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Assessment of environmental influence of bentonite and lustrous carbon carrier - in an aspect of gases emission

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Abstract

The emission results of the selected gases from a bentonite-carbon mixture and from dusts originated from dry de-dusting of the green sand processing plant (at high temperatures) are presented in the paper. In order to check and compare samples of dusts and bentonite-carbon mixtures in respect of emission of gases the Evolved Gas Analysis (EGA) was performed by means of the mass spectrometry method. This method allows to determine emission conditions of the selected chemical compounds.

Key words : environment protection, gas evolution, bentonite, dust from de-dusting, green sand

1. Introduction

Total characteristics of moulding and core sands requires now-a-days taking into account their harmfulness for the environment. The notion ‘harmfulness for the environment’ includes toxic gaseous and dusty substances emitted into the atmosphere as well as substances leached into the environment. Harmful substances such as gases or dusts are emitted mainly directly during pouring liquid metals into casting moulds, however, certain parts of such substances penetrate into the bulk of the mould and condense on sand grain, from where they can be leached or evaporated into the environment [1].

Sources of toxic gases constitute components of moulding sands and protecting coatings, but - first of all - organic compounds and additions to moulding sands as well as organic binding and stabilizing agents. Composition of emitted gases depends on the composition of moulding sand and/or coating substances. Thus, apart from such basic compounds as: water vapour, CO, CO_2, other ones can be emitted: NH_3, HCN, SO_2, H_2S, PH_3, phenol, formaldehyde, benzene, toluene, ethylbenzene, xylene, isocyanate, polycyclic aromatic hydrocarbons and dioxines [2, 3].

Several examinations concerning harmfulness of moulding sands with bentonite were performed [2, 4- 8]. It occurred, that mostly coal dust and water should be blamed for the hazardous situation [2, 9].

2. Equipment and testing method

Evolved Gases Analysis (EGA) was done by means of the *Mettler-Toledo 851^e* thermoanalyser connected *on-line* with the *Thermostar Balzers* quadrupole mass spectrometer (QMS). Sample of a mass of 150 mg was placed in a corundum crucible (of a capacity of 150 μl) closed by a cover with a hole (ϕ=1mm) and analysed thermically in a temperature range of 30 - 1000°C with a heating rate of 10°C/min, in an argon atmosphere (99.999%) - at its flow rate being 80 ml/minute. Thermoanalyser accuracy was 1 μg. Analysis of evolved gases was made in a channel mode recording relevant sets of mass lines corresponding to the emission of: H_2O, CO_2, SO_2, benzene (B), toluene (T), ethylbenzene (E) and xylenes (X). Quantitative analysis of the recorded mass spectra was possible due to the proper calibration performed for pure substances and their mixtures. An assessed systematic error does not exceed 20%.

Examinations were performed for:

- bentonite-carbon mixture, Kormix 75 (produced by the Zębiec Company)
- dusts from a dry de-dusting of the green sand processing plant.

3. Examination results and their discussion

The curves of water emission from a bentonite-carbon mixture, Kormix 75 and from dusts are presented in Figure 1 and 2.

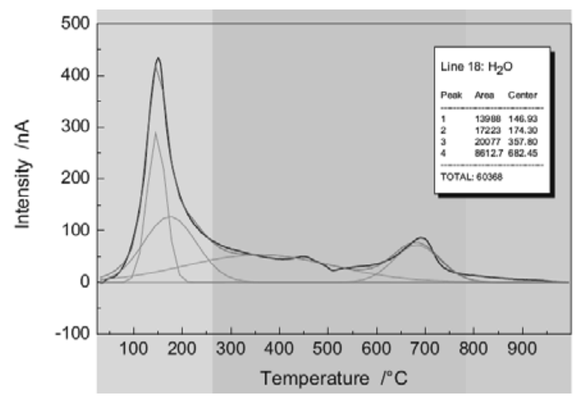

Fig. 1. Range of water emission from a bentonite-carbon mixture

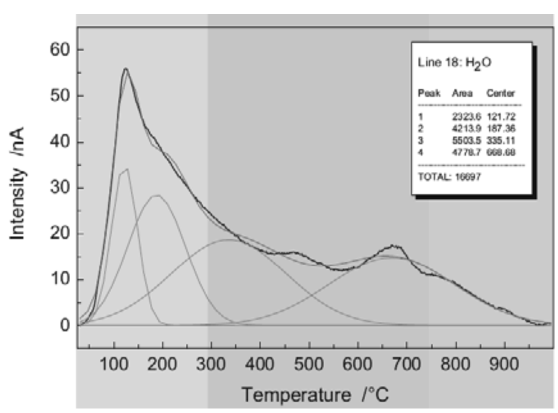

Fig. 2. Range of water emission from a dust

Emission of water from a bentonite-carbon mixture and from dust from de-dusting occurs in three stages:

I – at temperatures between 100ºC and 200ºC,

II – very low intensity, at a temperature approximately 450 – 480ºC,

III – at a temperature of 700ºC.

The first stage is related to a loss of humidity water, while the remaining two to a dehydration.

The range of carbon dioxide evolution from a bentonite-carbon mixture and from dusts is presented in Figure 3 and 4.

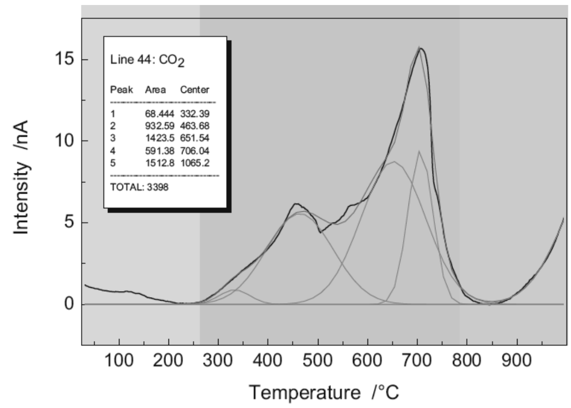

Fig. 3. Range of CO2 emission from a bentonite-carbon mixture

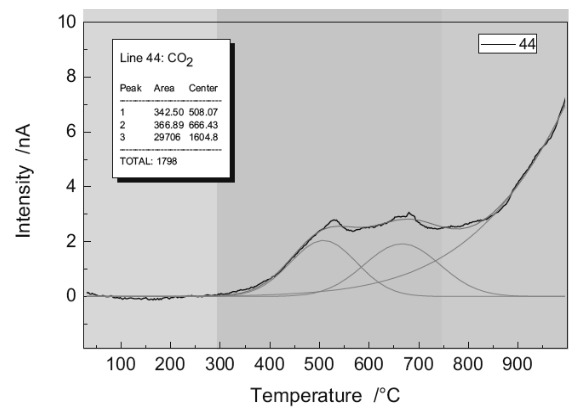

Fig. 4. Range of CO2 emission from a dust

Carbon dioxide evolution from the tested samples starts at a temperature above 250ºC. In the case of a bentonite-carbon mixture this process occurs by a multistage way. CO_2 emission from a dust sample starts at a higher temperature, reaching the biggest intensity above 800ºC.

The curve of the sulphur dioxide emission from the sample of Kormix 75 and from the dust is shown in Figure 5 and 6.

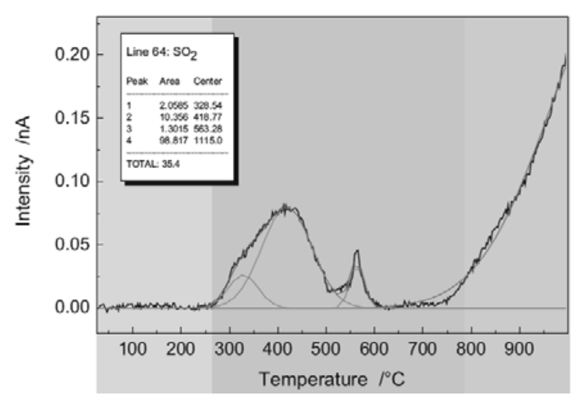

Fig. 5. Range of SO2 emission from a bentonite-carbon mixture

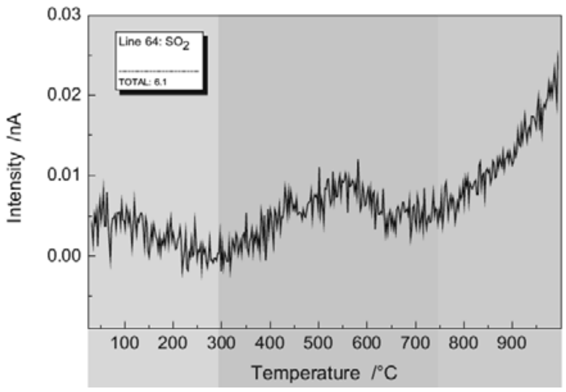

Fig. 6. Range of SO2 emission from a dust

SO_2 emission from a bentonite-carbon mixture is also a multistage process. Minimal emission of sulphur dioxide from dusts can indicate that sulphur contained in coal dusts was burned out during the production process of castings.

Emission processes of benzene, toluene, etylbenzene and xylenes are illustrated in Figures 7, 8, 9 and 10.

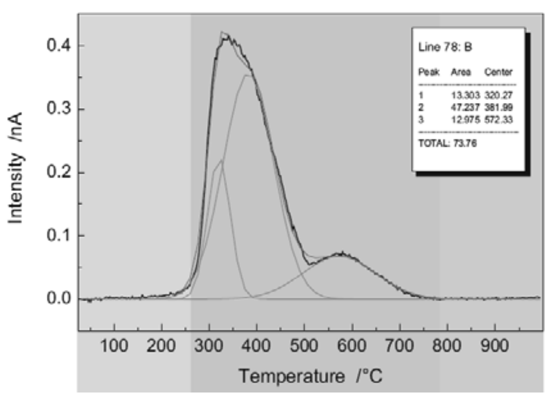

Fig. 7. Range of benzene emission from a bentonite-carbon mixture

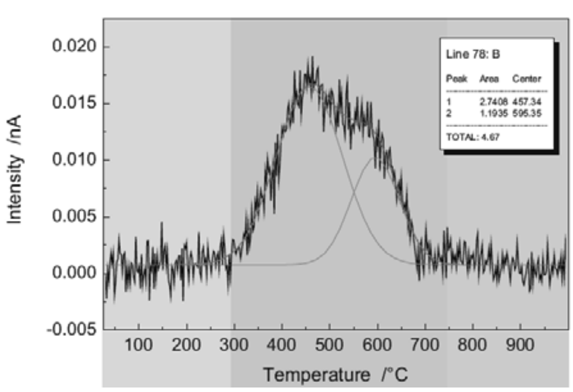

Fig. 8. Range of benzene emission from a dust

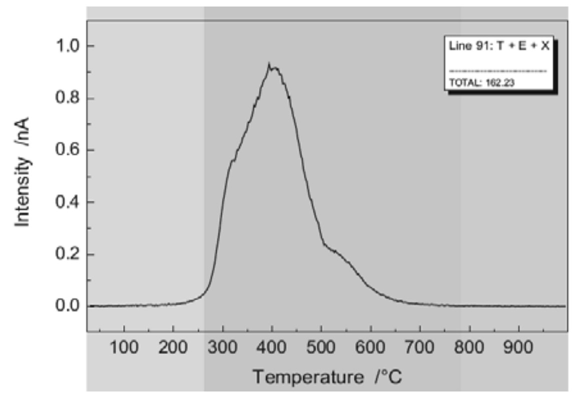

Fig. 9. Range of toluene, etylbenzene and xylenes emission from a bentonite-carbon mixture

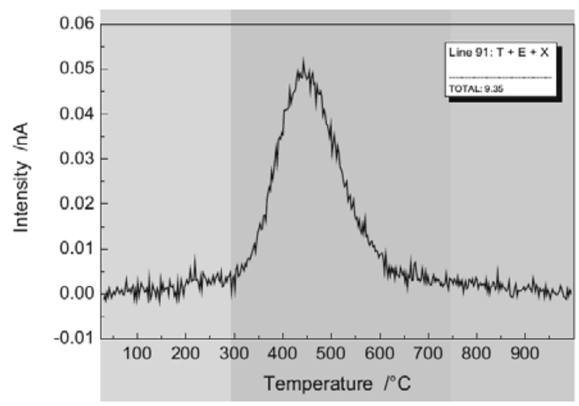

Fig. 10. Range of toluene, etylbenzene and xylenes emission from a dust

Benzene emission from a bentonite-carbon mixture takes place in two stages at temperatures between 200 – 750ºC. Maximum emission occurs at a temperature of approximately 350ºC. Dusts from de-dusting is characterised by a much smaller emission of this gas.

The obtained results of the harmful gases emission from a bentonite–carbon Kormix 75 mixture indicate that BTEX (benzene, toluene, ethylbenzene and xylenes) are formed in the same temperature range (200 - 700ºC), of a maximum at approximately 400ºC. Emission of these compounds from dusts is smaller by one order of magnitude.

The results of emission of CO_2, SO_2 and BTEX from the bentonite-carbon mixture and from dusts are presented in Figures 11, 12 and 13.

4. Conclusions

- Larger amounts of CO_2 evolved from dusts can be a result of the presence of residues of core sands containing organic binding agents.
- Emission of SO_2 from dusts from the de-dusting process is approximately 60% smaller than from the bentonite – carbon mixture. This might be caused by the previous

burning out of sulphur contained in coal dusts, due to a high temperature of casting alloys.

- Emission of BTEX from dusts originated from dry de-dusting of moulding sands with bentonite provides positive results when the ecological problems are considered. This emission is much lower than the one from the bentonite-carbon mixture.

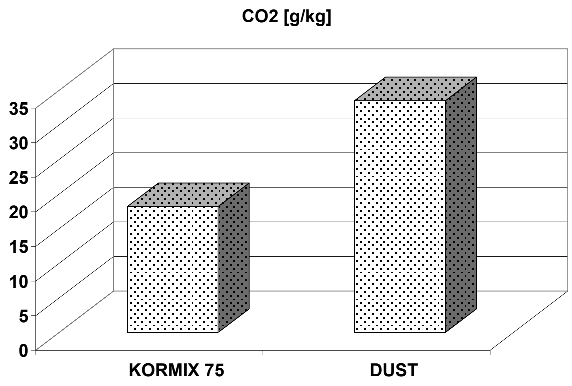

Fig. 11. CO_2 emission from the bentonite-carbon mixture and from dusts

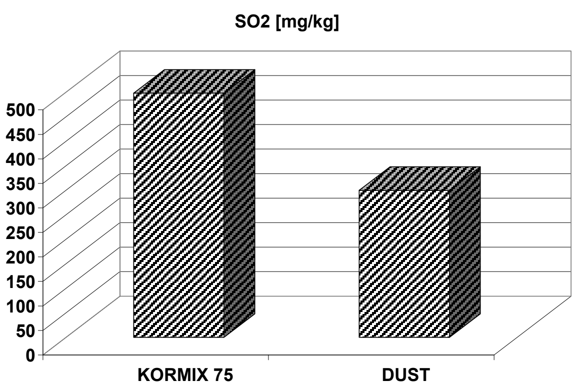

Fig. 12. SO_2 emission from the bentonite-carbon mixture and from dusts

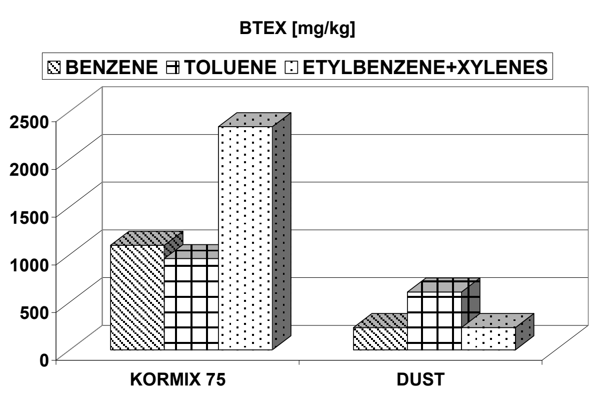

Fig. 13. BTEX emission from the bentonite-carbon mixture and from dusts

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