We are proposing

PhD/Postdoc projects

Usage of hydrogen and hydrogenous gases in conventional iron making routes

Are you interested in changing the world into a climate-friendly future? Are you enthusiastic to work in research and development for CO_2 emission reduction within a dynamic team of process experts?

Framework

Steelmaking contributes approximately 7% to the global greenhouse emissions. The traditional blast furnace and converter steelmaking route generates most of these emissions. The transition of this conventional iron making route is thus of utmost importance. The development of such transition paths requires huge efforts. To tackle the required research and development work, Paul Wurth is looking for motivated researchers who will work in close collaboration with industrial experts.

Paul Wurth as a global leader in ironmaking technology is actively working on CO_2 reduction approaches for the blast furnace based iron production route. Therefore, a dedicated R&D group focusing on different CO_2 reduction techniques along with the usages of green energy and hydrogen has been setup.

Blast furnace as the main iron production route has been developed over centuries and is currently working near its optimum. Therefore, fundamental changes in the blast furnace process are required to meet the new environmental concerns. One of the most promising research paths for the modernization of the blast furnace steel production route is the injection of hydrogenous gases into the tuyere and the shaft of the blast furnace.

In this framework, several PhD/Postdoc projects are proposed giving the possibility to work in an international company and contributing to a new transition route for CO_2 emissions reduction.

» Topic 1: Development of a new reforming process for synthesis gas production

» Topic 2: To develop three-dimensional modelling of an enhanced blast furnace with H_2-rich gas injection

» Topic 3: To develop a detailed hydrogen combustion model applicable to the blast furnace

If you are a team player, if working independently combined with strong organizational and analytical skills are your strength and passion, then you are here at the right place.

Paul Wurth group is an international engineering company driven by innovation. Our experience is based on a tradition of 150 years and the professional know-how of 1600 employees, located in around 20 countries worldwide. As global leader in ironmaking technologies, we constantly face new challenges that force us to manage an on-going cycle of innovation. We thus take an active role in shaping the industry of tomorrow.

Join us in conquering new challenges and be part of our Paul Wurth R&D team!

Annexe:
Detailed description of topics 1 - 3.

PAUL WURTH
SMS group

Topic 1

Development of a new reforming process for synthesis gas production

Paul Wurth is currently developing a new reforming process for syngas production using exhaust gases from the steel making plant.

The synthesis gas composition produced by Paul Wurth's new reforming process is highly influenced by many operation parameters e.g. the operating pressure, temperature or feed composition.

To determine the optimum process conditions, a reaction model describing the kinetic of the gas phase reactions was already developed and validated by lab-scale reforming tests.

As the next development step, a pilot plant will start up, operating under real process conditions using industrial gases from the steel plant.

During the pilot plant operation, we will test different materials within different operating points. For a future integration of the reforming plant in the steel plant, we need to upscale the pilot plant to the industrial operation. This includes also the integration of the reforming process model into the design calculation of the industrial plant.

Furthermore, we will evaluate possible configurations of combining reforming plants with other CO_2 emission reduction technologies such as e.g. carbon capture.

The tasks of the FNR applicant are as follow:

- Analysing the state of the art and market potential for CO_2 emission reduction technologies and related topics
- Supervision of the reforming pilot plant on site
- Verification, adaptation, and optimization of a reaction model using data from the reforming pilot plant
- Scale-up of the reforming pilot plant to industrial scale
- Integration of the reforming process model in a design and dimensioning calculation of the industrial process plant.

Requirements:

- Master or PhD in process, chemical engineering or related discipline
- Strong analytical mindset and joy in research activities
- Advanced knowledge in thermodynamics, heat and mass balance
- Experienced in data evaluation, programming, modeling and simulation
- Passion for processes
- Strong interpersonal and communication skills
- Proficiency in English (Knowledge of French, German or Luxemburgish are considered an asset).

Topic 2

Development of three-dimensional modelling of an enhanced blast furnace with H_2-rich gas injection

Lowering CO_2 emissions has become a challenging issue in ironmaking processes, and particularly for the blast furnace process. To further improve its operational performance and reduce the related CO_2 emissions, innovative technologies and approaches are needed. The injection of hydrogenous gases at different levels of the blast furnace will play an important role in these new approaches and will have important impacts on the blast furnace process as its thermal and chemical performance and in the end its energy efficiency and fuel rate. The requirement of cost-effective mathematical modelling is undeniable for understanding the important impact that these technologies will have on the blast furnace process.

This PhD project focusses on the modelling of an enhanced blast furnace with H_2-rich gas injection and operating with the minimum coke rate. The injection of hydrogenous gases at different levels of the blast furnace has important impacts on the blast furnace process as its thermal and chemical performance and in the end its energy efficiency and fuel rate. Moreover, running an enhanced blast with the minimum possible usage of coke requires an elaborated burden distribution.

Therefore, the candidate would

- develop a 3D, steady-state, CFD model for an enhanced blast furnace
- develop the burden distribution model
- validate and verify the developed code with lab-scale experiments and with data from an industrial blast furnace
- find out the optimal quantity of hydrogen/hydrogenous gases injected to the BF and its distribution to the different injection levels
- evaluate the different arrangement of shaft injection scenarios.

Requirements:

- A master's degree in computational engineering, Chemical, or Process Engineering or Metallurgical Engineering or related discipline
- Experience in numerical modelling
- Experience in programming (C, C++)
- Good knowledge of CFD, heat, and mass transfer
- Strong interpersonal and communication skills
- Proficiency in English (Knowledge of French, German or Luxemburgish are considered an asset).

Topic 3

Development of a detailed hydrogen combustion model applicable to the blast furnace

The tuyere and raceway are the areas of the blast furnaces where the fuel is partially combusted with hot and oxygen-enriched air. The correct operation of these areas is thus key for the control of the complete blast furnace process. With the objective of reducing CO_2 emission from steelmaking, injection of rich hydrogenous gases to the raceway is of high interest. However, a deeper understanding of the injection behaviour of these gases into the tuyere and raceway of the blast furnace requires a detailed mathematical model as experimental studies are practically impossible. State-of-the-art modelling technics have been developed and adjusted mainly for pulverized coal injection. These simulation tools should now be extended and adapted allowing for the co-injection of hydrogen-rich gases. Computational Fluid Dynamic (CFD) calculations can be employed for this purpose by taking into account the fluid flow, turbulence, heat transfer, radiation, chemical kinetics, and coal particle combustion.

The candidate would:

- adapt and extend a CFD model for H_2-rich gases combustion in the tuyere and raceway
- Implement reaction rates and their corresponding enthalpies
- Investigate the interaction of H_2-rich gases with coal injection
- Evaluate burnout percentage of fuels
- Optimize the process by defining restrictions for H_2-rich gases injection in the raceway
- Evaluate the design parameters (such as geometry, injection point, and amount)
- Provide guidelines for optimizing H_2-rich gases injection
- The raceway model shall ,later on, be coupled with the 3D blast furnace model.

Requirements:

- A master's degree in computational engineering, chemical, or process engineering or metallurgical engineering or related discipline
- Experience in numerical and computational modelling
- Good knowledge of fluid dynamics, chemical reactions, heat, and mass transfer
- Being familiar with Computational Fluid Dynamics (CFD)
- Being familiar with OpenFOAM
- Strong interpersonal and communication skills
- Fluency in English (Knowledge of French, German or Luxemburgish are considered an asset).