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CAN THE ENERGY MANAGEMENT AND THE WASTE MANAGEMENT BE HARMONIZED?

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Abstract: *One of the biggest tasks of the environmental science is creating more economic and environmentally friendly energy sources. The enormously increasing amounts of waste material are also a huge challenge for the environmental protection. These previously mentioned problems can be treated in a harmonized way. The uneven energy consumption requires peaks in the production of energy. The energy consumption is higher in winter than in summer in northern part of Europe. Such a seasonal deviation of energy consumption can be compensated with the waste burning in winter during the cold weather. The significant portions of municipal wastes are burnable and hardly biological degradable (e.g. polyurethane, PET, PVC, PE, etc.). Moreover several types of them cannot be recirculated. The plastic materials can be used for energy production. The invention of our proposal is the plastic waste materials have to be collected and stored during the less energy consuming period, and burn them when the energy requirements are high. The selected burnable waste can be collected during the whole year period, and stored in compressed forms. The abandoned open cast mines are appropriate for such depots. In this way the consumption of fossil fuel will significantly be reduced and the waste stream decreased. Several alternative ways are also shown for the use of plastic waste.*

Keywords*: Energy management, harmonization, plastic materials, waste management*

INTRODUCTION

The recent time is being called polymer age since the middle of 20th century [1]. Nowadays the production of plastics is more than double by volume than the production of crude steel production worldwide. The global plastics production reached almost 360 million tonnes in 2018, and Europe took 61.8 million tonnes share of it [2]. 40% of world productions were used as packing materials. The success of polymer originates from various sources. They are rather cheap and versatile materials. They can be produced and formed among mild conditions. They contain only traces of poisonous materials (plasticisers, stating materials etc.). Practically the modern life cannot be imagined without plastic materials.
On the other hand, such an enormous volume products result in very big amounts of wastes. Overwhelming part of the productions becomes waste [3]. Recently one of the most important goals of the environmental protection is to reduce the amount of plastic waste pollution. Only 29.1 million tonnes of plastic were collected selectively from the 61.8 million tonnes plastic productions in Europe [2]. It seems more than the half of the used plastic volumes were not collected selectively or were not collected at all. The part of the thrown away plastics gathers in ocean surface. The Great Pacific Garbage Patch is the largest accumulation

of plastic waste, having 2.41 million tonnes plastic garbage in 1.6 million square kilometres [4].
It is necessary to reduce the plastic flood to prevent the environment. One way is to reduce the production volumes of plastics. The less prodigal packaging material usages are one of the main goals of environmental protection. The other important goal is increasing the recycling and reusing rates of the used plastics. The energy recovery is a meaningful part of the reuse techniques [5, 6], but there are several other ways of utilization of the used plastic materials.
The subject of this paper is important not only from the point of environmental science, but it is also useful in education aspects too [6].

General characterisation and description of polymer materials

Plastics are a wide range of synthetic or semi-synthetic organic compounds. They build up chemically connected monomers reaching several thousand molecular weights. Generally the plastic molecules are indigestible and non-poisonous. Their toxic effects come from their additives (e.g. ftalates) or the remaining traces of monomers and oligomers (e.g. styrene, bisphenol-A, vinyl chloride). Some type of the plastics are biodegradable, but the majority of them none or hardly biodegradable materials. The environmental difficulties come from these non-degradable features. Very huge amount of the plastics are produced yearly (Figure 1), which generate enormous volume waste [7].

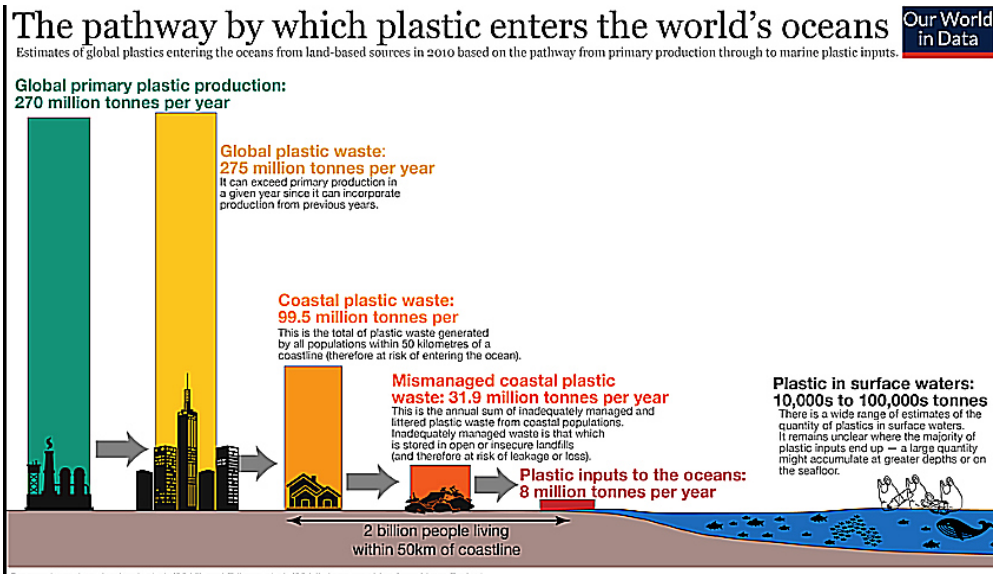

Figure (1) The way of the plastic flood from the production to ocean [7]

The treatment of plastic waste is unsolved recently, but is necessary to overcome this trouble urgently. First of all the selective collection of the plastic wastes have to be solved with high efficiency. Unfortunately, less than the half of the plastic waste is collected separately todays. For example, 275 million metric tons of plastic wastes were produced by coastal countries, and 4.8 -12.7 million metric tons were discarded into the oceans in 2010 [8]. The European plastics manufacturers are committed to reach 60% rates of reusing and recycling for plastic packaging by 2030, 100% rate by 2040 [8].

The fate of the selectively collected plastic materials

There are three ways of the fates of plastic materials: recycling, energy recovery and landfill [2]. The recycling can be the usage in original forms as the bottle redemption and refilling. The another way of recycling to create new products from the plastic, making textile from the grinded PET bottles or use them as raw materials of art objects.
The Figure (2) shows the ratio of different fates of plastic in function of time in the period 2006-2018 in Europe. The amounts of collected waste have increased with 19% from 24.5 million tons to 29.1 million tons, more steeply than production amount of plastic materials. The ratio of energy recovery and recycling increased steeply, and the ratio of land fill decreased greatly. Even the absolute amount of landfills also has decreased.

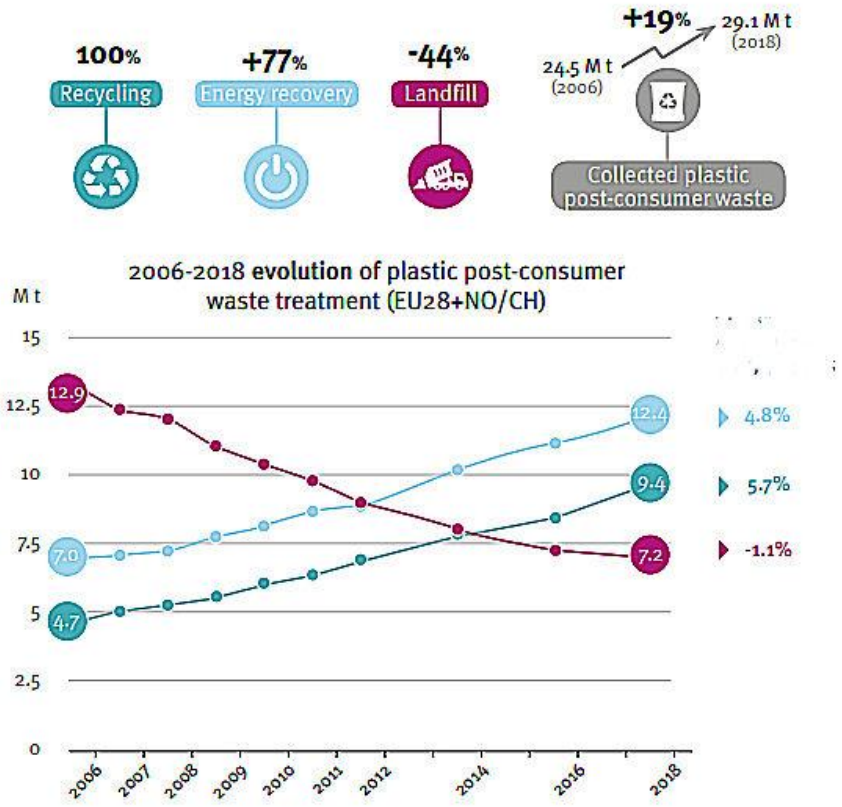

Figure (2) The tendency of the fate of plastic waste between 2006 and 2018 in Europe

These tendencies are promising, but the landfills still share 18% of the plastic wastes [2].

Energy recovery

The energy recovery seems more easily manageable than recycling. The energy recovery needs less organization and investment than the recycling. Moreover, the energy recovery need not fight with the well-developed Chinese competition.

The energy contents of the plastics are rather high according to Figure (3). [9] The hydrogen has higher energy contents (140MJ/kg) by weight than plastics (40-60 MJ/kg), but the energy content by volume of plastics are much higher than hydrogen. Moreover, the plastics are much more advantageous from the point of view of the safety than hydrogen. Several researches try to solve the energy production of future using solar energy.

These plans produce hydrogen with the electrolysis of water, and the gained hydrogen is transformed with further reactions to hydrocarbons. The Fischer-Tropsch reactions result in hydrocarbon from the reaction of hydrogen and carbon dioxide [10]. The long time storage of the pressurized hydrocarbon can be solved using the natural cavern (e.g. depleted natural gas fields). However, plastics can store more effectively the energy than the pressurized hydrocarbons, and the storage and treat of the plastic are simpler and safer in solid state.

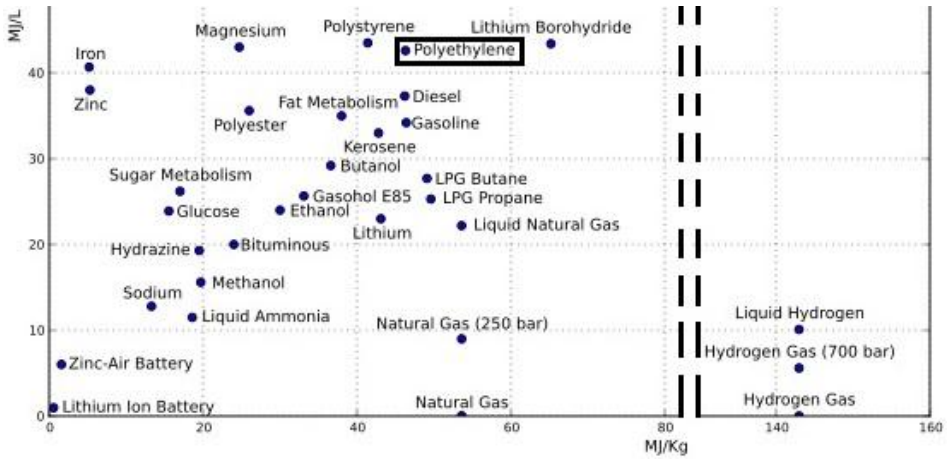

Figure (3) The energy densities of different materials (exception of oxidizing chemical agents) [9]

The collected plastic materials can be used as fuel materials in the peak seasons of energy consumptions. Seasonal deviation of energy consumption can be easily compensated by plastic wastes. The summer collected plastic waste can be burnt in winter. The compressed plastic waste bales can be stored in abandoned quarry until their burn. The materials of Great Pacific Garbage Patch can be expected potential raw materials of electricity productions. Such of plastic wastes burnings require precautions. The burning PVC can produce extremely toxic dioxins [11]. Of course, such toxic effect can be eliminated with plasma torch in the chimney. A well designed garbage incineration is good not only for environment, but it can be an artistic object too (Figure 4).

Figure (4) Garbage incineration in Vienna, designed by Hundertwasser

The plastics themselves do not destroy the environment. The environmental troubles are caused by the humans with their unsparing and careless attitudes. The use of decreased amount of packing plastic materials can significantly reduce the plastic waste flood. The non-produced plastics do not become plastic wastes. The selective waste collections and separations of the plastics from other waste materials are another significant ability to make a better waste management and shrinking the plastic gush.

To improve the plastic waste managements need several changes in the human attitudes, legislative issues and better taxation and subsidization systems. The environmentally friendly education can help a lot. To ban of the plastic straw does not decrease significantly the volume of the plastic waste, but such actions draw the attentions of the children for the less prodigal use of plastics?

The high product fees and redemption fees push the producers for reusing the plastic products instead of purchasing, use and throw away practice. The redemption of bottles is a typical example for such a practice. The free of charge selective waste collections have to introduce everywhere. The expanses of selective waste collection must be included the prices of the products. In this way, the people feel, the selective waste collections are free-of charge. Of course, the non-selective municipal waste practice must be fine.
The investments of selective waste managements (e.g. selection conveyor belt, flotation basin and gridding mills) require financial supports or tax reduction, from national as well European sources.

CONCLUSION

The plastic materials are indispensables in our recent life. The waste stream of plastic can be reduced in several ways. The plastic waste can be used very effectively as secondary energy source. However, there is a need for a significant improvement in attitudes from education to legislation in the waste management.

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References

[1] G. B. Kauffman, Heros of Polymer chemistry, Chemical and engineering news, 1998 (16) 38-39
Plastics – the Facts 2019 https://www.plasticseurope.org/application-/files/9715/7129/9584/FINAL_web_version_Plastics_the_facts2019_14102019.pdf
[2] L. Lebreton, A. Andrady, A. Future scenarios of global plastic waste generation and disposal. Palgrave Commun 5, 6 (2019). https://doi.org/10.1057/s41599-018-0212-7
[3] Ocean clean-up, The great pacific garbage patch, https://theoceancleanup.com/great-pacific-garbagepatch/#:~:text= The%20GPGP%20covers%20an%20estimated,times%20the%20size%20of%20France.
[4] L. Tolner, M. Hartman, E.Karácsony Szemét-e a műanyaghulladék? 2019, Környezetkémiai Szimpózium, Siófok, 2019.10.10-11. Program és előadáskivonatok 35.
[5] R. Bodáné Kendrovics, Az ökológiai szemlélet igénye és kialakítását elősegítő módszerek a Környezetmérnök BSc képzés Vízminőség-védelem c. tárgy oktatásában, Új Pedagógiai Szemle 2011 (1-5) 460-483 ISSN 1215-1807
[6] H. Ritchie, M. Roser, Plastic Pollution 2018, OurWorldInData.org. 'https://ourworldindata.org/plastic-pollution
[7] J. R. Jambeck, R. Geyer, C. Wilcox, T. R. Siegler, M. Perryman, A. Andrady, R. Narayan, K. L. Law, Plastic waste inputs from land into the ocean, Science 13 Feb 2015: Vol. 347, Issue 6223, pp. 768-771 DOI: 10.1126/science.1260352
[8] Plasticseurope Welcomes Ec's Plastics Strategy https://www.plasticseurope.org/en/newsroom/press-releases/archive-press-releases-2018/plasticseurope-welcomes-ecs-plastics-strategy
[9] S. Dial, A plot of selected energy densities (excluding oxidizers). 2008, https://commons.wikimedia.org/wiki/File: Energy_density.svg
[10] H. Schulz, Short history and present trends of Fischer–Tropsch synthesis, 1999, Applied Catalysis A 186, 3-12
[11] I. Patkó, Z. Juvancz, M. Turi, E. Lumnitzer, B. Darina, and H. Beáta, 2010, Emission of Dioxins In Biomass Using, Acta Mechanica Slovaca, 14, 94-99