ReziProK

Resource-efficient Circular Economy – Innovative Product Cycles

OptiRoDig

Optimisation of raw material productivity in the foundry and steel industry from products of the recycling industry by using modern mathematical methods, networking and digitalisation

Resource-efficient Circular Economy – Innovative Product Cycles (ReziProK)

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In the foundry and steel industry, around 45 percent of the raw material requirements are already covered by secondary raw materials. This proportion should and can be increased. A prerequisite is that the smelters know the exact composition of available scrap types and can procure them in a targeted manner. For this reason, the "OptiRoDig" project aims to develop a digital network system that enables data exchange between the recycling industry and steelworks for optimized melting processes

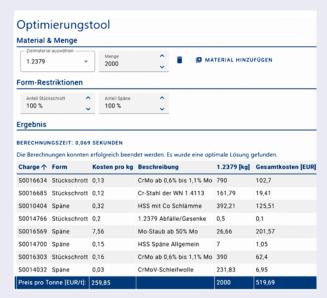## Metal recycling with potential

Metal scrap is produced in large quantities as waste from metal processing, e.g. chips, punching waste, material residues. Usually, their exact composition and any impurities they may contain, e.g. oils, are not known exactly. However, this information is a prerequisite for the smelters to be able to use specific scrap qualities for the production of a certain alloy without having to add expensive alloy surcharges.

Foundries and steelworks or smelters want to purchase the raw materials suitable for their melting processes in a targeted and cost-effective manner. Today's common procedure – inquiry, quotation, order – is time and personnel consuming. In addition, the desired material data is often not available in a timely manner.
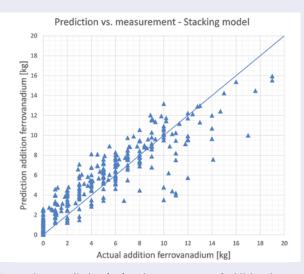
In the course of OptiRoDig, a digital network system is to be developed between the recycling industry and the smelters. In this system, extensive analysis data of available secondary raw materials – metal scrap – will be provided. This database should enable the smelting works to procure suitable raw materials, to optimise their melting processes and thus to use higher proportions of secondary raw materials in a targeted manner.

Digitisation and networking

For interactive data exchange and automated process optimization in the melting plants, both the data to be recorded and various software tools must be developed

Screenshot optimizing tool.

Comparison prediction (ML) and measurement of additional alloy FeV.

and coordinated. In OptiRoDig an innovative digital system is to be developed for this purpose, via which the raw material data and process requirements are made available digitally to the participants along the process chain through digitisation, networking, defined interfaces and data formats in such a way that these can be taken directly from the planning software and evaluated using mathematical methods. For this purpose, comprehensive analysis coordinated between the partners is required. After completion of the development phase, the digital system is to be made available to other companies within the framework of a cloud solution.

First results

With the cloud-enabled web application created for the project, it is already possible to optimize the composition of the melting in terms of costs and shape (share of turnings and massive pieces) using a simplex algorithm. The optimization can be supplemented with further boundary conditions. The screenshot on the left shows the result of a cost optimization from the web application in a shortened view.

The melting process in the furnace of a foundry is modeled with machine learning (ML) to analyze the process-related influencing variables. The graph on the left shows as an example the forecasted required quantity result (with ML) of ferrovanadium (FeV) to produce 1.3343 steel. As input the process data from the project partner Lohmann are used. The ML models will be integrated into the cloud application to enable an overall optimization in terms of metallurgical interactions in the melt and total costs.

Consolidation of competences

The joint project OptiRoDig brings together the main players in the supply chain between the points where metal waste is generated and steel production. These are supplemented by the know-how of university institutes.

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The project coordinator is RHM Rohstoffhandelsgesellschaft mbH, a wholly owned subsidiary in the RHM Group, based in Mülheim. As a scrap trading company, RHM specialises in the sector of high-quality steel alloys and related metal alloys with rare elements such as tungsten, chromium, vanadium, cobalt, nickel, titanium, etc.

The smelting works of Friedr. Lohmann GmbH, based in Witten, act as representatives of the "OptiRoDig" network. In their two steelworks, high-speed, tool and special steels are produced as well as highly wear-resistant and heat-resistant castings.

The Institute of Metal Technologies at the University of Duisburg-Essen (UDE) and the University of Applied Sciences Kempten have many years of expertise in the fields of process optimisation, database systems, static evaluation and predictive manufacturing.

The partners RHM and Friedr. Lohmann benefit from the results by optimizing their processes and the application-oriented evaluation of raw materials. The university institutes can test and optimize developed models and algorithms in operational practice. In the second project phase of "OptiRoDig", the data exchange is then to be made accessible to other companies in the recycling industry as well as the foundry and steel industry.

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"ReziProK" is part of the research concept "Resource-efficient Circular Economy" of the Federal Ministry of Education and Research (BMBF) as part of the FONA Field of action 6: "The circular economy – efficient use of raw materials, avoiding waste" and supports projects that develop business models, design concepts or digital technologies for closed product cycles.

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