1-CHLORONAPHTHALENE DECOMPOSITION IN AIR USING ELECTRON BEAM IRRADIATION

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Polychlorinate naphthalenes (PCNs) are persistent and bioaccumulative, some of them are very toxic. 1-Chloronaphthalene was widely used in Xylamits as a wood preservative with fungicidal and insecticidal properties in the past in Poland [1]. 2-Chloronaphthalene was produced and used as a solvent in Poland, some of PCNs were found in polychlorinated biphenyls (PCBs) congeners. Chlorinated hydrocarbons are emitted into atmosphere from medical waste incinerators, waste oil combustion power plants, metallurgical factories, *etc.*

Certain pesticides, PCBs and dioxins are listed as persistent organic pollutants (POPs) based on Stockholm convention. They were banned on usage and will be destroyed in a long term. Electron beam (EB) process was demonstrated as a promising technology to remove chlorinated aliphatic and aromatic compounds from gas phase [2], dioxins [3] and polyacrylic aromatic hydrocarbons (PAHs) from industrial off-gases [4]. Because chemical and physical properties of PCNs are similar to those of PCBs, we selected 1-chloronaphthalene as a studied object. Different gas mixtures influencing the decomposition efficiency of 1-chloronaphthalene were studied in order to examine PCBs' degradation in the future.

A method for the preparation of model gas containing 1-chloronaphthalene can be referred to 1,1-DCE (dichloroethene) [5].

A pulsed electron beam accelerator ILU-6 (2.0 MeV max., 20 kW max.) was used as an irradiation source. Pyrex glass vessels were placed under scan horn of the accelerator for irradiation. Irradiation conditions were the following: pulse repetition rate – 2 Hz, energy – 2 MeV and pulse current – 54 mA. An average absorbed dose rate inside the glass vessel was measured by an N_2O gas dosimeter. The absorbed dose rate inside the glass vessel was 10.835 kGy/min. Total absorbed dose was adjusted by changing irradiation time of the Pyrex glass vessels.

1-Chloronaphthalene concentration was analyzed using gas-chromatography (Perkin Elmer 8700) with a flame ionizing detector (GC-FID) before and after irradiation, respectively. A capillary column (SPB-5, 30 m x 0.32 mm x 0.25 μm, Supelco Company, USA) was used. Stack solution of 1-chloronaphthalene (2000 μg/ml) was used for a calibration curve (Supelco Company, USA). Experiments were carried out at ambient temperature conditions and under atmospheric pressure.

Figure 1 shows the 1-chloronaphthalene decomposition efficiency in air as a function of dose under EB irradiation. Concentration of 1-chloronaphthalene in air decreases with increasing dose. Over 80% 1-chloronaphthalene is decomposed in air at 57.9 kGy dose when the initial concentration of 1-chloronaphthalene was 12-30 mg/Nm^3. In order to investigate whether different gas mixtures have influence on organic compound decomposition under EB irradiation, we studied 1-chloronaphthalene decomposition in N_2 under EB irradiation and the results are shown in Fig.2. Similar to 1-chloronaphthalene decomposition in air, concentration of 1-chloronaphthalene in N_2 decreases with increasing absorbed dose. Over 50% 1-chloronaphthalene was decomposed in N_2 when initial concentration of 1-chloronaphthalene was 15-42 mg/Nm^3. Decomposition efficiency of 1-chloronaphthalene in air was higher than that in N_2, this phenomenon was different from that observed by Kim [6], who claimed that the order of decomposition efficiency of toluene in different gas mixtures was: N_2 > air.

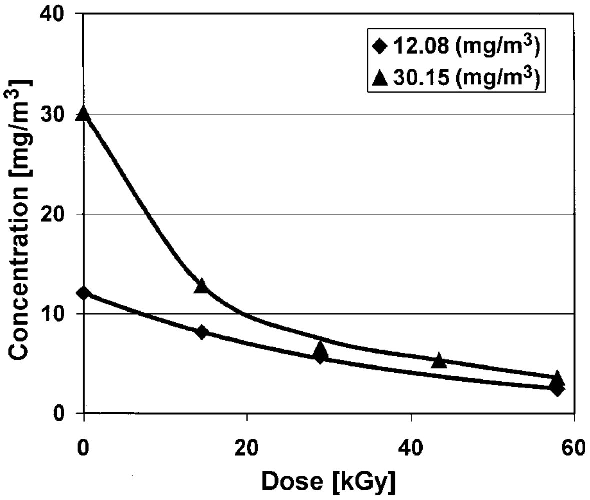

Fig.1. 1-Chloronaphthalene decomposition in air under EB irradiation.

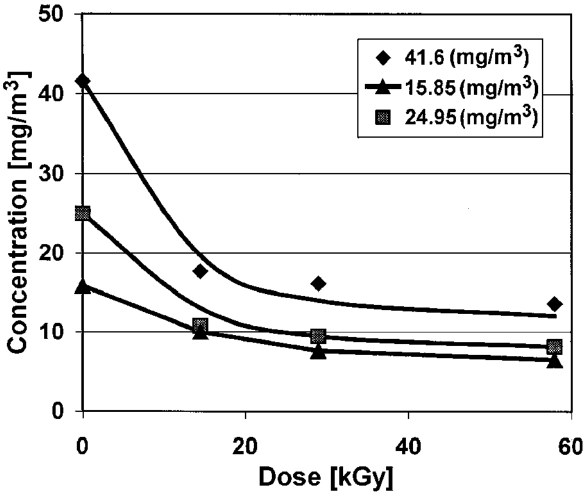

Fig.2. 1-Chloronaphthalene decomposition in N_2 under EB irradiation.

1-Chloronaphthalene can be decomposed in air or N_2 using EB irradiation. Decomposition efficiency of 1-chloronaphthalene in air is higher than that in N_2. Positive charge transfer reactions and OH radicals' reaction may play a main role in 1-chloronaphthalene decomposition process.

References

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INVESTIGATION OF CATALYSTS FOR CRACKING OF POLYETHYLENE WASTES INTO LIQUID HYDROCARBONS

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Plastic wastes contain 65 to 70% polyolefines. Part of them is recycled, but in Poland most of them is dumped in landfill sites. In other countries plastic wastes are burned in incinerators, but this needs very expensive methods for control of pollutant emission in flue gas. Very perspective is the transformation of polyolefines into liquid hydrocarbons, which can be used as a fuel like gasoline and diesel or heating oil. The liquid hydrocarbons can be produced from polyolefines by thermal or thermocatalytic cracking. Thermocatalytic cracking with the use of proper catalyst gives a lower content of gas and coke in the products of decomposition. In our work 11 aluminosiliate catalysts were tested in a laboratory batch reactor connected with a distillation column (Fig.). List of catalysts is given in Table 1. The reactor was loaded with 800 g of polyethylene wastes and 200 g of catalyst. Decomposition products in the form of a gas-vapor mixture separated in the distillation column. Uncondensed gas is burned in a burner. The five side fractions are taken from the distillation column. The reflux from the distillation column containing heavy hydrocarbon is returned to the reactor for decomposition. Solidification point, viscosity, density and normal distillation curves were determined for all fractions. In experiments, temperatures were measured at points of withdrawal of distillates in the distillation column and in the bottom of the reactor in the layer of catalyst and in the top of the reactor in gas phase over the layer of the melted polyethylene wastes. Distillates from the distillation column during the normal distillation process were separated into 3 fractions: gasoline with the boiling temperature up to 200°C, light oil with the boiling temperature ranging from 200 to 350°C and heavy oil with the boiling temperature above 350°C. The properties of the gasoline and light oil fractions are presented in Tables 2 and 3.

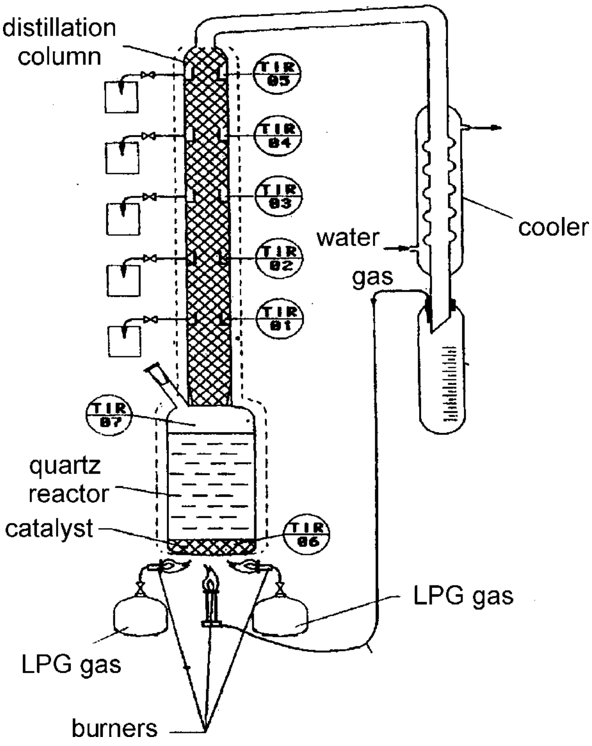

Fig. Scheme of apparatus for waste polyolefines cracking.

Table 1. List of tested catalysts.

Exp. No	Catalyst	Temperature of decomposition [°C]	Fractions [%]			
			gas	gasoline	light oil	heavy oil
1	Without catalyst	400-420	10.2	17.2	43.3	29.3
2	Molecular sieves 4A, balls	398-435	16.0	13.7	48.1	22.0
3	Molecular sieves 5A, Carl Roth	395-410	-	16.7	58.0	25.3
4	$SiO_2 + Al_2O_3$, powder	400-440	11.6	19.5	33.0	35.9
5	Diatomite CECA, powder	370-420	13.6	9.6	40.5	36.3
6	Diatomite polish, powder	420-429	15.2	15.9	27.4	41.5
7	Molecular sieves H-4A, balls	400-412	5.8	13.0	36.7	41.6
8	H-G5, 0,9 nm, X, balls	404-433	34.7	25.2	27.9	10.7
9	H-NK10, 0,4 nm, powder	390-420	15.5	16.1	42.5	26.0
10	Catalyst from Orlen	390-415	-	32.3	41.9	25.8
11	Molecular sieves 5A, extrudes from Mątwy	405-420	-	14.9	61.3	23.8