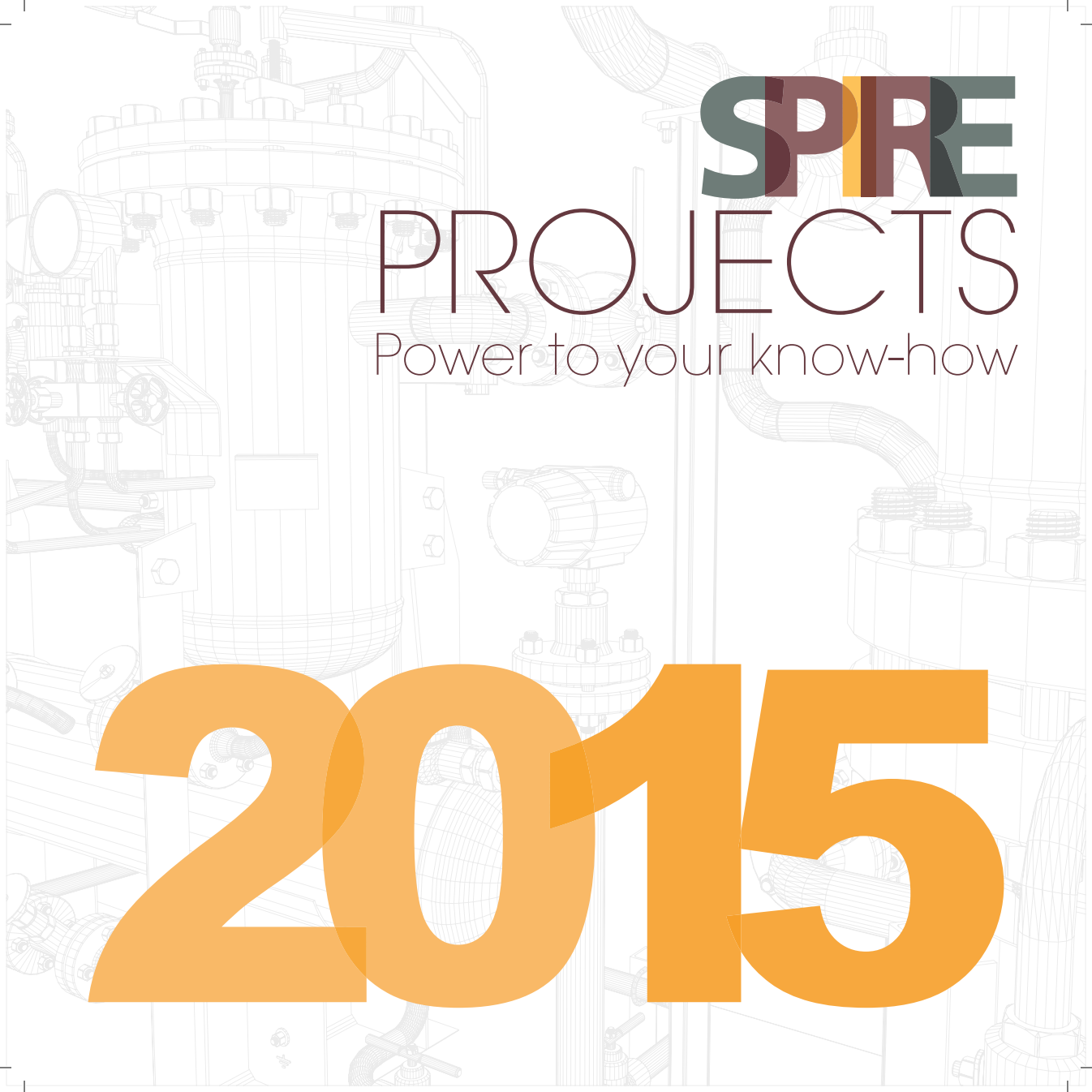

SPIRE

PROJECTS

Power to your know-how

2015

SPIRE 5 – 2015

New adaptable catalytic reactor methodologies for Process Intensification

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SPIRE 5 - 2015

New adaptable catalytic reactor methodologies for Process Intensification

ADREM

Adaptable Reactors for Resource- and Energy-Efficient Methane Valorisation

Adaptable Reactors for Resource- and Energy-Efficient Methane Valorisation

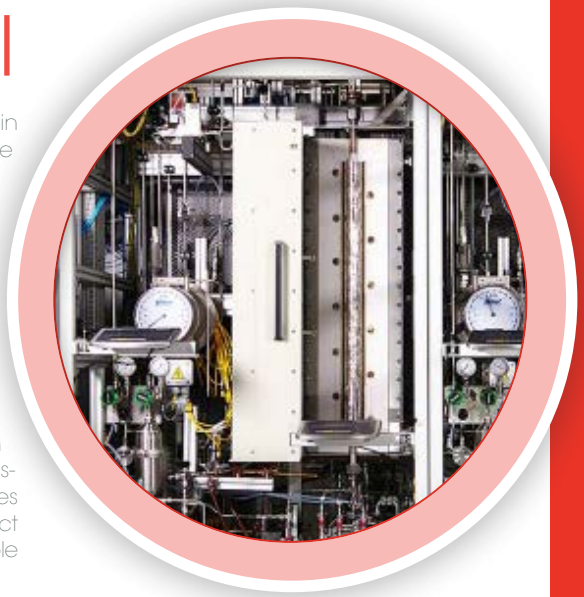
the AIM

The enormous reserves of natural gas, its potential contribution to improved environmental sustainability and lower overall costs point to its use as the dominating primary source for energy and chemicals in the near future. The diversity of methane sources creates the need to develop new, intensified and adaptable catalytic reactor systems for flexible and decentralised production with high process performance.

the CONCEPT

ADREM focuses on the design, development and validation, in an industrially relevant environment, of intensified, adaptable and modular catalytic reactor systems able to operate with changing feedstock composition to deliver, on-demand, the required product distribution. The project will also boost the selectivity of methane valorisation reactions to achieve the desired high value products.

The project will use a unique integral process intensification methodology pioneered by the project consortium. This is the only approach able to deliver a fully intensified equipment and/or process. The key feature is the systematic, simultaneous addressing of the four project domains: spatial, thermodynamic, functional and temporal. The reactor technologies addressed in the project are based on microwave, non-thermal plasma, gas-solid vortex, and high-temperature gradient plasma technologies in combination with innovative catalysts. The significant impact anticipated will be further increased by the use of renewable electricity sources to power the reactors.



This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement n° 680777

www.spire2030.eu/adrem

MEMERE

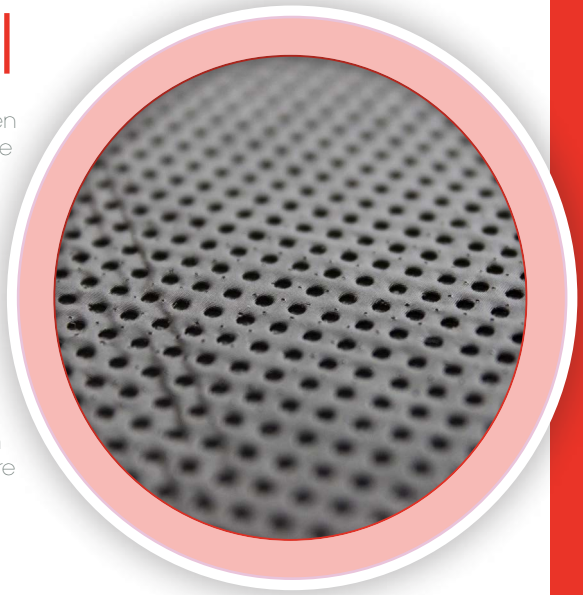
MEthane activation via integrated MEmbrane REactors

the AIM

MEMERE's objective is the design, scale-up and validation of a novel membrane reactor for the direct conversion of methane into ethylene. The focus is on air separation using novel mixed ionic-electronic conducting membranes integrated within a reactor operated at high temperature for oxidative coupling of methane (OCM) allowing integration of several different process steps in a single multifunctional unit to achieve significantly higher yields compared to conventional reactor technologies, combined with improved energy efficiency.

the CONCEPT

The project is developing novel, cheap yet more resistant oxygen selective membranes for efficient air separation and distributive oxygen feeding to the reactor system. The objective is to give a robust proof of concept and validation of the new technology by designing, building, operating and validating a prototype module based on the OCM technology that will be integrated in a mini pilot-plant built in a standard container. MEMERE technology will deliver direct conversion of methane to C2+ hydrocarbons with a reduced energy penalty in a much more effective way (target C2 yields are greater than 30%) as compared to currently available techniques. In addition, as air separation is integrated in an efficient way in the reactor, the MEMERE technology can also be used at small-to-medium scales to convert methane produced in remote areas where conventional technologies cannot be exploited today.



This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement n° 679933

www.spire2030.eu/memere

PRINT CR3DIT

Process Intensification through Adaptable Catalytic Reactors made by 3D Printing

the AIM

PRINTCR3DIT will implement a methodology to integrate 3D printing technologies in the advanced design, modelling and manufacture of structured catalysts and catalytic reactors. This will result chemical processes with significant reductions in cost, resource utilisation and energy, and give access to new design strategies and faster lead times. This technique is particularly useful in reactions where diffusion, mixing and/or heat transfer are barriers to achieving higher process performance.

the CONCEPT

The concept of the hybrid utilisation of additive manufacturing (also known as 3D printing) has especially high impact in cases where optimal or innovative designs cannot be realised with traditional manufacturing approaches or when producing such designs are very expensive. The project methodology will be applied to three defined market segments (fine chemicals, specialty chemicals, and fertilizers) where production ranges from few tons to millions of tons of production per year. This demonstrates the enormous versatility of 3D printing for reactor and catalyst designs. For all three processes, the challenges to be solved are thermal management, innovative reactor design and flow distribution. These examples will provide realistic data in different markets to delineate robust business case scenarios with the options of new integrated plants or retrofitting for large-scale applications.

This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement n° 680414

www.printcr3dit.eu

ROMEO

Reactor Optimisation by Membrane Enhanced Operation

the AIM

A new level of process intensification for catalytic-driven and environmentally-friendly reaction systems is at hand: ROMEO's aim is to reduce energy consumption by up to 80% and emissions by up to 90% for industrial catalytic gas-phase reactions. In the project, European industry and academia have teamed up to develop a new reactor concept using novel homogeneous catalysis and membrane technology to combine chemical synthesis and downstream processing in a single step.

the CONCEPT

ROMEO's new reactor design includes bundles of tubes and a homogenous catalyst being fixed onto a membrane. Both chemical synthesis and processing are carried out in a single step thanks to this reactive membrane. In this «two-in-one» reactor, the product is continuously removed from the reaction mixture as it is formed. The project will obtain a detailed understanding of the processes involved in the new reactor, from the nanoscale (catalyst phase, membrane, transport mechanisms across and inside the membrane) to the macro-scale (including heat and mass flow, industrial process design etc.). The new know-how gained will be used to develop a flexible reactor design method allowing for use of the system in a wide range of applications.
Processes for bulk chemicals and bio-energy applications have been chosen to demonstrate the efficiency of ROMEO's technology in a close to industrial conditions environment. Two demonstration plants will be built: one running a hydroformylation reaction and one running the water-gas shift reaction.

This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement n° 680395

www.romeo-h2020.eu

Tandem Electrocatalytic Reactor for Energy Resource Efficiency and Process Intensification

the AIM

TERRA aims to develop a tandem electrocatalytic reactor (TER) with the capability to couple an oxidizing reaction with a reducing reaction. This will deliver the potential competitive advantages of (1) saving resources and energy (needed to produce the oxidant and reductants for the two separate reactions), and (2) intensifying the process (by reducing the number of steps, coupling two synthesis processes and eliminating those required to prepare the oxidation and reduction agents).

the CONCEPT

The TER unit may be used in a large range of applications, but will be developed for a specific relevant case: the synthesis of PEF (PolyEthylene Furanoate), a next generation plastic. The TERRA project aims to make a major step forward in this process by coupling the synthesis of Furandicarboxylic acid and mono ethylene-glycol in a single novel TER reactor, with relevant process intensification. Amongst the elements of innovation there are: (1) operation at higher temperature and pressure than «conventional» electrochemical devices for chemical manufacturing; (2) the use of noble-metal-free electrocatalysts; (3) the use of novel 3D-type electrodes to increase productivity; (4) the use of electrode with modulated activity; (5) and the possibility to use an external bias (from unused renewable electrical energy) to enhance flexibility of operations.
In addition to scaling up the reactor and testing under environmentally-relevant conditions, TERRA will address the critical elements necessary to pass from lab-scale experimentation to industrial prototype with intensified productivity.

This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement n° 677471

www.terraproject.it

SPIRE 6 - 2015

Energy and resource management systems for improved efficiency in the process industries

EPOS
SYMBIOSIS IN INDUSTRY

Enhanced energy and resource Efficiency and Performance in process industry Operations via onsite and cross-sectorial Symbiosis

the AIM

EPOS brings together five global process industries from five key relevant sectors (steel, cement, chemicals, minerals and engineering) to enable cross-sectorial Industrial Symbiosis (IS) and provide a wide range of technological and organisational options for making their businesses and operations more efficient, more cost-effective, more competitive and more sustainable across process sectors.

the CONCEPT

With the aim of reinforcing the competitiveness of the European industry, it is the ambition of the EPOS partners to gain cross-sectorial knowledge and investigate cluster opportunities using an innovative Industrial Symbiosis (IS) platform to be developed and validated during the project. Its activities include (1) cross-sectorial key performance indicators; (2) sector profiles and cross-sector markets; (3) industrial symbiosis toolbox development; (4) training and validation of the industrial symbiosis management tool in five clusters strategically located throughout Europe in France, Poland, Switzerland and the UK. An entire work package is dedicated to define realistic business scenarios for the exploitation of the EPOS tool and the results of the overall cost-reducing industrial symbiosis cluster activities to ensure a wide uptake of IS concepts. The project will undertake extensive outreach activities.

This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement n° 679386. This work was supported by the Swiss State Secretariat for Education, Research and Innovation (SERI) under contract number 15.0217

www.spire2030.eu/epos

Total resource and energy efficiency management system for process industries

the AIM

MAESTRI aims to provide a resource and energy management system in the form of a flexible and scalable platform to promote and simplify the implementation of an innovative approach: the Total Efficiency Framework. Based on a holistic approach, which combines different assessment methods and tools, the Framework generates improvement on a continuous basis and increases eco-competitiveness by fostering sustainability in routine operations.

the CONCEPT

The Total Efficiency Framework will encourage a culture of improvement within process industries by assisting decision-making processes, supporting the development of improvement strategies and helping define the priorities to improve the company's environmental and economic performance. The Framework's development and validation will be achieved through application in four real industrial settings across a variety of activity sectors. It will be based on four main pillars: (1) an effective management system targeted at process and continuous improvement; (2) efficiency assessment tools to define improvement and optimisation strategies and support decision-making processes; (3) integration with a toolkit for Industrial Symbiosis focusing on material and energy exchange between plants and operations; (4) a software platform, based on the Internet of Things, to simplify the concept implementation and ensure an integrated control of the improvement process.

This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement n° 680570

www.maestri-spire.eu

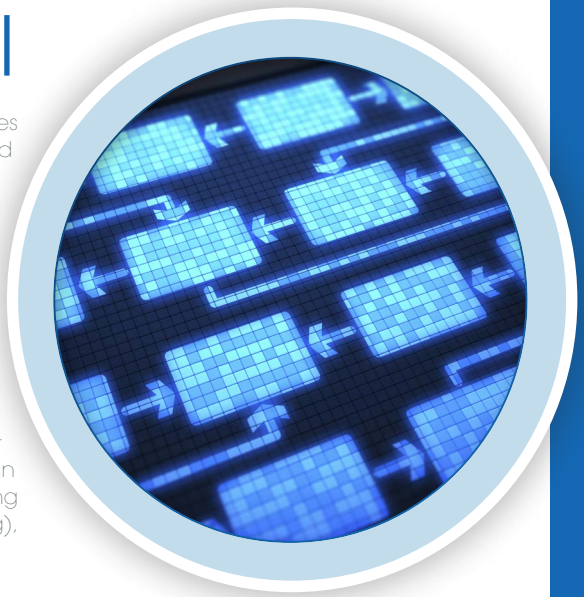
Secure Management Platform for Shared Process Resources

the AIM

SHAREBOX will develop a secure platform for the flexible management of shared process resources that will provide plant operations and production managers with the robust and reliable information that they need in real-time to effectively and confidently share resources (plant, energy, water, residues, and recycled materials) with other companies in an optimum symbiotic eco-system. The project has the potential to act as a major catalyst to enable wide-scale industrial symbiosis (IS).

the CONCEPT

SHAREBOX centres on the identification of new symbiotic synergies through optimised connections among companies and organisations in established symbiotic relationships. In order to overcome the limitations in current Industrial Symbiosis delivery and the Information and Communication Technology (ICT) tools for its facilitation, a number of key innovations are being brought to the SHAREBOX development. These will yield a world first ICT platform technology that holds the potential to be a major catalyst for increased IS among process industries and for enabling cross-sectoral interactions. This secure platform will integrate analysis and optimisation tools for flexible energy use and material flow integration to enable a holistic approach for resource management, suitable both for small and large scale operations. The final goal is to deliver an affordable, robust and reliable software, based on data mining and mathematical tools (game theory, agent-based modelling), and validated in real industrial environments.



This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement n° 680843

www.sharebox-project.eu

Human-mimetic approach to the integrated monitoring, management and optimization of a symbiotic cluster of smart production units

the AIM

SYMBIOPTIMA aims to improve industrial resource and energy efficiency by: (1) developing a cross-sectorial energy & resource management platform for intra- and inter-cluster material streams; (2) developing extensive, multi-disciplinary, modular and "plug&play" monitoring of all relevant cluster information flows; (3) integrating all thermal energy sources, flows and sinks of a cluster into a systemic unified vision; and (4) considering disruptive increase of cross-sectorial re-use of materials particularly impacting on current waste material streams.

the CONCEPT

The project proposes a completely new paradigm for industrial clusters: the human-mimetic symbiosis. Drawing inspiration from the complexity of the human body, it promotes the mutual interaction of diverse industries, and different sectors, for beneficial reuse of flows (such as water, waste, by-products, energy or recycled materials) that could result in more resource-efficient production at the network level, and reduced environmental impact. Synergy and optimisation of the flows in a cluster are obtained thanks to the hierarchical decentralisation of operations management tasks to multiple collaborating Production Units, integrating at inter-plant and cross-sectorial level the monitoring and supervision systems and sharing optimisation of their overall activities.

This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement n° 680426

www.symbioptima.eu

SPIRE 7 - 2015

Recovery technologies for metals and other minerals

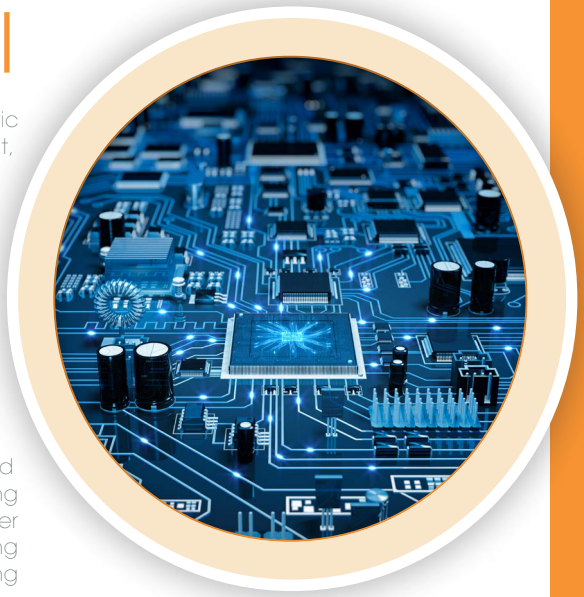
Next generation urban mining - Automated disassembly, separation and recovery of valuable materials from electronic equipment

the AIM

A number of raw materials are critical to the manufacture of high level industrial products. In particular, electronic equipment contains precious metals and other strategic raw materials often sourced outside Europe. Today, certain critical elements cannot be recovered efficiently or are, in fact, lost in dust or residual fractions. The ADIR project will demonstrate the feasibility of a key technology for next generation urban mining. An automated disassembly of electronic equipment will be developed to separate and recover these valuable materials and help secure their supply in Europe.

the CONCEPT

The project concept is based on image processing, robotic handling, pulsed power technology, 3D laser measurement, real-time laser identification of materials, laser processing (to access components, to selectively desolder these, and to cut off parts of the printed circuit board), and automatic separation of components into different sorting fractions. A machine concept will be developed that is capable of selectively disassembling printed circuit boards and mobile phones in short cycle times to gain sorting fractions containing high amounts of valuable materials. For example, this will include materials with high economic importance and that have significant supply risk such as tantalum, rare earth elements, germanium, cobalt, palladium, gallium and tungsten. A demonstrator unit will be developed and evaluated in field tests at a recycling company. The sorting fractions obtained will be evaluated with respect to their further processing and recovery potential for raw materials. Refining companies will define the requirements and test the processing of sorting fractions with specific material enrichments.



This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement n° 680449

www.adir.eu

Integrated high temperature electrolysis and Ion Liquid Extraction for a strong and independent European Rare Earth Elements Supply Chain

the AIM

REE4EU will realise a breakthrough in securing the availability of rare earth elements in Europe, providing a cost effective and efficient method of extraction and direct Rare Earth Alloys (REA) production from abundantly available in-process and end-of-life rare earth-containing waste streams. REE4EU will also collate and provide urgently required market data on end-of-life rare earth availability. Rare earth elements are vital components for ICT and renewable energy technologies.

the CONCEPT

REE4EU will prove technical and economic viability for recycling of in-process permanent magnet waste, as well as end-of-life permanent magnets and NiMH battery waste. The targeted integrated solution is based on recently developed lab-proven technologies for direct high temperature electrolysis of REA production. This will be combined in the pilot stages with an innovative and proven Ionic Liquid Extraction or tailored hydrometallurgical pre-treatment to demonstrate dramatic improvements in cost and environmental performance compared to current state-of-the-art technologies. This includes avoidance of process steps, 50% energy savings, and 100% recycling of reagents as opposed to disposal of strong acid leaching agents in state of the art pre-treatment steps. REE4EU will also develop a triple value-chain business case for a new European secondary rare earth alloys production sector. This will create new jobs, increase Europe's independence from imports and provide valuable raw materials for fast growing European green-technology industries including electrical/hybrid vehicles and wind turbines.

This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement n° 680507

www.ree4eu.eu

Remaghic

New Recovery Processes to produce Rare Earth -Magnesium Alloys of High Performance and Low Cost

the AIM

REMAGHIC will contribute to Europe's rare earth recovery and magnesium recycling technologies, improving the efficiencies of these processes and advancing their technology readiness levels to enable a new generation of industrial processes that will produce new low cost competitive alloys for a wide variety of sectors across Europe's manufacturing value chain. The project's main motivation relates to the fact that magnesium alloys can offer a significant weight reduction across a wide range of applications when compared to current aluminium alloys.

the CONCEPT

Weight reduction is a cross sectorial key driver for design. If the material's superior energy absorption and vibratory behaviour is added, magnesium is a very promising candidate for future applications subject to improved material characteristics, such as its cost, manufacturability problems, corrosion and creep behaviour and low allowable service temperature. However, addition of Rare Earth Elements (REE) improves the performance of Mg alloys significantly. REMAGHIC believes that by investing in recovery and recycling technologies, a new alloying process can be developed to yield low cost Mg+REE alloys. To do this, REE that are usually stockpiled (Ce, La) in favour of those REEs in most demand (Nd, Dy) can be considered as attractive candidates to lower the price. This list of REE will be completed by other promising candidates (Y, Gd, Sm). The project will help to reduce the dependency of the supply of critical elements (REE and Mg) on sources outside the EU and to solving the REE Balance Problem. REMAGHIC will help improve the penetration of magnesium alloys in important sectors including transport, energy, and biomedicine.

This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement n° 680629

www.remaghic-project.eu

SPIRE 8 - 2015

Solids handling for intensified process technology

Intensified by Design® for the intensification of processes involving solids handling

the AIM

IbD will create a holistic platform for facilitating process intensification in processes in which handling of solids is an intrinsic part, the cornerstone of which will be an intensified-by-design® (IbD) approach. Through five IbD-enabled case studies, the project will develop and upgrade methods for the handling of solids in continuous production units based, on the one hand, on the intensification of currently existing processes and, on the other hand, through completely new approaches to the processing of solids.

the CONCEPT

No comprehensive software is currently available for assisting process engineers to design solutions based on Process Intensification (PI). Therefore, the IbD Platform will be a disruptive tool for widely fostering PI beyond the scope of the IbD project itself. The Platform will have a built-in TRIZ (Theory of Inventive Problem Solving) module to assist practitioners to conceive innovative solutions which have not been created before. The IbD approach is hinged on the use of robust data about a process to 'redesign', modify, adapt and alter that process in a continuous, intensified system, and will represent a new paradigm in the intensification of processes based on statistical, analytical and risk management methodologies in the design, development and processing of high quality safe and tailored chemicals, pharmaceuticals, minerals, and ceramics, etc. under intensified processes.

This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement n° 680565

www.ibd-project.eu

EE 18 - 2015

New technologies for utilization of heat recovery in large industrial systems, considering the whole energy cycle from heat production to transformation, delivery and end use

Indus3Es

Industrial Energy and Environment Efficiency

the AIM

Large quantities of waste heat are continuously produced and rejected by many industries. Most of this waste energy, however, is of low-quality and it is not practical or economical to recover it with current technologies. Indus3Es will develop an innovative Absorption Heat Transformer specifically focused on recovery of low temperature waste heat (below 130°C). The Indus3Es System will effectively recover and revalorise almost 50% of the low temperature waste heat currently lost.

the CONCEPT

The Absorption Heat Transformer is the main technology of the project. The single effect heat transformer technology is effectively a single effect absorption chiller working in reverse mode. Single effect heat transformers can increase the temperature of approximately 50% of the waste heat by up to 50°C (depending on the available heat sink). In contrast to the absorption chiller, in a heat transformer the absorber and evaporator operate at higher pressure than the condenser and generator. Waste heat is fed into the evaporator and generator and upgraded/revalued heat at an increased temperature level is extracted from the absorber. The Indus3Es system can make a significant impact by increasing the energy efficiency and reducing the primary energy consumption of most energetic intensive industries in Europe. The embodied energy and the environmental footprint of products and their manufacturing costs will be reduced, thereby increasing the competitiveness of European products.

This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement n° 680738

www.indus3es.eu

I-ThERM

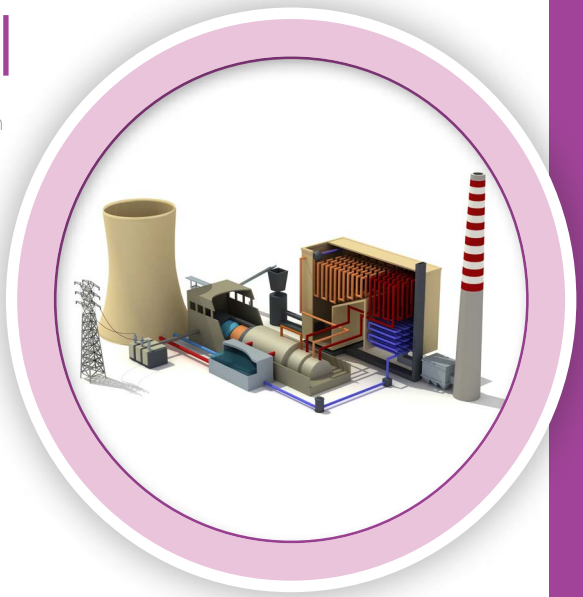
Industrial Thermal Energy Recovery Conversion and Management

the AIM

I-ThERM aims to investigate, design, build and demonstrate innovative plug and play waste heat recovery solutions to facilitate the optimum use of energy in selected applications with high replicability and energy recovery potential in the temperature range 70 °C – 1000 °C. The technologies developed will be optimally integrated with existing energy systems or configured for over the fence export of the heat recovered or electricity generated.

the CONCEPT

To benefit from the energy savings and greenhouse gas emission reductions offered by waste heat recovery it is necessary to both improve the efficiency of heat recovery equipment and reduce the installed costs. These objectives will be achieved within I-ThERM by using innovative two-phase heat transfer technologies combined with power generation using a Trilateral Flash Cycle System (TFC) for low temperature waste heat sources (70 °C to 200 °C) and a Supercritical Carbon Dioxide System (sCO2) for temperatures above 200 °C. It is projected that these technologies used alone, or in combination with heat pipe technologies, will lead to energy and emission savings well in excess of 15%, and exhibit attractive economic performance with payback periods for investment of less than three years.



This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement n° 680599

www.itherm-project.eu

Sustainable Production of Industrial Recovered Energy using energy dissipative and storage technologies

the AIM

SusPIRE works in the area of energy recovery from residual heat streams. Technology areas will include the development of materials and equipment such as the use of new Heat Transfer Fluids (HTF) and Phase Change Materials (PCM) as the basis for the manufacture of high efficiency heat exchangers in terms of energy capture and storage. Two Borehole Thermal Energy Storage areas will support an energy cascading concept where energy will be sequentially used and finally stored for further use or for commercial sale to third parties.

the CONCEPT

The SusPIRE project will establish a framework to foster the commercialisation of surplus energy. Residential areas, symbiosis with other companies in industrial parks and sports centres, amongst others, will benefit from cheaper energy, reduced environmental impact and social acceptance of energy intensive industrial activities. The coordination of manufacturing and energy recovery processes will be carried out through a smart methodology. A protocol definition software will deploy actions to create best practices in terms of process adjustment and operating instructions. Management concepts based on energy recovery rate as Key Process Indicator (KPI), will be integrated into the decision making mechanisms of companies to assure permanent advances in this field of activity in future years.

This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement n° 680169

www.suspire-h2020.eu

The Sustainable Process Industry through Resource and Energy Efficiency (SPIRE) is a contractual Public-Private Partnership (PPP) dedicated to innovation in resource and energy efficiency enabled by the process industries. The SPIRE Partnership is based on the Article 19 of the EU Research and Innovation Framework Programme, Horizon 2020, Regulation and has been established through a contractual arrangement between the European Commission and A.SPIRE aisbl. SPIRE will be implemented through competitive calls included in the Horizon 2020 work programmes. The objective of the SPIRE PPP is to develop the enabling technologies and value-chain solutions required to reach long-term sustainability for Europe in terms of global competitiveness, ecology and employment.

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SPIRE Sustainable Process Industry through Resource and Energy Efficiency