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GREENCASTING

Towards zero emissions in European ferrous foundries using inorganic binder systems

GREEN CASTING LIFE

Project duration 09/2022-02/2026

Actions in 2024-2025:

Emission measurement results in WP2

The casting using industries (e.g. automotive) have expressed a strong desire to become green. This has caused pressure on foundries to find cleaner production methods, and at the same time EU pollution regulations are getting tighter. The poor indoor air quality has made the foundry's image bad among workers and accordingly it is no longer a desirable working environment.

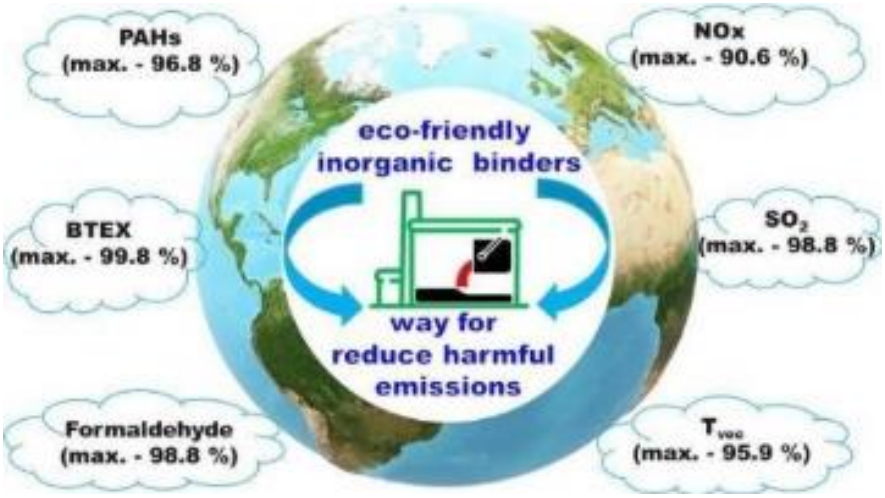
The goal of the Green Casting LIFE project is to show European foundries an efficient and cost-effective way to find solutions to these pressures.

The main expected impacts of the project are the reduction of harmful emissions, improved indoor air quality and reduction of the waste sand which needs to be landfilled, after the foundries have changed from current organic binder systems to new inorganic binder systems.

Organic binder systems using furan or phenolic resins which are currently widely used, and the so-called green sand method (bentonite + coal) cause harmful emissions, especially after pouring the molten metal into the moulds.

The main emissions consist of polycyclic aromatic hydrocarbons (PAHs)—organic compounds with multiple fused rings formed during incomplete combustion—as well as BTEX compounds (a group of volatile organic compounds including benzene, toluene, ethylbenzene, and xylenes), particulate matter, formaldehyde, CO, NOx, and SO2

The results of the WP2 emission tests (laboratory-scale tests at AGH and production-scale chamber tests at OPSA and Azterlan) have shown that the following emission reductions are achieved when changing from an organic binder system to an inorganic one. Conclusions from WP2:



Laboratory-scale experiments comparing seven types of inorganic binders to a phenolic urethane binder demonstrated significant environmental benefits. The inorganic binders consistently achieved over 90% reduction in emissions across a comprehensive range of pollutants, including BTEX, PAHs, phenol, formaldehyde, NOx, SO2 and TVOCs. Pilot/Industrial scale tests compared various organic binders (furan, phenolic urethane, and phenolic alkaline) and green moulding to inorganic binders in mould and core production. Inorganic resins reduced BTEX emissions by 65-71% compared to green moulding, while compared to organic binders this reduction reached >90%, consistent with laboratory findings. Benzene was the primary BTEX component (>60%) for most systems, except furan where toluene dominated. Inorganic binders showed over 98% reduction in particulate matter compared to organic systems. Organic binders produced higher NOX and SO2 emissions, while green sand and furan systems led in CO emissions. These results demonstrate the environmental advantages of inorganic binders in foundry applications.

Implementing inorganic binders in the 6 flagship foundries

The LIFE project 6 European flagship ferrous foundries are implementing at industrial scale the inorganic binder system on their production process implying major changes, starting with selection of the suitable inorganic binder system, changes in processes and investments in new equipment.

Pretests at 6 flagship foundries started in the beginning of 2023. Aim was to make pretests with average 2-4 different inorganic binders. In reality, much more pretests were needed from 2023 to 2025 in most of the foundries. Binder system suppliers also developed new variations of inorganic binders and special additives for to ensure the suitability of the binders in the foundry conditions. Results and further actions were discussed in regular TEAMS meetings.

Odlewnie Polskie S.A. (OPSA) locates in Starachowice, Central Poland. OPSA produces all kind of cast irons, including ductile ADI irons, as a sole producer in Poland. Current annual production is ca. 22 000 tons. OPSA has several automated green sand production lines for series production and one manual moulding line for small batches. This line used an organic, phenolic Pep-set as the binder system. During the project, OPSA has built a new production line for the use of no-bake type inorganic binder systems, to replace the Pep-set line.

New inorganic binder system line at OPSA foundry in Starachowice, Poland

OPSA has carried out numerous pretests in this new line with inorganic binders from three producers. Initially there were problems with the cracking of the moulds in handling and after pouring. Fine tuning the binder systems and with proper recipes of binders and hardeners these problems have been solved, and good quality casting have been produced. OPSA is building a new sand reclamation station for this line, and it will be assembled and tested before the end of the project.

JEZ (Voest-Alpine Railway Systems JEZ) produces mainly different manganese steel crossings and track devices for the railroads. Current moulding lines use organic furan resin systems in silica and chromite sand.

JEZ has tested four no bake type inorganic binder systems in cores using olivine sand. In the beginning there were problems with collapsibility of the cores made by inorganic binders. Inorganic binder producers modified their binders eg. new formulations, adding special additives…etc for solving this problem. Final results were good.

In spring 2025 JEZ tested inorganic binders also in mould making with the SandTeam portable mixer. After promising results in the tests, JEZ decided to start purchasing new mixer for inorganic binders. Due to long delivery time of the equipment, JEZ unfortunately could not finalize the investment in the duration of the project.

voestalpine
ONE STEP AHEAD.

Pretests at Voestalpine Railway Systems JEZ foundry in Spain.

Metallugica Madrilena, (Metamsa) produces a variety of quality steel castings for Spanish and European customers. They already have experience with inorganic binders, as their moulding line for castings weighing more than 80 kg has used a silicate (inorganic) binder system for years. Castings of less than 80 kg are made in green sand line. Metamsa's experiences and knowledge of inorganic binders are shared among the flagship foundries while they try to improve the behaviour of the inorganic line in cooperation with binder manufacturers and other project experts. Metamsa tested inorganic binders from three producers with good results.

In order to be able to increase production with inorganic binders, Metamsa decided to invest in a new mixer line, including demoulding equipment.

Pretests at Metamsa foundry in Spain.

Peiron is an iron and steel foundry producing parts mainly for the producers of industrial machines. Maximum casting weight is ca. 5000 kg.

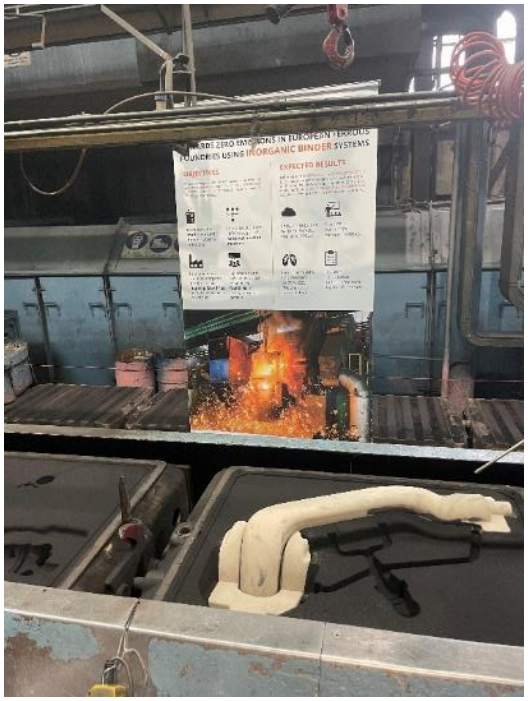
Peiron invested a continuous mixer line for the tests with inorganic binders. Three different inorganic binder systems have been successfully tested in this line for production on ductile iron and steel castings. Over 20 net tons of castings in sizes between 5 to 1000 kg have been produced in pretests using inorganic binders, and sand usage have been 55 tons. The casting quality has been at least comparable with the castings made by their current phenolic Alphaset moulding line. Surface quality is even better.

Peiron will continue normal production with inorganic binders on this line.

New mixer for the inorganic binder system line in Peiron.

Fonderie di Assisi (FA Spa) is an iron and steel foundry producing demanding parts mainly for automotive industry. Typical casting weights are between 10-100 kg. There are 2 production lines, an automatic green sand line for cast iron castings and a robot-operated moulding line for steel castings, total capacity approx. 15,000 tons/y. Cores are manufactured on 5 hot-box and 13 cold-box lines with organic binders.

In the project FA Spa tested cores made with hot cured inorganic binder systems by core sup-suppliers. Cores were mounted in green sand moulds before casting. Results of these tests were mainly good. The original goal in the project was to build own core line based on inorganic binders. After considerations, FA Spa decided to invest its own core line based on inorganic binders cured with CO_2. The new line is now in commissioning.



Cores made of inorganic binders at FA Fonderie di Assisi in Italy.

Waste sand reclamation tests

In addition to the inorganic binder system implementation actions in the flagship foundries, **different surplus foundry sand reclamation and reuse methods have been tested** in order increase the recycling of foundry sand back in foundry processes, to find new reuse applications for inorganic binder system waste sands or "mixed" waste sands with inorganic and organic binder system sands. The aim is to reduce the amount of surplus sand to be landfilled in the future.

Project partner SandTeam and Peak Deutschland as inorganic binder system supplier partners have actively supervised and visited the partner foundries during the tests. SandTeam has carried out several tests with the partner foundry sand samples with their secondary reclamation unit and they have got promising results. Also other sand treatment methods in small scale tests have been carried out by CETIM in France and Azterlan in Spain in their experimental foundry

The first results in WP5 show that **waste sands from the casting production made by inorganic binders contains less harmful compounds compared** to waste sand from the production with organic binder systems. This enables reuse of inorganic binder waste sands, e.g. in the geo construction, without any further processing (e.g. composting) or need for landfilling.

Composting tests were carried out in Finland and promising results were got. The inorganic binder system waste sand contains less harmful substances and therefore it suit well to the composting purposes and the end product can be used as soil material for green constructing purposes meeting the limit values set for Fertiliser Product (2019/1009).

Consortium meetings and project monitoring visit

Regular TEAMS meeting have been arranged during the project. In total over 100 TEAMS meetings have been arranged. Project meeting was arranged on 22-23.4.2024 at OPSA foundry in Poland.

Project meeting at OPSA foundry in Starachowice, Poland 22-23.4.2024.

Project monitoring meeting took place in Finland on 3-4.9.2024 in Finland. External monitoring expert Mrs Inta Duce from ELMEN EEI was present along with project partners AINS, Meehanite, Peak, Foundryteam, Peiron and Mr Pekka Kemppainen (external consult). We visited also the partner foundry Peiron in Kokemäki during the monitoring meeting.

During the project monitoring visit on 3-4-.9.2024 partners and Mrs Inta Duce from ELMEN IIE visited also the partner foundry Peiron in Kokemäki.

More information at:

https://www.azterlan.es/en/projects/green-casting-life-project.html

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