

**Green Foundry Life project (LIFE17 ENV/FI/000173)**

**Action B1: Emission different binder systems during small-scale test casts.**

*Method 1. Testing foundry at AGH-UST- laboratory tests.*



## 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 classifications during small – scale test casts.**

**Method 1. Testing foundry at AGH-UST - laboratory test.**

Investigation of the gases emission in the small test were performed according to the original method developed in the AGH-UST Krakow (Poland). A sample of the investigated moulding sand of a cylinder shape of dimensions 50 mm x 50 mm, weight about 150 g is poured with liquid cast iron of a temperature of 1350°C. Gases emitted from the sample – after pouring it with liquid metal are led by means of a steel pipe via the drying system and heating system and the capsule with activated carbon (during BTEX measurement) or polyurethane foam (during PAHs measurement) into pump. 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).

Total emission BTEX and benzene calculated per 1 kg of binder and 1 kg of moulding sand

CODE	Per 1 kg of binder, mg		Per 1 kg of moulding sand, mg	
	Total BTEX	Benzene	Total BTEX	Benzene
<b>MF</b>	43 852	40 158	658	602
<b>MA</b>	32 994	30 911	495	464
<b>MG</b>	3 342	2 837	60	51
<b>MC</b>	715	496	24	16
<b>MB</b>	2 510	2 301	176	161
<b>MI</b>	860	556	22	14

Total emission PAHs and benzo(a)pyrene calculated per 1 kg of binder and 1 kg of moulding sand

CODE	Per 1 kg of binder, mg		Per 1 kg of moulding sand, mg	
	Total PAHs	Benzo(a)pyrene	Total PAHs	Benzo(a)pyrene
<b>MF</b>	806	16	12.09	0.24
<b>MA</b>	658	11	9.87	0.17
<b>MG</b>	175	3	3.14	0.06
<b>MC</b>	66	0.39	2.18	0.01
<b>MB</b>	83	2.19	5.80	0.15
<b>MI</b>	76	0.6	2.0	0.02

Below summarizes the results of gas emission: CO, CO<sub>2</sub>, SO<sub>2</sub> and NO<sub>x</sub> during laboratory tests.

Emission of SO<sub>2</sub>, CO, CO<sub>2</sub> and NO<sub>x</sub> from moulding sands

Moulding sand symbol	Amount of: SO <sub>2</sub> , NO <sub>x</sub> , CO, CO <sub>2</sub> emitted in experiment and calculated per kilo of moulding sand			
	SO <sub>2</sub> [cm <sup>3</sup> /kg]	NO <sub>x</sub> [cm <sup>3</sup> /kg]	CO [cm <sup>3</sup> /kg]	CO <sub>2</sub> [cm <sup>3</sup> /kg]
<b>MG</b>	0.82	-	394	53.6
<b>MC</b>	1.3	-	273	25.9
<b>MB</b>	13.7	-	965	72.7
<b>MI</b>	2.0	-	282	25.6

## Conclusions

Comparative studies of moulding sands with organic and inorganic binders exposed at high temperature (1350 °C) carried out on a laboratory scale have shown that:

- moulding sand with organic binder generated 2 to 3 times more gas volume than other moulding sands,
- moulding sands with organic binder (MA and MF) showed significantly higher emission of compounds from the PAHs and BTEX group than moulding sand with inorganic binder (MI, MC, MG and MB); the difference was even 10 times;
- in the BTEX group, the main component emitted was carcinogenic benzene (up to 95%),
- in the PAHs group, the main component emitted was naphthalene, in addition, small amount of carcinogenic benzo (a) pyrene was also identified in these gases,

- the moulding sands with inorganic compounds, hardened with temperature (MI, MC), showed lower emissions of BTEX, whereas for moulding sands with inorganic binder, but hardened by organic hardener (MG),
- a particularly low emission from the group BTEX and PAHs were characterized by moulding sand with water glass (MI, MC) cured by hot air,
- green sand (MB) showed relatively low emission of compounds from the PAHs and BTEX groups because in the bentonite mixture the coal dust was partly replaced by more environmentally friendly components,
- in the case of moulding sands with organic binder (MF and MA) and green sand (MB), SO<sub>2</sub> was found in the tested gases. The presence of SO<sub>2</sub> in the gases from the moulding sand (MF) is the result of decomposition of benzenesulfonic acid which is used as a solvent, while the presence of SO<sub>2</sub> in gases from the MB moulding sand is associated with the sulfur content of carbon-containing additives introduced into bentonite,
- NO<sub>x</sub> oxides were found in gases released from MF and MA moulding sand, which are probably the result of the decomposition of compounds containing nitrogen e.g. urea, which is introduced to resin by manufacturers in order to extend resin life.