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EUROPEAN COMMISSION

Rejuvenating the European chemical sector

Sustainable chemistry as a catalyst for change

2009

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Chemical research crucial to sustainable production in many sectors

Under the broad concept of sustainable development, sustainable chemistry (or green chemistry) encompasses the design, manufacture and use of more environmentally friendly chemical products and processes. The overall idea is to produce in a more efficient and safe manner, exploiting and integrating advances in nanosciences, biotechnologies, materials technologies and new engineering concepts. The use of renewable resources as raw material is an important asset.

Research being one of the keys to industrial performance, EU chemical firms must innovate to reduce inefficiencies and improve on existing processes and products. Before the economic crisis and as a result of its research effort, the chemical industry was one of the fastest growing industrial sectors in Europe (+2.6 % in 2007). It is still the world's leading chemical producer (one third of global chemical production), a strong contributor to Europe's balance of payments, and one of Europe's main employers (1.8 million jobs in direct employment, i.e. 7 % of total manufacturing jobs). Beyond the chemical industry proper, chemical processes are a core activity for a broad spectrum of industrial sectors (pulp and paper, pharmaceuticals, plastics, textiles, etc), also involved in Europe's research efforts.

We now need to build on the successes of the last decade. The challenge to chemists and engineers is to concentrate on key priorities and above all to lower barriers to innovation through interdisciplinary approaches.

Process chemistry begins in the laboratory, but is further developed through reactor design and process engineering. Feedstock characteristics, reaction mechanisms, and downstream processing (e.g. separations) all come into play in developing new process chemistries.

Building on the achievements under FP6, some examples of which are given in this brochure, Theme 4 "Nanosciences, Nanotechnologies, Materials and New Production technologies" (NMP) of the 7th Framework Programme has been designed to effectively contribute to industrial transformation and is particularly relevant to the emergence of science-based industries. Innovation and sustainability within the chemical sector remain a high priority, a promising area of research being the convergence with nanotechnologies and biotechnologies for the production of chemical products and materials with new functionalities. Green chemistry, simultaneously targeting the development of new synthetic routes, innovative materials and their production facilities can be considered as one of the unifying concepts of the NMP programme, which has a budget of € 3.5 billion for the period 2007-2013.

Research activities to ensure a sustainable recovery

Since the onset of the economic downturn late in 2008, Europe has not been immune to the worldwide fall in capacity utilisation and its inevitable impact on employment figures. Particularly hard-hit have been the basic inorganic, petrochemical and polymer industries, for which the slump in demand from downstream markets has forced sharp reductions in output and some temporary plant closures.

However, early signs of improvement are now beginning to appear with the re-opening of some production lines. Meanwhile, long-term needs present before the crisis have not disappeared. Faced with strengthening global competition, the EU chemical industry had already undertaken restructuring and cost-saving measures in order to improve competitiveness. It also developed a highly skilled workforce, the product of strong investment in education and training over recent years. Despite current constraints on investment, this momentum needs to be maintained. Research to support the economic and environmental objectives of the Lisbon strategy is now more essential than ever to ensure a sustainable recovery.

Sustainable Chemistry as a driver

As energy consumption typically accounts for around 10 % of the industry's production costs, and rises to 40 % or more for some bulk chemicals, raising energy-efficiency is of paramount importance. An industry-wide effort enabled energy use per unit of product to be reduced by almost 40 % from 1990 to 2004, with a corresponding decline in greenhouse gas (GHG) emissions.

In many processes, the industry is approaching the practical limits of energy-saving – but technological breakthroughs could still achieve further advances to help to meet the EU's ambitious CO_2 reduction targets.

The only alternative to safer and cleaner production appears to be the route of Sustainable Chemistry which aims at using renewable raw materials as primary feedstocks, thereby reducing the dependence on fossil energy and reducing the release of greenhouse gases. It also opens a new approach of producing "more with less", by developing more flexible and adaptive chemical engineering methods.
Sustainable chemistry reconciles society and industry by protecting citizens, biodiversity and environment and paves the way to a more responsible industry.

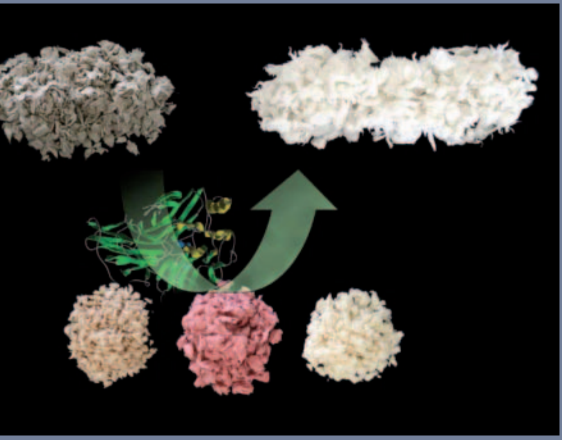
Promising results from EU projects

Because 80 % of chemicals manufacturing processes involve at least one catalyst-promoted reaction, the development of new, more effective catalysts is a highly interesting area for research. As illustrated in this brochure, biotechnology and combinatorial techniques are already delivering very promising results.

Other avenues explored in projects described over the following pages include process intensification and microreactor technology – plus a drive to unlock the potential of biomass, the world's most abundant renewable resource, as a feedstock for the synthesis of many useful chemicals currently derived from fossil fuels.

Bioengineering unlocks nature's limitless resource

The BIORENEW project is exploring bioengineering processes to derive maximum added value from the natural polymers cellulose and lignin, which are among earth's most abundant renewable materials, using enzymes as industrial biocatalysts.



Paper pulp bleaching with oxidative enzymes (fungal laccase).

Lignocellulose, the major structural component of trees and plants, is the most abundant organic material on Earth. Its complex structure is a cross-linked matrix of compounds, in which the polymers cellulose, hemicellulose and lignin are the main constituents – all of which are potential sources of a wide range of valuable end-products.

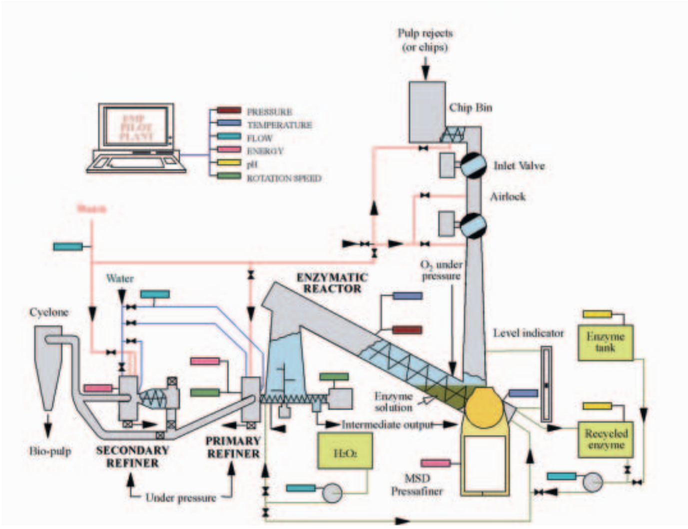
Large tonnages of cellulose are consumed as pulp for paper-making. However, this requires removal of the lignin, which is highly resistant to degradation and thus requires harsh chemical or mechanical treatment. Moreover, a huge volume of biomass 'waste' from the paper industry and other agroindustrial sectors (including second generation bioethanol) is simply disposed of by burning, despite the fact that it could make a significant contribution to the production of many organic chemicals.

Lignin, as the only naturally occurring polymer with an aromatic backbone, could become a renewable alternative to petrochemical feedstocks for the production of different aromatic compounds; while aliphatics can be derived by fermentation of sugar generated from cellulose, at the same time that this polymer can be used for the sustainable production of different materials.

In the BIORENEW project, 26 participants from 13 European countries are therefore exploring the use of bioengineered enzymes for sustainable and more environmentally acceptable production of added-value products from both lignin and cellulose.

Improving on nature

Enzymes known as oxidoreductases act as catalysts in the biosynthesis of lignin within plant cells, as well as in its biodegradation by white-rot fungi. The enzymatic machinery of related brown-rot fungi is able to degrade cellulose, but lacks the genes to attack lignin. In their natural form, these enzymes are far from optimal for use under industrial conditions, but extensive investigation



Pilot plant adapted for biomechanical pulping using enzymes.

of their structural/functional relationships has enabled the BIORENEW team to tune their catalytic and operational properties using protein engineering tools to obtain tailor-made industrial biocatalysts.

New analytical methodologies for the characterisation of the starting and bio-treated materials were specifically developed. At the same time, available microbial genomes and large collections of microbial strains were screened using high-throughput methods. As a result, a large and growing database of gene sequences has been created.

Evaluation underway

In addition to the discovery of new enzymes, already known oxidoreductases have been engineered by genetic modification or forced evolution. Application trials are continuing, with three main goals:

- increasing the strength and other properties of cellulose fibres;
- manufacturing lignin-free cellulose for high-quality products;
- producing lignin-based surfactants, adhesives and other chemicals.

Life-cycle analysis is also being conducted to evaluate the environmental feasibility of the bioprocesses and bioproducts.

The project's outcomes will strengthen Europe's position in the market for industrial biotechnology, while also helping to achieve eco-friendly transformation of its forest-paper sector, which is currently worth around €400 000 million/year.

BIORENEW • White biotechnology for added value products from renewable plant polymers: design of tailor-made bio-catalysts and new industrial bioprocesses
Total cost | **€14 364 070**
EC contribution | **€9 500 000**
Project duration | **October 2006-September 2010 (48 months)**
Coordinator | **Prof. Ángel T. Martínez, Consejo Superior de Investigaciones Científicas, Spain**
More information | **www.biorenew.org**

Added-value products from biomass

Legislation such as Europe's Biocidal Products Directive is eliminating the use of toxic and environmentally undesirable chemicals for wood preservation, wood based panels and composite production. The SME-led Integrated Project ECOBINDERS developed sustainable new processes and products employing alternative biomass-based materials.

Biomass-based resins produced from agricultural wastes.

The goal of ECOBINDERS was to introduce novel technologies allowing the sourcing and production of natural binders based on lignin and furan resins derived from biomass, for use in Europe's SME-intensive wood products sector.

From research to innovation

A consortium including 15 European SMEs conducted studies ranging from extraction of the raw materials, through application-oriented chemical modification, to the demonstration of commercially viable end-products.

The partners researched the production of furfural – the base material for furan resins – from wood pulping by-products and chestnut residues (crops that are readily available in Scandinavia and Central Europe). They also developed a method to recover lignin from sulphur-free pulping black liquor and chestnut cellulignin.

A subsequent step was the development of chemically modified lignins with improved binding properties and processability. Variants with adjusted softening points, molecular weights and reactivity showed potential as extenders for phenolic resins, or as binders in thermoplastic and thermosetting wood composites. They are now available on an industrial scale.

Further work within the project extended the range of thermosetting furan resin binders, which are suitable as wood modifiers, or as binders for wood panels and injection-mouldable compounds.

Environmental advantage

Modification of solid wood with furfuryl alcohol or furan prepolymers improves its durability for outdoor and water-contact applications, offering a renewable

Bio-modification of soft wood species to obtain sustainable, durable high quality wood.

alternative to undesirable chemical treatments. It also improves the properties of local European species, making them competitive with tropical woods, the mass exploitation of which is considered to be ecologically and environmentally unacceptable. Demonstrators of the technology included utility poles, cladding, flooring and decking, garden furniture and window frames.

A technique to impregnate and compress wood veneers into plywood for exterior use was also developed. In addition, fire-resistant doors and wall panels, constructed from laminates of wood veneers and cork layers bonded with special furan resins, were realised at industrial scale.

A third activity was the development of natural thermoplastic and thermosetting binders suited for injection moulding or extrusion processing. Earlier wood/polymer composites (WPC) incorporating thermoplastic binders such as polypropylene or pvc had previously gained significant markets, mainly for decking applications, but suffer from durability problems. To address this issue, ECOBINDERS combined furan-modified wood fibres with a binder obtained by specific esterification of lignin. Samples produced on lab scale showed comparable mechanical properties to conventional WPCs, together with a significantly improved resistance to decay.

A special design study produced a new injectable version of the traditional roof shingles used in Alpine regions. These were not only more weather-resistant and cheaper to manufacture, but also easier to install. Based on forest waste, the tiles can be produced in various colours and textures.

ECOBINDERS • Furan and lignin based resins as eco-friendly and sustainable solutions for durable wood, panel and board, and design products
Total cost | **€10 770 375**
EC contribution | **€6 112 000**
Project duration | **July 2005-June 2008 (36 months)**
Coordinator | **Dr. Wim Van Rhijn, Transfurans Chemicals bvba, Belgium**
More information | **www.ecobinders.net**

Micro-systems maximise production efficiency

The use of miniaturised devices has been shown to improve the productivity, selectivity and energy-efficiency of chemicals production in the laboratory. Integrated Project IMPULSE demonstrated the technological and economic feasibility of applying this approach to manufacture on an industrial scale.

Pilot-scale internally parallelised micromixer (IMM – Germany). Tested at P&G.

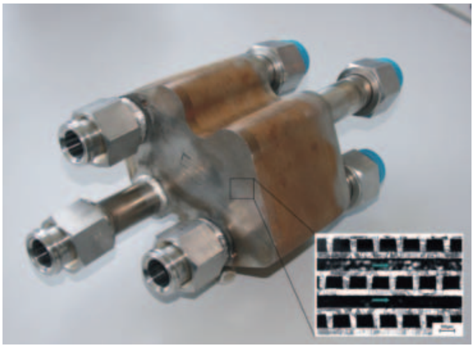
The massive growth of microelectronics and the subsequent emergence of micro-electro-mechanical systems (MEMS) have brought dramatic performance improvements and cost reduction to a host of everyday applications, from communications to medical equipment and automotive engine control. Today, for example, complete laboratory-on-a-chip devices incorporating sensors and flow control devices are used to automate a variety of biomedical assays.

In IMPULSE, seven industrial partners and 11 research institutes representing eight EU countries sought ways to achieve similar benefits in the production of chemicals at commercially viable levels. Their approach combined two essential concepts: intensification – producing more with less energy, less solvent, reduced transport and lower inventories; and miniaturisation – using series of micro-channels to deliver reaction conditions with higher efficiency and greater precision at scaleable volumes.

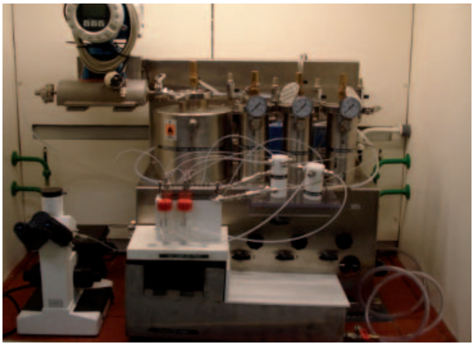
Practical approach

The project concentrated on three principal sectors: pharmaceuticals, specialty chemicals and consumer products. Because intensification or miniaturisation of entire process systems is seen to be unrealistic and economically prohibitive, effort focused on local intensification by the incorporation of arrays of equipment such as microreactors, compact heat exchangers, thin-film devices and other micro- and meso-structured components running in parallel in those parts of existing plants where they can produce the greatest benefit.

This entailed addressing whole processes, including integration, connectivity and operability issues. To ensure industrial acceptability, the research also embraced the validation of appropriate business arguments, including critical analysis of the advantages and disadvantages of the technologies from economic, safety, and environmental perspectives.



Pilot-scale highly parallelised SO2 oxidation microchannel reactor (FZK – Germany). Tested at P&G.



Microencapsulation demonstration unit: micromixer from IMM (Germany), process developed by ETSEQ (Spain), Demo Unit built in P&G (Belgium) with additional support from ICPF (Czech Republic), a true collaboration across borders.

One interesting proposal was to locate small-scale plants closer to customers' premises, in order to accommodate on-demand production. The idea of distributing a large number of production units over Europe would not only reduce the environmental impact of transporting products, but also boost competitiveness by increasing reactivity to changing market conditions.

Solid legacy

Five demonstrator units were constructed to provide proof of principle, respectively for the production of active pharmaceutical ingredients, ionic liquids, surfactants, perfume microcapsules and liquid fabric enhancers.

A book summarising the underlying methodology is due to be published in 2010, while a new web portal at http://impulse.inpl-nancy.fr/ will include documentation, case studies and training material on aspects such as microscale phenomena, and multiscale process design.

According to coordinator Prof. Michael Matlosz (Centre National de la Recherche Scientifique, and Institut National Polytechnique de Lorraine, Nancy France), industrial confidence in the results was such that several aspects of the work are actively being carried forward in a number of new initiatives, notably including the FP7 project F3 FACTORY.

IMPULSE • Integrated multiscale process units with locally structured elements
Total cost | **€17 115 820**
EC contribution | **€10 500 000**
Project duration | **February 2005-January 2009 (48 months)**
Coordinator | **Prof. Michael Matlosz, Centre National de la Recherche Scientifique, France**
More information | **http://impulse.inpl-nancy.fr/**

Microfluidics increase nitration yield, reduce risk

Nitration is a fundamental step in the production of chemicals ranging from pharmaceuticals and fertilizers, to polymers and explosives. As the NEPUMUC project has demonstrated, process intensification by means of microreactor technology makes it more efficient, faster and safer.

Front area of the NEPUMUC microreaction plant.

Nitrocompounds are precursors in the synthesis of a great variety of economically important chemicals. However, since nitration reactions are highly exothermic, they can pose considerable industrial hazard. Careful plant design and management are required to avoid uncontrollable temperature increases that may cause significant damage. Consequently, less effective nitration agents are often used to reduce the risk.

In NEPUMUC, eight participants from six countries explored the potential of microreaction technology to increase yields and improve safety in process systems that could be scaled up to produce commercially viable volumes.

The large surface-to-volume ratio of microreactors gives them far better heat exchange characteristics than can be realised in large-scale plants. In addition, selectivity is improved, and unwanted side reactions can be suppressed as a result of improved heat and mass transport. The challenge lies in establishing how they can best be deployed and integrated with the other stages to provide sufficient throughput in a complete production line.

Multi-purpose system

NEPUMUC focused on the nitration of substituted aromatic compounds and alcohols, but aimed to show how the technology might be applied in a flexible multi-purpose manner to meet a wide variety of industrial needs.

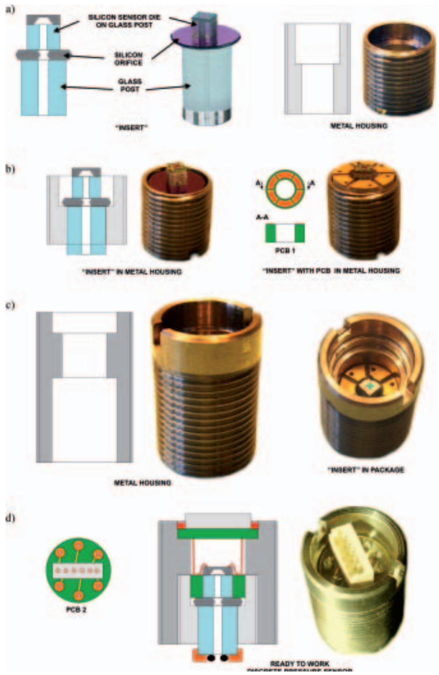
The partners began by simulating and modelling the entire nitration process and its core component, a microfluidic reactor. Laboratory experiments were conducted to ascertain whether worthwhile increases in yield and selectivity could be achieved for the selected nitration processes, and to obtain feedback for refinement of the modelling.

It quickly became evident that the desired results could not be achieved using standard microfluidic components.

Special glass microreactors were therefore constructed to withstand the aggressive reaction conditions. The final version, comprising up to 14 layers bonded together to form a complex three-dimensional network of micro-channels, is believed to be one of the most complex of its kind ever fabricated.

To ensure stable and safe processing, a new pressure/temperature microsensor platform was also designed, providing accurate process monitoring and control of the microreactor in real-time, with easy parameter change to accommodate different types of reaction.

Finally, an automation system interacting with the sensors and macroscopic actuators such as pumps and heating/cooling devices was developed, to make operation comparable to that of conventional industrial processes.



Step-by-step assembling of microfabricated pressure sensor.

Whole process considered

A thorough evaluation investigated not only the technical and economic benefits, but also the potential limitations of the microreaction strategy. For this purpose, the entire chemical process was considered, including the microreactor itself and all the subsequent downstream steps.

The considerable technological advances made during the project have encouraged the continuation of work on most of its aspects. Among other outcomes, a pilot plant built at Fraunhofer ICT in Germany is now producing liquid explosives at a rate of several kg/h.

NEPUMUC • New eco-efficient industrial process using microstructured unit components – safe and environmental friendly production of sensitive compounds ensured by process intensification
Total cost | **€1 799 731**
EC contribution | **€1 000 000**
Project duration | **May 2005-July 2008 (39 months)**
Coordinator | **Dr Stefan Loebbecke, Fraunhofer ICT, Germany**
More information | **www.nepumuc.info**

Dye makers turn green

Historically, the dyeing industry has used materials and processes that are environmentally unsound and often hazardous to human health. SOPHIED project researched biotechnological methods for safer dye production and the cleaning of wastewater effluents.

SOPHIED ecocolorants.

Azo (nitrogen-containing) compounds form the largest group of dyes in terms of both production tonnage and the number of different structures. Yet studies show that these and the widely-used cationic dyes are among the most toxic, and sometimes mutagenic, substances of their kind.

Moreover, their chemical synthesis and the dyeing process itself are environmentally undesirable. In the dyeing of fibres, some 10-40 % of the dyes are not consumed on the substrate but find their way into wastewaters, where they constitute a considerable risk to living organisms.

In an effort to solve these problems and contribute to a sustainable future for Europe's colour industry, the SOPHIED project assembled a consortium of 16 SMEs and 10 universities to pursue three parallel objectives:

- development of new processes for the safe production of dyes for use in the textiles, cosmetics and leather sectors;
- creation of new molecules that are less toxic and can be synthesised through 'white biotechnology' for high-added-value markets; and
- discovery of new bioremediation technology to detoxify coloured wastewaters.

Following an analysis of industry's needs, screening of fungal species from a number of world locations was undertaken to identify candidate microorganisms producing enzymes suitable for both dye production and waste treatment.

Lower cost colorants

For dye biosynthesis, examination of hundreds of samples eventually led to the selection of 10 precursors and five enzymes. Comparison whole-cell processes and enzymatic bioconversions showed the latter to be generally more efficient and easier to handle. Some also led to improved extraction of coloured plant extracts (natural dyes), allowing complete removal of a mutagenic compound.

Technical enzymes used in textile industries.

Whereas chemical synthesis of azo dyes involves elevated temperatures and dangerous chemicals, enzymatic synthesis is achieved at ambient temperature, under mild conditions. Low-cost fermentation processes for enzyme production were established and scaled up to pilot volumes, mainly using recovered industrial waste as a source of nutrients for the microorganisms. Using these enzymes, ecocolorants biosynthesis was upscaled into a pilot facility designed by the engineers of the project. In order to provide a "proof of concept", ecocolorants were used to dyes items such as t-shirts, jewels, puppies, leather bags…

Effluent clean-up

To reduce the toxicity of coloured effluents, whole-cell processes using free or immobilised mycelium were studied on 11 strains, including bacteria, aquatic fungi and white rot fungi. In this case, comparison with enzymatic processes showed the whole cells to be generally more efficient, mainly due to the instability of some enzymes in harsh effluent conditions. The selected fungal strains achieved a 70 % toxicity reduction, and up to 90 % decolouration.

A group of the partners carried out extensive testing to assess the industrial quality of the dyes on fibres and leather, and to evaluate the potential impacts of the products and processes on health and environment. Methods introduced to reduce testing time, sample amounts and costs also included new alternatives to animal testing.

Finally, "life cycle assessment" of both bioprocesses showed promising to participate in reducing the impact of the colour industry on the environment.

SOPHIED • Novel sustainable bioprocesses for European colour industries
Total cost | **€9 720 821**
EC contribution | **€6 258 000**
Project duration | **July 2004-September 2008 (51 months)**
Coordinator | **Dr. Sophie Vanhulle, Université catholique de Louvain, Belgium**
More information | **www.sophied.net/**

Combinatorial approach accelerates catalyst discovery

In an extended search for more cost-effective and sustainable chemical synthesis routes, the TOPCOMBI project has devised high-throughput and miniaturisation methodologies that are accelerating the discovery of new catalysts and alternative processes.

Prototype of a 16-fold parallel reactor designed at CNRS-IRCELYON and commercialised at Amtec GmbH as "Switch 16".

Catalysis plays a part in over 80 % of today's chemicals production. With new, more effective catalysts, processes can be made safer, cheaper and more energy-efficient, with higher yields and reduced environmental impact. However, because the experimental space to be explored in chemical R&D is immense, identifying suitable candidates can be extremely time-consuming.

TOPCOMBI, a large Integrated Project with 22 industrial and academic partners from 11 European countries, employs 'combinatorial discovery' to accelerate the development of alternative synthesis routes. In particular, it is using high throughput and miniaturisation methodologies to screen catalysts and process conditions for key chemicals manufacturing processes.

Main targets, seen as posing significant challenges in catalysis and chemical engineering, are:

- new ways to convert light alkanes (methane, ethane…) into valuable chemicals or transportable feedstocks;
- cleaner, safer and cheaper bulk chemical processing, using eco-efficient catalysts and avoiding hazardous steps or extensive solvent use – e.g. NOx abatement in nitric acid plants, and replacement of toxic phosgene in the synthesis of polycarbonates, isocyanates and polyurethanes; and
- processes for green chemical synthesis of high-added-value products from bio-feedstocks such as glycerol.

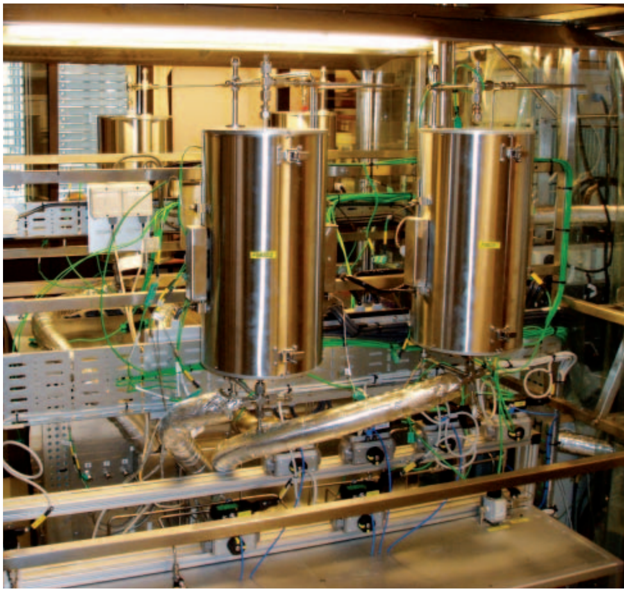
Complete toolbox

A common strategy adopted by the partners is enabling innovative findings to pass more rapidly from the laboratory, via pilot scale, to process implementation – reducing time-to-market by up to 50 %. This entailed the initial construction of a complete high-throughput toolbox, including innovative micro-engineered equipment, new robotics, appropriate computational aids, databases, optimisation algorithms and an e-infrastructure.

Advances included the development and clustering of high-throughput material synthesis and screening tools, plus the use of micro- and parallel reactors to progress from lab to mini-pilot scale. Harmonisation of the e-languages and e-infrastructures employed also allowed the creation of a common platform for data management, modelling and reaction studies.

Early successes

After four years of intense R&D activity, an impressive number of breakthrough catalytic systems have been discovered, demonstrating greatly reduced lab-to-pilot-to-process cycle times, with higher quality R&D, reduced environmental impact and cost. These achievements have been obtained first by developing an advanced HT toolbox, including high-tech micro-engineering, new robotics, appropriate computational tools, databases, optimisation algorithms and e-infrastructure. This toolbox has then been systematically applied by the TOPCOMBI partners to the abovementioned chemical objectives.



Parallel reactors designed for screening four catalysts per day in ammonia oxidation for nitric acid production and HCN synthesis.

The organisation for the second time of the "EURO-COMBICAT" conference this year in Gandia, Spain, April 26-29, 2009 by the consortium (www.eurocombicat.org) can also be seen as an indicator of the good health of the project, which now begins its last year of activity, dedicated mainly to finalize the main discoveries (in term of potential exploitation) and disseminate all the public parts of its abundant production.

TOPCOMBI • Towards optimised chemical processes and new materials discovery by combinatorial science
Total cost | **€22 753 339**
EC contribution | **€11 500 000**
Project duration | **March 2005-February 2010 (60 months)**
Coordinator | **Claude Mirodatos, Centre National de la Recherche Scientifique, France**
More information | **www.topcombi.org/**

New support mechanisms

Within the Seventh Framework Programme (FP7), which runs until 2013, the EU has introduced a number of new measures to combine public and private funding of research, development and innovation.

Under the umbrella of the European Economic Recovery Plan, the launching in 2009 of the three public – private partnerships (PPPs) aimed at supporting sectors severely hit by the current crisis represents a real opportunity for innovation in the chemical sector. The sector is an important actor in developing breakthroughs in the use of renewable and non-polluting energy sources as well as for providing energy-efficient materials for the construction sector and delivering components to be used in electric cars.

The Energy-efficient Buildings PPP will devote € 1 billion of public-private funding to the development of energy-efficient systems and materials for new and renovated buildings with a view to reducing their energy use and CO_2 emissions.

There is as well an increasing demand for greener, more customized and higher quality products. The € 1.2 billion Factories of the Future PPP will help European industry to meet these needs by converting to a demand-driven industry with lower waste generation and energy use. Electrochemical storage for electric vehicles will be developed in the Green Cars PPP, with € 1 billion for research activities.

As a leading partner in the cross-thematic calls of the three PPPs, the NMP programme is directly involved in the development of these novel initiatives.

Coordination of EU Member States' research in the field of chemical sciences will continue to receive support under FP7 through an ERANET on applied catalysis, which is of paramount importance for developing greener pathways in synthesis. Maintaining strong position in catalytic technologies is essential for Europe's continued success in global markets.

Strength through integration

Enhancing the competitiveness of the chemicals sector requires a transformation from resource-intensive modes of operation to knowledge-intensive activities that deliver high-added-value products and services to meet the customer's growing expectations. At the same time, the industry must satisfy the Community's high standards of environmental care and social responsibility. Given the important challenges ahead of us and the extremely broad spread of topics to be addressed, it is clear that collaborative projects at EU level will continue to be useful to help to achieve the sustainable chemistry goals.

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J.L. Vallés, Head of Unit RTD-G2 ‘New generation of products’

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