Pollution Caused by Thermal Engines When Using Biofuels

Marin Bica(✉), Dragos Tutunea, and Eugenia Trasca

Faculty of Mechanics, University of Craiova, Craiova, Romania
marinbica52@gmail.com

Abstract. The environment is naturally polluted with reversible effects through biological and biochemical cycles. Artificial pollution from industry activities disrupts natural cycles with irreversible consequences. Internal combustion engines are among the most polluting machines manufactured by humans. Worldwide they are used in transport, road, naval and air or agriculture offering a long running range. Reducing gas emissions from combustion to engines is a research topic for specialists around the world. The use of biofuels is a research direction approached by thermal engine companies with promising results. The EU has issued regulatory acts setting limits on emissions that affect the quality of the environment. In this paper we present the measures imposed by the EU for thermal engine manufacturers. The results of laboratory research for different concentrations of biodiesel at different load and speed regimes will be presented in a future paper.

Keywords: Biofuel · Pollution · Emissions

1 Environmental Impact

The increase in the price of crude oil products, in particular heat engine fuels, has restored interest in biofuels obtained from vegetable or animal oils. This interest in biofuels has contributed to higher prices for food. In rural areas where the cultivation of plants with energy potential used in the production of biofuels with immediate economic benefits has developed. Agricultural food production is diminished which can lead to a food crisis. The desire to obtain large productions has led to the excessive use of chemical fertilizers that degrade the soil and affect human health. Soil may be degraded if long periods of crop cultivation are overgrown to produce biofuels (monoculture practices). In the manufacturing process results in by-products that are actually residues:

- Rapeseed:
  - Raw material rape:
  - Glycerin
- Sugar sorghum

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Table 1. Population of the globe – according to the UN [1]

Year	1950	1998	2050
Population of the globe	2.521	5.901	8.909
Most developed regions	0.813	1.182	1.155
Least developed regions	1.709	4.719	7.754
Africa	0.221	0.749	1.766
Asia	1.402	3.585	5.268
Europe	0.547	0.729	0.628
Latin America and the Caribbean	0.167	0.504	0.809
North America	0.172	0.305	0.392
Oceania	0.013	0.030	0.046

  - Sorg bagasa (sugar-squeezed sorghum strains)
  - Fermentation yeast

- Corn

  - Corn pulp
  - Fermentation yeast
  - The use of synthetic fertilizers and herbicides and pesticides,
  - Residues that can pollute the soil.

Internal combustion engines are particularly equipped with the means of transport-automobiles, trains, airplanes or machinery used in agriculture. The number of cars circulating in the world is over 800 million [1]. Today, about 65 million cars are being built annually [2]. Each year there are around 14 million vehicles operating in Europe, and in the US, between 10 and 11 million cars (cars, trucks and vans). The food crisis can also occur due to population growth, according to UN estimates in 2050 will be around 8,909 billion [3]. The effects of pollution using petrofuels are presented in Table 2, 3 (Tables 1 and 4).

The global energy equivalent is 7.8 × 109 tons of oil equivalent and resources are estimated at 136 × 109 tons of oil equivalent, insufficient for the current pace of development [3].

2 Polluting Areas

Environmental pollution is considered when polluting gases are present in sufficient quantities in the atmosphere to cause short- or long-term deterioration of the lives of humans, plants, animals or the environment (Fig. 1).

Table 2. Negative effects of emissions on human health and environmental quality [2]

No. Crt.	Impact category	Emissions	Characterization factors
1	Greenhouse effect	CO_2 CH_4 HFC-134a	1 21 1300
2	Acidity	SO_2 and SOx HC1 NO_2 and NOx	1 0.88 0.70
3	Air pollution (with effects on people's health)	SO_2 and SOx CO HC_1 NMHC (Non-Methane Hydrocarbon) NOx Particles Pb	1.00 0.01 0.72 0.80 1,39 1,08 -

Greenhouse effect: carbon oxides and halogenated compounds. Acid rain: Sulphur compounds. Toxic gases: nitrogen compounds.

Table 3. Road transport and environmental pollution [3]

Natural element	effects
air	- NOx, CO, CO2, volatile organic compounds (VOC), PT, which cause worsening health - NOx and VOC emissions produce O3 tropospheric and peroxyacetyl nitrate (PAN) - the use and evaporation of additive fuels leads to increased lead emissions - noise pollution
water	- contamination with salts, additives and solvents of surface and depth water - acidification by SO2 and NOx - modification of hydrological systems through the road network
soil	- road construction produces fragmentation and erosion of the soil - risk of accidental contamination with hazardous substances - storage problems of old vehicles and their components
natural environment	- extraction of building materials leads to landscape degradation

Table 4. Pollution from road transport [3]

pollutant	Gasoline	Diesel cars	Commercial vehicles on gasoline	Commercial vehicles on diesel	Industrial vehicles and buses
Co.	81.9%	2.4%	4%	1.2%	10.5%
NOx	44.6%	12.2%	1.3%	4.9%	37%
SOx	≈0	30%	≈0	10%	60%
Hc	74%	4.6%	2.7%	4.3%	14.3%
Pt	≈0	30%	≈0	10%	60%

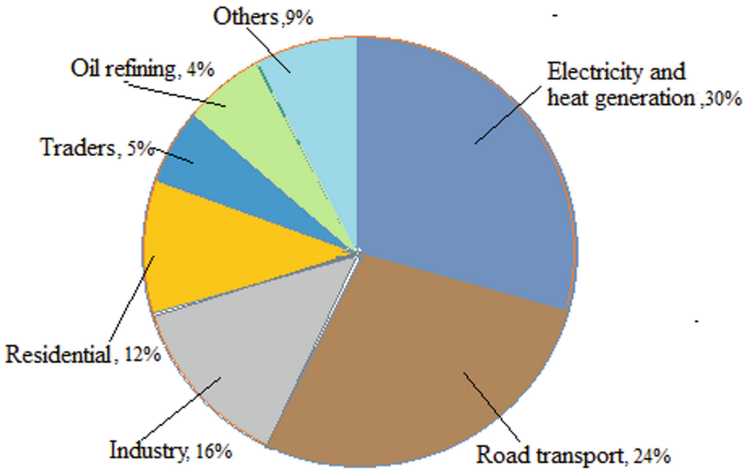


Fig. 1. Formation of pollutant emissions by sectors of activity [3]

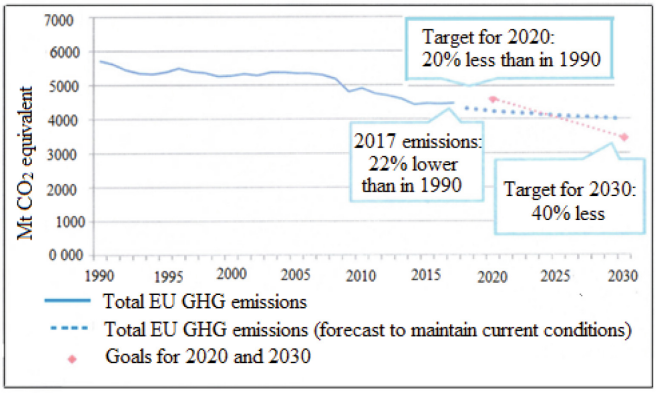
3 EU Emission Targets and Standards

Reducing pollutant emissions is not possible without investment in research and technological innovation. The EU proposes to reduce emissions by 80% by 2050 compared to 1990 [4] (Fig. 2).

4 Economic Impact

4.1 Relationship Between Biofuels and Sustainable Development

Sustainable development (sustainability) concerns all EU countries. As a member of the European Union, Romania is committed to achieving these objectives. Romania's energy resources are used to eliminate dependence on imports and to develop industry, in particular, and the economy in general. But the government's mission in sustainable



Total EU GHG emissions (historical emissions 1990-2017, 2018-2030 emission forecasts) (CO_2 equivalent Mt) and GHG emission reduction targets

Fig. 2. Possible reductions in emissions by sector in the EU [4]

Table 5. Production of greenhouse gases by the different technical crops used for fuels [5]

Biofuel	Emissions [kg CO2 equivalent/ GJ]			
	CO_2	CH_4	N_2O	total
Rapeseed methyl ester	25	0.69	15	40.7
Beet ethanol	34	0.32	5.6	39.9
Ethanol from wheat grains	24	0.69	3.7	28.4
Wheat straw ethanol	0	-0,59	13.3	12.7
Raw rapeseed oil	15	0,49	14.3	29.8

development can be sustained with appropriate conceptual tools, concepts that take reality into account, concepts assimilated into collective research. The methods used to model development are used in adopting the most appropriate development policies. Important in decision-making is also the care for the environment, the protection of soil, water and air. Sustainable development is not just environmental protection; economic and social problems are identified in addition to environmental concerns. "Sustainable development can be understood as development that meets the needs of the present, without compromising the ability of future generations to meet their own needs." (Brundtland) Environmental pollution is inevitable in the process of industrialization, natural resources are not infinite, regeneration capacity is limited. We believe that the deterioration of the state of the environment is brought only by the type of management practiced so far in industrial organizations (Tables 5 and 6).

Table 6. Assessment of soil risks of different crops for biofuels [6]

	Other cereals	Cultivated grasses	Alfalfa clover	Sorghum	Sunflower	Sugar beet	Potatoes
Erosion	a	a	a	a	Bc	C	C
Soil compaction	a	A/B	A/B	b	a	C	C
Washing nutrients	a	b	b	a	A/B	b	b
Leaching	a	b	b	a	A/B	B/C	B/C
Pesticide pollution	a	a	a	B/C	b	b	b
Water deficiency in soil	a	a	a	a	b	b	C
Risk of fires	-	C	-	a	-	-	-
Biodiversity risks	b	B/C	b	b	A/B	b	B/C
Risk of monocultural practices	b	a	a	C	B/C	b	A/B

4.2 Strategies and Policies to Promote Biofuels

Sustainable development of any economy must follow several strategies:

– urban transport to become environmentally friendly, without environmental pollution and without sonic pollution;
– since the first oil crisis, the improvement of internal combustion engines has been triggered to reduce consumption and reduce pollution; continue this direction because such a source of locomotion cannot be waived,
– replacement of conventional fuels with biofuels only after studies and research to establish the effects on the environment, the economy and social effects.

EU-wide studies on the use of biofuels suggest a possible increase in greenhouse gases due to the expansion of plant-grown areas used in the production of vegetable oils and the narrowing of forest areas that were effective in carbon dioxide absorption and oxygen production. Increased income from biofuel crops will cause farmers to change the structure of traditional crops, wheat, corn, generally cereals, rapeseed, sorghum or soybeans, which would exacerbate or generate a food crisis [7]. The increase in cultivated areas, to the detriment of forests, grassland even parks would lead to an increase in greenhouse gases of between (80–160)% [5]. What solutions should be adopted:

– finding technical and economic solutions for access to electric cars,

– the transition to a higher generation of biofuels- it is suggested to change the way agricultural waste from food production is chemically decomposing by enzymatic decomposition.

Current generations of biofuels can be classified into four groups:

– the generation of biofuels obtained from sugar, vegetable oils, starch all obtained from seeds, vegetable oils, cereals which are also food materials;
– generation of biofuels obtained from biomass (non-food plants, by-products from food crops);
– generation of biofuels obtained from algae (producing 30 times more energy than land crops);
– generation of biofuels obtained from genetically modified microorganisms.

The latest generation has the ability to store and capture carbon by helping to reduce greenhouse gas emissions.

5 Conclusions

Internal combustion engines pollute through combustion gases emitted into the environment resulting from the oxidation of fuels, which is a complex process that generates, in addition to CO_2, N_2 and O_2 in excess, a number of chemicals - due to incomplete combustion - which is in small amounts in the exhaust gas (2% by volume). These substances are highly toxic and have significant adverse effects on the environment in general, and on human health in particular. The production of biofuels must take into account the impact on agricultural production for food. The increase of cultivated areas with plants for the production of biofuels attracts the decrease of forests and as a consequence will increase the emission of greenhouse gases. Regardless of the technology applied, environmental pollution cannot be avoided.

References

1. Walsh, P.M., Global Trends in Motor Vehicle Pollution Control-Accompliance to Date and Challenges Ahead, FISITA World Automotive Congress, Helsinki (2002).
2. Webb, A., A Piston Revolution, Engineering Management Journal, February (2002).
3. *** European Environment Agency, Eurostat
4. Baumgarten, C. 2006: Mix training in internal combustion engines, Springer, Hannover, Germany.
5. ***www.proenvironment.ro ProEnvironment ProEnvironment, 4, p. 147–150, (2011).
6. Affenzeller, J., Kriegler, W., Lepperhoff, G., Owen, N., Gruson, J. F., Blaich, M., FURORE-Future Road Vehicle Research, A Roadmap for the Future, 9th EAEC International Congress, Paris (2003).
7. Filippi, F., Industrial Vehicles and Environment, ATA, (1990).