PREMA

www.prema-project.eu

Press release #2

Energy efficient, primary production of manganese ferroalloys through application of novel energy systems in the drying and pre-heating of furnace feed materials

September 2021

PreMa is all about increased energy flexibility and the use of sustainable energy sources followed by reduction of the overall energy consumption and CO_2 emission

The challenge

There is a constantly increasing political as well as social pressure to turn industrial processes into more effective ones with less environmental burden. It refers especially to sectors that are highly energy and resource consuming and contribute in large numbers to CO_2 emissions. Metallurgy definitely belongs to them.

With an objective of near-zero emissions, a supply chain approach is needed demanding that the involved processes are more energy and resource efficient causing less environmental impacts. Mn alloys production belongs to these processes. Mn in a form of ferroalloy is an important additive for high quality steel production. It decreases the brittleness of steel and imparts its strength. It is thus an essential part of the value chain, however at the same time a significant contributor to its environmental burden due to energy consumption, dependence on fossil fuels (mainly carbon) and the resulting CO_2 emissions.

About 1.8 billion tons of steel was produced in 2020, which generated about 2.6 billion tons of direct CO_2 emissions[1], correlating to 7-9% of the total global emissions. To produce steel of high quality, around 1-5% of manganese alloys is added to the steel. As production and consumption of steel is expected to increase in the foreseen future, so will the need for good alloying elements, such as ferromanganese. In 2020 about 4.74 million tons of ferromanganese alloys (not including SiMn) were produced worldwide[2]. Basing on values from 2012 with a similar production volume, the estimated electrical energy consumption in 2020 was 14500 GWh and direct CO_2 emissions generated in the process of Mn-alloys production reached 16.8 million tons[3].

Although a lot has been done in the area of energy efficiency improvements over the last decade to reduce the CO_2 emission levels from the steel sector, new approaches still need to be implemented to accelerate deployment of innovations for low emission processes including those involving renewable energy sources.

At the racketing prices for CO_2 emissions at the European as well as global markets, Mn manufacturers are becoming more open to innovations that may help them reduce the operational costs and improve the environmental profile by cutting down the consumption of electric energy and the resultant CO_2 emissions.

How PreMa will address these needs and expectations

The objective of the PreMa project is to develop technologies allowing for reduction of the overall electric energy and fossile carbon materials use resulting in reduction in CO_2 emission end energy consumption.

PreMa is addressing this by developing and demonstrating a technology for pre-treatment of manganese ores to increase energy source flexibility, energy efficiency, enhance use of raw material fines and reduce CO_2 emissions in production of Mn-alloys.

Our research and development efforts are to provide that PreMa delivers a process that is:

- Innovative
- has a significant environmental contribution demonstrated by reduced CO_2 emissions (along with SO_2 and NO_X)
- robust in terms of use of different Mn ores types
- flexible in terms of different renewable energy sources to replace fossil fuels
- compatible with the current industrial operations of Mn processors

1. World Steel Association
2. International Manganese Institute (IMnI)
3. Laplace Conceil: Impacts of energy market developments on the steel industry. 74th Session of the OECD Steel Committee, Paris, July 2013

This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement No 820561

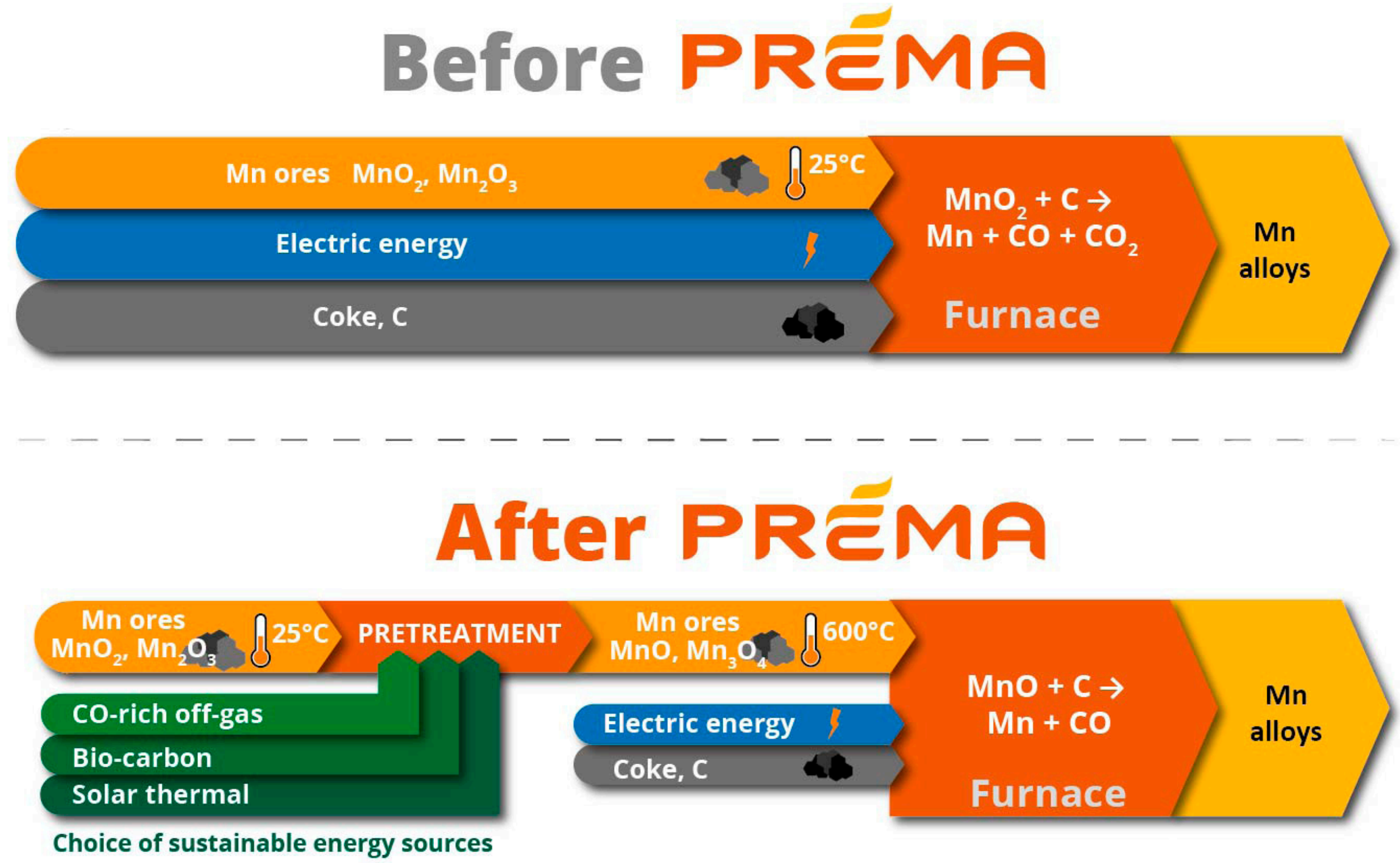
- economically feasible in terms of CAPEX and OPEX costs

PreMa's ambition is to provide a novel technology developed in collaboration with **all European Mn-alloy manufacturers**, that will allow to reduce energy consumption up to 25% and CO_2-emissions up to 15% in Europe. If Europe still holds its relative global production share from 2013, this correlates to 780 GWh electrical energy and 0.7 Mill. tonnes of CO_2-emissions for 2020 production.

The PreMa pretreatment technology

The new solution developed under PreMa project consist in the implementation of a Mn ores pretreatment process using alternative and renewable energy sources such as CO-rich off gas, solar-thermal energy and bio-carbon.
In today's process the manganese ores are fed directly to the submerged arc furnace at ambient temperature. With PreMa technology, some of the energy intensive and/or CO_2-emitting steps in the furnace process will be performed in the pretreatment unit, thus increasing the energy flexibility, reducing the energy consumption and decreasing CO_2-emissions. Process steps to be performed in the pretreatment unit includes evaporation of moisture and preheating of materials to e.g. 600°C, where these two steps can account for 25% of the total energy consumption[4].

Electric energy and coke are still required but in significantly smaller amounts. The reduction process in the furnace is the same in the traditional smelting process and in the smelting process using PreMa pre-treatment unit.



What we have tested and tried so far

Energy sources

We have investigated three sustainable energy sources for the pre-treatment unit: solar thermal energy, CO and CO_2 gas and bio-carbon.

The thermo-solar technology is developed and tested as the energy source for pre-treatment unit at Stellenbosch University (SU), MINTEK and the German Aerospace Center (DLR).

4. Tangstad, M., Ichihara, K., & Ringdalen, E. (2015). Pretreatment unit in ferromanganese production. Infacon XIV

This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement No 820561

The solar thermal energy use is being tested using two pilot facilities. First solar thermal plant with thermal storage for continuous production of hot air at 800°C at DLR in Germany and second solar thermal plant for use of air at 800°C for Mn pre-heating at MINTEK in South Africa.

For the purpose of additional lowering the equivalent of CO_2 emission in Mn-alloys production with solar thermal energy, the economy of the innovative HelioPod technology use was tested and proved by Stellenbosch University in South Africa, where it was developed for solar thermal systems. This technology allows for easy assemble and disassemble of the setup, facilitating the redeployment of the solar thermal plant, reducing the financial and environmental costs of operation.

The use of CO and CO_2-gases heated to about 1000°C for pretreatment of Mn-ores will be tested at ERAMET Ideas, and its effects on Mn-ores will be determined. For that purpose a pilot test installation of a custom shaft furnace connected to the CO generator system will be built.

Another tested source of energy for pretreatment of Mn ore is the biocarbon mixed with off-gas. Its influence on different mixtures of Mn ores properties is tested at SINTEF.

Pre-heating technology

To choose the best technology for preheating three existing technologies were evaluated at laboratory scale by Metso Outotec: rotary kiln, fluidised bed and shaft furnace. Two technologies, rotary kiln and shaft furnace, were chosen for further testing . Eramet Ideas piloting tools allowed to scale up:

– Two campaigns were realized in rotary kiln in 2020, with first pre-heating and then pre-reduction trials.

– Shaft furnace equipment is currently under design. It should be implemented in 2022 and ready for first trials.

The challenge is still however how to effectively transfer the warm material from the pre-treatment unit to the SAF. We are dedicating a part of our investigations to this topic. MINTEK, Metso Outotec and ERAMET are working on that issue. At MINTEK the technology of heat transfer from hot air to Mn ore is being investigated. The pilot campaigns at ERAMET Ideas, only with the pre-treatment unit, allow to have first elements on the possible re-oxidation of the ore and on the cooling kinetics, but it is the pilot including rotary furnace with loading in the SAF at MINTEK which will allow to measure the technical difficulty and the limits of hot transfer.

As the developed technology must be robust and reliable, we use different kinds of Mn-ores and mixtures of those ores in our trials.

Compatibility with conventional process

The effect of the furnace operation on the materials are examined. Materials from the pilots are sent to the Norway Research Institute (SINTEF) and Norwegian University of Science and Technology (NTNU) and 11 pilot experiments is conducted. The experiments will test how these pre-treated materials behave in the submerged arc furnace. A large experiment integrating pre-heating and manganese alloys production is to be conducted at MINTEK to test the integration of the developed technologies.

The design, engineering solutions and cost figures for the full-scale implementation of the pre-treatment module will be developed during the project, along with the business plan for its industrial implementation.

Project and Partners

PreMa Project - Energy efficient, primary production of manganese ferroalloys through the application of novel energy systems in the drying and pre-heating of furnace feed materials - is developed within the scope of Horizon 2020 EU funding programme for research and innovation. To achieve the project ambitious objectives, PreMa has a strong consortium. Many partners are industrial manganese alloy producers: ERAMET, FERROGLOBE and OFZ from Europe and TRANSALLOYS from South Africa. The engineering and equipment supply company is Metso:OUTOTEC in Finland and Germany. There are the DLR and the Helmholtz Zentrum Dresden Rossendorf (HZDR) institutes from Germany, the Institute for Ecology of Industrial Areas (IETU) from Poland, SINTEF and NTNU from Norway and MINTEK from South Africa.

The project has a budget of 12 million euros of which 10 million is the contribution of the EU. It started in 2018 and was planned for completion in 2022 but will be prolonged to 2023.

Webpage: www.prema-project.eu

LinkedIn: prema-project

Twitter: @PremaProject

For more information visit our website: www.prema-project.eu

For technical details contact **Eli Ringdalen**, PreMa project Coordinator from SINTEF, Trondheim, Norway:
e-mail: eli.ringdalen@sintef.no
phone: +47 995 19 645

For dissemination contact **Izabela Ratman-Kłosińska**, from Institute for Ecology of Industrial Areas, Katowice, Poland:
e-mail: i.ratman-klosinska@ietu.pl
phone: +48 32 254 60 31 ext. 243

This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement No 820561