Unclassified **ENV/JM/MONO(99)19/PART3**

Organisation de Coopération et de Développement Economiques
Organisation for Economic Co-operation and Development

OLIS : 09-Sep-1999
Dist. : 13-Sep-1999

English text only

ENVIRONMENT DIRECTORATE
JOINT MEETING OF THE CHEMICALS COMMITTEE AND THE WORKING PARTY ON CHEMICALS

ENV/JM/MONO(99)19/PART3
Unclassified

Series on Risk Management No. 10

PROCEEDINGS OF THE OECD WORKSHOP ON SUSTAINABLE CHEMISTRY PART3

Venice, 15 - 17 October, 1998

English text only

81257

Document complet disponible sur OLIS dans son format d'origine
Complete document available on OLIS in its original format

The "Simple Chemistry" Program for Sustainable Chemistry

Akira Kanai
Japan Chemical Innovation Institute (JCII)

History

In 1994, the Japan Chemical Engineers Society (JCES) started a study of breakthrough technologies to maximize energy- and resource-saving processes by cooperating industry and academia.

Based on the proposals of JCES, in 1995 the government, MITI, started the "Simple Chemistry" program, which aims to introduce an innovative concept for the future chemical industry by simplifying the production processes.

Research teams composed of a national institute, universities and private chemical companies have been promoting the above mentioned projects through governmental budget support.

Concepts

Innovative process R&D project for the future chemical industry: simplifying production processes through maximizing energy and resource-saving and minimizing emissions

Specific programs

1) Development of highly selective chemical reaction

   Catalytic conversion of naphtha to lower olefin. R&D of catalyst to produce ethylene and propylene in high yield by catalytic conversion of naphtha.

2) Novel catalysts and chemical reaction processes for the selective oxidation of light alkanes. R&D of selective oxidation catalyst to produce acrylic acid from propane, maleic anhydride from n-butane and methacrylic acid from isobutane. Development of continuous process of synthesis and separation.

   Simple synthetic processes using solidified catalyst.

   R&D of solidification processes of homogeneous catalysts, which will be able to get features of easy separation. Examples: solidification of homogeneous complex salt catalyst.

   Combined reaction and membrane separation process. R&D of highly active dehydrogenation catalyst, high performance hydrogen permeable membrane and the combined membrane reactor.

Example: Synthesis of styrene from ethyl benzene by removing generated hydrogen by membrane.

3) Preparatory study. In addition to the above mentioned programs, preparatory studies are going on under the study group of JCII and JCES. Several promising projects are as follows:

   - Non-halogen chemical process
   - Non-aqueous enzymatic process

   JCII will organize the research team this year, and the research of non-halogen chemical process will start next year.

Symposia

The annual review symposia of total "Simple Chemistry" programs are held every year. More than 100 persons join the symposia with hot discussions.

Development of Biodegradable Plastics

Kazuyuki Komagata (NEDO)

Introduction

Production of plastics as an essential base material in modern society has increased each year, owing to their excellent durability, weather resistance, chemical resistance, and ease of processing. Today, however, all the merits of plastics such as toughness, durability, and resistance to rust are problems when discarding waste plastics.

This project focused on biodegradable plastics that are completely decomposed to carbon and water by microorganisms existing in the environment. From the standpoint of conservation of the global environment and establishing a circulation-type recycling society, the development of biodegradable plastics has become increasingly important.

Results of the study

In this project, development was carried out over a broad range to produce biodegradable plastics, including a method using natural materials as raw materials of fermentation, a method using natural materials as direct base materials, and a chemical synthesis method using carbon dioxide, etc. as raw materials.

Broad-ranging development work was conducted in close cooperation with various research fields. As a result, a core technology was developed for producing completely biodegradable plastics that have excellent properties of conventional plastics and are degradable by microorganisms in nature. The study aimed to develop plastics having performance (physical properties) equivalent to or superior to petroleum-based plastics such as polyethylene and polystyrene which are used as general-use resins.

The study developed design guidelines for completely biodegradable base materials, a material design technology for controlling physical properties and biodegradability, and a biochemical modification technology to produce novel biodegradable base materials.

As a result, the biodegradability and performance balance characteristics of each of the microorganism production system, the polysaccharide derivative system, and the chemical synthesis system were identified, and the positioning of material technologies for each of the systems was clarified. In addition, a life-cycle assessment was performed for the first time for biodegradable plastics, and it was confirmed that biodegradable plastics can help reduce adverse effects on the global environment. To strengthen the efficiency of biodegradable plastics for solving global environmental issues, versatile technology to suit natural environmental conditions as well as versatility of the substances being biodegraded are important. Accordingly, biodegradable plastics must be compatible with the local environmental conditions. In this regard, the implication of the possibility of a new industrial technology system that is different from the system of producing plastics from single-source petrochemicals is highly significant.

LCA

The life-cycle assessment of biodegradable plastics was conducted in cooperation with the RITE System Research Laboratory. The assessment revealed that the microorganism production polyester system and the polysaccharide derivative plastics system are markedly superior to the existing petrochemical plastics system in view of carbon dioxide and energy.

For both variables, chemical synthesis polyester is almost equivalent to that of PET. However, from the standpoint of solid waste, ash and dust emissions, and dioxin generation, it is apparent that biodegradable plastics which were developed by the project were clearly superior. Further improvements will be made by switching raw materials and other means.

More than 300 Waste-Free Gas-Solid Reactions in 22 Reaction Types: The Production Techniques of Tomorrow

G. Kaupp, J. Boy, M. Haak, A. Herrmann

University of Oldenburg, Germany

---

22 Gas-Solid Reaction Types	
inclusion reactions	condensation of carbonyls
electron transfers	cycloadditions
proton transfers	cycloreversions
oxygen transfers	substitutions with RX
oxygenations	aromatic substitutions
additions of RR, NH, H_2O, ROH	cyclizations
additions of halogens and HX	methylations
eliminations	nitrations at N and C
catalyzed rearrangements	diazotations
C - C bond formations	azocouplings
Carboxylations with CO_2	Sandmeyer reactions

AFM : what does it tell for theory ?

topotactic reactions: no geometric change, no movements, no features

non-topotactic reactions: long-range molecular movements are essential (anisotropic, tens or hundreds of nm, guided by the crystal bulk)

step 1 phase rebuilding

(the original lattice becomes distorted and builds features due to molecular movements in easy ways; if molecules cannot move, there will be no reaction)

step 2 phase transformation

(the product lattice forms usually with buildup of very large features in a sudden discontinuous event)

step 3 crystal disintegration

(at and from grain boundaries; fresh surface is formed)

maximal movement, not minimal movement

Sustainable Chemistry Activities of the Environmental Chemistry and Ecotoxicology Division, Gesellschaft Deutscher Chemiker

E. Bayer, H, Behret, D. Lenoir

In 1997, the "Environmental Chemistry and Ecotoxicology" division of the Gesellschaft Deutscher Chemiker installed a working group on environmentally benign chemical synthesis and processes. The Division held a national symposium with the general theme:

Ways and Contributions of Chemistry to Sustainable Development
Heidelberg, November 3-4, 1997

More than 90 oral and poster contributions from the chemical industry and academia, and 200 participants, demonstrated the broad interest in sustainable chemistry.

Another conference on

Environment and Chemistry: Innovation and Product Design

is scheduled for September 27-30, 1998 in Karisruhe.

The working group on "environmentally benign chemical synthesis and processes" will cooperate with other divisions of the GDCh.

The poster shows the network of divisions of the German Chemical Society concerned with sustainable chemistry of the GDCh, the programs of the relevant conferences in 1997-1998, as well as the charter of the working group on "environmentally benign chemical synthesis and processes".

A survey of the technical activities and projects on sustainable chemistry will be given.

New Duroplastic Materials with Phosphorous Compounds as Flame Retardant: Fate and Behavior in Thermal Reactions

D. Lenoir, K. Kampke-Thiel, A. Kettrup

Institute of Ecological Chemistry, GSF Research Centre for Environment and Health

D-85758, Oberschließheim, Germany

As a result of the activity in the field of environmentally benign chemistry, new duroplastic materials for electronic devices have been developed. Halogen-free flame retardants based on organic nitrogen and phosphorous compounds are chemically bound in the polymeric matrix. We investigated the thermal fate of phosphonate in a laminate and a moulding compound matrix during incineration in the German VCI oven at 400, 600 and 800°C. Therefore, a balance for phosphorous related to volatile products and the amount remaining in the solid incineration residue was studied. Furthermore, some thermal degradation products of organophosphonates formed at the three incineration temperatures were identified. At 800°C, phosphonates are completely converted to P_4O_{10} while about ten different volatile organophosphorous compounds are formed at 400°C. Three main products were isolated, and their structures were elucidated. Incineration at 600°C gives mainly phosphorous oxides, besides a small amount of organophosphorous compounds. The influence of $Al(OH)_5$ as an inorganic filling material on the formation of phosphorous degradation products was evaluated, as well as the toxic potential of the incineration products.

Reference:

Isolation, Characterization, and Toxicological Aspects of Volatile Phosphorous Compounds from Combustion of Flame Retarded Epoxy Resins with Phosphonate Substructures; Chem. Eur. J. 4, 1581-1586 (1998).

New Environmentally Acceptable Methodologies for the Synthesis of *N,N'*-Disubstituted Ureas

F. Bigi, B. Frullanti, R. Maggi, G. Sartori, E. Zambonin

Dipartimento di Chimica Organica e Industriale dell'Università,
Parco Area delle Scienze 17A, 43100 Parma,Italy

The Heterogeneous Catalysis

The main part of the reactions actually performed both in labs and plants was discovered at the beginning of this century, during a period that completely ignored environmental problems. Today the situation is so different, and it is possible to state that the future of the chemical industry is strictly related to environmental protection. The gravity of the problem is easily intelligible if we consider the waste production for the synthesis of 1 Kg of product: 5-50 Kg for fine chemicals and 25-100 Kg for pharmaceuticals[1]. Solid catalysts could represent an optimal answer to this problem as they show very low environmental impact, avoiding the formation of inorganic salts, being reusable several times, being easy to handle and safe to store, and being removed simply by filtration. Furthermore, they often promote reactions in high yields and selectivities[2].

The *N,N'*-disubstituted Ureas

Substituted ureas have received considerable attention due to their wide range of applications, including use as antidiabetic and tranquillizing drugs, antioxidants in gasoline, corrosion inhibitors and herbicides[3].

The conventional methods reported for the ureas' synthesis are essentially based on phosgene and isocyanates[4], phosgene substitutes, carbonates and carbamates or carboxylic acid derivatives. However, phosgene and isocyanates are toxic and expensive to handle and the above methods are often difficult to apply.

There is thus a continuing interest in the catalytic synthesis of ureas *via* phosgene-free reactions.

The Zeolite HSZ-360

HSZ-360, a faujasitic type zeolite prepared by Tosoh Corp. for petrochemical purposes, is the catalyst utilised in this study.

Formula: $0.03Na_2O \cdot Al_2O_3 \cdot 14.5SiO_2$
Pore dimension: 7.4Å
SiO_2/Al_2O_3: 14.5
Surface area: 500±10 m^2/g
Acidity: 0.51±0.05 meq H^+/g

NUOVE METODOLOGIE ECOCOMPATIBILI PER LA SINTESI DI UREE *N,N'*-DISOSTITUITE

Franca Bigi, Bettina Frullanti, Raimondo Maggi, Giovanni Sartori, Elena Zambonin

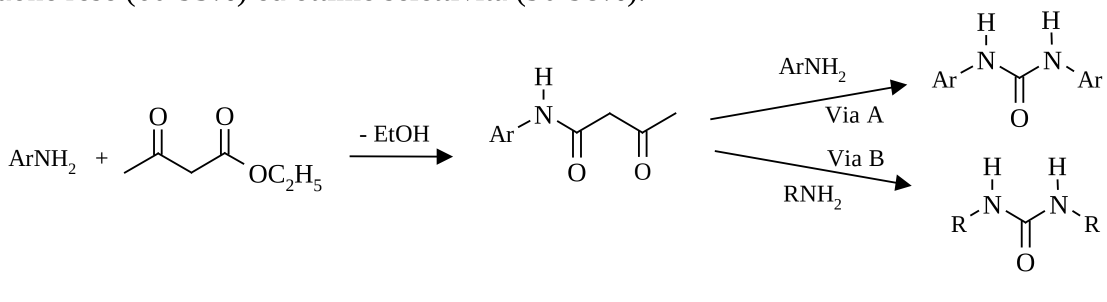
Dipartimento di Chimica Organica e Industriale dell'Università

Viale delle Scienze, 78 - 43100 PARMA - E-mail: ellesse@ipruniv.cce.unipr.it

L'utilizzo di acidi solidi quali clays e zeoliti per la preparazione di "fine chemicals" ha avuto negli ultimi anni un notevole sviluppo visto il loro basso costo, il loro possibile riciclo, il loro quasi nullo impatto ambientale ma soprattutto le elevate rese e selettività che si ottengono.[1]

Le uree *N,N'*-disostituite rappresentano una classe importante di composti utilizzati a livello industriale per la produzione di antiossidanti, erbicidi e farmaci.[2] E' noto che i processi convenzionali per la sintesi delle uree fanno essenzialmente uso di fosgene od isocianati; i nostri metodi, al contrario, utilizzando acetoacetato di etile od acetoacetanilide come agenti carbonilanti, operando in assenza di solvente e sfruttando la tecnica della precipitazione come metodo separativo, rappresentano strategie innovative ed altamente ecocompatibili per la sintesi con elevate rese e selettività di *N,N'*-difenil- e dialchiluree.

Il catalizzatore da noi utilizzato è la zeolite HSZ-360 (Tosoh Corp.) che consente l'ottenimento di difeniluree per reazione di aniline con acetoacetato di etile (via A) oppure la produzione di dialchiluree per reazione di ammine alifatiche primarie con acetoacetanilide (via B) con buone rese (60-95%) ed ottime selettività (90-98%).[4]



1. Corma, A. *Chem. Rev.* **1995**, *95*, 559; Thomas, J.M.; Zamaraev, K.I. *Angew. Chem., Int. Ed. Engl.* **1994**, *33*, 308; Sheldon, R.A. *Chem. and Ind. (London)*, **1997**, 12.

2. Vishnyakova, T.P.; Golubeva, I.A.; Glebova, E.V. *Russ. Chem. Rev. (Engl. Transl.)* **1985**, *54*, 249.

3. March, J. *Advanced Organic Chemsitry*, Wiley, New York, **1985**, 370; Knölker, H.-J.; Braxmeier, T.; Schlechtingen, G. *Angew. Chem., Int. Ed. Engl.* **1995**, *34*, 2497.

4. Bigi, F.; Maggi, R.; Sartori, G.; Zambonin, E. *J. Chem. Soc., Chem. Commun.* **1998**, 513.

Biodegradable Polymers from Activated Sludges Selected Under Aerobic Intermittent Feeding

M. Majone*, A. Martinelli, R. Ramadori+ and M. Beccari

***Department Of Chemistry, University "La Sapienza", Majone@Axrma.Uniroma1.It**
+Water Research Institute, National Research Council, Ramadori@Irsa1.Irsa.Rm.Cnr.It

PHB and its copolymers are of commercial value as thermoplastics. Processes for their production are presently in use or being investigated, based on pure cultures of particular microorganisms and on well-defined nutrient-deficient media. Consequently, selection of the microorganism and substrate can critically influence the costs (Anderson, 1990).

In activated sludge processes for wastewater treatment, the biomass grows under transient (unsteady) conditions in several plant configurations. Under such transient conditions, growth becomes unbalanced and the storage of substrates as internal polymers becomes of importance as a mechanism of response to the transient condition (Daigger, 1982; Majone, 1996). For these reasons, in the present work mixed cultures with high storage response have been selected by intermittently-fed continuous cultivation under full aerobic conditions. Storage response has been characterized by batch experiments based on maximum storage rate and maximum storage capacity. The effect of previous dilution rate and feed concentration on the storage response of the selected culture has been investigated in the range 0.3-2.6 d^{-1} and 1-15 CODg/L, respectively.

It has been shown that alternating conditions of feast and famine of external substrate were effective to select from activated sludges mixed cultures with high storage response. The selected mixed cultures presented immediate response to the acetate spike with very fast removal and the storage of it as PHB was the main metabolism occurring. Depending on experimental conditions, rate of acetate removal ranged between 600 and 1400 CODmg/CODg h while PHB storage yield ranged between 0.5 and 0.6 (usually 70-80% of the overall observed yield; moreover, the selected sludge presented high storage capacity (PHB was stored up to about 40-50% of the total dry weight).

Even though operating conditions investigated up to now cannot be directly transferred yet to industrial production of biodegradable polymers, kinetic selection of mixed cultures with high storage response seems to be a promising alternative to usual processes. As a matter of fact, specific rates (per unit of biomass) of PHB production here obtained were higher than that reported for *A. eutrophus* in fed-batch processes (Ramsay, 1990). Moreover, these mixed cultures can be produced continuously by using well-established technologies like sequencing batch reactors, thus avoiding costs of selection, maintenance and growth of axenic cultures. Use of mixed cultures also makes easier to use substrates from waste streams which are available at low cost, e.g. from acidogenic fermentation of concentrated industrial wastewaters or urban sludges. A possible flow-sheet of the process will be presented

[1] Anderson A.J. and Dawes E.A. *Microbiological Reviews*, 54 (4), 450-472, 1990.

[2] Daigger G. T. and Grady C.P.L. *Wat. Res*., 16, 365-382, 1982.

[3] Majone M., Massanisso P., Carucci A., Lindrea K. and Tandoi V. *Wat. Sci. Tech*., 34 (5-6), 223- 232, 1996.

[4] Ramsay B.A., Lomaliza K., Chavarie C., Dube' B., Bataille P. and Ramsay J.A. *Applied and Environmental Microbiology*, 56 (7), 2093-2098, 1990.

Chemicals for tomorrow

J. Ranke, B. Jastorff

Centre for Environmental Research and Environmental Technology, Dept. Bioorganic Chemistry, University of Bremen P.O. Box 330440, D-28334 Bremen, Germany, e-mail: jranke@uni-bremen.de

THESIS I

The **choice of products** is generally dictated by ease of obtainment and technological aptitude. In the case of chemical products legal compliance and public acceptance are especially sensible parameters for their sustainability. In order to assure legal compliance and public acceptance on the long term anyone participating in the choice of chemicals must rely on information about their inherent risks to the biosphere.

THESIS II

A **transfer of knowledge** from pharmazeutical and agricultural chemistry is considered to be capable of improving qualitative and quantitative understanding of Structure-Activity-Relationships SAR. The cultivation of knowledge about fate and effects of chemicals is crucial for a sustainable business process.

THESIS III

Considering the significant difficulties in conducting a scientifically sound risk assessment for a specific application emphasis has to be put on methods for **low-expenditure risk analysis** resulting in indicators representing persistence, spatial range, bioaccumulation, biological activity and data limitation.

QUESTION I

What are the **values** that we see in the surrounding biosphere? Do we want to protect it because of its functional value that can be shown or do we believe that there are inherent values that we can´t perceive through a functional perspective?

QUESTION II

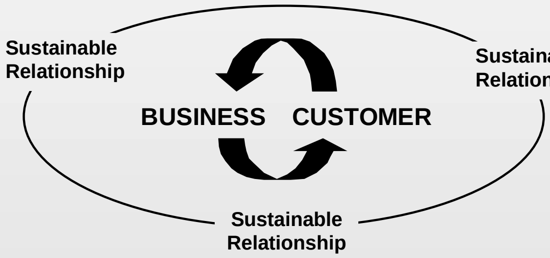
What are the consequences that result from the **complexity** of the biosphere? Since abundance of chemical receptors in biological systems and amount of relationships between the organisms make predictions of effects on the basis of deterministic models seem impossible, are there alternative concepts of evaluation?

QUESTION III

How can we overcome the **reductionist scientific approach** in the prediction of effects without sacrificing fundamental principles of science such as rationality, transparency and universal validity? Is it scientifically acceptable to support evaluations on a weak factual basis, but with high relevance?

LEGAL ENVIRONMENT

PUBLIC



BIOSPHERE

SOME THOUGHTS ON RISK INDICATORS

Persistence, defined by the global half-life of a chemical impulse, is traditionally an important argument in the evaluation of chemicals. It has to be pointed out that an estimated global half-life is far more meaningful than any half-life calculated from a degradation rate in a single environmental compound.

Spatial range as the 95%-quantile of the spatial distribution of expositions due to specific release of a chemical is a second exposure-based indicator that can be estimated by measured exposition data or by applying multi-compartment-models.

A further exposure-based indicator might be the fraction of the exposure to be found in organisms. Exact definition and development of methods for the determination of such an **organismic fraction** are yet to be carried through.

Due to the ongoing development of biological and ecological testing systems there is a large amount of often inhomogeneous data about effects of chemicals on organisms, organs, cells and cellular structures. Flexible aggregation of this data to an indicator for **biological activity** is desirable.

Data limitation is an important issue in the evaluation of ecological risks. The qualitative and quantitative limitations of available data necessary to determine the above indicators are an important measure of the uncertainty about the effects caused by the application of a chemical. Regarding ecosystem health as well as regarding human health it is true that every substance is toxic at some exposure/dose. Ignorance of the effect concentrations/doses of chemicals to be handled must be regarded as an indicator of risk.

RESEARCH AIMS

- Evaluation of performance and reliability of computer-based expert systems designed to predict fate- and effect- data
- Aggregating information from bioassays
- Case-studies for replacement chemicals
- Prediction of metabolites and analysis of their risks
- Cooperation with jurisprudence
- Considering the needs of small and medium size companies for risk analysis
- Transdisciplinary evaluation of risks

INTERDISCIPLINARY EDUCATION

- Undergraduate courses:
  „SAR of organic compounds“
  „The chemical logic of natural compounds“
- Post-graduate courses:
  „Ecotoxicology and risk assessment“

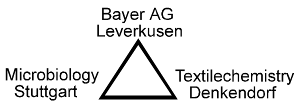
LITERATURE

Hungerbühler, K., J. Ranke and T. Mettier, 1998, Chemische Produkte und Prozesse: Grundkonzepte zum umweltorientierten Design, Springer, Berlin
Scheringer, M., 1997, Characterization of the environmental distribution behavior of organic chemicals by means of persistence and spatial range, Environmental Science & Technology, 31(10), 2891-2897
Störmann, R. and B. Jastorff, 1993, Ecological risk assessment and the regulation of chemicals: II. Exposure and hazard identification of metabolites, The Science of the Total Environment Supplement 1993, 1655-1676
Störmann, R. and B. Jastorff, Alle Dinge sind Gift - Lassen sich die Wirkungen von Umweltchemikalien prognostizieren? http://www.uni-bremen.de/campus/pressestelle/impulse/impulse-11-1991/stoerma/

Benign by Design: New Textile Auxiliaries

Paul-Gerhard Rieger and Hans-Joachim Knackmuss
Institut für Mikrobiologie, Universität Stuttgart, Allmandring 31, D-70569 Stuttgart, Germany

Tel: +49-711-6855480/88 Fax: +49-711-6855725 Email: imbpgr@po.uni-stuttgart.de, imbhjk@po.uni-stuttgart.de



Interdisciplinary project supported by the German Federal Ministry for Education, Science, Research, and Technology

History

- research interest of industry and academic institutions focussed on technical and biological processes to eliminate hazardous waste products
- these end of pipe technologies are now subject to rapid substitution as they are time consuming, expensive, and contradictory to a sustainable development
- new technologies must deliver products that meet the criteria of environmental protection
- in the field of the textile industry we still are facing waste streams with very high loads of recalcitrant organic carbon

Objective

- development of readily biodegradable textile auxiliaries

Approach

- natural biocoenoses have evolved their catabolic potential by long-term adaptation to natural compounds
- the probability is high to find catabolic activity towards products that resemble natural compounds or constitute themselves of natural building blocks
- identify natural analogs with high similarity to proven effective structures in commercial products (Fig. 1)
- implement these theoretical studies in the chemical synthesis
- generate substances with a backbone similar or closely related to natural compounds
- test biodegradability according to relevant OECD guidelines

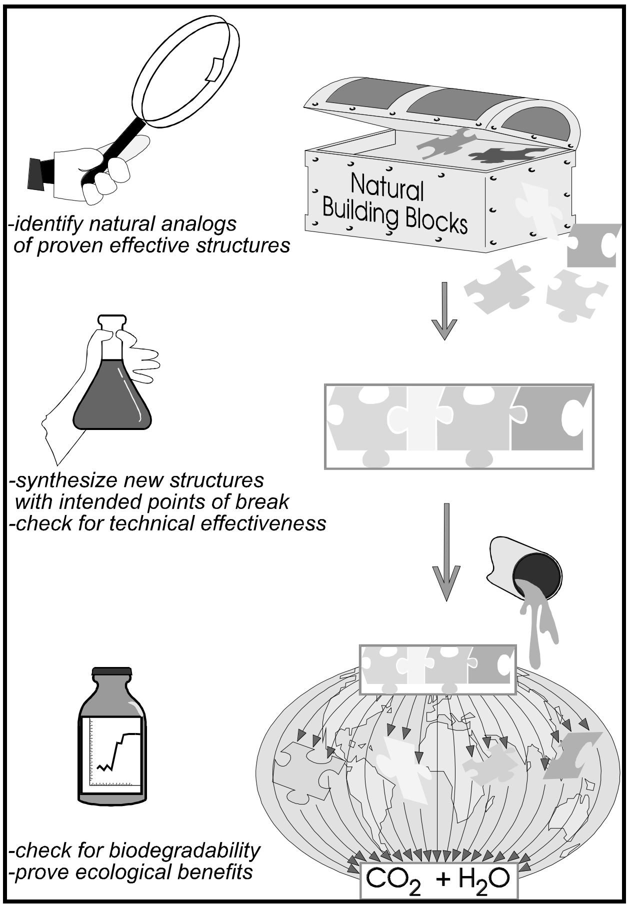
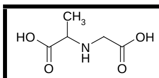
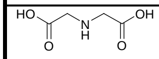
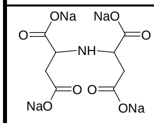
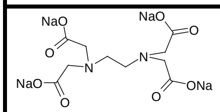


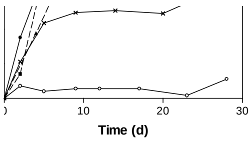
FIG. 1. Sustainable development by novel synthetic compounds

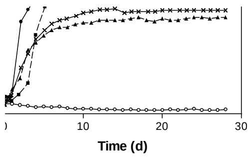
Example

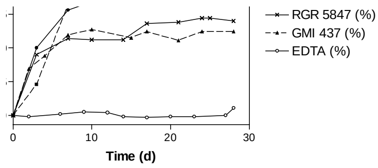
Development of an alternative to persistent sequestrants like EDTA

	RGR 5825 natural product
	RGR 5846
	RGR 5847
modified amino acid	GMI 437
	EDTA

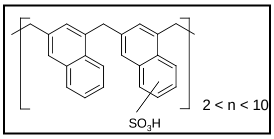
Biodegradation tests







Current investigations



Problem: Persistence of condensed naphtha-lenesulfonic acid dispersing agents.

Approach: Avoid aromatic sulfonic acids, avoid methylene bridged polyaromatics, use naturally occurring aromatic structures and combine them by hydrolyzable bonds.

To promote sustainable chemistry

- new products must be compared to old products on the overall properties and not only on the basis of technical effectiveness and current production costs.
- charge for waste water should consider persistence of the compounds. This should result in more competitive prices for new benign products.
- interdisciplinary lectures should be implemented into chemical education.
- knowledge coming from basic research must be combined with knowledge from applied sciences.
- flexible funding of both applied and basic research is needed.

Acknowledgements

We thank the German Federal Ministry for Education, Science, Research, and Technology for support under grant numbers 01RV9603, 01RV9602/8, and 01RV9604/3.

DIMETHYLCARBONATE: A REAGENT FOR ENVIRONMENTALLY BENIGN SYNTHETIC PROTOCOLS

Maurizio Selva, Pietro Tundo

Dipartimento di Scienze Ambientali dell'Università Cà Foscari

Calle Larga S. Marta 2137, 30123 – Venezia, Italy

Fax: +39 41 257 8620; e-mail: selva@unive.it

Why dimethylcarbonate?

Environmental and synthetic benefits:

- Dimethylcarbonate (DMC) is a non-toxic reagent
- Co-products of DMC-mediated reactions are methanol (easily recoverable) and/or CO_2 (does not involve disposal problems)
- Reactions of DMC can be run under safe conditions
- DMC exhibits a double reactivity that can be tuned by changing the reaction temperature: thus, both methoxycarbonylation and methylation reactions are allowed. As a consequence,
- DMC can replace highly toxic and corrosive chemicals such as:
  a) fosgene for carbonylation processes
  b) methyl halides (or dimethylsulfate) for methylation reactions
- Most reactions of DMC are catalytic processes

Introduction. The Methylation Processes

The reactions of nucleophiles (Y^-) with methyl halides (CH_3X), or dimethyl sulfate DMS) often allow very synthetically efficient methods to produce methyl derivatives (YCH_3):

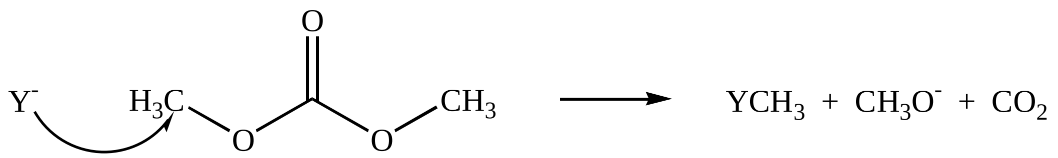
$$Y^- + CH_3X \text{ (or } CH_3OSO_3CH_3) \xrightarrow{\text{Base}} YCH_3 + X^- \text{ (or } CH_3OSO_3^-)$$

However, these methylation procedures pose a serious concern from both the environmental and safety standpoints:

- Both CH_3X and DMS are **very toxic**
- Reactions need **stoichiometric amounts of bases** which produce inorganic salts as by-products to be disposed of
- Reactions often require **solvents**

Methylation Reactions by DMC

$$YH + B \rightleftharpoons Y^- + BH^+$$



$$CH_3O^- + BH^+ \rightleftharpoons CH_3OH + B$$

DMC can be a valuable environmentally friendly alternative to traditional alkylating agents. In the presence of a nucleophile (Y^-), methylations reactions by DMC occur through a $B_{Al}2$ mechanism:

- Reactions take place in the presence of **catalytic amounts of the base** (B) so that no inorganic wastes are generated

- **No additional solvents** are required

Some Results of Our Group

We extensively reported on the use of **DMC as a methylating agent** of phenols, methylene-active compounds, and aromatic amines.

Phenols. In the presence of a base, DMC reacts with phenols to yield **selectively** the corresponding anisoles:

$$ArOH + DMC \longrightarrow ArOCH_3 + CH_3OH + CO_2$$

Operating Mode	**Substrate**	**DMC**	**Reaction Conditions** T/ P / Flow rate	**Catalytic Bed**	**Product (%)**	**Ref.**
Continuous- Flow (GL-PTC)	PhOH	2 Molar excess	140-160 °C, 1 atm, 30 mL/h	K_2CO_3, PEG 6000 (100 g)	$PhOCH_3$ (100)	1
Continuous-Flow (CSTR)	PhOH	1-5 Molar excess	160-200 °C, 1 atm, 20-140 mL/h	K_2CO_3, PEG 1000 (300 g)	$PhOCH_3$ (98-100)	2
Continuous-Flow (CSTR)	$4CH_3C_6H_4OH$	1.5-3 Molar excess	160-200 °C, 1 atm, 50-80 mL/h	K_2CO_3, PEG 1000 (300 g)	$4\text{-}CH_3C_6H_4OCH_3$ (97-100)	2
Batch (Autoclave)	PhOH	18 Molar excess	140-160 °C, 2-5 atm	K_2CO_3 (5% respect to Phenol)	$PhOCH_3$ (100)	3

Methylene-active Compounds. In the presence of traditional alkylating agents, CH_2-active compounds undergo simultameously both mono- and di-alkylation, especially when methylation is concerned:

$$YCH_2W \xrightarrow{CH_3X} YCH(CH_3)W + YC(CH_3)_2W$$

$Y = R, Ar, ArO$; $W = CN, COOR, SO_2R, SO_2Ar$

Instead, DMC allows very high selectivity in mono-methylation (≥ 99%) at substantially quantitative substrate conversion (up to 99%):

$$YCH_2W + DMC \longrightarrow YCH(CH_3)W + CH_3OH + CO_2$$

Operating Mode	Substrate	DMC	Reaction Conditions T / P / Flow rate	Catalytic Bed	Product (%, by gc)	Ref.
Continuous-Flow (GL-PTC)	$PhCH_2CN$	4 Molar excess	180 °C, 1 atm, 25 mL/h	K_2CO_3, PEG 6000 (100 g)	$PhCH(CH_3)CN$ (95)	4
Batch (Autoclave)	$ArCH_2W$ (X = CN, $COOCH_3$)	18 Molar excess	180-220 °C, 6-12 atm	K_2CO_3 2 Molar excess	$ArCH(CH_3)W$ (99-100)	5-6
Batch (Autoclave)	$ArOCH_2X$ (X = CN, $COOCH_3$)	18 Molar excess	180-210 °C, 6-10 atm	K_2CO_3 2 Molar excess	$ArOCH(CH_3)W$ (99-100)	7
Batch (Autoclave)	$ArCH_2SO_2Z$ (Z =Ar, R)	130 Molar excess	180-210 °C, 6-10 atm	K_2CO_3 2 Molar excess	$ArCH(CH_3)SO_2Z$ (100)	8

Primary Aromatic Amines. The reaction of primary aromatic amines with classical methylating agents is even less selective than that of CH_2-active compounds. Mixture of mono- and di-N-alkylated products are always obtained along with the corresponding quaternary ammonium salts:

$$ArNH_2 \xrightarrow{CH_3X} ArNHCH_3 + ArN(CH_3)_2 + ArN(CH_3)_3^+ X^-$$

Also in this case, DMC allows very **selective mono-N-methylation** reactions under both continuous-flow and batch conditions:

$$ArNH_2 + DMC \longrightarrow ArNHCH_3 + CH_3OH + CO_2$$

Operating Mode	**Substrate**	**DMC**	**Reaction Conditions** T / P / Flow rate	**Catalytic Bed**	**Product (%, by gc)**	**Conv'n, %**	**Ref.**
Continuous-Flow (GL-PTC)	$XC_6H_4NH_2$ X = H, o-CH_3, o-Cl, p-Cl	4 Molar excess	180 °C, 1 atm 24 mL/h	K_2CO_3, PEG 6000 (100 g)	$ArNHCH_3$ (42-70)	45-90	9
Batch (Autoclave)	$XC_6H_4NH_2$ X = H, p-NO_2, p-CN, o-COOMe	~ 40 Molar excess	120-180 °C, 2 – 6 atm	faujasites X and Y (1.5-6 weight excess)	$ArNHCH_3$ (70-80)	75-90	10

Conclusions

Alkylations by DMC offer a true **environmentally benign synthetic alternative** to methylating procedures involving toxic alkylating agents (methyl chloride and DMS). Remarkable benefits are:

* The **intrinsic safeness** of DMC;
* The **"cleanliness" of these reactions** which yield neither organic nor inorganic by-products

Moreover, methylations by DMC allow the use and the development of **eco-friendly catalysts** (zeolites), and the utilization of base (alkaline carbonates) in just catalytic amounts.

From the synthetic standpoint, the reactions of DMC offer **unprecedented opportunities** of preparing mono-C- and mono-N-methyl derivatives of methylene-active compounds (both arylacetic acid derivatives and α-methylene sulfones) and primary aromatic amines with high selectivity (90-99%) at substantially quantitative conversions.

To conclude, the use of DMC is an excellent starting point to plan methylation reactions which may **prevent pollution at the source**.

References

1. Tundo, P. *Continuous-Flow Methods in Organic Synthesis*, E. Horwood, Pub.; Chichester (UK), 1991; (b) Tundo, P.; Selva, M. *Chemtech* 1995, *25(5)*, 31-5.
2. Bomben, A.; Selva, M.; Tundo, P. *paper submitted.*
3. Selva, M.; Trotta, F.; Tundo, P. *J. Chem. Soc., Perkin Trans. II* 1992, *4*, 519-522.
4. Tundo, P.; Trotta, F.; Moraglio, G. *J. Chem. Soc., Perkin Trans.* I, 1989, 1070.
5. Selva, M.; Marques, C. A.; Tundo P. *J. Chem. Soc., Perkin Trans. I* 1994, 1323-1328.
6. Tundo, P.; Selva, M. In *Green Chemistry: Designing Chemistry for the Environment*, P. Anastas, T. Williamson, Eds., ACS Symposium Series No. 626, 1996; Ch. 7, pp. 81-91.
7. Bomben, A.; Marques, C. A.; Selva, M.; Tundo, P.; *Tetrahedron* 1995, Vol. 51, No. 42, 11573-11580.
8. Selva, M.; Bomben, A.; Tundo P. a) *J. Chem. Res. (S)* 1997, 448-449; b) *J. Chem. Res. (M)*, 1997, 2688-2696.
9. Trotta, F.; Tundo, P. and Moraglio, G. *J. Org. Chem.* 1987, 52, 1300-1304.
10. Selva, M.; Bomben, A.; Tundo, P. *J. Chem. Soc., Perkin Trans 1*, 1997, 1041-1045.

Green Chemistry at the University of Massachusetts Boston

John C. Warner

Historically, scientific research has been considered a separate task from classroom teaching. There has always been some pedagogic emphasis on laboratory research, but this has usually been reserved for a select group of students who elect to take certain advanced courses. The great majority and general population of students never have the opportunity to experience, let alone witness, the excitement of laboratory research.

We have tried to accomplish three things at U Mass Boston:

1. Interest students in chemistry & science by using "real world" illustrations of chemistry.

2. Integrate "Green Chemistry" into chemistry education by using actual examples in industry as positive illustrations of chemistry at work.

3. Help forge alliances between Industry, University Research and K-12 education under the umbrella of "Green Chemistry".

Several efforts in order to accomplish these goals will be described.

John C. Warner
Department of Chemistry
University of Massachusetts Boston
100 Morrissey Blvd
Boston, MA 02125-3393
USA

Annex I

OECD Workshop on Sustainable Chemistry

(Venice, 15-17 October 1998)

Report of the Survey on Sustainable Chemistry Activities

Prepared by the U.S. Environmental Protection Agency

September 1998

OECD REPORT OF THE SURVEY ON SUSTAINABLE CHEMISTRY ACTIVITIES

This report, prepared by the US EPA, presents a summary of the results of a survey conducted by the OECD Risk Management Program in spring 1998 to gather information from OECD governments and industry on sustainable chemistry activities. Annex 1 to this document contains a compilation of all of the completed questionnaires that were submitted by respondents; and Annex 2 contains a copy of the questionnaire.

TABLE OF CONTENTS

INTRODUCTION

"Sustainable Chemistry" is the design, manufacture, and use of environmentally benign chemical products and processes to prevent pollution, produce less hazardous waste, and reduce environmental and human health risks. In order to turn the concept of sustainable chemistry into reality, there needs to be a partnership between government entities, industry, and academic institutions. This partnership should focus on the development and dissemination of new science and technology that forms the basis of sustainable chemistry. OECD's role will be to assist countries in the establishment of sustainable chemistry programmes, and to promote sustainable chemistry activities in governments, academia and industry.

Defining Sustainable Chemistry

For purposes of theses activities, "Sustainable Chemistry" -- also sometimes known as Green Chemistry or Environmentally Benign Chemistry -- is defined as chemistry designed for pollution prevention as opposed to waste treatment and control or characterization of chemicals in the environment. Sustainable chemistry is the design, manufacture, and use of environmentally benign chemical products and processes that prevent pollution, reduce or eliminate the use and generation of hazardous waste, and reduce risk to human health and the environment. By way of example, the following lists some, but not all, types of sustainable chemistry activities:

Use of Alternative Feedstocks: The use of feedstocks which are both renewable, rather than depleting, and less toxic to human health and the environment.

Use of Innocuous Reagents: The use of reagents that are inherently less hazardous and are catalytic whenever feasible.

Employing Natural Processes: The use of biosynthesis, biocatalysis, and biotech-based chemical transformations for efficiency and selectivity.

Use of Alternative Solvents: The design and utilization of solvents which have reduced potential for detriment to the environment and serve as alternatives to currently used volatile organic solvents, chlorinated solvents, and solvents which damage the natural environment.

Design of Safer Chemicals: Use of molecular structure design -- and consideration of the principles of toxicity and mechanism of action -- to minimize the intrinsic toxicity of the product while maintaining its efficacy of function.

Developing Alternative Reaction Conditions: The design of reaction conditions that increase the selectivity of the product and allow for dematerialization of the product separation process.

Minimizing Energy Consumption: The design of chemical transformations that reduce the required energy input, in terms of both mechanical and thermal inputs, and the associated environmental impacts of excessive energy usage.

The above mentioned areas, while not comprehensive, provide an illustration of how sustainable chemistry is utilized to accomplish pollution prevention at the design stage of chemical products and processes, thereby obviating the need in these cases for the traditional approaches to environmental protection such as waste treatment, waste control, and remediation.

OECD's Role in Promoting Sustainable Chemistry.

At the third meeting of the OECD Working Party on Risk Management in February 1998, delegates gave their support for the initiation of work on sustainable chemistry. (The OECD Joint Meeting later endorsed this work.) As a first step to initiate this activity, a Steering Group on Sustainable Chemistry [Germany, Italy, Japan, the US, IUPAC, and the Business and Industry Advisory Committee to the OECD (BIAC)] conducted a survey to collect basic information on sustainable chemistry activities recently completed or on-going in Member countries. This included activities initiated by governments, academia and industry, and which are managed solely by one of these parties, or are managed in a collaborative fashion (e.g. government/industry partnership). The results of this work will be discussed at a workshop to be held in Venice, Italy from 15-17 October, 1998.

OECD Workshop on Sustainable Chemistry

The specific objectives of the Venice Workshop are to 1) identify the types of sustainable chemistry activities underway (supported by the results of the survey); 2) identify effective techniques and approaches in the field of sustainable chemistry, highlighting problems encountered and considering solutions; and 3) identify activities that can further the development and use of sustainable chemistry programmes.

With respect to objective 3), the Workshop will focus specifically on mechanisms to a) recognize sustainable chemistry accomplishments by the chemical industry and scientists in universities and research institutions; b) disseminate technical information and event information related to sustainable chemistry (e.g. via the Internet); c) promote incorporation of sustainable chemistry principles into various levels of chemical education; d) support and promote the research, discovery and development of innovative sustainable chemistry technologies; and e) develop guidance on how to implement sustainable chemistry programmes for use by OECD Member countries and others.

OECD SURVEY QUESTIONNAIRE

Distribution of Questionnaire

A copy of the survey questionnaire was distributed on 10 April 1998 to each Head of Delegation (HOD) to the Working Party on Risk Management. Each HOD served as the focal point for distribution of questionnaires within their country, and as coordinator of responses (i.e. each HOD was responsible for distributing the questionnaire to relevant experts from government or academia, collecting the completed questionnaires and submitting them to the OECD Secretariat). Industry was also invited to complete the questionnaire. All of the completed forms were forwarded to the US EPA.

Design of the Questionnaire

The survey questionnaire covered activities that were completed after 1996 or are still on-going. The questionnaire was divided into four parts. Part I requested information about research projects to develop more environmentally benign products or processes. Part II was designed to collect information on the introduction and use of sustainable chemistry concepts in educational settings. This was intended to include, for example, teaching specific courses on sustainable chemistry or developing supporting material. Part III requested information on specific government programmes or initiatives that have been established to promote sustainable chemistry. For instance, this was intended to include activities providing technical assistance to academia and industry, or publicly recognizing sustainable chemistry efforts. Finally, Part IV was designed to identify mechanisms by which people learn about the existence of sustainable chemistry activities.

General Survey Results

Table 1
Number of Responses

SUMMARY	TOTAL
Survey responses received	35
Survey responses included in summary[1]	33
Countries represented	12
Others represented[2]	2
Individual government agencies, universities, professional societies, industries, and other organizations represented[3]	42

[1] Two responses from Belgium (BASF Antwerpen NV and Fedichem) were not included (the response from BASF Antwerpen NV was a letter with no specific mention of sustainable chemistry and the response from Fedichem was in the form of a leaflet).

[2] Two responses were received from companies that represented the results from more than one country.

[3] Several survey responses were a compilation of responses from different organizations.

Although some survey respondents described only a few sustainable chemistry activities in their countries, most respondents described multiple activities in each of the four parts of the survey mentioned in the “OECD Survey Questionnaire” section of this document. The level of detail provided varied significantly among responses but, with the exception of a few cases, it was sufficient to adequately summarise the activities that the respondents were attempting to describe. A few activities described in some responses (e.g. waste treatment and recycling activities) do not fit the definition of sustainable chemistry given in the introduction of this document.

Several survey responses included only those sustainable chemistry activities within the respondents’ organizations. For most countries, however, at least one respondent attempted to provide a reasonably complete overview of the sustainable chemistry activities within their countries. In addition, in cases where OECD received several responses from the same country, it can be assumed that this collective response is a reasonably complete overview of the sustainable chemistry activities within those countries.

Despite the reasonably high level of detail provided in many of the survey responses, it is difficult to determine trends within and across countries and regions with respect to who is conducting what types of sustainable chemistry activities. In some cases the activities described were too varied to determine a trend. In other cases, however, there was significant similarity in the activities described. More specific information about who is conducting what types of sustainable chemistry activities in which countries is provided in Annex 1 of this document. Trends that were able to be identified are described as well.

Table 2
Listing of Respondents

Country/Other	**Respondent’s Name**
Australia	* Environment Australia, Environment Protection Group
Belgium	* Group Tessenderlo * INSPEC Belgium N.V. * Shell Research SA * Agfa-Gevaert N.V. * Ministere de l’Emploi et du Travail * VITO - BAT centre
Canada	* Environment Canada
France	* ADEME * INERIS * Institute National de Recherche et de Securite * Ministry of Environment
Germany	* University of Bremen * University of Oldenburg * Max-Planck-lnstitut fur Kohlenforschung (MPI) * German Aerospace Center, Project Management and Organisation on behalf of the Federal Ministry of Education, Research, and Technology * Fachgruppe Umweltchemie und Okotoxikologie Gesellschaft Deutscher Chemiker * Federal Environment Agency

Italy	* Tuscan Environmental Protecting Agency (ARPAT) * ICS-UNIDO * Dipartimento di Chimica Industriale e dei Materiali Universitadi Bologna (DCIM) * Agenzia Nazionale per la Protezione dell'Ambiente (ANPA) * Consorzio Interuniversitario Nazionale per la Scienza e tecnologia dei materiali (INSTM) * Interuniversity Consortium "Chemistry for the Environment" (INCA) * Regione Abruzzo Settore Ecologia e Tutela Ambiente * International Union of Pure and Applied Chemistry (IUPAC)
Japan	* Japan Chemical Innovation Institute * Ministry of International Trade and Industry * Chemical Society of Japan * Society of Chemical Engineers of Japan * Japan Chemical Industry Association * Japan Bio-Industry Association
Republic of Korea	* Ministry of Environment and National Institute of Environmental Research * Korean Chemical Society
Sweden	* National Board for Technical and Industrial Development (NUTEK)
Switzerland	* Swiss Federal Institute of Technology (ETH, Zurich)
United Kingdom	* ICI PLC
United States	* United States Environmental Protection Agency (USEPA)
(Company reporting on activities in more than one country)	* EniChem (Italy, France, United Kingdom, Germany, Belgium, Hungary, and United States)
(Company reporting on activities in more than one country)	* Euro

Summary of Results by Activity

Table 3
Summary of Results by Activity

Country	Research Activities[1]	Education Activities	Government Activities	Information Activities
Australia	1	1	-	✓
Belgium	11+	5	3	✓
Canada	-	-	1	✓
France	6+	6+	3	✓
Germany	12+	7	3	✓
Italy	13+	10+	5	✓
Japan	8+	9	7	✓
Republic of Korea	2+	2+	3	✓
Sweden	1+	-	3	✓
Switzerland	1+	2	-	✓
United Kingdom	4+	2+	4	✓
United States	12+	9+	3+	✓
Enichem	6+	-	2	-
Euro	1	-	-	-

[1]Specific research activities as well as general program areas were provided.

Part I - Research

Part I of the survey asked respondents to describe the sustainable chemistry research activities in their countries and provide information on who is conducting as well as funding these activities. This section received by far the most feedback from survey respondents. All but one respondent indicated that sustainable chemistry research activities have been or are being conducted in their countries. Canada provided only a very brief response to the entire survey and did not report on sustainable chemistry research activities. The compiler of the survey responses, the United States Environmental Protection Agency (USEPA), is aware, however, of sustainable chemistry research activities in Canada.

Although several respondents described specific and individual sustainable chemistry research activities (e.g. an individual chemical company is researching improvements to a specific industrial process), most respondents described general program activities responsible for broader sustainable chemistry research (e.g. a consortium effort supporting several research activities in the area of development and use of alternative solvents). With respect to who is conducting the research, responses indicated that the work is being conducted by academia, industry, and government, although the majority of the work is being conducted by academia and industry. With respect to who is funding the research, responses again indicated that the work is being funded by academia, industry and government. On this issue, however, the majority of the work is being funded by industry, and government. A comment made by a few respondents worthy of mentioning here is that government organizations, in addition to conducting and funding research activities, have acted and continue to act as facilitators and coordinators of activities that involve multiple participants.

Regarding the type of sustainable chemistry research activities that are being conducted, the work that is being conducted by academia tends to be more fundamental in nature (e.g. involving research on new chemical techniques or syntheses), whereas industrial research activities tend to be more applied in nature (e.g. involving improvements to a product or process within a specific industrial sector). Some of the general areas in which sustainable chemistry research activities are being conducted include waste-free syntheses, energy efficient syntheses and manufacturing processes, and general improvements to industrial processes. In addition, several responses described research activities focused on general safety issues, media-specific issues, and the general impact of pollutants on the environment.

With respect to the specific sustainable chemistry focus areas indicated in the survey and described in the background section of this document, survey respondents indicated that activities are being conducted in all of these areas, with research in the areas of alternative feedstocks, reagents, and solvents receiving the most responses. Within the area of alternative feedstocks, a significant amount of work focusing on renewable feedstocks was described. For the alternative reagents focus area, research includes catalysis, substitutes for toxic metal reagents, and cleaner oxidations. Research into alternative solvents includes aqueous conditions and supercritical fluids. Within the area of alternative reaction conditions, solvent-free and solid phase research is being conducted and membrane technologies are being investigated. For the designing safer chemicals focus area, a significant amount of work is being conducted on polymers, and, in particular, on bio-based and biodegradable polymers. Other specific areas of sustainable chemistry research include improved separation processes, analytical methods, and process/reactor modeling and design.

Part II - Education

Part II of the survey asked respondents to describe the sustainable chemistry education activities in their countries and provide information on who is conducting these activities as well as who is the intended audience. Although this section did not receive as much feedback from survey respondents as Part I, information was still provided for a significant number and variety of educational activities intended for a variety of audiences. With respect to who is conducting education activities, responses indicated that academia, industry, and government are all involved, with academia being significantly more active in conducting these activities.

The intended audiences of sustainable chemistry education activities includes young students (as young as age 6) through college and university students, teachers, industrial workers, and the general public, with college and university students identified as the primary audience for the most activities. The type of sustainable chemistry education activities being conducted include traditional educational activities such as textbook and course development, especially when the intended audience is college and university students, but also when the audience includes industrial workers. Lectures and seminars on sustainable chemistry were also described for a variety of audiences,in addition to making general sources of information available (such as brochures, leaflets, and other informational materials). An activity described for educating general audiences and the public involves public relations efforts, such as Responsible Care. The use of magazines, television, and radio was mentioned by two respondents as another activity used to reach general audiences and the public at large.

Part III - Government Programs

Part III of the survey asked respondents to describe any government policies or programs that promote sustainable chemistry through, for example, incentives or recognition activities. Several respondents indicated that they were not aware of any programs of these types in their countries. Several other respondents indicated that governments in their countries are just starting or soon will be starting promotional activities. A few respondents provided only names of programs and did not provide a description of those programs.

The government promotional programs described in the responses generally fall into two categories. The first category includes traditional educational activities (such as those described in Part II) that both educate and promote sustainable chemistry. Information collection and dissemination activities can be included in this category as well, since these types of activities also serve to both educate and promote. Specific activities of these types include making available databases, reports, and information documents. Technology transfer activities and establishment of contact networks were also mentioned.

A second category of government promotional programs includes awards and incentives activities. Several respondents indicated that their governments had programs of these types. Awards programs are focused on recognizing innovative accomplishments in sustainable chemistry. The actual awards are both monetary and non-monetary. Incentive programs include eco-labeling to encourage the purchase of sustainable chemistry-based products, financial support, and tax incentives. A comment by the University of Oldenburg in Germany, worthy of mentioning here, is that the government of Niedersachen currently does not support academic programs in sustainable chemistry, and that the installation of new governmental programs takes too much time.

Part IV - Information Collection/Dissemination Activities

In Part IV of the survey, respondents were asked to describe information collection and dissemination activities in their countries. In particular, respondents were asked to describe mechanisms for identifying on-going sustainable chemistry activities, provide information on databases of sustainable chemistry activities, explain how information on sustainable chemistry activities is made available to the public, and provide information on meetings and conferences on sustainable chemistry. The responses to this section are briefly described below. For specific details on these activities, please refer to the compiled survey in Annex 1.

Identification

Mechanisms described by respondents for identifying on-going sustainable chemistry activities include surveys of sustainable chemistry activities and networks (informational, i.e. in database format, and contact-based).

Databases

Please refer to the compiled survey for details on the databases that respondents listed.

Dissemination

Mechanisms described by respondents for dissemination of sustainable chemistry activities to the public include web sites, publications and document distribution, and meetings and conferences. Please refer to the compiled survey for details on the web sites that respondents provided.

Conferences

Please refer to the compiled survey for details on the conferences that respondents listed.

ANNEX 1 TO THE SURVEY REPORT:

COMPILATION OF SURVEY RESPONSES

Table of Contents to Annex 1

SURVEY ON SUSTAINABLE CHEMISTRY ACTIVITIES

1. a. *Name of ministry, academic institution or company that is reporting:*

   This information is provided in each section of the survey.

   b. *Country in which it is located*:

   This information is provided in each section of the survey.

PART I: RESEARCH

2. Are you aware of any on-going or recently completed "sustainable chemistry" research activities in your country? ________ (Yes or No)

If yes, please answer questions a-c below; otherwise, skip to question 3.

a. Is this research being conducted by government, industry, and/or academia (alone or in collaboration)?	**b. Describe the area of focus for such research** (*e.g,. renewable feedstocks; environmentally benign solvents, etc.*).	**c. Who provides the financial support for this work** (i.e. government, industry, and/or academia)?
Australia **Environment Australia**		
government	synthetic polymers of low concern	government
Belgium **Group Tessenderlo**		
government, academia & industry	renewable feedstocks	government & industry
government & industry	recycling plastics from ELV'd	government & industry

Belgium **Inspec Belgium N.V.**		
academia & industry	heterogeneous catalysis ??? (increased product selectivity, ???)	industry & government
industry	ethoxylation of renewable raw materials	industry
Belgium **Shell Research SA**		
industry	solvent free (powder) metal protection coatings	industry
industry	waterborne (benign solvent) latex paints	industry
industry	less toxic curing agents for epoxy resins	industry
industry	VOC (pentane) reduction in production of EPS foams	industry
industry	solvent-free hot melt adhesives	industry
Belgium **Agfa-Gevaert N.V.**		
This research is being conducted by Agfa in partial collaboration with universities, research institutes, & commercial partners.	*See Appendix to this document for additional information.*	This research is funded by Agfa with partial financial aid of the government in long-range activities.
Belgium **Ministere de l'Emploi et du Travail**		
This research is being conducted by industry with subsidies from the Walloon Region	Replacement of nickel by palladium in the production of H_2O_2; use of oxygen instead of air in the production of vinyl chloride to prevent the release of N_2; replacement of mercury cells by membrane cells in the production of chlorine and soda	industry & the Walloon Region

France ADEME		
industry	air pollution (NO_x, solvents, VOC)	ADEME (50%) & contractant (50%)
CNRS	waste minimization; clean technologies	ADEME (50%) & contractant (50%)
university	energy efficient processes	ADEME (50%) & contractant (50%)
France INERIS		
public institute (in collaboration with academia & industry)	safety of industrial processes; impact of pollutants on the environment; impact of products on the environment	government (90%) & industry (10%)
industry	safety of industrial processes; impact of pollutants on the environment; impact of products on the environment	industry
France Institute National de Recherche et de Securite (INRS)		
INRS, sur le risque chimique	sante au travail: recherches toxicologiques; recherches epidemiologiques; recherches metrologiques	Securite Sociale
Germany University of Bremen		
academia	molecular design	academia
Germany, Niedersachsen University of Oldenburg, Organic Chemistry I		
academia	waste-free syntheses	academia
Germany Max-Planck-Institut fur Kohlenforschung (MPI)		
MPI	alternative feedstocks	MPI & Deutsche Forschungs-gemeinschaft (DFG)
MPI & industry	environmentally benign solvents	MPI, DFG, & industry
DFG Schwerpunkt (mainly academia)	utilization of supercritical fluids; clean oxidation chemistry	DFG
BMBF Schwerpunkt (academia & industry)	catalysis	BMBF

Germany **German Aerospace Center, Project Management;** **Organisation on behalf of the Federal Ministry of Education, Research, and Technology**		
academia & industry, alone and in collaboration	closing and internlinking of material flows; substitution or partial substitution of toxic input material; use of regenerating raw materials	government & industry
Germany **Fachgruppe Umweltchemie und Okotoxikologie Gesellschaft Deutscher Chemiker**		
Universitat Oldenburg	environmentally benign synthesis	Stiftung Umwelt
Universitat Tubingen	renewable resources in the southern hemisphere	BMBF, Bonn & CNPq, Brasilien
Technische Universitat Munchen	catalysis	FORKAT, Land Bayern
Germany **Federal Environmental Agency**		
programme for financial support of innovative industrial installations (Investprogramme) of the Federal Environmental Agency and industry	development of the best available technologies in the chemical industry	Ministry of the Environment
endowments from the Salzgitterstiftung to institutes or industry	renewable feedstocks, sustainable technologies, etc.	DBU (Deutsche Bundesstiftung Umwelt/German Federal Foundation Environment)
Italy **Tuscan Environmental Protection Agency** (**ARPAT)**		
government	use of natural processes	government
Italy **ICS-UNIDO**		
academia & industry	clean technologies; renewable feedstocks; etc.	government & industry
Italy **Dipartimento di Chimica Industriale e dei materiali Universita di Bologna (DCIM);** **Agenzia Nazionale per la Protezione dell' Ambiente (ANPA)**		
academia & ANPA	renewable feedstocks; water treatment and re-use; energy recovery from chlorinated wastes	DCIM

Italy Consorzio Interuniversitario Nazionale per la Scienza e tecnologia dei materiali (INSTM)		
INSTM	microporous catalysts for super selective partial oxidation of hydrocarbons; oxidic catalysts for NO_x abatement; membranes; microporous systems for gases separation; macroporous systems for selective CO_2 adsorption; layered materials; corrosion phenomena; photochemical processes in microporous and layered materials	MURST (Ministry of University, Research, and Technology), CNR (Consiglio Nazionale delle Ricerche), INSTM with several universities participating (Torino, Milano, Genova, Venezia, Firenze, Cagliari, Roma, Carabria, Messina), research contracts with various industries (SNAM, EniChem, ECV), Brite Euram projects
Italy Interuniversity Consortium "Chemistry for the Environment" (INCA)		
INCA Project of a High National Interest: *Eco-compatibility of Chemical Processes*	photochemical processes; development of alternative, cleaner, and safer reactions, processes, and products environmental catalysis; environmental modeling; advanced analytical methodologies.	MURST
INCA Project Title: *Green Chemistry and Pollution Prevention* Project Title: *Charcoal and Chemicals from Biomass; Agricultural Wastes and Polymeric Material by Pyrolysis* Project Title: *Phase-Transfer Catalysis in Supercritical* CO_2 Project Title: *Research and Development of New Drugs: Flurochinolons and Benzomorphans* Project Title: *Removal of Contaminants through Membrane and Photocatalytic Processes*	development of alternative, safer, and cleaner reactions, processes, and products; recycling and degradation of wastes; pollutants photocatalytic removal	MURST

INCA & CNR Project Title: *Clean Chemical Processes and Pollution Prevention*	green reagents	CNR
INCA & RECAM Project Title: *Sustainable Closed Loop Systems for Recycling of Carpet Materials*	new feedstocks; efficient recycling of carpet materials	European Union
INCA & MILLENNIUM	monolith supports for environmental catalysis	MILLENNIUM Inorganic Chemicals Limited (France)
Japan **Japan Chemical Innovation Institute; Ministry of International Trade and Industry; Chemical Society of Japan; Society of Chemical Engineers of Japan; Japan Chemical Industry Association; Japan Bio-Industry Association**		
National institution	utilization of polysaccharide from waste of marine products (renewable feedstocks); research on composite materials made from agrowastes (renewable feedstocks); development of environmentally benign catalysts using light as site specific catalysts (environmentally benign processes)	government
National institution & industry	development of new bio-reactor for chemical synthesis (environmentally benign process); development of environmentally benign process for hydrogen production (environmentally benign process); development of new technology using solid phase reactions (environmentally benign process)	government
National institution & industry	bio-catalytic production of erythritol (environmentally benign process)	government & industry

Government & industry	development of biodegradable plastics (renewable feedstocks); development of new refrigerants, blowing agents and cleaning solvents for effective use of energy (environmentally benign solvent & energy conservation)	government
Academia	research on catalytic chemistry under specific reaction conditions (increase of reaction selectivity)	academia
Academia & industry	development of new technologies for the use of bio-resources such as mixed microorganism (environmentally benign process); research on application of super critical fluids to chemical processes (environmentally benign process); development of highly selective chemical process using membrane reactor (reduce wastes and emission)	government
Industry	development of fuelification of waste plastics (renewable feedstocks); development of new production process of caustic soda by ion-exchange method (environmentally benign process)	government & industry
Industry	replacement of butyl tin copolymers for ship coating biocide by tin-free compounds (environmentally benign process)	industry

Republic of Korea Ministry of Environment and National Institute of Environmental Research (NIER); The Korean Chemical Society (KCS)		
This research is being conducted by a collaboration of government, academia, & industry.	recycling technology for waste reagents; heavy metal removal technology from waste batteries; development of clean products; development of clean production processes; technology for waste recycling; the study of risk assessment and management of air/water pollutants; study on greenhouse gases controlling and utilizing	government, government & industry
The Korea Environment Institute	measures for designing environmental clean technology; measures for low-pollutant emission motors; measures for the development of environmentally friendly products	government
Sweden National Board for Technical and Industrial Development (NUTEK)		
On-going "sustainable chemistry" research activities. Research is carried out either by academic institutions, research institutes, or larger companies on their own, or in collaboration between these groups. The government acts through NUTEK as a co-ordinator of activities and NUTEK finances part of the research.	environmentally benign surface treatment; surfactants based on natural products; amphiphilic polymers from renewable resources	government & industry; Financed by NUTEK
Switzerland Swiss Federal Institute of Technology (ETH, Zurich)		
Academia & industry	inherent safety methods for process development; methods for development of eco-efficient processes; life cycle design of textile processing chemicals; energy models for multi-purpose batch plants	academia & industry

United Kingdom **ICI PLC**		
academia & industry, separately and in collaboration	clean technology programming including cleaner synthesis for industry and programming which included all the approaches to sustainable chemistry mentioned in the preamble to this survey	government & the Engineering and Physical Sciences Research Council (EPSRC) with additional support from industry
academia & industry separately and in collaboration	waste minimization and industry through recovery reuse and recycling	government via EPSRC & the Department of Trade and Industry (DTI) - link programming
academia & industry, separately and in collaboration	competitive materials from non-food crops	government via the Biotechnology and Biological Sciences Research Council (BBSRC) & the Ministry of Agriculture, Fisheries and Food
academia & industry, separately and in collaboration	applied catalysis and catalytic processes	
United States **United States Environmental Protection Agency (USEPA)**		
academia*: Environmentally Benign Chemical Synthesis Solicitation* (one time grant opportunity in 1992)	environmentally benign chemical syntheses	federal government (USEPA)
academia: *Technology for a sustainable environment Solicitation* (on-going annual grant opportunity since 1995)	all areas of focus	federal government (USEPA & the National Science Foundation, NSF)
small businesses: *Small Business Innovation Research Solicitation* (on-going, annual grant opportunity)	all areas of focus	federal government (primary USEPA)
academia: new grant opportunity	all focus areas	federal government (United States Department of Energy, USDOE)
government laboratory: on-going research by the National Institute of Standards and Technology (NIST) laboratories	process analytical chemistry	federal government (NIST)
government laboratory: new research by the USEPA's Cincinnati laboratory	environmentally benign chemical syntheses	federal government (USEPA)
government laboratory: on-going research by Los Alamos National Laboratory (LANL)	environmentally benign solvents, catalysis	federal government (USDOE & USEPA)

government laboratory: on-going research by Argonne National Laboratory (ANL)	membrane technology, environmentally benign solvents	federal government (USDOE)
government laboratory: on-going research by the National Renewable Energy Laboratory (NREL)	renewable feedstocks	federal government (USDOE)
Academic Center: on-going research by the Center for Clean Industrial Treatment Technologies (CenCITT) at the University of Michigan	catalysis	federal government (USEPA) & industry
academic center: on-going research by the Center for Process Analytical Chemistry (CPAC) at the University of Washington	processing	federal government (USEPA & NSF) & industry
industry: on-going research	all areas of focus	industry
Euro **Europe - Worldwide**		
industry	chlorine chemistry/PVC (study under consideration)	industry
EniChem **Italy, France, United Kingdom, Germany, Belgium, Hungary, United States**		
industry	new propylene oxide process (absence of chlorine); new dimethyl carbonate process (environmental and human risk reducing)	industry
industry	new alkylation processes with zeolites (elimination of polluting waste); new caprolactame process (waste reduction and energy saving); isocyanates production without phosgene (use of non-toxic reagents); study of chemical sensors (reducing environmental and human risk); avoiding the use of toxic solvents (reducing environmental and human risk)	government & industry
industry	plastic recycling to fuels and feedstocks (feedstock recycling)	consortium of industries
industry	recycling car plastic (reduction in land-filling waste)	government & industry (Eureka project)

academia & industry collaboration	advanced method for chemical engineering in high safety conditions (reducing environmental and human risk)	government & industry
academia & industry collaboration	N_2O abatement by catalytic treatment (reducing environmental and human risk); recycling of carpet materials (waste reduction); intelligent electro-pneumatic positioner (reducing environmental and human risk; improving manufacturing processes); chemical reactor modeling for fast exothermic and sensitive reactions (reducing environmental and human risk; improving manufacturing processes); advanced design methods for improved performance of industrial gas-liquid reactor (waste reduction; improving manufacturing processes)	European Commission & industry

APPENDIX

Belgium
Agfa-Gevaert N.V.

Like all Bayer companies, Agfa subscribes to the principles of "responsible care." A sparing use of natural resources, a safe production, and a minimization of environmental impact are considered to be fundamental obligations. In fulfilling these commitments, R&D assumes a major responsibility. By innovating the technologies, products, and production processes of the company, R&D obviously has a direct influence on the environmental aspects of Agfa's chemically oriented business activities. This environmental impact is continuously optimized in two main areas:

> *in-company*: the development and manufacturing of chemicals and other products and/or systems have to be realized in accordance with the principles of responsible care.
>
> *on Agfa's markets*: Agfa has to either optimize its present chemical-based products and systems with a view to environmental impact, or substitute them by products and/or systems having no harmful effect on the environment, so that at the Agfa customer's the chemicals become environmentally safer or can entirely be dispensed with.

1. In-company

The Agfa R&D is operating on a project base, wherein two main stages can be distinguished:

> a research and feasibility stage in the course of which various component parts of a new product or system are investigated and combined to form a first prototype
>
> a development stage in the course of which the new product or system is made ready for manufacturing or for market launching.

Both stages include various restraints for the project managers wherein:

> it is expressly stated what products are approved and rejected for use in manufacturing or for incorporation into the material composition
>
> a decision is given on the application and the use in manufacturing of new chemicals as a result of a screening of their toxicological and ecological features and their explosion hazards
>
> when new chemical production processes are introduced, they are systematically audited with a view to safety, environmental impact, minimization of chemicals consumption, minimum waste disposal and accident or emergency scenarios
>
> coating processes are designed in a way to promote water-based and solventless or at least low-solvent coatings.

These activities are controlled and monitored by a central rationalization committee for chemicals (CRC). During the development stage of new equipments (both for chemical-based and non-chemical-based products), a life cycle analysis is performed systematically.

2. On the Agfa markets

The previous image processing technology included a component with a substantial chemical orientation. The evolution of the art in this field allowed a marked reduction and often even a full suppression of the chemical aspect at the customer's due to the increased change-over to digital technologies for imaging, image processing, image storage and image exchange, dry systems (dispensing with any chemical processing step) holding a prominent place.

As a result of the efforts of R&D, Agfa is participating in this evolution of the art, and these innovations are implemented in products and systems. A few examples of on-going activities in this respect are listed below:

- digital X-ray diagnostics (ADC)
- heat-mode recording hardcopy films for medical diagnostic applications (Drystar)
- a shift in the graphic pre-press workflow from analogue contact copying systems to digital systems, i.e. initially computer-to-film and secondly computer-to-plate systems (resp. Alliance and Lithostar)
- heat-mode recording graphic film (Freeway)
- low-processing and no-processing printing plates (Thermostar)
- inkless and solvent less digital printing processes (Chromapress)

In imaging applications that are still requiring the use of chemical additives, an optimization is aimed at in order to promote user-friendly and environmentally sound chemicals, to reduce the consumption of chemicals and to reduce and (possibly) recycle the flows of waste:

- reduction of raw material consumption (e.g. silver) in film production
- realization of films the processing of which requires a reduced amount of developer, fixer and rinsing water
- realization of films generating less waste
- substituting conventional developers by environmentally sound developers
- development of closed film processors with reduced consumption of chemicals, reduced emission and reduced amount of chemical waste
- equipping the film processors with built-in chemical recycling units and silver recovery units

The above-mentioned trends can be noticed in Agfa's three business groups (i.e. Graphic systems, Technical Imaging Systems, and Photographic Products).

PART II: EDUCATION

3. Are you aware of any activities in your country designed to educate the public, students, workers, or others about sustainable chemistry (e.g. university course of sustainable chemistry)? __________ (Yes or No)

If yes, answer questions a-c below; otherwise, skip to question 4.

a. Who is responsible for such activities (i.e. government, academia, industry)?	b. In what form is this education provided (e.g. course on sustainable chemistry, text books, etc.)?	c. Who is the audience (e.g. university students, the public, workers, etc.)?
Australia **Environment Australia**		
government	network of databases on the Internet	industry, researchers, students, & the public
Belgium **Group Tessenderlo**		
government, academia, & industry (all)	public maps etc.	all students
Belgium **Inspec Belgium N.V.**		
FCN	weekly magazine	industry
IWT (government)	monthly magazine	industry & universities
industry	??? magazine (3 x open)	public
Belgium **Ministere de l'Emploi et du Travail**		
industry - employers organize the workers and often organize an "open house" for those in the area as well	short presentations	workers & those in the area wishing to participate

France ADEME		
Ecoles d'ingenieurs	courses	university student
University Centres Techniques	???	workers
IFP - ENSPM	???	???
France INERIS		
academia (schools, colleges, universities)	courses	schoolchildren through college/university students
industry (through the Responsible Care Program)	leaflets, courses, informational meetings	workers, public, & the media
France Institute National de Recherche et de Securite		
stages de formation de l'INRS	brochures, films, stages	medecins du travail, ingenieurs et techniciens de prevention
Germany University of Bremen		
government & academia	textbook on structure activity relations of chemicals	university students from different disciplines
academia	disciplinary lectures on chemicals	university students
academia	graduate seminars on toxicological and ecotoxicological risk assessment of environmental chemicals and their metabolics	university students from different disciplines (including law students)
Germany, Niedersachsen University of Oldenburg, Organic Chemistry I		
academia	course on sustainable chemistry	students
Germany Max-Planck-Institut fur Kohlenforschung (MPI)		
MPI	textbook on chemical synthesis in supercritical fluids (in preparation)	researchers & students
Gesellschaft Deutscher Chemiker (GDCh)	course on chemical synthesis in supercritical fluids	researchers from industry & academia
Germany Federal Environmental Agency		
industry (through the Responsible Care Program)	different public relations work concerning the activities of the chemical industry in Germany	the public

Italy ICS-UNIDO		
university	courses on chemical technology	university students
Italy Regione Abruzzo Settore Ecologia e Tutela Ambiente		
ANPA	text books	workers & the public
ENEA	courses, text books	workers & the public
university	lectures, text books	university students
Italy Dipartimento di Chimica Industriale e dei Materiali Universita di Bologna (DCIM); Agenzia Nazionale per la Protezione dell' Ambiente (ANPA)		
government, DCIM, Italian Chemistry Society	courses, meetings, workshops	university students, graduates, & local authorities
ANPA	post-doctorate fellowship	post-doctorate students
Italy Consorzio Interuniversitario Nazionale per la Scienza e tecnologia dei materiali (INSTM)		
academia	course on sustainable chemistry	university students
Italy Interuniversity Consortium "Chemistry for the Environment" (INCA)		
academia	courses on sustainable chemistry	university students
INCA - EU TMR Programme (European Union Training and Mobility of Researchers Programme)	post-graduate summer school on green chemistry	post-doctorate students
INCA	chemical technologies with low environment impact	post-doctorate students
Japan Japan Chemical Innovation Institute; Ministry of International Trade and Industry; Chemical Society of Japan; Society of Chemical Engineers of Japan; Japan Chemical Industry Association; Japan Bio-Industry Association		
	text books	workers & the public
	courses, text books	workers & the public
	lectures, text books	university students
	courses, meetings, workshops	university students, graduates, & local authorities
	post-doctorate fellowship	post-doctorate students

	course on sustainable chemistry	university students
	courses on sustainable chemistry	university students
	post-graduate summer school on green chemistry	post-doctorate students
	chemical technologies with low environment impact	post-doctorate students
Japan **Japan Chemical Innovation Institute; Ministry of International Trade and Industry; Chemical Society of Japan; Society of Chemical Engineers of Japan; Japan Chemical Industry Association; Japan bio-Industry Association**		
academia	courses of lectures as a part of a curriculum on environment related technology and science	university & college students
academia	courses of lectures as a part of a curriculum (at least 30 schools in 1997)	junior & senior high school students
academia & industry	contests on essays on chemistry including environmental activities (more than 9,000 applicants annually since 1995)	junior & senior high school students & teachers
academia & industry	experiences in chemical laboratory program “Chemistry Makes Our Dreams Come True” (environment related subject included; 6,000 participants at 42 universities in 1997)	junior & senior high school students & teachers
academia & industry	open house and exposition of chemical laboratory program “Dream of Chemistry 21" (environment related subjects included; about 4,500 visitors in 1997)	elementary school children, parents, & citizens
academia	environmental education as part of curriculum (at least 23 elementary schools)	elementary school children
academia & industry	simultaneous nation-wide survey on acid rain by schoolchildren in Japan	elementary school children
academia	local radio program on environment (12 hours/year since 1994)	citizens
academia	nation-wide TV program on environment by national “University of the Air”	citizens

Republic of Korea Ministry of Environment and National Institute of Environmental Research (NIER); The Korean Chemical Society (KCS)		
NIER	textbook; study on Improvement of Chemical Management System; Handbook for Chemical Safety	the public
KCS & academia	slogan and sticker (conducting a campaign for green chemistry under the slogan "Green Chemistry, Clean World"; part of chemistry and chemical engineering curriculum)	university students & the public
Switzerland Swiss Federal Institute of Technology (ETH, Zurich)		
academia	case studies concerning product and process design	students
academia & industry	post-graduate courses	academia & industry
United Kingdom ICI PLC		
academia (University of York) & industry (Chemical Industries Education Centre, University of York)	booklists and other materials; workshops and secondments for teachers	both students aged 6-18 & teachers
	teaching materials from teachers relevant to national curriculum	secondary schools
United States United States Environmental Protection Agency (USEPA)		
National Pollution Prevention Center at the University of Michigan	supplemental reference materials	primarily university students, also professional chemists
cooperative agreement between the American Chemical Society (ACS) & USEPA for green chemistry education	all forms (textbooks, supplemental materials, short courses, multimedia tools)	all audiences (professional chemists, high school and university students, the public)
Partnership for Environmental Technology Education (PETE), supported by academia, industry, & government	community college courses and workshops	community college & technical college students
Microscale Center at Merrimack College	courses and laboratory equipment on the microscale chemistry approach	high school, community college, & university students
Center for Science, Mathematics, and Technology Education (CSMATE) at Colorado State University	courses and laboratory equipment on the small scale chemistry approach	high school, community college, & university students

Carnegie Mellon University	courses, problem sets	university students
Scranton University	courses	university students
Howard University	seminars	university students
Georgetown University	seminars	university students

PART III: GOVERNMENT PROGRAMS

4. Please describe any government policy or programme designed to promote sustainable chemistry (this could include, for instance, establishing incentives or recognition activities which reward industry or the scientific community for accomplishments in sustainable chemistry).

Australia
Environment Australia

There are no programs that specifically reward, or offer incentives for activities in the area of sustainable chemistry in Australia. The EnviroNET does, however, give scientific researchers, industry, and government an opportunity for activities in sustainable chemistry to be recognized.

Belgium
Group Tessenderlo

European Development Programs and IWT programmes *[no description given]*

Belgium
Ministere de l'Emploi et du Travail

[no description given - the Walloon Region can be consulted for specific information]

Belgium
VITO-BAT centre

The BBT/EMIS project of the Flemish government aims at the distribution of information on cleaner technologies/techniques in industry in general, thus also in chemistry. For example, a BAT-sector study on the paint industry has been performed and the report of this study will be distributed to civil servants, industry, and consultants by means of brochures, oral information sessions, and the Internet.

Canada
Environment Canada

Green chemistry is generally viewed by government in Canada in the context of pollution prevention. It is an integral part of the framework of the 1995 Canadian Federal Strategy for pollution prevention, and Environment Canada is exploring other options for promoting the concept of green chemistry as a pollution prevention tool. The Canadian Council of Ministers of the Environment (CCME), a federal-provincial body, has established an awards program to recognize innovation in a variety of areas, including cleaner production and process modifications (further details available on the Internet at <http://www.ccme.ca/ccme/brochure.html>).

France
ADEME

ADEME solicits proposals on the theme of cleaner technologies from chemical industrialists (who can work with public research centers) and offers financial help to the best projects on this theme. In addition, ADEME awards each year the trophy of the cleaner technologies. The agency offers funds to finance some theses on pollution problems.

France
INERIS

INERIS actively participates in technical programmes dedicated to three main areas: (1) prevention of technological risks (explosions, fires, spills) which could affect people, equipment, and the environment; (2) reduction of emissions polluting air, water, soils; and (3) risk assessment of products which could possibly affect human health.

France
Ministry of Environment

Two official eco-labels, NF Environment and the European eco-label, are available and are delivered by l'Association Francaise de Normalisation (AFNOR). Criteria are defined for the different types of products. Paints and detergents are examples of such products. Every two years, an eco-product award is given by l'Assemblee des Chambres Francaise de Commerce et d'Industrie (ACFCI).

Germany, Niedersachsen
University of Oldenburg, Organic Chemistry I

Academia programs in sustainable chemistry are not supported or rewarded by the government of Niedersachsen, Germany. At best, the initiatives of academic researchers and teachers are tolerated unless they ask for financial or institutional support. Funding of DFG or BMBF is troublesome in that area. The installation of new governmental programs is by far too time consuming (years) and even impossible out of the mainstream.

Germany
Max-Planck-Institut fur Kohlenforschung (MPI)

No specific awards are available, but limited financial support is possible for small projects through the programmes listed under Part II (research).

Germany
German Aerospace Center, Project Management;
Organisation on behalf of the Federal Ministry of Education, Research, and Technology

Within the framework of the promotional programme “Research for the Environment - Programme of the Federal Government Germany”, collaborative projects between scientific and industrial sectors are supported to develop solutions to problems.

Germany
Federal Environmental Agency

The idea of sustainable chemistry is presented in a number of product requirements for the German “Blue Angel” environmental label. Labeling with the “Blue Angel” increases sales of the labeled products. Product requirements are added in English and a list of applicants in German.

Italy
International Union of Pure and Applied Chemistry (IUPAC); Working Party on Reaction Pathways and Processes in Green Chemistry;
IUPAC Physical Organic Chemistry Commission III.2

A new project will point out and examine new organic and physical organic industrial pathways for the chemical industry, and the impact of new products and processes on the environment. It is among the first to address the new area of green chemistry research.

Each step taken towards the creation of a policy for sustainable development will have to be clearly indicated, and if necessary, listed by objectives (i.e. elimination of chlorine derivatives, atom economy in synthesis, catalysis, biocatalysis, replacement of organic solvents, oxidation reactions, recycling, etc.). The project will have to be carried out in collaboration with the IUPAC Environmental Division and will be joined and followed by many initiatives, such as promotion and evaluation of new curricula and courses in environmental organic chemistry in education and training at the academical level.

The results of the project will be reported at IUPAC international meetings and in publications. A book series related to new chemical processes and reactions which better correspond to the environmental demand may well match with the purpose of the diffusion of information within the whole scientific community.

Italy
ICS-UNIDO

The Italian Ministry for Foreign Affairs is financing a project, International Center for Science and High Technology, which is an autonomous body of ICS-UNIDO. The aim of this project is to transfer know-how on technologies to developing countries. Particular programs are dedicated to clean chemical technologies evaluation and overview of remediation technologies.

Italy
Dipartimento di Chimica Industriale e dei Materiali Universita di Bologna (DCIM)
Agenzia Nazionale per la protezione dell' Ambiente (ANPA)

Recognition of research groups (university and industry) working on sustainable chemistry, to promote synergism and common projects.

Italy
Interuniversity Consortium "Chemistry for the Environment" (INCA)

National Research Program for Chemistry, funded by Research Ministry for Chemistry for Quality Life; National Research Program for the Environment, funded by Research Ministry *[no description given]*.

Italy
Regione Abruzzo Settore Ecologia e Tutela Ambiente

Recently the Italian government published a law which provides incentives for use of solar energy for heating buildings. This may be considered a sustainable chemistry activity on energy sources.

Japan
Japan Chemical Innovation Institute; Ministry of International Trade and Industry; Chemical Society of Japan; Society of Chemical Engineers of Japan; Japan Chemical Industry Association; Japan Bio-Industry Association

A. (Response 1)

1. Tax incentives

a. Taxation program/special depreciation program for the application of new technologies for the reduction or replacement of specified chemicals, such as chlorofluorocarbon compounds.

b. Taxation program to promote development of new technologies for energy reduction or recycling of specified chemicals.

2. Awards

There is only one award specific to sustainable chemistry activities so far, but many environmentally-related technologies have been included in awards by the Academic Society and the Industry Associations, and the number is increasing.

B. (Response 2)

1. Annual Blue Planet Prize

Awards for activities sponsored by Asahi Glass Foundation. The awards cover a wide range of scientific activities. Among them are the Blue Planet Prize, about $350,000 annually, which has been given to contributors to environment, world-wide, since 1991.

C. (Response 3)

1. Annual Awards for New Chemical Technology

(The Chemical Society of Japan)

2. Annual Awards for New Chemical Engineering Process

(Japan Chemical Engineering Association)

3. Annual Awards for New Chemical Process and Products

(Japan Chemical Industry Association)

Republic of Korea
Ministry of Environment and National Institute of Environmental Research (NIER);
The Korean Chemical Society (KCS)

The Toxics Release Inventory (TRI) system has been introduced, and a pilot project for the petroleum refinery industry will be implemented. In addition, the Designation of Environmentally Friendly Business Management and Eco-Labeling programs have been implemented.

1. Encouraging Environmentally Friendly Business Management

This program has been underway since 1995. Its purpose is to induce industry to take environmental factors into consideration throughout the entire life-cycle of products - from production and consumption to disposal. If designated by the Ministry of Environment as an environmentally friendly business, the company receives benefits, such as exemption from inspections periodically conducted by local governments or regional environmental offices and favorable conditions when borrowing to finance anti-pollution facilities.

2. Eco-Mark program (Eco-Labeling)

The government introduced the Eco-Labeling program in April 1992. Twenty-three items consisting of recycled goods and low-pollution goods are awarded the Eco-Label mark. Quality recycled goods bearing the Eco-Mark are given priority in purchases by government organizations, tax benefits and financial support.

Sweden
National Board for Technical and Industrial Development (NUTEK)

1. The Nutek programme *Environmentally Sustainable Surface Treatment*

The Environmentally Sustainable Surface Treatment program focuses on environmentally benign technologies for the surface treatment industry. The program is a collaboration between NUTEK, research institutes, academic institutions and industry. Participating companies are supposed to finance 50% of project costs. The main focus of the program is:

1994-1997 low temperature powder coating and Cd- and Cr-free processes

1997-1999 SME-orientated; simple solutions for small companies; project examples include phosphate processes, recovery of heavy metals from process water, general information on surface treatment technology

2. NUTEK Competens Centre for Surfactants Based on Natural Products (SNAP)

The centre is based at the Royal Institute of Technology (KTH) and is a collaboration between NUTEK, KTH, and industry. The main goal of the centre is to build, from an industrial need, a long-term knowledge and experience regarding new environmentally safe surfactants derived, entirely or partly, from natural products.

3. NUTEK Competens Centre for Amphiphilic Polymers from Renewable Resources (CAP)

The centre is based at Lund University (LU) and is based on a three-party agreement between NUTEK, LU, and industry. The overall long-term objectives of the centre are to carry out fundamental research focused on the preparation and properties of amphiphilic polymers, aiming at the utilization of renewable resources such as cellulose and starch.

United Kingdom
ICI PLC

Enquiries at the Department of Trade and Industry failed to identify any explicit policy or programs focused on promoting sustainable chemistry. The following programmes may indirectly promote and reward it:

1. Queen's Award from Environmental Achievement

2. Environmental Technologies Best Practice Programme

   encourages technology transfer leading to waste minimization

3. Foresight challenge

As a professional body, the Royal Academy of Engineering has appointed four chemists active in the area of "sustainable chemistry" to Clean Technology Research Fellowships.

United States
United States Environmental Protection Agency (USEPA)

1. The U.S. Environmental Protection Agency's Green Chemistry Program

   The U.S. Environmental Protection Agency's Green Chemistry Program fosters the research, development, and implementation of innovative chemical technologies that accomplish pollution prevention in both a scientifically-sound and cost-effective manner. EPA's Green Chemistry Program recognizes and promotes chemical technologies that reduce or eliminate the use or generation of hazardous substances during the design, manufacture, and use of chemical products and processes and that have broad application in industry. More specifically, the Green Chemistry Program supports fundamental research in the area of environmentally benign chemistry as well as a variety of educational activities, international activities, conferences and meetings, and tool development, all through voluntary partnerships with academia, industry, and other government agencies.

2. Presidential Green Chemistry Challenge

   Part of EPA's Green Chemistry Program, the Presidential Green Chemistry Challenge, was announced by President Clinton on March 16, 1995 as part of the Reinventing Environmental Regulations Initiative to promote pollution prevention and industrial ecology through a new EPA Design for the Environment partnership with the chemical industry. Through a highly visible awards program, the Presidential Green Chemistry Challenge recognizes innovative research, development, and implementation of green chemistry technologies by academia, industry, and government. Partnering organizations represent academia, industry, other government agencies, scientific societies, trade organizations, national laboratories, and research centers.

3. State of Massachusetts Green Chemistry Bill

The State of Massachusetts Green Chemistry Bill, if passed, will provide tax incentives to industry for the research, development, and implementation of green chemistry technologies.

EniChem
Italy, France, United Kingdom, Germany, Belgium, Hungary, United States

National Research Program for Chemistry, funded by Research Ministry for Chemistry for quality life; National Research Program for Environment, funded by Research Ministry *[no description given]*

PART IV: INFORMATION COLLECTION/DISSEMINATION ACTIVITIES

5. Are you aware of any mechanisms for identifying on-going sustainable chemistry activities in your country (e.g. a survey)? _________ (Yes or No) If yes, please describe

Australia
Environment Australia

EnviroNET is a network of databases that are designed to link people with the latest research on environmental initiatives. This network addresses the environment protection needs of the community at different levels: education, research and development, environmental technologies, and industry expertise. EnviroNET Australia has, since its launch in December 1995, generated world-wide interest from government, business, industrial, scientific and academic organizations and is being accessed over 20,000 times each month.

The information on the EnviroNET Australia network was collected by the Environment Protection Group of the Federal Environment Department in partnership with industry stakeholders. These include the CRC for Waste Management and Pollution Control, the Environment Industry Development Network, the Environment Management Industry Association of Australia, the National Science TAFE Network, and the University of Queensland.

Because not everyone has access to the Internet, the Department of the Environment has worked with the Environment Management Industry Association of Australia to set up alternative access by providing information on environment protection solutions by phone Australia-wide.

France
ADEME

ADEME carries out surveys on pollution problems in the chemical sector to identify the existing process to reduce the pollution.

France
INERIS

Activities coordinated by the French professional association of the chemical industry (UIC) promotes the Responsible Care approach, the Product Stewardship approach, and the managerial approach in health, safety, and the environment.

Germany
University of Bremen

Formal and informal contacts have been established with universities and scientific institutions in Germany and other countries.

Germany, Niedersachsen
University of Oldenburg, Organic Chemistry I

Waste-free techniques of chemical production are being developed in almost unsupported but pioneering academic institutions by gas/solid- and solid/solid-reactions that give 100% yield. These do not find reasonable support for some strange reasons in Germany, despite their unbeatable environmental benefit. They are thus only published in scientific journals or in the patent literature (German) and are presented in lectures at international conferences. Further information is available in the Internet.

Germany
Max-Planck-Institut fur Kohlenforschung (MPI)

There are no specific mechanisms or general information systems on chemical research.

Germany
German Aerospace Center, Project Management;
Organisation on behalf of the Federal Ministry of Education, Research, and Technology

A survey on “Product and Production Integrated Environmental Protection at the Chemical Industry” was conducted by the Federal Ministry of Education, Science, Research, and Technology and published by VDI - Technologiezentrum (Physikalische Technologien, Graf-Recke-Str. 84, D-40239 Dusseldorf).

Germany
Fachgruppe Umweltchemie und Okotoxikologie Gesellschaft Deutscher Chemiker

The working group “Resource and Environment Savings Synthesis” of the professional group “Environmental Chemistry and Ecotoxicology” of the Society of German Chemists was founded in November 1997. The programme is similar to that of the USEPA for green chemistry. The working plan is published in the newspaper of the professional group.

Italy
ICS-UNIDO

ICS-UNIDO is currently working on a global survey of catalytic processes and chemical technologies, focusing on their environmental impact and on guidelines on how to transform existing technologies to clean ones.

Italy
Dipartimento di Chimica Industriale e dei Materiali Universita di Bologna - (DCIM)
Agenzia Nazionale per la Protezione dell' Ambiente (ANPA)

There are on-going collaborations between ANPA and INCA, ANPA and DCIM, and there is activity within the Environmental Division of the Italian Chemistry Society.

Italy
INSTM (Consorzio Interuniversitario Nazionale per la Scienza e tecnologia dei materiali)

The consortium Interuniversitario "La Chimica per l'Ambiente" should be better informed.

Italy
Regione Abruzzo Settore Ecologia e Tutela Ambiente

In Italy there are Eolic plants to produce electricity.

Japan
Japan Chemical Innovation Institute; Ministry of International Trade and Industry; Chemical Society of Japan; Society of Chemical Engineers of Japan; Japan Chemical Industry Association; Japan Bio-Industry Association

There is no established local or nation-wide mechanism for promoting sustainable chemistry activities. The Japan Chemical Innovation Institute intends to include the sustainable chemistry activity as one of its subjects to work on.

For the moment, the offices listed below can respond to inquiries or questions relating to sustainable activities in their respective area.

1) Japan Chemical Innovation Institute
Fax: +81-3-5282-5272, Attention: Akira Kanai
E-mail kanai@jcii.or.jp

2) Ministry of International Trade and Industry
Fax: +81-3-3501-0196, Attention: Hisao Ida

3) Chemical Society of Japan
Fax: +81-1-3292-6318, Attention: Takeshi Tomura

4) Japan Chemical Engineering Association
Fax: +81-3-3943-3530, Attention: Katsuhiko Takaya

5) Japan Chemical Industry Association
Fax: +81-3-3580-0764, Attention: Keiichi Torii

6) Japan Bio-Industry Association
Fax: +81-3-5541-2737, Attention: Atsushi Hirano

Republic of Korea
Ministry of Environment and National Institute of Environmental Research (NIER);
The Korean Chemical Society (KCS)

When deciding on research projects as mentioned in Part II (research), the government has encouraged industry and academia to participate in seeking useful research projects. This process has been conducted by the Ministry of Environment and the NIER.

United Kingdom
ICI PLC

The Royal Society of Chemistry (RSC) is planning to launch a green chemistry network later this year which is proposed to include a national database on green chemistry linked to other overseas networks via the RSC Web site.

It should be noted that much chemistry not describing itself as sustainable or green, and not explicitly targeted at a sustainable chemistry objective, will in fact make possible an improvement in the environmental impact of a product or process. For this reason, a broad general chemistry-based search is needed to maximize coverage of sustainable chemistry activities.

United States
United States Environmental Protection Agency (USEPA)

1. EPA's Green Chemistry Program

   EPA's Green Chemistry Program and its partners continually identify green chemistry activities in the United States through its various program activities, in particular through its educational activities, grant programs, and the Presidential Green Chemistry Challenge.

2. The Green Chemistry Institute

   The Green Chemistry Institute and its partners continually identify green chemistry activities in the United States through its various program activities, in particular through its grant programs.

6. Are you aware of any databases in your country which contain technical information on sustainable chemistry projects? _________ (Yes or No)

Australia
Environment Australia

EnviroNET as described above in Part IV, #5.

Belgium
VITO - BAT centre

The BBT/EMS database contains information on cleaner technologies in general and/or per industrial sector.

France
ADEME

ADEME is working on a database collecting all non-confidential data available in ADEME on air pollution and wastes that are generated by the chemical sector.

France
INERIS

Technical information on sustainable chemistry projects exists at the UIC organization but may not be in database form.

Germany
University of Oldenburg, Organic Chemistry I

UFORDAT and ULIDAT include relevant work.

Germany
Max-Planck-Institut fur Kohlenforschung (MPI)

There are specific databases or general information systems on chemical research.

Italy
ICS-UNIDO

The outputs of the survey indicated in Part IV, #5 will be implemented on the web page of ICS-UNIDO (http://www.ics.trieste.it/).

Italy
INSTM (Consorzio Interuniversitario Nazionale per la Scienza e tecnologia dei materiali)

The consortium Interuniversitario "La Chimica per l'Ambiente" should be better informed.

Italy
Interuniversity Consortium "Chemistry for the Environment" (INCA)

INCA, ANPA, ENEA (Environment Department), CNR (Consulting National Committee for Environment and Habital Sciences and Technologies) *[no description given]*

Japan
Japan Chemical Innovation Institute; Ministry of International Trade and Industry; Chemical Society of Japan; Society of Chemical Engineers of Japan; Japan Chemical Industry Association; Japan Bio-Industry Association

There is no centralized database on sustainable chemistry projects. Databases for specified areas exist. The URL for one is given below.

1. Database of Super Critical Fluid: <http://www.aist.go.jp/RIODB/scf/>

Republic of Korea
Ministry of Environment and National Institute of Environmental Research (NIER); The Korean Chemical Society (KCS)

Databases exist but are not directly related to sustainable chemistry. The URLs for two of these are given below.

1. Integrated Chemical Safety Information DB, DB on the Circulation of Chemicals: <http//www.nier.go.kr/krptc/krptc.html>

2. KCS DB: <http//www.kcsnet.or.kr/publi/publications.html>

United Kingdom
ICI PLC

1. BEST: British Expertise in Science and Technology
2. CRIB: Current research in Britain
3. database of projects funded by the UK Research Council: www.oaklands.co.uk
4. ACTIN: Alternative Crops Technology Interaction network
5. and possibly SORIS: Specialised Organics Information Service
6. CORDIS Projects Database and EUREKA Database (operated at the European level)

United States
United State Environmental Protection Agency (USEPA)

1. EPA's Green Chemistry Program keeps databases of technical information on green chemistry activities collected through its various program activities, in particular through its grant programs and the Presidential Green Chemistry Challenge. EPA's Green Chemistry Program is also currently developing a "Green Chemistry Expert System."

2. NSF, DOE, and other federal government agencies also keep databases of technical information on green chemistry activities collected primarily through their grant programs.

7. How is information on sustainable chemistry activities made available to the public? (If there are Internet Web sites associated with sustainable chemistry activities, please provide the URL address.)

Australia
Environment Australia

1. EnviroNET: <www.environment.gove.au/net/environet.html>

2. EnviroLink (information on environment protection solutions is available by phone Australia-wide via a Freecall: 1 800 500 289)

3. Commonwealth of Australian Chemical Gazette

Belgium
VITO - BAT centre

1. BBT/EMIS: <http://www.vito.be/emis/bbt/kennis.htm>

Canada
Environment Canada

1. CCME: <http://www.ccme.ca/ccme/brochure.html>

France
ADEME

ADEME informs the public on these programmes in a paper "Lettre de l'ADEME" and in other French reviews.

France
INERIS

[no description given - the UIC organization can be consulted for specific information]

Germany, Niedersachsen
University of Oldenburg, Organic Chemistry I

1. Internet Web sites (http://kaupp.chemie.uni-oldenburg.de)

2. regular publications

3. lectures on conferences

Germany
Max-Planck-Institut fur Kohlenforschung (MPI)

Responder is not aware of any specific advertisements/publications.

Germany
German Aerospace Center, Project Management;
Organisation on behalf of the Federal Ministry of Education, Research, and Technology

1. Selected projects are available on Internet Web sites (http://www.dir.de/ut/uthome.htm)

2. Further information (final reports of projects) are available at Universitatobibliothek Hannover, Technische Informationsbibliothek (TIB), Welfengarten 1B, D-30167 Hannover

Germany
Fachgruppe Umweltchemie und Okotoxikologie Gesellschaft Deutscher Chemiker

1. Information about the working group “Resource and Environment Saving Synthesis” can be obtained from the Internet (http://www.ta-bs.de/institute/oekochem/Ak-umweltchemie); a printout from the Internet and a paper outlining the principal positions in German language are added

Italy
International Union of Pure and Applied Chemistry (IUPAC)

1. IUPAC: <http:\\www.chem.qmw.ac.uk/iupac/iupac.html>

Italy
ICS-UNIDO

1. See Part IV, #6

2. Organization of ICS-UNIDO training courses and workshops in various developing countries

Italy
Dipartimento di Chimica Industriale e dei Materiali Universita di Bologna - (DCIM)
Agenzia Nazionale per la Protezione dell' Ambiente (ANPA)

1. Technical reports or information available on request

Italy
Interuniversity Consortium "Chemistry for the Environment" (INCA)

1. INCA: <http://www.unive.it/inca>
2. ENEA: <http://www.sede.enea.it>
3. CNR: <http://www.cnr.it>

Italy
Regione Abruzzo Settore Ecologia e Tutela Ambiente

1. Information is made available to the public by meetings and text books (there are no Internet Web sites)

Japan
Japan Chemical Innovation Institute; Ministry of International Trade and Industry; Chemical Society of Japan; Society of Chemical Engineers of Japan; Japan Chemical Industry Association; Japan Bio-Industry Association

1. Internet Web sites including Information on Safety of Chemical Products: <http://www.jcia-net.or.jp>

2) Publications including Annual Report on Responsible Care Activity in Japan (Japan Responsible Care Association)

3) Open courses including Courses for Local Public Administrators (with participants of about 500 annually)

Republic of Korea
Ministry of Environment and National Institute of Environmental Research (NIER);
The Korean Chemical Society (KCS)

1. Internet Web site: <http//www.nier/go.kr/krptc/krptc.html>
2. KCS's web site on sustainable chemistry: <http//www.kcsnet.or.kr/green/green.html>

Sweden
National Board for Technical and Industrial Development (NUTEK)

Information on sustainable chemistry is made available through dissemination activities which are mandatory for projects in NUTEKs program. Other information sources are the web sites of the academic institutions, the research institutes, and NUTEK.

United Kingdom
ICI PLC

1. ACTIN: <http://www.actin.co.uk>

2. Research Councils: <http://www.epsrc.ac.uk>, <http://www.bbsrc.ac.uk>, <http://www.nerc.ac.uk>

3. Technology Foresight Programme (chemicals panel); Natural Resources and the Environment Panel (materials panel): <http://www.foresight.gov.uk>; Chemical Societies Network: <http://www.chemsoc.org>; Link Directorate: <http://www.dti.gov.uk/ost/link>; Institute of Applied Catalysis: <http://www.iac.org.uk>; Sustech: <http://www.cefic.be/sustech/>

United States
United States Environmental Protection Agency (USEPA)

1. conference, symposia, workshops, and other meetings

2. mailings

3. Internet Web sites; primary sites: <http://www.epa.gov/greenchemsitry>, <http://es.epa.gov/ncerqa/grants/>, http://www.nsf.gov/geo/egch/envresop.htm>, <http://www.acs.org>,<http://www.acs.org/meetings/gcec98.htm>, <http://www.lanl.gov/Internal/projects/green/index.html>, <http://www.grc.uri.edu/programs/1998/green.htm>

8. Please list any meetings, conferences or symposia on sustainable chemistry that are planned or have recently been held in your country on the subject of sustainable chemistry.

Title of Meeting/Conference	Date of Meeting/Conference	Contact Point
Australia **Environment Australia**		
Polymers of Low Concern Focus Group	28 April 1998 29 May 1998	Megan Smith Chemical Assessment Division NOHSC P.O. Box 58 Sydney NSW 2001 Australia
Belgium **Inspec Belgium N.V.**		
NAWAROS 98	8-9 June 1998	Tracey Murray IRC Niedersachsen/Sachsen-Anholt Gustav-Adolf-Strasse 23 39106 Magdeburg Germany Tel: 49 391 671.85.33 Fax: 49 391 671.12.13 E-mail: tti-irc.md@I-online.de
France **INERIS**		
Responsible Care and Management	17 June 1998	UIC
Germany **University of Bremen**		
Workshop on reliability of QSAR	1994	Fastorff (See Below)
Expert meeting on the future of sustainable chemistry	October 1996	M. Wolcke Federal Institute of Occupational Safety and Health
Germany **Max-Planck-Institut fur Kohlenforschung (MPI)**		
OMCOS G	20-25 July 1997	(general aspects of catalysis in chemical synthesis)
12th European Symposium on Fluorine Chemistry	29 August - 2 September 1998	(includes a section on ‘new solvents’)
31. Jahrestreffen deutscher Katalytiker	March 1998	(general aspects of catalysis in chemical synthesis)

Germany **Fachgruppe Umweltchemie und Okotoxikologie Gesellschaft Deutscher Chemiker**		
Wege und Beitrage der Chemie zu Sustainable Development	3-4 November 1997 Heidelberg, Jahrestagung der Fachgr. Umweltchemie u. Okotoxikologie	Vorsitzender der Fachgruppe, Professor Dr. E. Bayer, siehe auch Presseerklarung der GD Ch (beigefugt)
Umwelt und Chemie-Innovationen und Produktdesign	27-30 September 1998 Karlsruhe	Gesellschaft Deutsher Chemiker, Dr. Behret
Umweltschonende Synthesen; gemeinsame Tagung der Liebig-Vereinigung u. Der Fachgruppe Umweltchemie u. Okotoxikologie	geplant fur March 1999 in Tubingen	Professor Dr. E. Bayer
Italy **International Union of Pure and Applied Chemistry (IUPAC)**		
General Conference of IUPAC Berlin	September 1999	
Italy **ICS-UNIDO**		
Trends in Catalysis in Industrial Application	27-29 April 1998 Trieste E.G.M.	Prof. S. Miertus (Secreteriat: M. Varvesi) ICS-UNIDO Tel: 39 40 922 8116
Environmental Pollution and BATEV in Remediation	19-21 March 1998 Trieste E.G.M.	Prof. S. Miertus (Secreteriat: M. Varvesi) ICS-UNIDO Tel: 39 40 9228116 Fax: 39 40 9228115
Forum for the Diffusion of Environmental Plastics	16-18 April 1998 Trieste E.G.M.	Prof. S. Miertus (Secreteriat: M. Varvesi) ICS-UNIDO Tel: 39 40 9228116 Fax: 39 40 9228115
Remediation Technologies: New Trends and Tools For Soil Decontamination	20-25 July 1998 Poland T.C.	Prof. S. Miertus (Secreteriat: M. Varvesi) ICS-UNIDO Tel: 39 40 9228116 Fax: 39 40 9228115
New Catalytic Systems and Processes Applicable to Small and Medium Enterprises - BATEV	28 September - 3 October 1998 Slovak Republic Workshop	Prof. S. Miertus (Secretariat: M. Varvesi) ICS-UNIDO Tel: 39 40 9228116 Fax: 39 40 9228115

Italy **Dipartimento di Chimica Industriale e dei Materiali Universita di Bologna (DCIM)** **Agenzia nazionale per la Protezione dell'Ambiente (ANPA)**		
Environmental Chemistry Third Annual Meeting	17-20 June 1998	Prof. A. RIVA Tel: 39 051 6443681 Fax: 39 051 6443681
RICICLA 98	September 1998	Prof. L. MORSELLI Tel: 39 051 6443668 Fax: 39 051 6443668
National School on Waste Management	September 1998	Prof. A. TATICCHI University of Perugia Tel: 39 075 5855537
Italy **Consorzio Interuniversitario Nazionale per la Scienza e tecnologia dei Materiali (INSTM)**		
1 Convegno Nazionale sulla Scienza e Tecnologia dei Materiali	April 97	INSTM
Tecnologie Chimiche compatibili	June 97	SCI - Divisione chimica Industriale Gruppo Interdivisionale di catalisi
Italy **Interuniversity Consortium "Chemistry for the Environment" (INCA)**		
"The first National Congress of the Interuniversity Consortium - Chemistry for the Environment"	26-28 February 1997 Ferrara, Italy	http://www.unive.it/inca
International Conference "Green Chemistry: Challenging Perspectives"	28 September - 1 October 1997 Venice, Italy	http://www.unive.it/inca
The first post-graduate Summer School on Green Chemistry	29 August - 7 September 1998 Venice, Italy	http://www.unive.it/inca
Japan **Japan Chemical Innovation Institute; Ministry of International Trade and Industry; Chemical Society of Japan; Society of Chemical Engineers of Japan; Japan Chemical Industry Association; Japan Bio-Industry Association**		
Annual Meeting of the Chemical Society of Japan Symposium "Chemistry under Critical Reaction Conditions"	14-19 September 1998	Ehime University, Matsuyama-Shi, Ehime-ken
Symposium on Development of Technologies for Chemical Process of Next Generation		
Seminar on Risk Assessment System	annual	industry participants

Republic of Korea **Ministry of Environment and National Institute of Environmental Research (NIER);** **The Korean Chemical Society (KCS)**		
1998 Symposium on Operation of Environment Day (Focusing on Risk Assessment and Management)	2 June 1998	Risk Assessment Research Division - NIER
Workshop on Green Chemistry	23-24 October 1998	KCS
Sweden **National Board for Technical and Industrial Development (NUTEK)**		
Project conference on sustainable surface treatment	planned for fall 1998	
Switzerland **Swiss Federal Institute of Technology (ETH, Zurich)**		
R'99 (4th World Congress) Recovery, Recycling, Re????	2-5 Feb 1999	Flan Bahle Tel: 71 1 386 4444
R95, R97		Flan Bahle Tel: 71 1 386 4444
IEB Geneva Special Waste	1990	Inter Environ???? 61, ???, CH 1208 Geneva
United Kingdom **ICI PLC**		
Gordon Conference on Green Chemistry	July 1997	Prof. James Clark University of York
Organic Electrochemistry: Moving Towards Clean and Selective Synthesis	April 1998	Dr. J. Hendkovic GSF
7th International Symposium: The Activation of Oxygen and Homogeneous Catalytic Oxidation	July 1998	Dr. John Gibson Royal Society of Chemistry
N.B. Many meetings and conferences contain contributions which will lead to sustainable chemistry, but which are not explicitly identified as meetings or conferences devoted to sustainable chemistry		
United States **United States Environmental Protection Agency** (USEPA)		
1998		
1998 SETAC Conference: Green Chemistry Session	November 1998	(Green Chemistry session; Green Chemistry - Designing Chemical Products and Processes for the Environment presentation)
1998 Gordon Conference on Green Chemistry	16-21 August 1998 New Hampshire	William Tumas Los Alamos National Laboratory

15th Biennial Conference on Chemical Education	9-13 August 1998 University of Waterloo, Waterloo, Ontario, Canada	(Green Chemistry session; Green Chemistry - A New Approach to Pollution Prevention presentation)
2nd National Green Chemistry & Engineering Conference	30 June - 2 July 1998 Washington, DC	Paul T. Anastas USEPA
1998 Micro Scale Chemistry Workshop	15-19 June 1998 Merrimack College North Andover, MA	
1998 Small Scale Chemistry Workshop	15-26 June 1998 Colorado State University Fort Collins, CO	
NETI Workshop	11-12 June 1998 University of Massachusetts Amherst, MA	
LANL Workshop	April 1998	
Central North Carolina ACS Section Meeting	23 April 1998 University of North Carolina, Greensboro, Greensboro, NC	(Green Chemistry - Designing Chemical Products and Processes for the Environment presentation)
Continuing Education Committees of the Society for Analytical Chemists of Pittsburgh and the Spectroscopy Society of Pittsburgh (symposium on Pollution Prevention in the Chemistry Laboratory)	18 April 1998 Pittsburgh, PA	(Green Chemistry - Designing Chemical Products and Processes for the Environment presentation)
215th American Chemical Society National Meeting:	29 March - 2 April 1998 Dallas, TX	(The Presidential Green Chemistry Challenge symposium; The Presidential Green Chemistry Challenge exhibit)
1998 Pittsburgh Conference:	2-5 March 1998 New Orleans, LA	(The Presidential Green Chemistry Challenge exhibit)
	1997	
Florida Environmental Conference	2-6 December 1997	
Pollution Prevention - Green Chemistry for Chemical and Petroleum Refining Industries Conference	29 October 1997 Rice University Houston, TX	
EPA Pollution Prevention - Green Manufacturing Conference for Industry and Business	17-19 November 1997 Atlanta, GA	

Annual CCR Meeting	27-30 September 1997 St. Louis, MO	
214th American Chemical Society National Meeting	September, 1997 Las Vegas, NV	(The Presidential Green Chemistry Challenge exhibit)
Gordon Conference on Supermolecules and Assemblies	10-15 August 1997 Newport, RI	(Clean Chemistry in Structured Systems session)
1st National Green Chemistry & Engineering Conference	23-25 June 1997 Washington, DC	
1997 Micro Scale Chemistry Workshop	17 June 1997 Merrimack College North Andover, MA	
Small Scale Chemistry Workshop	2-4 June 1997 Colorado State University Fort Collins, CO	
213th American Chemical Society National Meeting:	13-17 April 1997 San Francisco, CA	(Green Chemistry/Environmentally Sustainable Manufacture as a Competitive Advantage symposium; The Presidential Green Chemistry Challenge exhibit)

9. Who can be contacted for more information concerning this survey?

<u>AUSTRALIA</u>

Environment Australia

Name:	Mr. Gareth Rees Assistant Director
Address:	International Chemicals and Scheduled Waste Section Chemicals and the Environment Branch Environment Australia P.O. Box E305 Kingston ACT 2604 Australia
Telephone:	61 2 6274 1516
Fax:	61 2 6274 1610
E-Mail:	*Not provided.*

<u>BELGIUM</u>

Group Tessenderlo

Name:	Not provided.
Address:	Not provided.
Telephone:	Not provided.
Fax:	Not provided.
E-Mail:	Not provided.

Inspec Belgium N.V.

Name:	Decadt Ghislain
Address:	Njeune Neg 1 Haven 1053 8-2070 Zwjnjrecht Belgium
Telephone:	00 32 3 2509279
Fax:	00 32 3 2509072
E-Mail:	ghislain.decadt@ispec.be

Shell Research SA

Name: J.A.N. Scott
Address: Shell Research SA
Ave Jean Monnet 1
B-1348 Louvain-la-Neuve
Belgium
Telephone: 00 32 10 477 255
Fax: 00 32 10 477 219
E-Mail: j.scott@msmail.satcllln.simis.com

Agfa-Gevaert N.V.

Name: Peter Verschave
Address: Agfa Gevaert N.V.
Septestraat 27
2640 Mortsel
Belgium
Telephone: 3 444 3788
Fax: 03 444 3787
E-Mail: verschave@twi.agfa.be

Ministere de l’Emploi et du Travail

Name: Not provided.
Address: Not provided.
Telephone: Not provided.
Fax: Not provided.
E-Mail: Not provided.

VITO - BAT centre

Name: VITO - Mr. DYKMANS
Address: Boerentang 200
2400 MOL
Belgium
Telephone: 014 33 55 11
Fax: Not provided.
E-Mail: Not provided.

CANADA

Environment Canada

Name: Ruth Brydon
Address: Commercial Chemicals Evaluation Branch
Environment Canada
Place Vincent Massey, 14th Floor
351 St. Joseph Blvd.
Hull, Quebec, K1A OH3
Telephone: 819 997 7588
Fax: 819 953 4936
E-Mail: ruth.brydon@ec.gc.ca

FRANCE

ADEME

Name: Anne Paiuier
Address: ADEME
27, rue Louis Vicat
75737 Paris
France
Telephone: 01 4765 2163
Fax: 01 4642 5443
E-Mail: Not provided.

INERIS

Name: J.F. Raffoux
Address: B.P. 2
60560 Verneuil-en-H.
France
Telephone: 03 4455 6317
Fax: 03 4455 6600
E-Mail: Not provided.

Institute National de Recherche et de Securite

Name: Jean Francois Blanchier
Address: Not provided.
Telephone: 01 4044 3009
Fax: 01 4044 3099
E-Mail: Not provided.

Ministry of Environment

Name: Jean-Paul Ventere
Address:
Telephone: 01 4219 1557
Fax: 01 4219 1668
E-Mail: Not provided.

GERMANY

University of Bremen

Name: Prof. Dr. Tsernd Fastorff
Address: University of Bremen
Center of Environmental Research
and Technology, Leobenerstr
D-28359 Bremen,
Germany
Telephone: 49 421 218 7644
Fax: 49 421 218 7645
E-Mail: FASTORFF@UFT.UNI-BREMEN.DE

University of Oldenburg

Name: Prof. Dr. Gerd Kaupp
Address: University of Oldenburg
Organic Chemistry I
Postfach 2503
D-26111 Oldenburg
Germany
Telephone: 49 441 798 3842
Fax: 49 441 798 3409
E-Mail: kaupp@kaupp.chemie.uni-oldenburg.de

Max-Planck-Institut fur Kohlenforschung (MPI)

Name: Priv.-Doz. Dr. Walter Leitner
Address: Max-Planck-Institut fur Kohlenforschung
Kaiser-Wilhelm-Plazt 1
D-45468 Mulheim an der Ruhr
Germany
Telephone: 49 208 306 2272
Fax: 49 208 306 2993
E-Mail: Leitner@mpi-muelheim.mpg.de

German Aerospace Center, Project Management;
Organisation on behalf of the Federal Ministry of Education, Research, and Technology

Name: Bernd Hartmann
Address: Deutches Zentrum fur Lutt und Raumfahrt
Sudstrasse 125
D-53175 Bonn
Germany
Telephone: 49 228 382 1147
Fax: 49 228 382 1258
E-Mail: bernd.hartmann@dh.de

Fachgruppe Umweltchemie und Okotoxikologie Gesellschaft Deutscher Chemiker

Name: Professor Dr. Ernst Bayer
Address: Forschungsstelle fur Nukleinsarue und Peptidchemie Institute fur Organische Chemie
Universitat Tubingen
Auf der Morgenstelle 18
D-72076 Tubingen
Germany
Telephone: 49 707 129 72437
Fax: 49 707 129 5034
E-Mail: ernst.bayer@uni-tuebingen.de

Federal Environmental Agency

Name: Dr. Steffi Richter
Address: Federal Environment Agency
Seeckstr. 8-10
D-13851 Berlin
Germany
Telephone: 49 308 903 3275
Fax: 49 308 903 3993
E-Mail: Steffi.Richter@UBA.de

ITALY

International Union of Pure and Applied Chemistry (IUPAC)

Name: Prof. Pietro Tundo
Address: Chairman of the Working Party
Dorsoduro 2137
30123 Venice
Italy
Telephone: 39 41 257 8642
Fax: 39 41 257 820
E-Mail: tundop@unive.it

Tuscan Environmental Protecting Agency (ARPAT)

Name: Dr. Marco Mazzoni
Address: Via Paganini 66
5D127 Firgnre
Italy
Telephone: 39 055 320 6314
Fax: 39 055 320 6324
E-Mail:

ICS-UNIDO

Name: Prof. S. Miertus (secreteriat: M. Varvesi)
Address: ICS-UNIDO
Area Science Park, Padriciano 99
34012 Trieste
Italy
Telephone: 39 40 922 8114 (922 8116)
Fax: 39 40 922 8115
E-Mail: Varvesi@sci.area.trieste.it
Miertus@sci.area.trieste.it

Dipartimento di Chimica Industriale e dei Materiali Universita di Bologna (DCIM)
Agenzia Nazionale per la Protezione dell'Ambiente (ANPA)

Name: Prof. A. Riva
Address: DCIM - Universita degli Studi di Bologna
Viale del Risorgimento, 4
40136 Bologna
Italy
Telephone: 39 051 644 3681
Fax: 39 051 644 3681
E-Mail: riva@ms.fci.unibo.it

Consorzio Interuniversitario Nazionale per la Scienza e tecnologia dei material (INSTM)

Name: Adriano Zecchina
Address: Via P. Giuria 7
10125 Torino
Italy
Telephone: 39 11 670 7537
Fax: 39 11 670 7855
E-Mail: Zecchina@ch.unito.it

Interuniversity Consortium "Chemistry for the Environment" (INCA)

Name: Dr. Giuseppe Blasco
Address: Dorsoduro 2137
30123 Venice
Italy
Telephone: 39 41 257 8620
Fax: 39 41 257 8620
E-Mail: blasco@unive.it

Regione Abruzzo Settore Ecologia e Tutela Ambiente

Name: Regione Abruzzo - Settore Ecologia E.T.A.
Address: Plaza Unione
A3-65100 Pescara
Italy
Telephone: 39 85 151 1651
Fax: 39 85 151 6559
E-Mail: *Not provided.*

JAPAN

Japan Chemical Innovation Institute; Ministry Of International Trade And Industry Chemical Society Of Japan; Society Of Chemical Engineers of Japan; Japan Chemical Industry Association; Japan Bio-industry Association

Name: Akira Kanai
Address: Fuzambo Bldg.
1-3-5, Kanda Jimbouchou
Chiyoda-ku Toyko 101-0051
Japan
Telephone: 81 3 5282 7272
Fax: 81 3 5282 0250
E-Mail: kanai@jcii.or.jp

REPUBLIC OF KOREA

Ministry of Environment and National Institute of Environmental Research (NIER); The Korean Chemical Society (KCS)

Name A1:	Dr. Kyung-Hee Choi NIER 613-2 Bulkwang-dong. Eurpyung-gu, Seoul, Korea
Address:	635-4 Yeogsam-dong Kangnam-gu, Seoul 135-703 Korea
Telephone:	82 2 382 1638
FAX:	82 2 388 7987

Name A2:	Mr. Ki-Seon Han. Head of Division Hazardous Substance Management Division Ministry of Environment, Kwacheon Korea Address: 635-4 Yeogsam-dong Kangnam-gu, Seoul 135-703 Korea
Telephone:	82 2 504 9288
FAX:	82 2 504 6068

Name B:	The Korean Chemical Society
Address:	635-4 Yeogsam-dong Kangnam-gu, Seoul 135-703 Korea
Telephone:	82 2 3453 4018
Fax:	82 2 3453 2785
E-Mail:	*Not provided.*

SWEDEN

National Board for Technical and Industrial Development (NUTEK)

Name:	Nils Gabrielsson
Address:	NUTEK-BIOBAS 117 86 Stockholm Sweden
Telephone:	46 8 681 9303
Fax:	46 8 681 9365
E-Mail:	nils.gabrielsson@nutek.se

SWITZERLAND

Swiss Federal Institute of Technology (ETH, Zurich)

Name: Konrad Hungerbuhler
Address: Universitatstr 31
CH-8092 Zurich
Switzerland
Telephone: 41 1 631 6098
Fax: 41 1 632 1053
E-Mail: hungerb@tech.chem.ethz.ch

UNITED KINGDOM

ICI PLC

Name 1: Dr. F.G. Rose
Address: SSME Dept
9 Millbank
London SWIP 33F
United Kingdom
Telephone: 0191 798 5403
Fax: 0171 798 5862
E-Mail: frank.rose@ici.com

Name 2: Neil Winterton
Address: Research & Technology Dept.
Runcorn Technical Centre
P.O. Box 8, The Heath
Runcorn, Cheshire
WA7 4QD
United Kingdom
Telephone: 0192 851 3087
Fax: 0192 856 7979
E-Mail: *Not provided.*

UNITED STATES OF AMERICA

United States Environmental Protection Agency

Name: Paul T. Anastas or Tracy C. Williamson
Address: Office of Pollution Prevention and Toxics (MC 7406)
U.S. Environmental Protection Agency
401 M Street, SW
Washington, DC 20460
USA
Telephone: 202 260 2659
Fax: 202 260 0816, 202 260 0981
E-Mail: anastas.paul@epa.gov, williamson.tracy@epa.gov

MULTI-NATIONAL

EniChem (*Italy, France, United Kingdom, Germany, Belgium, Hungary, United States*)

Name: Bruno Piperno Beer
Address: Piazza Boldrini 1
20097 S. Donato Milanese MI
Italy
Telephone: 39 2 520 32579
Fax: 39 2 520 42864
E-Mail: Bruno_Piperno@hq.enichem.geis.com

Euro (*Europe* - *Worldwide*)

Name: Loys Adseen
Address: Av. E. Van Nieunden Reyse 4
Box 2 Belgium/Brussels
Belgium
Telephone: 32 2 676 7251
Fax: 32 2 676 7241
E-Mail: ase@cefrc.be

LIST OF ACRONYMS

AUSTRALIA

BELGIUM

FNC - [*not given*]
IWT - [*not given*]
BBT/EMS - [*not given*]

CANADA

CCME - The Canadian Council of Ministers of the Environment

FRANCE

ACFCI - l'Assemble des Chambres Francaise de Commerce et d'Industrie
ADEME - [*not given*]
AFNOR - l'Association Francaise de Normalisation
CNRS - [*not given*]
IFP - ENSPM - [*not given*]
INERIS - [*not given*]
INRS - Institute National de Recherche et de Securite
UIC - (French professional association of the chemical industry)

GERMANY

BMBF - [*not given*]
DBU - Deutsche Bundesstiftung Umwelt (German Federal Foundatin Environment)
DFG - Deutsche Forschungs-gemeinschaft
GD Ch - Gesellschaft Deutscher Chemiker
MPI - Max-Planck-lnstitut fur Kohlenforschung

ITALY

ANPA - Agenzia Nazionale per la Protezione dell'Ambiente
ARPAT - Tuscan Environmental Protecting Agency
CNR - Consiglio Nazionale delle Ricerche
DCIM - Dipartimento di Chimica Industriale e dei Materiali Universita di Bologna
ENEA - [*not given*]
ICS/UNIDO - [*not given*]
INCA - Interuniversity Consortium "Chemistry for the Environment"
INCA /EU TMR - Interuniversity Consortium "Chemistry for the Environment"/European Union Training and Mobility of Researchers Programme
INSTM - Consorzio Interuniversitario Nazionale per la Scienza e tecnologia dei materiali
MURST - Ministry of University, Research, and Technology
RECAM - [*not given*]

JAPAN

REPUBLIC OF KOREA

NIER -	National Institute of Environmental Research;
KCS -	Korean Chemical Society
TRI -	Toxics Release Inventory

SWEDEN

KTH -	Royal Institute of Technology
LU -	Lund University
NUTEK -	National Board for Technical and Industrial Development
SNAP -	NUTEK Competens Centre for Surfactants Based on Natural Products
CAP -	NUTEK Competens Centre for Amphiphilic Polymers from Renewable Resources

SWITZERLAND

ETH -	Swiss Federal Institute of Technology

UNITED KINGDOM

BBSRC -	Biotechnology and Biological Sciences Research Council
DTI -	Department of Trade and Industry
EPSRC -	Engineering and Physical Sciences Research Council
ICI PLC -	[*not given*]
RSC -	Royal Society of Chemistry

UNITED STATES

ACS -	American Chemical Society
ANL -	Argonne National Laboratory
CenCITT -	Center for Clean Industrial Treatment Technologies
CPAC -	Process Analytical Chemistry
CSMATE -	Center for Science, Mathematics, and Technology Education
LANL -	Los Alamos National Laboratory
NSF -	National Science Foundation
NIST -	National Institute of Standards and Technology
NREL -	National Renewable Energy Laboratory
PETE -	Partnership for Environmental Technology Education
USDOE -	United States Department of Energy
USEPA -	United States Environmental Protection Agency

MULTINATIONAL

IUPAC -	International Union of Pure and Applied Chemistry

ANNEX 2

SURVEY ON SUSTAINABLE CHEMISTRY ACTIVITIES

1. a. Name of ministry, academic institution or company that is reporting:

b. Country in which it is located

PART I: RESEARCH

2. Are you aware of any on-going or recently completed "sustainable chemistry" research activities in your country? ___________ (Yes or No)

If yes, please answer questions a-c below; otherwise, skip to question 3.

a. Is this research being conducted by government, industry, and/or academia (alone or in collaboration)?	**b. Describe the area of focus for such research (e.g. renewable feedstocks; environmentally benign solvents, etc.)**	**c. Who provides the financial support for this work (i.e. government, industry, and/or academia)`**

PART II: EDUCATION

3. Are you aware of any activities in your country designed to educate the public, students, workers, or others about sustainable chemistry (e.g. university course of sustainable chemistry)? ______ (Yes or No)

If yes, answer questions a-c below; otherwise, skip to question 4.

a. Who is responsible for such activities (i.e. government, academia, industry)?	**b. In what form is this education provided (e.g. course on sustainable chemistry, text books, etc.)**	**c. Who is the audience (e.g. university students, the public, workers, etc.)**

PART III: GOVERNMENT PROGRAMMES

4. Please describe any government policy or programme designed to promote sustainable chemistry (this could include, for instance, establishing incentives or recognition activities which reward industry or the scientific community for accomplishments in sustainable chemistry).

PART IV: INFORMATION COLLECTION/DISSEMINATION ACTIVITIES

5. Are you aware of any mechanisms for identifying on-going sustainable chemistry activities in your country (e.g. a survey)? If yes, please describe.

6. Are you aware of any databases in your country which contain technical information on sustainable chemistry projects? If yes, please describe.

7. How is information on sustainable chemistry activities made available to the public? (If there are Internet Web sites associated with sustainable chemistry activities, please provide URL address.)

8. Please list any meetings, conferences or symposia on sustainable chemistry that are planned or have recently been held in your country on the subject of sustainable chemistry.

Title of Meeting/Conference	Date of Meeting/Conference	Contact Point

9. *Who can be contacted for more information concerning this survey?*

Name ....

Address ....

....

....

Telephone Number ....

Fax Number ....

E-Mail Address ....

Annex II: List of Participants

AUSTRALIA	
Ms Deborah WILLCOCKS Existing Chemicals Section Worksafe Australia 4 rue Puyals, le Cazal 11300 Limoux France	mcgrath@enternet.com.au
AUSTRIA	
Mr Erwin TOMSCHIK FCIO Wiedner Hauptstraáe 63 1045 Wien	Tel 43-1 501 05 3348 Fax 43 1 502 06 280 TomschikE@fcio.wk.or.at
BELGIUM	
Ms Anne JACOBS BAT Centre Boeretang 200, B 2400 MOL.	Tel 32 14 33 58 64 Fax 32 14 32 11 58 Jacobsa@vito.be
Mr. G.J. MARTENS Direction Centrale des Recherches Laboratoire Central Rue de Ransbeek 310 Solvay s.a. B1120 Bruxelles	Tel 32 2 264 2158 Fax 32 2 264 3245
Mr Diederik SCHOWANEK Environmental Scientist Procter & Gamble EUROCOR Temselaan 100 B-1853 Strombeek-Bever	Tel 32 2 456 29 00 Fax 32 2 456 28 45 schowanek.d@pg.com
CANADA	
Mr Ian BRINDLE Brock University Chemistry Department St Catharines, Ontario L2S 3A1	Tel 1 905 688 5550 X3545 Fax 1 905 682 9020 ibrindle@spartan.ac.brocku.ca
Mr John KEATING Natural Resources Canada 580 Booth Street Ottawa K25 158	Tel: 1 613 992 4409 Fax: 1 613 943 8453 Jkeating@nrcan.gc.ca

DENMARK	
Ms Lise Emmy MOLLER Danish EPA Strandgade 29 DK 1401 Copenhagen K	Tel 32 66 01 00 Fax 32 66 04 79 lj@mst.dk
FRANCE	
Mr Michel SPAGNOL Senior Manager, Rhone Poulenc Catalysis Department 24 Avenue Jean-Jaures F 69153 Decines –Charpieu Cedex	Tel 33 4 72 93 67 54 Fax 33 4 72 93 68 90 Michel.spagnol@crit.rhone-poulenc.com
GERMANY	
Mr BAYER Universitat Tubingen,Gesellschaft Deutscher Chemiker Auf der Morgenstelle 18 72 026 Tubingen	Tel 49 7071 297 2437 Fax 49 7071 29 5034
Mr BIAS Wolf Rudiger BASF -AG DUU/0-Z 570 67056 Ludwigshafen/Rh.	Tel 49 621 60 58078 Fax 49 621 60 58043 Ruediger.bias@msm.basf-ag.de
Ms GREINER Umweltbundesamt FG IV 1.1 Postfach 33 00 22 14 191 Berlin	Tel 49 30 8903 3110 Fax 49 30 8903 3900 Petra.Greiner@uba.de
Ms Ursula GUNDERT-REMY Bundesinstitut fur gesundheitlichen Verbraucherschutz und Veterinarmedizin FB 8 Postfach 33 00 13 14 191 Berlin	Tel 49 30 8412 3300 Fax 49 30 8412 3003 u.gundert-remy@bgvv.de
Mr. Bernd HEINS Leiter der Abteilung Umweltschutz Industriegewerkschaft Bergbau, Chemie, Energie VB Sozialpolitik-Umweltschutz – Recht Konigsworther Platz 30167 Hannover	Tel 05 11 76 31 2 72/276 Fax 05 11 76 31 7 69
Ms Monika HERRCHEN Fraunhofer Institut Auf dem Aberg 1 D57392 Schmallenberg-Grafs	Tel 49 2972/302215 Fax 49 2972/302319

Mr Frank HIRSINGER Henkel KGAA D-40191 Dusseldorf	Tel 49 211 797 3399 Fax 49 211 798 13399 frank.hirsinger@henkel.de
Mr HULPKE BAYER-AG Gebaude 9115 51 368 Leverkusen	 Fax 49 214 307 1130
Mr KAUPP Universitat Oldenburg Postfach 25 03 26 111 Oldenburg	Tel 49 441 798 3842 Fax 49 441 798 3409 kaupp@kaupp.chemie.uni-oldenburg.de
Mr Werner KÖRDEL Fraunhofer-Institut Auf dem Aberg 1 D-57392 Schmallenberg-Grafschaft	Tel 49 2972 302217 Fax 49-2972 302 319
Mr M. KRAUTTER Greenpeace e.V. Grosse Elbstr. 39 22 767 Hamburg	Tel 49 403 0618 358 Fax 49 403 0631 158 manfred.krautter@greenpeace.de
Mr LENOIR GSF - Institut fur Okologische Chemie Postfach 1129 85 758 OberschleiBheim	Tel 49 89 31 87 4047 Fax 49 089 3187 3377 Lenoir@gsf.de
Mr MEYER Bergbau, Chemie, Energie Industriegewerkschaft Konigsworther Platz 6 30167 Hannover	 Fax 49 511 7631 769
Mr Johannes RANKE Zentrum fur Umweltforschung und Umwelttechnologie Abteilung Bioorganische Chemie Leobenerstrasse D-28359 Bremen	Tel 49 421 218 2380 Fax 49 421 218 7643
Mr Paul-Gerhard RIEGER Inst. fuer Microbiologie Universitat Stuttgart Allmandring 31 70569 Stuttgart	Tel 49 711 685 5480 Fax 49 711 6855 725 pg.rieger@po.uni-stuttgart.de
Mr Lars TIETJEN University of Bremen UFT Dept Bioorganic Chemistry Leobener StraBe Postfach 330440 D28334 Bremen	49 421 218 2380 49 421 218 7643 tietjen@uni-bremen.de

Mr Kurt WAGEMANN Dechema Deutsche Gesellschaft fur Chemisches Apparatewesen Chemische Technik und Biotechnologie Th. Heuss-Allee 25 60486 Frankfurt	Tel 49 69 7564 290 Fax 49 69 7564 117
Mr Uwe WOLCKE Bundesanstalt fur Arbeitschutz und arbeitshedizin Abt. AS 2 Postfach 17 02 02 44 061 Dortmund	Tel 49 2 31 90 71 323 Fax 49 2 31 9071 611 amst@baua.do.shuttle.de
Mr Achim ZICKLER Bundesministerium fur Bildung, Wissenschaft Forschung und Techonologie-Referat 624 Heinemann-Str. 2 53 170 Bonn	49 228 57 3540 Fax 49 228 57 3605 Achim.zickler@bmbf.bund400.de
ITALY	
Mr Angelo ALBINI Dip. Chimica Organica, v. Taramelli 10 27100 Pavia	Tel 0382 507 316 Fax 0382 507 323
Mr Giuseppe BLASCO Interuniversity Consortium, Chemistry for the Environment Dorsoduro 2137 30123 Venice	Tel/Fax 39 041 257 8620 blasco@unive.it
Mr Carlo BOTTEGHI Dep. di Chimica Universite Ca' Foscari, Dorsoduro 2137 30123 Venice	Tel 39 41 529 8515 Fax 39 41 529 8517
Mr Carrado CLINI Direttore Generale Ministero dell'Ambiente Via Ferratelle 33 00184 Rome	Tel 39 6 703 62 422
Mr Salvatore COLUCCIA Dip. di Chimica IFM Univ di Torino Via Pietro Giuria 7 10125 Torino	Tel 39 11 670 7535 Fax 39 11 670 7855 Coluccia@ch.unito.it

Mr Alessandro DI DOMENICO Director, Ecotoxicology Unit Lab. of Comparative Toxicology & Ecotox Istituto Superiore di Sanita Viale Regina Elena 299 00161 Roma	Tel 39-06 49 90 2826/2077 Fax 39-06 49 38 7139 addeke@iss.it
Mr Franco FORLANI Delegate Administrator ENITECNOLOGIE S. Donato Milanese Via. Maritano 26, I-20097 Milan	Tel 39 2 52036543 Fax 39 2 52 036 338
Mr GIUIUZZA Direttore Centrale Tecnico Scientifico Federchimica Via Accademia, 33 20131 Milan	Fax 39 2 268 103 229 TES1@federchimica.it
Mr Raimondo MAGGI Dipartimento di Chimica Organica e Industriale dell'Universita Parco Area delle Scienze, 17A 43100 Parma	Tel 39 0521 905 411 Fax 39 0521 905 472
Mr Mauro MAJONE Department of Chemistry University of Rome "La Sapienza" P.le Aldo Moro 5 BOX 34, Roma 62 00185 Rome	Tel 39 064 991 3646 Fax 39 064 906 31 majone@axrma.uniromal.it
Mr Alvise PEROSA Ca' Foscari University Environmental Sciences Department Dorsoduro 2137, 30123 Venice	Tel 39 41 257 8676 Fax 39 41 257 8620 alvise@unive.it
Ms Agata A. SCUDERI ENI SPA Piazzale E. Mattei, 1 00 144 Roma	Tel 39 6 5982 5457 Fax 39 6 5982 2819 marco.stampa@eni.it
Mr Maurizio SELVA Ca' Foscari University of Venice Environmental Sciences Department Dorsoduro, 2137 20123 Venezia	Tel 39 41 257 8687 Fax 39 41 257 8620
Mr Ferruccio TRIFFIRO Dipartimento di Chimica Industriale e dei Materiali Viale Risorgimento 4, 40136 Bologna	Tel 39 51 644 36 82 Fax 39 51 644 36 80 Trifiro@ms.fci.unibo.it

Mr Pietro TUNDO Director of the Consortium, Chemistry for the Environment Dorsoduro 2137 30123 Venice	Tel/Fax 39 41 529 8620 Tel 39 41 257 8642 Fax 39 41 257 8620 tundop@unive.it
Mr Nazareno VENTOLA ENITECNOLOGIE Studi ed Analisi, Sull'Evoluzione Tecnologica e Planificazione Strategica 20097 S. Donato Milanese Via F. Maritano, 26 Milano	Tel 02 52 04 6424 Fax 02 52 03 6239
JAPAN	
Mr Hisao IDA Materials and Process Engineering Division MITI Ministry of International Trade & Industry (MITI) 1-3-1 Kasumigaseki Chiyoda-ku Tokyo 100-8901	Tel 81 3 3501 1750 Fax 81 3 3501 0196 ihaa1822@miti.go.jp
Mr Akira KANAI Japan Chemical Innovation Institute Fuzambo Bldg 2F 1-3-5 Kanda-jimbocho, Chiyoda-ku Tokyo 101-0051	Tel 81 3 5282 7272 Fax 81 3 5282 0250 Kanai@jcii.or.jp
Mr Masao KITAJIMA Japan Chemical Innovation Institute JCII Fuzambo Bldg. 2F 1-3-5 Kanda-jimbocho, Chiyoda-ku Tokyo 101-0051	Tel 81 3 5282 7266 Fax 81 3 5282 0250 Kitajima@jcii.or.jp
Mr Kazuyuki KOMAGATA Global Environment Technology Dept. New Energy and Industrial Technology Development (NEDO) Sunshine 60, 29F 1-1, 3-chome, Higashi-Ikebukuro Toshima-ku, Tokyo 170-6028	Tel 81 3 3987 9369 Fax 81 3 5391 1744 Komagatakzy@nedo.go.jp
Mr Junshi MIYAMOTO President, Division of Chemistry & the Environment, IUPAC Sumitomo Chemical Co, Ltd, 5-33 Kitahama 4-Chome, Chuo-ku Osaka 541 8550	Tel 81 6 220 3152 Fax 81 6 220 3350 yokonaga@ohprime.sumutom o-chem.co.jp

Mr Tsutomu SUGETA Dept of Chemicals Systems, National Institute of Materials & Chemical National Institute of Materials & Chemicals Research Rearch, 1-1, Higashi Tsukuba Tsukuba-shi, Ibarakai-ken 305 8565	Tel 81 298 54 4720 Fax 81 298 54 4726 Sugeta@nimc.go.jp
Mr Takeshi TOMURA The Chemical Society of Japan 1-5 Kanda-surugadai Chiyoda-ku Tokyo 101-0062	Tel 81 3 3292 6162 Fax 81 3 3292 6318 tomura@chemistry.or.jp
NETHERLANDS	
Mr Jan HARMSEN Delft University of Technology Julialaan 136 2628BL Delft	Tel 31 15 278 4355 Fax 31 15 278 4452 g.j.harmsen@stm.tudelft.nl
Mr Jan VAN DER KOLK Directorate for Chemicals, External Safety and Radiation Protection Ministry of Housing, Physical Planning and Environment. IPC 655 P.O. Box 30945 NL-2500 GX The Hague	Tel 31-70 339 4729 Fax 31-70 339 1297 vanderkolk@dsvs.dgm.minvrom.nl
POLAND	
Mr Wlodzimierz ZIENTARSKI Manager of Marking Office ANWIL SA ul. Torunska 222 87-805 Wloclawek	Fax 48 54 237 3626
SPAIN	
Mr Peter EDER Joint Research Centre European Commission IPTS WTC Isla de la Cartuja E-41092 Sevilla	Tel 34 95 44 88 452 Fax 34 95 44 88 235 Peter.eder@jrc.es

SWEDEN	
Mr Bengt BUCHT Dep. Dir.Gen. The National Chemicals Inspectorate P.O. Box 1384 S-171 27 Solna	Tel 46-8-730-6805 Fax 46-8-735-7698 Bengtb@kemi.se
SWITZERLAND	
Mr Konrad HUNGERBUHLER Laboratorium fur Technische Chemie ETH Zurich Universitatsstr. 31/UNK C3 8092 Zurich	Tel 41 1 632 60 98 Fax 41 1 632 10 53 hungerb@tech.chem.ethz.ch
UNITED KINGDOM	
Mr Peter HINCHCLIFFE Department of Environment, Transport and the Regions Ashdown House, 123 Victoria Street London SW1 6DE	Tel 44 171 890 5262 Fax 44 171 890 5229 Phinchcliffe@easynet.co.uk
Mr Martin POLIAKOFF School of Chemistry University of Nottingham Nottingham NG7 2RD	martyn.poliakoff@nottingham .ac.uk
Mr Ian WATT Lennig House Rohm and Haas (UK) Ltd 2 Masons Avenue Croydon, Surrey CR9 3NB	Tel 44 181 774 5535 Fax 44 181 774 5546 ian_watt@rohmhaas.com
UNITED STATES	
Mr Paul ANASTAS Office of Pollution Prevention and Toxics (7406) US EPA 401M Street, SW Washington DC 20460	Tel 1 202 260 2257 Fax 1 202 260 0981 Anastas.paul@epa.gov
Mr Joseph BREEN Green Chemistry Institute 1650 Research Boulevard Rockville MD 20850	Tel 1 301 294 2854 Fax 1 301 294 2829 Breenjl@westat.com

Mr Joe CARRA Deputy Director Office of Pollution Prevention and Toxics (7401) US-EPA 401 M Street, S.W. Washington, D.C. 20460	Tel 1-202-260 1815 Fax 1-202-260 0575 carra.joe@epamail.epa.gov
Mr Terrence J. COLLINS Department of Chemistry Carnegie Mellon University 4400 Fifth Avenue Pittsburgh PA, 15213	Tel 412 2 686335 Fax 412 268 1061 tclu+@andrew.cmu.edu
Mr Richard DENISON Alliance for Environmental Innovation Environmental Defense Fund 1875 Connecticut Avenue, NW Washington, DC 20009	Tel 1 202 387 3500 Fax 1 202 234 6049 Richard@edf.org
Mr Dennis HJERESEN Senior Program Manager Los Alamos National Laboratory Environmental Management Programs Los Alamos NM 87545	Tel 1 505 665 7251 Fax 1 505 665 8118 Dennish@lanl.gov
Mr William TUMAS Chemical Science &Technology Division Los Alamos National Laboratory CST-18 Chemical and Environmental Research MS J514 Los Alamos NM 87545	Tel 1 505 667 3803 Fax 1 505 667 9905 tumas@lanl.gov
Mr John WARNER University of Massachusetts – Boston Harbor Campus, 100 Morrissey Blvd Boston MA 02125	Tel 617 287 6165 Fax 617 287 6127 Warner_j@umbsky.cc.umb.edu
Ms Sylvia WARE American Chemical Society 1155 Sixteenth St., NW Washington DC 20036	Tel 1 202 872 4388 Fax 1 202 872 8068 sware@acs.org
Ms Tracy WILLIAMSON Office of Pollution Prevention and Toxics (7406) US EPA 401M Street, SW Washington DC 20460	Tel 1 202 260 3960 Fax 1 202 260 0981 williamson.tracy@epa.gov
Mr Edward WOODHOUSE Department of Science & Technology Studies Rensselaer Polytechnic Institute Troy NY 12180	Tel 1 518 276 8506 Fax 1 518 276 2659 Woodhouse@rpi.edu

EUROPEAN COMMISSION

Mr Marco MORETTINI
European Commission
DGX1 Chemicals Unit
Rue de la loi
200 B 1049 Brussells BU 5 2-15

Tel 32 2 29 90384
Fax 32 2 29 66 995
Marco.Morettini@dg11.cec.be

OECD SECRETARIAT

ENVIRONMENTAL HEALTH AND SAFETY DIVISION

DIVISION DE L'HYGIENE ET DE LA SECURITE DE L'ENVIRONNEMENT

2 rue Andre-Pascal
75775 Paris Cedex 16
France
Internet site: http//www/oecd.org/ehs

Mr Richard SIGMAN	Principal Administrator	Tel 33 1 45 24 16 80 Fax 33 1 45 24 16 75 richard.sigman@oecd.org
Ms Jenny GRIFFIN	Secretary	Tel 33 1 45 24 98 43 Fax 33 1 45 24 16 75 jennifer.griffin@oecd.org