IENICA

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The IENICA project has received a lot of publicity over the last few months, at a number of meetings and conferences. The project is receiving an increasing amount of interest and registrants from all over Europe, as far as Poland, have been added to the circulation list.

A meeting for IENICA coordinators was held at the Athens Technical University during October 1998. Items such as national reports and seminars were discussed at length. The first of the three IENICA seminars is arranged for 27-28 May 1999 in Copenhagen, Denmark. The conference will address the title 'Natural Fibres Performance Forum' and is being held jointly with the Non-food Secretariat of the Danish Ministry of Food, Agriculture and Fisheries and the Danish Centre for Plant Fibre Technology. For further details please contact s.hugo@csl.gov.uk or visit the IENICA database. Those interested in contributing to Vegetable Oils - Meeting the Needs of Industry in Rotterdam, June 1999 or Speciality Chemicals for the 21st Century in Nice, October 1999 should please contact s.hugo@csl.gov.uk in the first instance or contact your national coordinator.

National reports for the IENICA project are all underway and the overall summary report will be presented to DGXII during April 1999. This report will be an important publication nationally and for the EC as a whole, it will be the first time comprehensive information on industrial crops in Europe has been collected and presented in one document. The executive summary of each contributing country will be made available on the IENICA website: http://www.csl.gov.uk/ienica

Forthcoming Industrial Crops Events

9 - 12 Feb 1999
Symposium on Sunflower and Other Oilseed Crops in Developing Countries
Polana Hotel, Maputo, Mozambique.
Contact:Mrs Laurencine Lot,
International Sunflower Association
12 Avenue George V, 75008-Paris, France.
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Fax: + 33 1 40 69 49 41
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4 - 5 March 1999
World Sustainable Energy Day 1999
Renewable energy and energy efficiency for the EU
Stadthalle Wels, Austria
Contact: O.O. Energiesparverband
Tel: + 43 732 6584 4380
Fax: + 43 732 6584 4380
Email: esv1@esc.or.at
Internet: http://www.esv.or.at/esv/

23 - 25 March 1999
Industrial Crops and Products
Bonn, Germany.
Contact: Sarah Wilkinson
Tel: +44 (0) 1865 843691
Fax: +44 (0) 1865 843958
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Web site: http://www.elsevier.nl/locate/icp99

For comprehensive details of events see the IENICA web site: **www.csl.gov.uk/ienica**
or contact Sarah Hugo at s.hugo@csl.gov.uk

New Nonwood Pulping Process in Finland

A new nonwood pulping process has been developed in Finland. The development work has been done in Oulu by Chempolis Ltd. The new process uses formic acid as the cooking chemical. Different reeds e.g. common reed (*Phragmites* spp.), reed canary grass (*Phalaris arundinacea*), sarkanda and straws (wheat and rice) have been successfully researched in laboratory, bench and pilot scales. The Technology Development Centre of Finland has been the main financier of the project. A large part of the development has been done also as M.Sc. and PhD work in the University of Oulu. In addition CTS Engineering Ltd. has been involved in the process engineering and design.

Commercialisation of the process to industrial scale will start in 1999. The first mill is planned to be the size of a demonstration plant. This scale is suitable for replacement of high-pollution pulp mills in Asia.

Paper from Reed Canary Grass (Keräsen Kuvaamo, 1995)

Process description: The fibre line of the Chempolis process is similar to other conventional pulp processes. It starts with cooking and follows with washing, screening and bleaching stages. Main differences are in the cooking chemicals and their recovery. Cooking is operated in formic acid (HCOOH). The recovery comprises of evaporation and distillation of the acid. The regenerated acid is circulated to cooking while the dissolved solid is dried. Lignin can further be used for processing in the chemical industry or it can be burned in an ordinary power boiler.

Technological advantages: Formic acid based technology is especially suitable for high silicate consistent non-wood plants i.e. reeds and straw. In conventional alkaline methods glazing and clogging arise by the dissolution of silicon to cooking liquor. This problem has been avoided by severing liquors to environment. In the Chempolis process this fundamental problem is avoided by using acid based cooking, in which silicon remains in the pulp during the recovery of cooking chemicals. Lignin dissolves to formic acid easily while the hemicellulose content of the stock can be adjusted. By optimizing the hemicellulose content good drainage properties in the wet-end of the paper machine is achieved. Moreover acetic acid is formed during cooking, which is separated as a by-product. Dissolved lignin can be burned in an ordinary boiler and utilized as steam and electricity in the mill or alternatively sold for other purposes. Energy gained from the dissolved material is higher than in conventional technology. This is due to higher energy efficiency, chemical recovery, low heat of vaporization of formic acid, low cooking temperature and high dryness of lignin when burned.

Mature technology: The Chempolis process has been tested in a pilot-scale mill. Pulp has been cooked in batch-type cooking reactors and further washed, screened and bleached. The runnability of the stock has been tested in a Valmet high-speed pilot paper machine. The machinery of the fibre line and recovery can be implemented with ordinary technology.

Quality of pulp: The characteristics of raw material determines primarily the properties of pulp. Straw and reeds have generally short fibres, therefore they produce pulp similar to northern birch. Pulp made by the Chempolis method can be bleached to over 90 ISO brightness. It is a prominent replacement for certain hardwood species, when high standard pulp is to be used in foodstuff packages, printing and writing papers and in the surface layer of boards. The quality and runnability of the Chempolis pulp has been tested in a pilot paper machine. Reed canary grass-based fine paper test trial was successful in as high speeds as 1400 m/min.

Environment: The process is free from the utilization of sulphur or chlorine based chemicals. Thereby it is possible to avoid difficulties in the closure of mill caused by these chemicals. The process is also over self-sufficient in bio-energy production.

Investment costs: Handling of nonwood based material compared to debarking and chipping of wood is simpler and inexpensive. The recovery of cooking chemicals is obviously cheaper than in conventional technology. A closed structure of process reduces investments in water treatment. The investments in energy production are also lower. According to a rough estimate a Chempolis mill is one third cheaper than conventional pulp mill.

Operating costs: Generally nonwood is a low-cost raw material compared to wood. The chemical costs are lowered as acetic acid is generated in the process. The energy economy is enhanced by higher energy efficiency in process. Lignin is also a potential product for chemical industry. The operation costs are lower also by reduced machinery and further operation personnel.

Future: The next step in the process development will be the establishment of a demonstration mill and the selection of partners. Machinery deliverers, energy and chemical companies are considered as potential partners.

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Non-Food Markets for Crops: The Example of Biomolecules in France

Creating value through non-food uses of major crops has been a high priority ever since the regulatory context in Europe and the CAP 92 imposed mandatory setting-aside of farmland. Industrial crops offer an alternative to idling lands. A number of R&D programmes have been launched in collaboration with public bodies (INRA, CNRS) and private corporations, funded notably under the auspices of AGRICE[1]. These research programmes satisfy a very strong consumer demand, and have already achieved very promising results which have spurred advances crucial for the development of non-food markets for agricultural resources. The achievements of the R&D programmes underway must lay the groundwork for the solutions society will need tomorrow. Three major objectives have emerged:

- Establish conditions ensuring a steady reduction in the cost price of biofuels – ethanol (ETBE) and rapeseed methyl ester – while enhancing the energy efficiency, environmental compatibility and economics of these products, and marketing these biofuels as additives that can improve the quality of petrol and diesel fuels.
- Foster feasible programmes for integrated biomass production that can at term supply combined heat and power facilities.
- Consolidate and develop pathways already explored by chemical research, notably in the areas of biolubricants, surfactants, solvents and organic polymers, exploiting the tremendous progress made in plant genetics and implementing new procedures.

This third domain has already opened up promising perspectives for the development of biomolecules in France. In industrial chemicals, environmental regulations and user requirements favour ever-increasing substitution of renewable feedstocks for petrochemical products. Biomolecules could rapidly become competitive, in particular:

- synthetic products such as biodegradable surfactants, complexing agents for detergents (replacing phosphates)
- substitutes for synthetic solvents
- lubricants.

The Current Advancement of Research

Various research projects, supported in part by AGRICE (40 million francs in public subsidies in 1997) have contributed to the following goals:

- Fostering the development of agricultural products that at comparable cost price can compete with fossil-based products
- Proof-of-concept demonstrating feasibility of synthesis for these products, the specific functions and features of the products obtained, and their environmental advantages
- Ascertaining the biodegradability and compostability of agricultural products in order to build up reference tools quantifying the environmental advantages of these products in the end-of-life phase.

These projects focus primarily on:

- Production via starchification and esterification by heterogeneous catalysis of surfactants with biodegradability and dermatological tolerance characteristics that are better than those of products currently obtained, by conversion of plant molecules (fats, sugars, proteins). These are designed for use in the cosmetics industry or in oil pollution clean-up applications.
- Production of lubricants (oxypolymerised and/or insufflated rapeseed oils, synthesis of fatty acid dimers, esterified crambe oil) for two-stroke engine motor oils, drilling fluids and pollution clean-up fluids.
- Production of plastifying agents in formulation in PVCs or other additives.
- Production of formulating agents for printing inks, concrete structures, herbicides.

[1] AGRICE (Agriculture for Chemicals and Energy) is a scientific interest group created by the public authorities and eight partners in France in 1994.

Advantages and Industrial Applications

1. Surfactants The "bio" surfactants which have been developed show better performance (foaming, emulsifying properties, etc.) than their petrochemical counterparts. In addition, their natural origins make them well tolerated by human skin:

- hydrophilic head derived from by-products of starch and sugar manufacture (wheat bran and straw, beet pulp)
- hydrophobic pole made up of fatty acids from tropical oils (copra, palm oil, i.e. short chains = wetting agents, detergents) or oils grown in continental France (rapeseed, i.e. long chains = emulsifiers, foaming agents).

In France the corporations SOLIANCE with the support of agro-industrial research, HENKEL and SEPPIC are particularly dynamic in this field, and already produce several thousand tonnes annually, principally for cosmetics. As the manufacturing processes are optimised, lower production costs should allow this market to expand into mass applications such as the formulation of household detergents or herbicides.

The European market for surfactants is globally estimated at 1,400,000 t/yr (source ONIDOL, 1998).

2. *Lubricants.* The biodegradability and ecotoxicological innocuousness of lubricants derived from vegetable oils should allow these products to be launched in markets for two-stroke engine motor oils, non-recovered oils or drilling fluids. Vegetable oils have an undeniable advantage for applications in which spent oils are not collected, and several European countries have adopted measures recognising this. Furthermore, many corporations are well aware of the need for preferential regulations for non-toxic oils, and are taking steps to gradually replace fossil-based products.

- NOVANCE uses 1 thousand tonnes of continentally grown vegetable oil in its biolubricant production.
- MOBIL is preparing to set up a clean lubricants production line (an AGRICE programme).
- SNCF (French railways) in partnership with Shell and BP is perfecting lubricants for greasing railroad tracks (roughly 700 t/yr).
- The buildings and public works sector is interested in oils for construction formwork that can reduce worksite pollution and job-related illnesses (6,000 tonnes of oil are applied to the inside of concrete construction casings). Formulations based on vegetable esters are now on the market for these applications (one supplier is Pieri FINA).
- The aeronautics industry has adopted vegetable-based fluids for cutting operations (smaller quantities applied, improved working conditions).
- Agro-food industries could prefer vegetable-based lubricants.

The European market for lubricants is globally estimated at 5,300,000 t/yr (source ONIDOL, 1998).

3. *Plastifying agents.* Several families of additives derived from vegetable oils can be used in the formulation of plastic materials. These additives are generally basic fatty chemical products (esters, amines, amides) or derivatives thereof. The main functional requirements are lubrication, antistatic and stabilising properties.

- **Lubricants** improve the plastic properties of PVCs, and can be external (stearic acid, for example) or internal (erucamides, for instance).
- **Antistatic agents** are essentially cationic or non-ionic derivatives of fatty acids. The European market for plastifying agents is globally estimated at 200,000 t/yr (source ONIDOL, 1998).
- **Stabilisers.**

4. *Various formulating agents.* In the paints and coatings industry polyesters obtained by polycondensation of fatty acids and polyols form alkyd resins: reticulated films with a range of drying times. The future derivatives of these resins are very quick-drying urethane alkyds.
NOVANCE uses several thousand tonnes of vegetable oils in its paints division.

In ink manufacture oxidability of vegetable oils could be exploited for the de-inking and recycling of short-life-cycle papers.
The BELAVOID and COATES LORILLEUX companies are currently readying new formulations of this kind. Biomolecules derived from vegetable oils can also be used in the formulation of heavy solvents present in plant protection products (the Phytorob line manufactured by ROBBE) and even as concentrated active media (Actirob B). Significant research has been carried out in this field.
ONIDOL supports a programme studying the fate in soil of vegetable oils used as solvents in plant protection formulations. The company aims to define a specifications standard that guarantees both product performance and protection of the environment. Other market outlets for biomolecules exist in rubber, nylon and other textile industries.

Conclusion
Significant research resources must be deployed and long-term projects conducted in order to secure these new outlets for agricultural products in energy, chemicals and materials markets. Above all they require strengthened co-ordination between actors ranging from pluridisciplinary research teams to agro-food industry to end users (chemical and materials companies) who face major challenges such as mitigation of the greenhouse effect.

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