Département de
Génie Energétique et Environnement
INSA
Lyon, France

Department of Civil and Environmental Engineering
Luleå University of Technology
Luleå, Sweden

THE USE OF CRUDE OIL IN PLASTIC MAKING CONTRIBUTES TO GLOBAL WARMING

Bruno GERVET

Supervisor: Prof. Bo Nordell

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Renewable Energy Research Group
Division of Architecture and Infrastructure
Luleå University of Technology
SE-97187 Luleå, Sweden

1. Net Heat Generation from the Use of Crude Oil in Plastic Making

1.1. Background

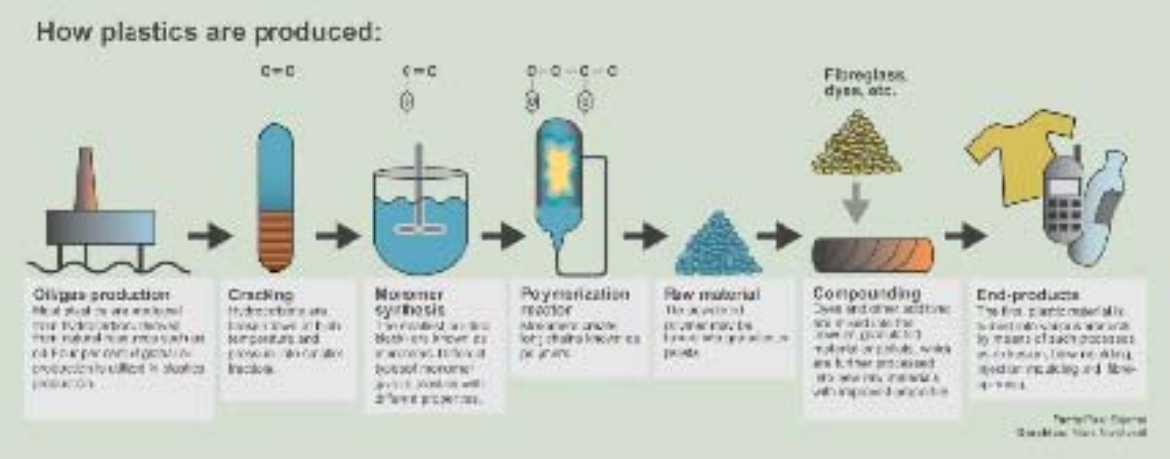
Although global warming is scientifically accepted, its cause is still disputed. Nordell (2003) suggested a most natural explanation; that this warming is a result of heat emissions from the global consumption of non-renewable energy. Global warming means that heat has been accumulating in air, ground, and water since 1880. During the same period heat was released into the atmosphere by heat dissipation from the global use of fossil fuel and nuclear power. Any such thermal pollution must contribute to the warming. A comparison of accumulated and emitted heat show that heat emissions explains 55% of the global warming. Moreover, the amount of emitted heat is underestimated, since the non-commercial use of fossil fuel is not included, e.g. gas flares, underground coal fires, oil used in production of plastics, and also biofuel (wood) consumed at a greater rate than the growth. Here, the task was to estimate the heating caused by one of the non-commercial energy sources, the use of crude oil in plastic making.

1.2. Definition

Plastic covers a range of synthetic or semisynthetic polymerization products. Plastics are polymers: long chains of atoms bonded to one another. All plastics are polymers but not all polymers are plastics; there are actually few natural polymers. Nature has always produced polymers such as cellulose, the DNA molecule and proteins. Plastic production was inspired by Nature's polymers. Plastics may contain other substances than polymers in order to reach a mean performance; certain types of plastic are suitable for packaging (25% of the US plastic production – 37% of the European plastic production), others for building and construction (22% in US – 20% in EU), and others for toys and medical stuff (13% in US – 9% in EU), transportation (5% in US – 7.5% in EU), furniture (4% in US – 3.5% in EU), electronic stuff (4% in US – 7.5% in EU) etc. ([1] and PlasticsEurope, Appendix 1).

Today, plastics frequently replace most traditional materials such as wood, metal, glass, leather, paper and rubber because they can be lighter, stronger, corrosion resistant, very durable and a better insulator. These properties often make plastics more economical to use than other materials. They are used throughout industry and business; they influence the way we dress, the way we enjoy ourselves and the way we live. Many plastics have become household names - nylon, polyester and so on…

Plastics can be produced from oil or gas that has undergone chemical processing, and consists of synthetic polymers (See Graph 1.1).



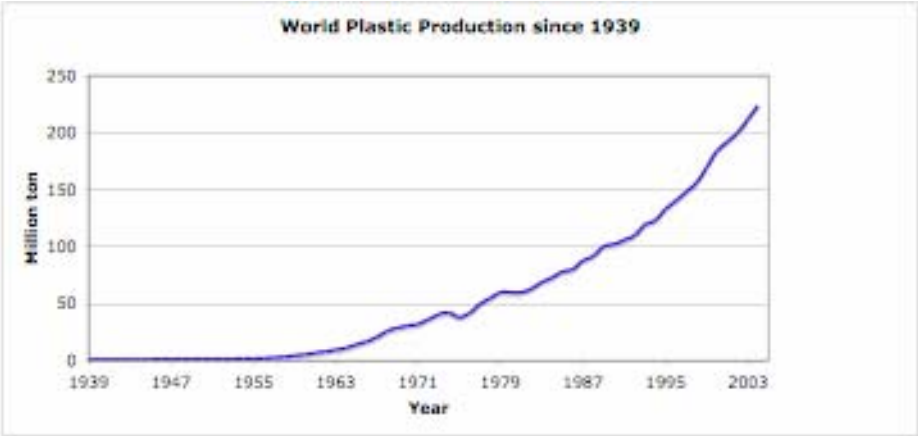
Graph 1.1, *How Plastics are Produced [2].*

1.3. Type of Plastics

In1920, Hermann Staudinger developed the theory of "polymers". Low Density Polyethylene (LDPE), Polystyrene (PS) and Polyvinyl Chloride (PVC) were commercially developed in 1930s, high density Polyethylene (HDPE), and Polypropylene (PP) were commercially developed in 1950s, and Polyethylene Terephthalate (PET) was commercially developed in 1970s. There is also other kind of plastics like Polyamide (PA), Polycarbonate (PC), Acrylonittrile Butadiene Styrene (ABS), Polyvinylidene Chloride (PVDC), Polytetrafluoroethylene (PTFE), Polymethyl methacrylate (PMMA), and Polylactic acid (PLA). On the other hand, the production of these plastics is negligible compare with those mentioned above.

1.4. World Plastic Production since 1939

The graph 1.2 shows the annual World Plastics Production since 1939 ([3] that contains data from PlasticsEurope – Appendix 1); Plastic was developed throughout the 1920s and 1930s. Plastic production started in around 1939 when it was used extensively during the Second World War. The production increased largely in the early 1950s since they had found their way into our homes. Moreover, the production decreased around 1973 due to the Yum Kippur war.



Graph 1.2, *Annual World Plastic Production since 1939.*

The table 1.3 presents the world production for different kind of plastic for the year 2003. The part of the world Polyethylene production in the world plastic production is bigger than the part of the US or European Polyethylene production in the US or European plastic production (respectively 45% and 37%).

Table 1.3. World Plastic Production – 2003 [3 – 4 – 5]**.**

	Polyethylene	Polypropylene	PVC	Others	World
Plastics production (in million ton)	**58.14**	**53.86**	**18**	**75**	**205**
Plastics production (%)	**28.3**	**26.3**	**8.7**	**36.5**	**100**

1.5. Crude Oil consumption

Crude oil is used in plastic making as main raw materials. 1 litre of petrol (0.76 kg) needs approximately 0.9 kg of crude oil, with 1 kg crude oil counted for 44 MJ/kg. This gives a plastic to petrol ratio in kg/l (Table 1.4 and 1.5).

Table 1.4. Petrol Consumption in Plastic Making for Different kind of Plastics [6]**.**

In kg/l	min	max
PVC	0.75	1.65
PE	0.57	0.72
PP	0.54	0.68
PS	0.50	0.72
PET	0.47	1.28
PC	0.37	1.10

The maximum corresponds to the case when the oil is used as raw materials and as minimum energy to derive the others raw materials; the minimum corresponds to the case when the oil is also counted as energy source for plastic making and for distilling crude oil.

Table 1.5. Energy Consumption versus Different Plastic Making [6]**.**

In MJ/ kg	Total	oil	others
PVC	53	24	29
PE	70	55	15
PP	73	58	15
PS	80	55	25
PET	84	31	53
PC	107	36	71

"Oil" being the used oil derivatives as raw materials and the minimal direct oil related energy use to derive these raw materials.

1.6. Results

From 1939 to 1950, only PE – PS – PVC were produced; thus the considered energy consumption for this period would be about 48MJ/kg assuming the PE production as the main plastic production. From 1950 to the early 1970, PP has to be added in consideration; the energy consumption would be 50 MJ/kg. So far the energy consumption would be 47.8 MJ/kg.

Considering the energy consumption mentioned above versus different plastic making, and in the case of oil is only used as raw material, the net heat generation is 0.38 10^{14} kWh from 1939 to 2000 and 0.49 10^{14} kWh to 2004.

Considering that the crude oil production report does not consider the oil used for plastic making and the oil used as energy in plastic plants (what is improbably), the net heat generation is 0.6 10^{14} kWh to 2000 and 0.77 10^{14} kWh to 2004.

Considering the worst case of energy consumption versus different plastic making, i.e. PP energy consumption, the net heat generation is 0.46 10^{14} kWh to 2000 and 0.59 10^{14} kWh to 2004.

1.7. Reviews and Uncertainties

Although the plastic production seems well reported since its start, some uncertainties have to be considered. The first one is obviously about the reliability of the plastic production database but since PlasticsEurope is an international organisation it should be reliable. Moreover, the plastic production was only considered since 1939, though there was a little plastic production since 1930; unfortunately it was not reported. An uncertainty can be also considered about the values of oil consumption.

Moreover, the evaluated net heat generation considers the case where all the plastic is decomposed (mainly burnt), i.e. all the plastic already consumed and its oil content transformed into heat. Even if the lifetime of plastics is not too long, some of the plastics produced are net yet decomposed.

1.8. Conclusion

According to the uncertainties mentioned above, the net generation from plastic making is overestimated. Unfortunately it is not possible to know the amount of plastic that was already burnt or decomposed. Moreover, it is not known whether the crude oil production reports consider the oil related raw material in plastic making.

Anyway, the net heat generation from the use of crude oil in plastic making is roughly $0.4 \cdot 10^{14}$ kWh from 1939 to 2000. It corresponds to 1.3% of the missing heat and contributes to 0.5% of the global warming. Its contribution is about the same magnitude than the gas flaring, less than the impact of nuclear power, and more than coal fires.

Whether this amount of crude oil was taken into account in crude oil production reports, it would be negligible considering the total crude oil production since 1880.

Pict. 1.6, *"Plastic field" in Tunisia.*

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Appendix 1: Plastics – Europe

http://www.plasticseurope.org/

PlasticsEurope represents the plastics manufacturers in Europe. The association has more than 60 member companies, producing over 90% of polymers across Europe's 25 member states plus Bulgaria, Croatia, Norway, Romania, Switzerland and Turkey. PlasticsEurope operates from six decentralised offices: one in Brussels and five regional centres (Central, Iberia, Mediterranean, North and West) located in France, Germany, Italy, Spain and the UK.

PlasticsEurope represents well over 90% of Europe's plastics raw materials production capacity. The plastics chain in Europe - including converters and machinery manufacturers - employs over 1.6 million people. The combined turnover of our industry is in excess of 160 billion euro per annum.

Aims and Objectives

On behalf of more than 60 member companies, PlasticsEurope generates information on the polymer industry and promotes plastics' positive contribution to society, both today and in the future. To achieve this, the Association aims to:

- Provide effective industry solutions for plastics - related issues;
- Represent the interests of the industry in general;
- Define and communicate industry's views on issues related to plastics production, use and waste treatment;
- Generate and promote factual information to ensure that a balanced view of plastics is presented to European institutions, media, consumers and pressure groups;
- Safeguard free trade for its products.