Green Foundry LIFE project (LIFE17 ENV/FI/000173)

AGH –UNIVERSITY OF SCIENCE AND TECHNOLOGY ACTIONS
Action B1: Emissions of different binder systems during small – scale test casts.
Method 2. Tests in foundry plants – small scale chamber

holtzer@agh.edu.pl

FACULTY OF FOUNDRY ENGINEERING

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SUMMARY
Green Foundry LIFE project (LIFE17 ENV/FI/000173)
AGH – University of Science and Technology Faculty of Foundry Engineering

The new inorganic binder system is based on the sodium silicate (glass water) or aluminosilicate, which reduces the amount of harmful components indoor and in ambient air.

Action B1: Emissions of different binder systems during small – scale test casts.
Method 2: Tests in foundry plants – small scale chamber

Research on the composition of gases (BTEX and PAHs groups) formed during pouring and cooling of moulds and knocking out of castings were conducted in foundry. The six binders for moulding sands were tested:

- organic binders: furan resin (code MF) and phenol-formaldehyde resin (code MA),
- inorganic binders; 2 binders on water glass base (code MI and code MC) and 1 binder on aluminosilicate base (code MG),
- greensand – activated bentonite (code MB).

Ratio (mould sand:metal) was 2.8 – 3.0. Temperature of liquid cast iron was 1380 – 1420^{o}C. Prepared moulds were placed on a vibrating table, the construction of which, after the pouring and cooling of the mould, allow knocking out the casting, without having to dismantle the stand. The whole system was placed in a metal box with a flap opened in the upper part, through which liquid metal was poured into the mould. The box was equipped with a connector, through which gases generated in the process were sucked.

The adsorbents used in the research: polyurethane foam and XAD resin (for adsorption of PAH compounds) and active carbon (for adsorption of BTEX compounds). Identification and quantitative analysis of compounds from the BTEX and PAHs groups released during the process of pouring and cooling moulds and knocking out of castings were carried out using GC/MS technics.

Amounts of compounds from BTEX group emitted during pouring, cooling and knock-out.

holtzer@agh.edu.pl

Amounts of compounds from BTEX group emitted during pouring, cooling and knock-out

Code	Benzene	Toluene	Ethylbenzene	m+p -xylene	o-xylene	Total
	[mg/kg][a]	[mg/kg][a]	[mg/kg][a]	[mg/kg][a]	[mg/kg][a]	[mg/kg][a]
	[mg/kg][b]	[mg/kg][b]	[mg/kg][b]	[mg/kg][b]	[mg/kg][b]	[mg/kg][b]
MF	18	63	0.46	2.1	0.46	**84**
	52	178	1.3	6.1	1.3	**238**
MA	23	7.2	0.31	3.1	0.46	**34**
	65	20	0.87	8.7	1.3	**96**
MB	2.6	1.7	0.15	0.46	0.15	**5.1**
	7.4	4.8	0.43	1.3	0.43	**14**
MI	1.1	0.46	0.15	0.31	0.15	**2.2**
	3.0	1.3	0.43	0.87	0.43	**6.0**
MG	1.1	0.31	0.05	0.15	0.01	**1.6**
	1.0	0.87	0.13	0.43	0.04	**4.5**
MC	0.15	0.06	0.01	0.03	-	**0.25**
	0.43	0.17	0.04	0.09	-	**0.73**

(a)-kg of moulding sand, (b)-kg of metal

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Amounts of compounds from PAHs group emitted during pouring, cooling and shaking-out

Test	Naphthalene [mg/process]	Acenaphthylene [mg/process]	Acenaphthene [mg/process]	Fluorene [mg/process]	Phenanthrene [mg/process]	Anthracene [mg/process]	Fluoranthene [mg/process]	Pyrene [mg/proces]	SUM [mg/process]
	[mg/kg][a]	[mg/kg][a]	[mg/kg][a]	[mg/kg][a]	[mg/kg][a]	[mg/kg][a]	[mg/kg][a]	[mg/kg][a]	**[mg/kg][a]**
	[mg/kg][b]	[mg/kg][b]	[mg/kg][b]	[mg/kg][b]	[mg/kg][b]	[mg/kg][b]	[mg/kg][b]	[mg/kg][b]	**[mg/kg][b]**
PAH Test 1 MF	7.7	0,1	0.2	0.5	0.7	0.4	0.2	-	**9.8**
	0.12	0.001	0.003	0.008	0.011	0.006	0.003	-	**0.15**
	0.33	0.004	0.009	0.022	0.030	0.017	0.009	-	**0.42**
PAH Test 2 MA	33	2.0	0.8	2.1	2.0	1.0	0.4	0.3	**42**
	0.51	0.031	0.012	0.032	0.031	0.015	0.006	0.005	**0.64**
	1,43	0,087	0,035	0,091	0,087	0,043	0,017	0,013	**1,8**
PAH Test 3 MB	8.3	0.7	-	0.4	0.8	0.4	0.2	0.3	**11**
	0.13	0.011	-	0.006	0.012	0.006	0.003	0.005	**0.16**
	0.36	0.030	-	0.017	0.035	0.017	0.009	0.013	**0.48**
PAH Test 6 MI	1.0	-	-	0.1	0.2	-	-	-	**1.3**
	0.015	-	-	0.001	0.003	-	-	-	**0.019**
	0.043	-	-	**0.004**	**0.009**	-	-	-	**0.056**

(a)-kg of molding sand, (b)-kg of metal

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Table con.

Test	Naphthalene [mg/process]	Acenaphthylene [mg/process]	Acenaphthene [mg/process]	Fluorene [mg/process]	Phenanthrene [mg/process]	Anthracene [mg/process]	Fluoranthene [mg/process]	Pyrene [mg/process]	SUM [mg/process]
	[mg/kg][a]	[mg/kg][a]	[mg/kg][a]	[mg/kg][a]	[mg/kg][a]	[mg/kg][a]	[mg/kg][a]	[mg/kg][a]	**[mg/kg][a]**
	[mg/kg][b]	[mg/kg][b]	[mg/kg][b]	[mg/kg][b]	[mg/kg][b]	[mg/kg][b]	[mg/kg][b]	[mg/kg][b]	**[mg/kg][b]**
PAH Test 8 MG	4.8	0.8	3.5	0.6	0.2	0.1	0.1	0.1	**10**
	0.073	0.012	0.054	0.009	0.003	0.001	0.001	0.001	**0.15**
	0.21	0.035	0.15	0.026	0.009	0.004	0.004	0.004	**0.41**
PAH Test 9 MC	0.6	0.1	0.1	0.2	0.1	0.1	0.1	0.1	**1.4**
	0.009	0.001	0.001	0.003	0.001	0.001	0.001	0.001	**0.018**
	0.026	**0.004**	**0.004**	**0.009**	**0.004**	**0.004**	**0.004**	**0.004**	**0.059**

holtzer@agh.edu.pl

Conclusions

In order to compare the harmfulness of the tested moulding sands, measurements of amounts of emitted substances from the BTEX and PAHs groups under an influence of high temperatures, were performed. Measurements were conducted for the whole cycle containing: pouring, cooling and knocking-out, within the Action B Tests in foundry plants – small scale laboratory. The obtained results were recalculated into the emission from 1 kg of the moulding sand and 1 kg of the binder applied in the given technology.

The following conclusions can be drawn on the bases of tests performed under the small scale chamber conditions:

1. Emissions of PAHs, as well as BTEX in case of moulding sands with organic binders is several dozen higher than the emission of these compounds from moulding sands with inorganic binders.
2. Green sands in respect of the PAHs emission are in the intermediate sphere, while in respect of the BTEX emission are comparable with moulding sands with inorganic binders.
3. From the comparison of moulding sands with organic binders it results, that the BTEX emission from the MA sand is more than two times lower than the emission from the MF sand, while benzene and toluene predominate in the composition of gases emitted from both sands.
4. Moulding sands with inorganic binders are comparable in terms of the emission amount of substances from the BTEX and PAHs groups. Higher values of the unitary emission from moulding sands with MG binder are the result of using the organic liquid hardener for this binder hardening, while for the hardening of the remaining two binders (MI, MC) high temperatures were used.
5. Moulding sands with inorganic binders (MG, MC and MI) are characterised by lower harmfulness for the environment and employees than moulding sands with organic binders.
6. Relatively environment friendly were green sands (MB), in which a part of coal dust was substituted by additions able to produce lustrous carbon.

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