SisAl Pilot

SisAl Pilot Project
Innovative pilot for Silicon production with low environmental impact using secondary Aluminium and silicon raw materials

Enjoy reading the SisAl Pilot newsletter!

A few months left on the SisAl Pilot path

Foreword by the coordinator

SisAl Pilot has entered its final project phase with less than four months left to the project end on October 31st, 2024. Many important milestones have been accomplished in the project during the four active years and you will learn about some of the latest achievements in this new letter including the production of SisAl metal in the rotary furnace at Fundiciones Rey in Spain and the production of high purity silicon (HP-Si) following the Silicor process at Reykjavik University at Iceland l.

We are now looking forward to the last four existing months which besides a well-deserved summer break are filled with the large final SisAl campaign at Mintek in South Africa, the finalisation of the hydrometallurgical pilot trial at METLEN Energy & Metals in Greece and last but not least the final project event on October 15th in Brussels where the project's success story, from research to demonstration will be showcased and topics on how research and innovation can lead to commercially viable and sustainable solutions will be discussed. The event will also serve as a platform to spread the project's outcomes among policy makers and to foster relationships with relevant industries interested in reducing their environmental impact and become more circular.

Stay tuned for the final updates about the SisAl story!

Warm regards,

Maria Wallin and Gabriella Tranell

The SisAl team at the project meeting at Mintek in May 2024

CIRCULAR VALUE CHAINS: DEMANDING, BUT NECESSARY – NTNU EU Conference

On April 17-18, NTNU organized a European Conference about the importance of circular value chains, in Brussels.

With ever-increasing geopolitical tensions, Europe has to become more independent of third-country resources such as China and Russia, in order to meet the green and digital shift. To succeed in this, we must maximize the value of our raw materials by closing the material loops by using waste and side streams. This requires the development of circular value chains through the establishment of new robust industrial partnerships.

NTNU is at the forefront of several major EU-funded initiatives where the aim of one project is to close the material loops in the silicon and aluminum industry, through the patented SisAl process. In this process, aluminum scrap or dross is used instead of carbon to produce silicon from quartz (silicon oxide), with no direct process emissions of CO2. If we succeed, the SisAl process will make a strong contribution to more circular value chains through industrial symbiosis where the aluminum industry will function as both raw material supplier and end user to the silicon industry.

Read more about the NTNU EU conference and how SisAl Pilot can be instrumental in this process!

More resources: bookmark, Roll-up.

New SisAl process pilot trials were run in FUNDICIONES REY with the presence of NTNU, ITMATI and SBC.

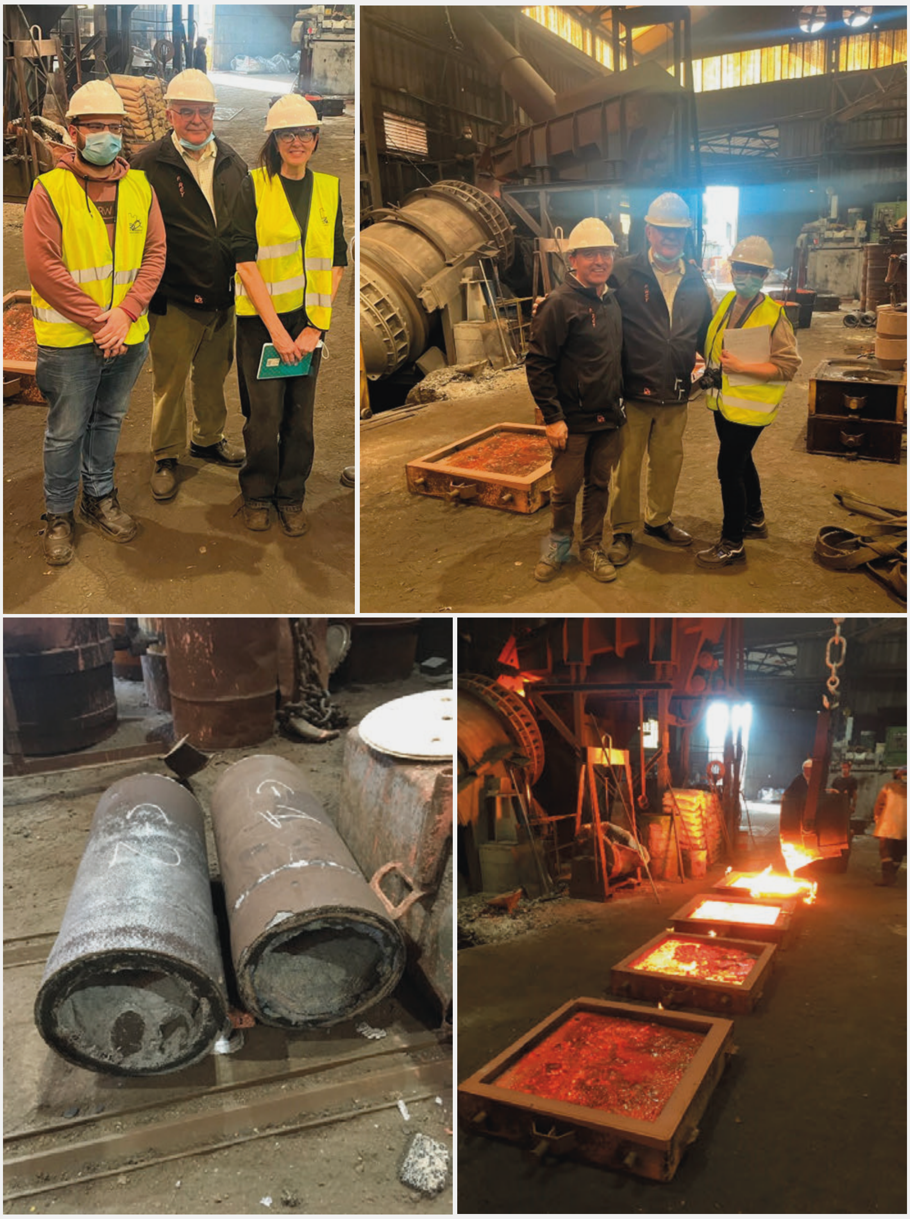
In this occasion, the rotary furnace was used to melt the slag (quartz and limestone at 1450°C) verifying that aluminothermic reaction successfully happens in a ladle (outside the furnace and without using a burner).

The Al was melted at 850°C in a gas furnace mixing it subsequently in a ladle with the melted slag coming from the rotary furnace.

It was a very productive work session at FRey factory with a very good coordination between the company and the Norwegian and Spanish universities. Many interesting results were obtained to be deeply analysed.

As a main conclusion, the rotary furnace seems to be the ideal technology for this process because the rotation facilitates the aluminothermic reaction and the mixing of melted materials.

Additionally, new tubes were produced, using the gas furnace and centrifugal casting, looking for parts with an Al/Si hypereutectic composition. In this case, the Si coming from the induction furnace of the first pilot trials -which is free of Fe- was used.



Reykjavik University, Solar-Grade Silicon

Reykjavik University is part of the SisAl pilot project, focusing on further purifying metallurgical-grade silicon (MG-Si) produced through the SisAl process to meet solar-grade silicon (SoG-Si) standards.

Traditional silicon refining methods, such as the Siemens process and fluidized bed reactors, involve hazardous chemicals like trichlorosilane ($SiHCl_3$) and are energy-intensive. The high energy consumption might lead to significant contribution to the global warming potential (GWP) of crystalline silicon, based on energy sources.

At Reykjavik University, we use a metallurgical method to refine MG-Si by solidification from the Al-Si melt. This method includes a directional solidification step, effectively removing most impurities except boron (B) and phosphorus (P), due to their high segregation coefficients (0.8 and 0.35 respectively) at silicon's melting point of 1410 °C. Therefore, the main objective during metallurgical purification is to reduce B and P to acceptable levels of a few hundred ppbw.

The process begins by heating Al and Si (approximately 50% / 50% wt.) to 1100 °C, with the melting point of the mixture occurring at 1050 °C. Following melting, a slow-cooling process allows silicon to crystallize, precipitate (Figure 1(a)), and form flakes (Figure 1(b)). The impurities in general will be trapped in the liquid phase. The liquid phase is then removed at a temperature above the eutectic point (577 °C). This procedure is repeated another three times to ensure the removal of most impurities and achieve the desired low concentrations of B and P. The refined silicon is then subjected to acid leaching (HCl) to eliminate the remaining aluminum (Figure 1(c)).

We have successfully refined MG-Si to 4N (99.99%) purity, achieving boron and phosphorus concentrations of 120 ppbw and 106 ppbw, respectively. Another issue was the high calcium content in MG-Si from the SisAl process, but our metallurgical refinement effectively removed Ca. We are now collaborating with SINTEF for the final directional solidification trial, anticipating obtaining 5N-6N crystalline silicon that meets SoG-Si requirements.

a) b) c)

Figure 1 a) Al-Si alloy Si crystals precipitate and form flakes, b) Si flakes resulted from the metallurgical purification, and c) Refined Si particles after acid leaching

Partners

Contact us

PROJECT COORDINATOR
Gabriella Tranell
gabriella.tranell@ntnu.no

ADMIN MANAGER
Maria Wallin
maria.wallin@ntnu.no

EXPLOITATION MANAGER
Torstein Haarberg
th@bnw-energy.com

DISSEMINATION MANAGER
Valentina Cinti
v.cinti@ciaotech.com

www.twitter.com/SisalPilot

www.linkedin.com/company/sisal-pilot-project

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