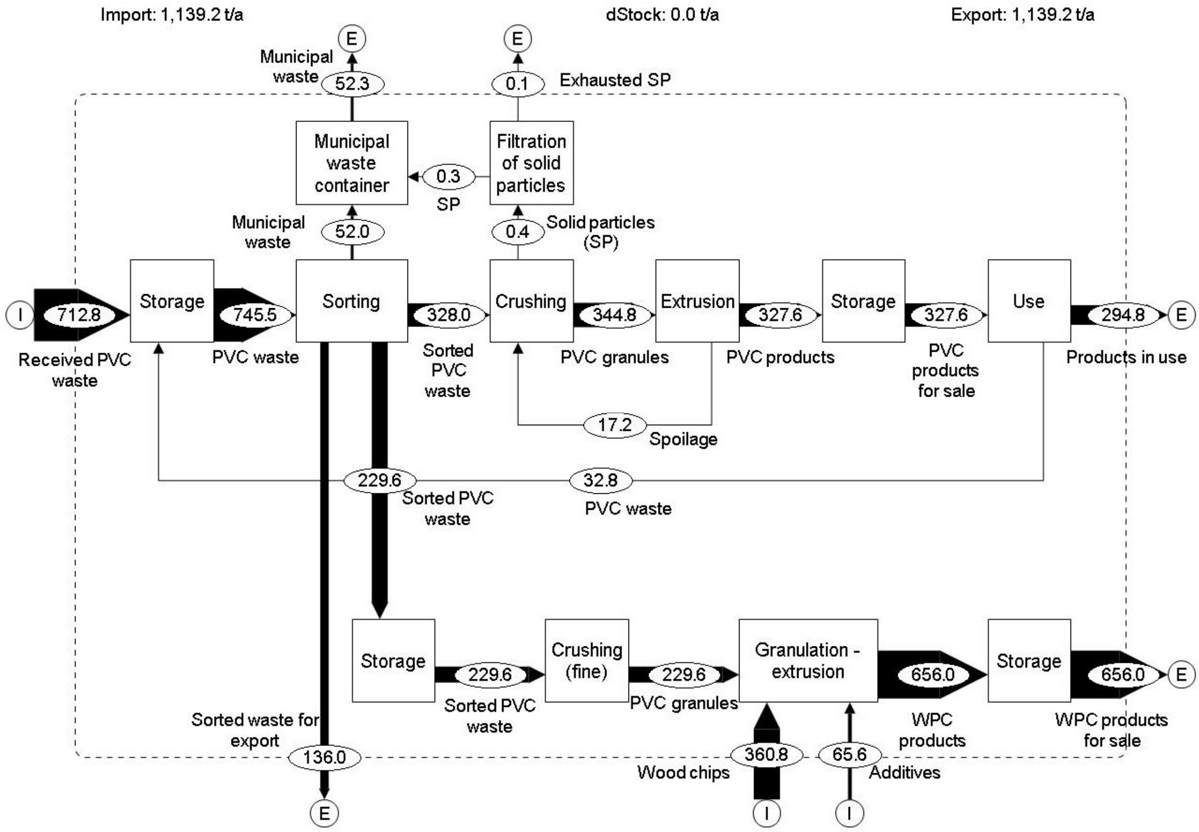

Fig. 12. Flow diagram of polyvinyl chloride and wood-plastic composite

Figure 12 shows the rational usage of generated stocks. Whereas during the usage of products it is possible to receive about 10 % of PVC waste from construction companies, this amount is directed to storage and later it is used for preparing raw materials. The diagram also shows that generatedPVC waste of ~ 230 tons per year, which is supposed to be used during the next year, is directed to storage and then to fine crushing and extrusion processes for manufacturing of WPC products. Results indicate that inputs and outputs are equal – 1139.2 tons per year. All imported materials are used and manufactured goods are exported, therefore there are no stocks in the system.

4. Conclusions

1. Results of the environmental life cycle analysis have clearly shown that carbon footprint of WPC wall panel is 37 % smaller than that of PVC wall panel. A production stage of both evaluated products makes a biggest impact on the environment. Moreover, production and disposal stages of WPC wall panels have a lower potential to global warming than PVC ones (35 % and 47 %, respectively).
2. The company analyzed in our case economizes non-renewable resources because they develop an industrial ecology conception. The company

uses recycled PVC waste received from construction companies as secondary raw material for production of new PVC wall panels. Besides, within the company the close loop conception is applied to PVC. The spoilage made during the manufacturing of PVC and WPC products is directed to preparing secondary raw material and reusing it in further production operations. Thus, the need for PVC secondary resources for PVC panels and primary PVC resources for WPC panel production is reduced by producing the same amount of a final product. The results of PVC flows show that the input (import) of the system is 745.5 tons per year and the output (export) is 483.2 tons per year. Consequently, the rest of 262.3 tons forms a stock (unused raw materials). This stock is the proper PVC resources, which remain for the follow-up operations.

3. In order to use the stock rationally, a conceptual model of material flow management is presented. Due to the limited production volume of PVC products, a large amount of PVC waste as secondary PVC recourses stays for the next year production. The suitable suggestion implies that WPC granules should be produced by themselves at the company using collected PVC secondary materials (PVC stocks). It would lower both environmental costs and environmental impact, would increase resource efficiency, and diminish dependence on suppliers.

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Efektyvus išteklių naudojimas ir anglies dioksido pėdsako mažinimas plastikinių gaminių gamyboje

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Efektyvi išteklių vadyba, atliekų prevencija, atsinaujinančių išteklių naudojimas skatina darnią gamybą ir mažina šiltnamio efektą sukeliančių dujų išsiskyrimą plastikinių produktų gamybos sektoriuje.

Straipsnyje yra pristatoma efektyvaus išteklių panaudojimo ir anglies dioksido (CO_2) pėdsako mažinimo galimybių analizė, diegiant medžio ir plastiko kompozito gamybą. Analizė buvo atlikta taikant būvio ciklo vertinimo ir medžiagų srautų analizės metodikas. Efektyvaus išteklių naudojimo ir anglies dioksido pėdsako mažinimo galimybės buvo vertinamos nustatant gaminių iš polivinilchlorido (PVC) ir medžio ir plastiko kompozito (angl. *wood-plastic composite – WPC*) būvio ciklą ir detaliai analizuojant gamybos proceso medžiagų srautus.

Vertinant gaminių būvio ciklą, buvo nustatyta, kad 1 kg WPC dailylentės CO_2 pėdsakas per visą gaminio būvio ciklą yra 37 proc. mažesnis negu to pačio svorio PVC dailylentės. Abiejų produktų didžiausias poveikis aplinkai susidaro vykstant gamybai, tačiau čia WPC dailylentės CO_2 pėdsakas yra 35 proc., o vykstant šalinimui – 47 proc. mažesnis negu PVC dailylentės.

Medžiagų srautų analizės rezultatai parodė, kad perdirbus broką ir dar kartą jį panaudojus, mažiau sunaudojamos antrinių PVC ir pirminių WPC žaliavos tam pačiam produkcijos kiekiui pagaminti. Taip pat įmonė plėtoja pramoninės ekologijos koncepciją, nes bendradarbiaujant su statybų sektoriaus įmonėmis jų PVC atliekos tampa aptariamosios bendrovės žaliavomis.

Efektyviam išteklių panaudojimui buvo pateiktas koncepcinis medžiagų srautų vadybos modelis. Kadangi WPC gaminiai yra gaminami iš pirminių WPC granulių, importuotų iš užsienio, pateiktame modelyje yra siūloma patiems gaminti šias granules, panaudojant surinktas PVC atliekų sankaupas. Plėtojant šią veiklą, būtų galima sumažinti aplinkosauginius kaštus, neigiamą poveikį aplinkai dėl transportavimo ir priklausomybę nuo granulių tiekėjų.