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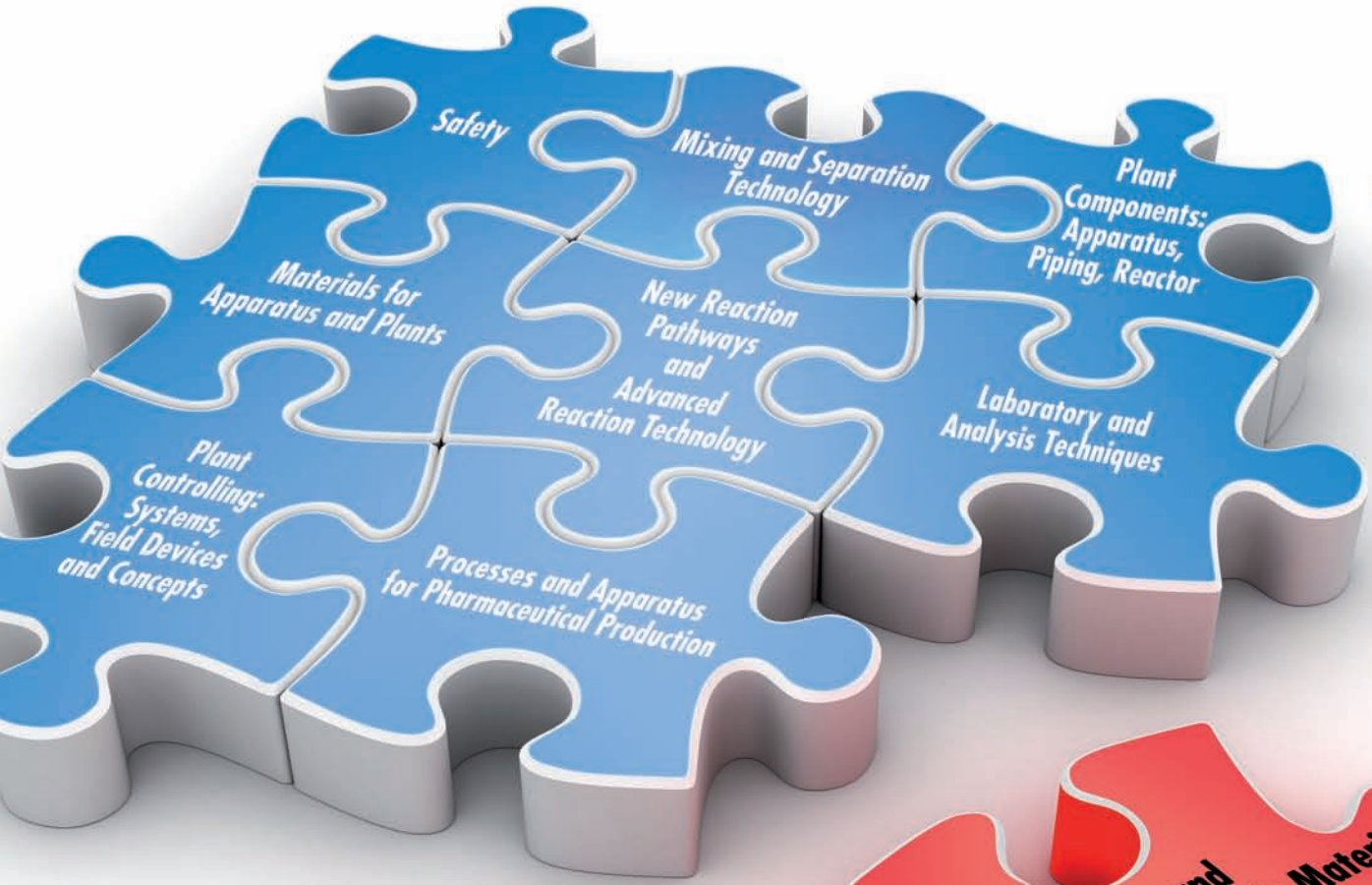
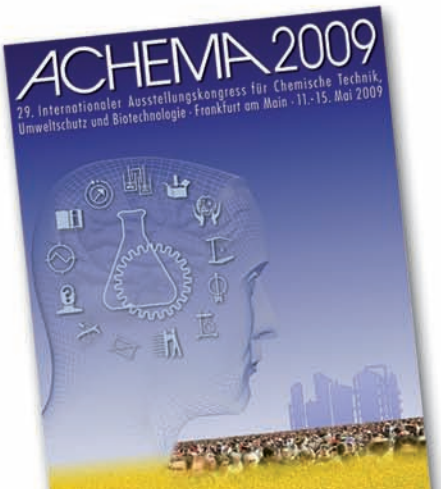
ACHEMA WORLDWIDE News





ACHEMA 2009: exciting conference topics

A special edition from PROCESS

Shaping *the future*

Luckily, technologies are not shares. Their future can be predicted more easily and precisely than that of share prices. But those who hold the technologies of the future need not worry about their share prices. If you are looking for the technology of tomorrow, you'll find it in the development laboratories of today. But who has the time to visit all the laboratories of the world? Who knows them all? Who gains admission everywhere? The chemical industry and its affiliated process industries possess a far more efficient trend barometer, a secure navigation system for the road to success: ACHEMA.

4,000 companies from 50 countries and numerous research institutes virtually bring their laboratories to Frankfurt am Main for one week every three years. Almost 200,000 people, leading scientists and engineers from 100 of the world's countries, meet up here. ACHEMA is the world's biggest hub for new ideas that design and put their mark on the future of process technology. No shares are traded here – it's about more. This is where knowledge is exchanged and converted into a force that designs the future. Decisions on the future are made exactly here, with the gates to success wide open.

The current stocks of fossil raw materials are far bigger than those in the year of the first oil crisis in 1973. The community, however, has recognized that we endanger the world's climate if we completely convert our fossil resources into carbon dioxide. The chemical process industries bear the responsibility for the world's carbon cycle. Renewable raw materials and energies as well as more efficient processes of their use are therefore the topic of next year's special show at ACHEMA.

We are already today looking forward to your participation in ACHEMA 2009, which takes place from 11th – 15th May in Frankfurt am Main, and are convinced that you will not miss this opportunity.

Yours sincerely,

Prof. Gerhard Kreysa
Chief Executive of DECHEMA e.V.

Contents

Cover: fotolia.de; [M]-Michaela Schenk

The class of new substances known as Ionic Liquids offers outstanding combinations of properties not achievable with any other material, such as being liquid and showing literally no vapour pressure. Using these liquids as operating liquids in pumps and compressors allows remarkable improvements by making additionally use of their good lubrication properties, high temperature stability and low compressibility.

New developments *in pumps and compressors* using Ionic Liquids

EBERHARD SCHLUECKER, LASZLO SZARVAS AND ERIC UERDINGEN

Ionic Liquids (ILs) are a new class of chemical substances having emerged in recent years in chemical research. Per definition, Ionic Liquids are organic salts with a melting point below 100°C. They consist of ions only, but this definition is different from the classic definition of molten salts. The latter are high-melting, highly viscous, and highly corrosive liquids, while ILs are liquid at usually much lower temperatures, have a much lower viscosity and contain organic cations rather than inorganic ones. In the scientific community mostly a sub-set of the class of Ionic Liquids – so called Room-Temperature Ionic Liquids (RTILs) being salts with a melting point lower than room temperature – stand at focus. In order to achieve such low melting points, cations or anions require an asymmetric charge distribution and have to considerably differ in size. Both effects lower the crystal lattice energy thus leading to a low melting point.

This new class of substances offers a unique set of properties not achievable with any other material. Most notably, ILs exhibit virtually non-measurable vapor pressures combined with a large temperature window for the liquid phase. Additionally, they comprise excellent thermal, mechanical and electrochemical stability. These properties make them safe to handle as they are highly non-

Prof. Dr.-Ing. E. Schluecker, institute of process machinery and plant technology, Friedrich-Alexander-University Erlangen Nuremberg/Germany; Dr. L. Szarvas and Dr. E. Uerdingen, New Business Development, Intermediates Division, BASF SE, Ludwigshafen/Germany

First focusing on applying them as alternative solvents in chemical processes, Ionic Liquids are today discussed as new materials in a broad range of applications, e.g. as operating liquids in pump and compressor applications.

Picture: BASF

flammable as well as usually non-explosive. Due to their outstanding physicochemical properties ILs have recently opened the door to new applications.

Room-temperature Ionic Liquids usually consist of nitrogen-containing organic cations, the most known are N,N'-dialkylimidazolium cations as described by: J. S. Wilkes, J. A. Levisky, R. A. Wilson, C. L. Hussey, Inorg. Chem. 1982, 21, 1263; J. S. Wilkes and M. J. Zaworotko, Chem. Comm. 1992, 965; and N-alkylpyridinium, F. H. Hurley, T. P. Wier, J. Elettrochem. Soc. 1951, 98, 203; H. L. Chum, V. R. Koch, L. L. Miller, R. A. Osteryoung, J. Am. Chem. Soc., 1975, 97, 3264; and common weakly coordinating inorganic anions ($AlCl_4^-$, BF_4^-, $CF_3SO_3^-$, etc.) (Figure 1).

The chance to combine different organic cations with both inorganic and organic anions gives an exceptional diversity on physical and chemical properties of these compounds. Physical properties such as solubility of gases can be designed in this way as well as lubrication properties, temperature stability and compressibility.

Over the past few decades the number of publications concerning Ionic Liquids has increased substantially, showing the continuously growing interest in many different research fields. First focusing on applying them as alternative solvents in chemical processes, they are today discussed as new materials in a broad range of applications. In the following we will focus on their utilization as operating liquids in pump and compressor applications.

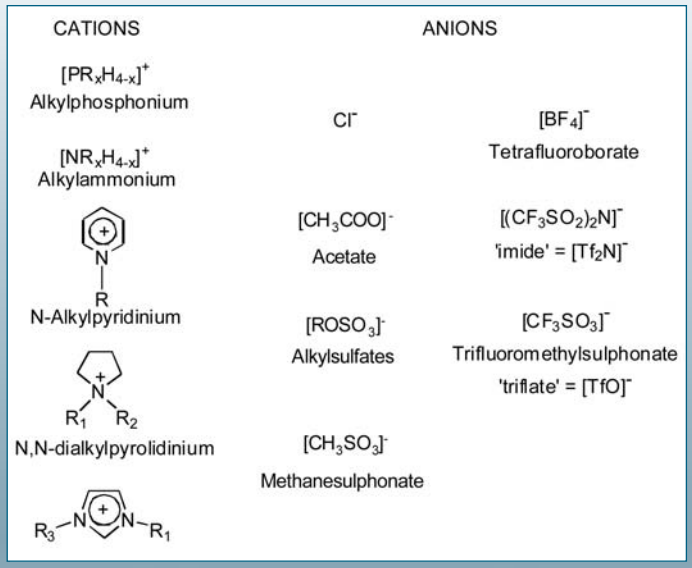


Figure 1: Common cations and anions for Ionic Liquids

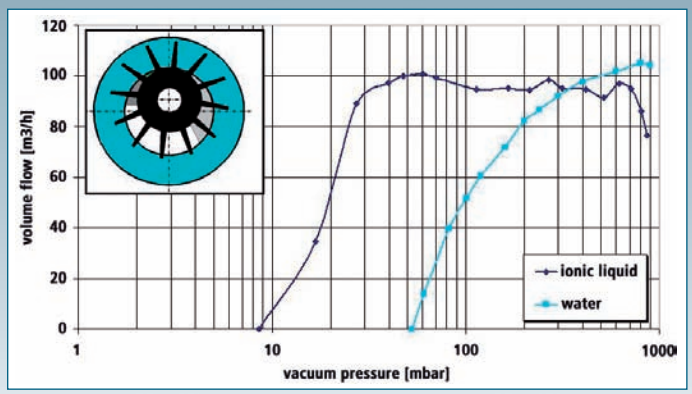


Figure 2: Characteristic delivery curves of liquid ring pumps with water and EMIM-$EtSO_4$

Outstanding properties of ILs in pump and compressor applications

Offering the unique combination of being liquid and literally showing no vapour pressure, ILs open new opportunities for operating liquids in pump and compressor applications as they additionally can offer good lubrication properties, high temperature stability, low compressibility and low solubility for gases.

The experimental search through many IL-types revealed also some ILs with better friction and wear values than normal motor oil (10 W 40) even without additives. In combination with or without additives this opens a big chance for smaller mechanical losses in machines. Criteria for good lubrication include an optimal viscosity and a small wetting ability angle, which can be designed with the chemical structure.

ILs are often non-corrosive, but esp. together with friction, corrosion effects with ILs have been observed – e.g. ILs with alkylsulfates as anion can be hydrolyzed in the presence of water and can show severe corrosion effects on e.g. ferrite steel. Therefore it is strongly recommended to check the corrosivity of ILs to all materials involved and under relevant conditions in the respective environment.

Beside other positive factors ILs offer low compressibility. For example 1-ethyl-3-methylimidazolium ethylsulfate (EMIM $EtSO_4$) shows 1/3 of the compressibility of mineral oil and 2/3 of water. Due to this, ILs enable remarkable improvements in the efficiency of high pressure generating pumps and pulsators (for fatigue testing) [2, 3].

Remarkable positive effects can be generated by the very small vapour pressure of ILs together with low gas solubility. These properties predestine ILs for the use as lubricating liquids in compressors and also vacuum pumps [2, 5]. Already EMIM $EtSO_4$ delivers good results (see. ff) in this respect. The only disadvantage is that EMIM $EtSO_4$ has low temperature stability (about 200°C). This leads to the last and most challenging aspect. If ILs with a high chemical and also temperature resistance can be developed, the direct contact with critical chemicals or highly reactive gases would be possible. ILs then might be used for a liquid piston or lubrication and interface liquid in high temperature compression. The chance for realizing such applications is quite good.

Application examples for pumps and compressors

Due to the good lubrication capabilities of Ionic Liquids, often combined with chemical inertia and stability, all machines using lubrication oil can expect an improvement in efficiency. Preliminary tests with simple drive units have already confirmed this expectation even without additives, and the necessary long life requirements seem also to be fulfilled. With these results also the basic requirements for using IL in pumps and compressors are given.

The first idea for using ILs in pumps was to replace the hydraulic oil in hydraulically driven diaphragm pumps with an Ionic Liquid with low compressibility. In such machines the compressibility is linked with the so called volumetric efficiency. Just by using EMIM $EtSO_4$ instead of mineral oil, a remarkable increase of the volumetric efficiency of about 10 to 30% was achieved. The higher the pressure, the bigger the detrimental space (liquid content) or the smaller the adjusted stroke length, the bigger is this benefit. Furthermore, it can be expected that an Ionic Liquid can be found which is able to decrease the gas dissolution effect during the suction process, so leading to a higher metering precision [2].

The low compressibility effect is also beneficial in pressure pulsating devices for fatigue behaviour testing e.g. of common rail tubes. In this application, Ionic Liquids can nearly double either the number of parts test-

ed with one machine or the volume of the parts [4], so introducing an economy of about 100% in the testing procedure.

A liquid ring vacuum pump uses a star shaped impeller rotating eccentrically in a circular housing. The liquid ring is generated by this rotation and generates together with the impeller a positive displacement effect in each chamber of the impeller. The limit of the vacuum possible with this machine is given by the vapour pressure and some design aspects. Just by replacing water with Ionic Liquid, the vacuum pressure was reduced from about 70 mbar to about 10 mbar (Fig. 2). Some improvements in the machine design allowed a further reduction to 1 mbar and even lower pressures appear to be achievable. This result, which is nearly ready for introduction into the market, offers a new field of applications for this type of machine.

Given adequate temperature stability, gas conveying processes can also be improved. An already available type is an Ionic Liquid piston compressor [2, 6] which acts like a reciprocating positive displacement compressor, usually with a smaller stroke frequency. This device is already used for pure hydrogen and other gases. Because liquid can penetrate complicate working chambers or the "piston" can move along pipelines and around bends, the volumetric efficiency (delivery rate) can be quite high, and with IL contact the compression process is close to isothermal. Using ILs with high temperature stability [3] higher compression ratios and higher end temperatures are possible, and the danger of oil conflagration does not exist anymore. From this result it is only a short step to the use of high temperature stable Ionic Liquids as lubrication liquids in all types of positive displacement compressors [2], also with higher pressure ratios.

Finally, two ILs were found which are able to withstand pure oxygen in a 30 MPa pressure impact test several times and also in an aerosol state. Using this outstanding property, a lubricated oxygen compressor is possibly no longer a dream.

Summary and outlook

The brief examples described above prove, that the outstanding properties of Ionic Liquids offer a lot of chances for remarkable improvements in the pump and compressor technology. The efficiency of all lubricated machines, e.g. engines, can rise remarkably. An increase of up to 30% higher volumetric efficiency of high pressure pumps is achievable; the economics of pulsating pressure testing devices can be improved by up to 100%. Utilizing Ionic Liquids in liquid ring vacuum pumps can lower the vacuum pressure from about 70 mbar to below 1 mbar. Liquid pistons for gas conveying are already realised as well as higher pressure ratios, due to the lack in danger of oil conflagration. Further, the realisation of the dream of lubricated oxygen compression is close to become reality.

Since Ionic Liquids can be tailored in order to optimize their properties, the authors firmly believe that in the future ILs will be designed, that are able to improve nearly each of the applications mentioned in this article even further. The authors are also convinced that this is not yet the end. There still is a wide open field for new ideas and applications. ■

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Nanofiltration based on polymer membranes is widely used to treat aqueous streams, and now it is on the point of being applied to organic liquids as well. Organophilic nanofiltration can separate molecules in the weight range 300–1000 g/mol from organic solvents, often at much lower costs than alternative technologies.

Industrial organophilic nanofiltration unit

Pictures: GMT

Nanofiltration *comes to organic solvents*

THOMAS BEESKOW AND BJÖRN HOTING

Nanofiltration based on polymer membranes is widely accepted as a separation technology for the treatment of aqueous streams. Now nanofiltration is on the threshold of being applied to separation tasks involving organic solvents as well. Membrane separation in non-aqueous systems, often called organophilic nanofiltration, can significantly reduce process costs, but requires different membranes and a profound knowledge of the behaviour of organic liquids. Organophilic nanofiltration membranes can separate molecules in the molecular weight range 300–1000 g/mol – either impurities or target molecules – from organic solvents.

In using membrane technology to separate organic solutes from organic solvents, we are just beginning to understand the fundamental transport and removal mechanisms involved. For instance, we need to take into account the swelling properties of the membrane, which depend on the interactions between the membrane and the solvent/solute system under possibly varying operating conditions.

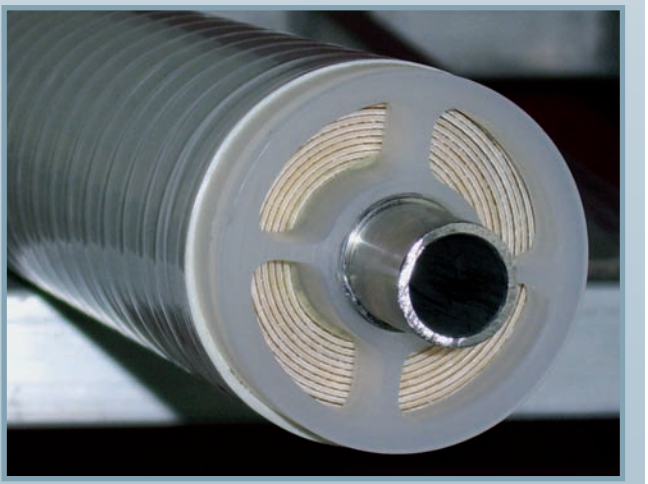
Polymers with the chemical resistance needed to act as organophilic nanofiltration membranes include polyimides, polyamide-imides, polyacrylonitriles (copolymer, crosslinking), silicones, polyphosphazenes, polyphenylene sulfide, polyetheretherketone, and polybenzimidazol.

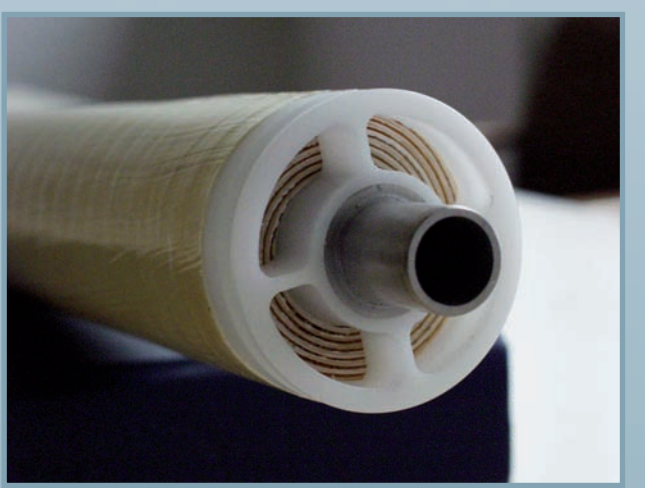
The rejection performance of a membrane for solutes of different molecular weights can be assessed using various approaches, including dye retention and direct measurements using different test solutes. The interactions referred to above can make this a complex business, but a rule of thumb for the performance of a typical silicone membrane is:

- MW 300–500 g/mol: 50–70% rejection
- MW > 600 g/mol: 80%+ rejection
- MW > 1000 g/mol: ~100% rejection

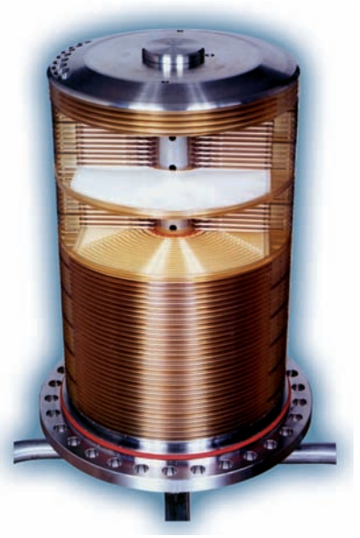
Compared to other organophilic nanofiltration membrane materials, silicone allows effective separation at higher fluxes.

Dr. Thomas Beeskow; GMT Membrantechnik GmbH, Rheinfelden/Germany;
Dr. Björn Hoting, Borsig Membrane Technology GmbH, Gladbeck/Germany





Spiral-wound modules provide an effective extension of the standard membrane module design to organic solvents.



Envelope-type modules show optimal chemical resistance thanks to their adhesive-free design.

Industrial applications

Organophilic nanofiltration membranes with this general rejection profile can help to solve industrial separation tasks such as:

- treating fuels and stabilizing chemical intermediates in the petrochemical industry;
- recovering homogeneous catalysts, a task normally performed using thermal separation;
- separating highly viscous hydrocarbons from higher-value low-viscosity hydrocarbons in the petrochemical industry;
- simplifying downstream processes, and/or debottlenecking, by removing hazardous compounds from hydrocarbons in the petrochemical industry; and
- general purification of organic solvents in different industries.

The technical literature often claims that the main limitation in extending membrane processes to treat organic solvents is the lack of availability of commercial organophilic membranes. This has changed over the past few years, and commercial organophilic nanofiltration membranes are now available.

Membranes available from GMT show excellent stability in hydrocarbons at 80°C and 40 bar, with reliable high retention at exceptionally high permeability. The membranes are also stable in aromatics, alkanes, alcohols, ethers and ketones. They can be used in both spiral-wound and LF (envelope-type) modules. They are the result of the combination of excellent research by GKSS, with GMT's ability to optimize manufacture on a commercial scale.

GMT spiral-wound modules provide an effective extension of the standard membrane module design to organic solvents. GMT LF (envelope-type) modules add the advantages of high specific permeate flux; optimization of flux and pressure drop using a flexible compartment design; optimal flow over the hydraulic discs; and optimal chemical resistance thanks to their adhesive-free design.

Success in the applications referred to above needs more than just an excellent commercial membrane, however. Companies need membrane processes that will operate reliably in an industrial environment, and this in turn requires an equipment manufacturer who understands membrane processes. GMT works closely with Borsig Membrane Technology GmbH (membrane process system supplier) and PolyAn GmbH (lab-scale feasibility testing) to provide industrial membrane processes from laboratory through to industrial production scale. Industrial units have already been commissioned for the industrial applications mentioned above. ■

Implementation of the GHS (Globally Harmonized System) in the EU – What are the changes?

New *GHS-Regulation*

—— *JULIANE KOCH, CORDULA WILRICH, THOMAS GEBEL* ——

The classification of dangerous chemicals in the EU is currently completely under revision. As a result the Substances Directive (67/548/EEC) and the Preparations Directive (1999/45/EC) are to be replaced by the GHS-Regulation. This Regulation will be the implementation of a recommendation of the United Nations (Globally Harmonized System of Classification and Labelling of Chemical, UN-GHS) into Community Law.

The GHS defines physical, health and environmental hazards which are divided into hazard classes reflecting the type of hazard (e.g. explosive, or acutely toxic or hazardous to the aquatic environment). These hazard classes are further divided into categories which (in most cases) reflect the degree of hazard. The criteria for the hazard classes and categories are laid down in Annex I of the GHS-Regulation.

Each hazard category has specific label elements assigned consisting of a pictogram, a signal word (either "Danger" or "Warning"), a hazard statement and precautionary statements (see table below for an example). The hazard statements are the GHS-equivalent of the currently used R-phrases according to the Substances Directive and the precautionary statements are the GHS-equivalent of the currently used S-phrases.

The European GHS-Regulation will implement all hazard classes of the UN-GHS but not all categories. For this the GHS-Regulation makes use of the so-called Building Block Approach of the UN-GHS which allows to implementing only parts of the UN-GHS under certain conditions. The EU mainly uses this tool in order to stay as close as possible to the current system of classification of dangerous chemicals.

Dr. Juliane Koch, Umweltbundesamt, Dessau/Germany; Dr. Cordula Wilrich, Bundesanstalt für Materialforschung und -prüfung – BAM, Berlin/Germany; Prof. Dr. Thomas Gebel, Bundesanstalt für Arbeitsschutz und Arbeitsmedizin, Dortmund/Germany

Changes in classification

■ Physical hazards: The physical hazard classes are structured differently than in the current EU-System. Even so, the new system is not an unfamiliar system. The GHS is based on the classification system which is already applied for the Transport of Dangerous Goods. The result is a very different system for the classification of explosives. Moreover, some hazard classes in the transport system are not part of the current system in the Substances Directive and therefore are newly introduced. Examples are: gases under pressure, self-reactive substances, self-heating substances.

However, most of the substances assigned to these hazard classes have been classified as dangerous before (e.g. as explosive or flammable). Exceptions are inert gases under pressure.

■ Health hazards: As a first approximation, the health hazard classes and also the classification criteria are rather similar in the GHS and the Substances Directive. The main change under the GHS is a change in the category criteria (cut-off values) in the classification for acute toxicity.

About one per cent of the hazardous substances might change their acute toxicity classification into a more stringent one. Also with respect to the classification of aspiration hazards, the criteria are more stringent. For further health hazards, the change in the criteria for substance classification is minor. The classification of mixtures will be different as the concentration limits for classification of skin/eye corrosives/irritants are lower leading to more mixtures being classified with the GHS.

However, the margin of evaluation with the new system is broader as it is allowed to deviate from the stan-

Label elements assigned to the hazard class flammable liquids

Classification	Category 1	Category 2	Category 3
GHS Pictograms			
Signal word	Danger	Danger	Warning
Hazard statement	H224: Extremely flammable liquid and vapour	H225: Highly flammable liquid and vapour	H226: Flammable liquid and vapour
Precautionary Statement Prevention	P210 P233 P240 P241 P242 P243 P280	P210 P233 P240 P241 P242 P243 P280	P210 P233 P240 P241 P242 P243 P280
Precautionary Statement Response	P303 + P361 + P353 P370 + P378	P303 + P361 + P353 P370 + P378	P303 + P361 + P353 P370 + P378
Precautionary Statement Storage	P403 + P235	P403 + P235	P403 + P235
Precautionary Statement Disposal	P501	P501	P501

dard criteria in case an evaluation using expert judgment leads to a different classification.

■ Environmental hazards: Classification of environmental hazards is based on acute and chronic hazards to the aquatic environment. On contrary to the Substances Directive, GHS clearly separates acute and chronic aquatic hazards. For acute aquatic hazards not all categories of the UN-GHS will be included into the GHS-Regulation. In addition, the GHS offers the option to use an additivity formula to classify the hazard to waters which was not possible with the Dangerous Preparations Directive.

As a so-called EU-left-over the GHS-Regulation will contain classification criteria and labelling elements for ozone depleting chemicals.

GHS as a living document allows further development and process at UN- and OECD-level. In relation to environmental hazards the work on the development of classification criteria and labelling provisions continues for terrestrial hazards and for ozone depletion. The latter is just about to be amended. Once further criteria have been agreed on the international level they then can be implemented in the EU.

Harmonized classification and labelling of substances

The GHS-Regulation will contain a list of harmonized classifications of substances in Annex VI. The substances in this list are those that are currently contained in the corresponding list of the Substances Directive but with transferred classifications according to the GHS. Further substances may be included into this list if they are of high concern (classification for respiratory sensitisation, germ cell mutagenicity, carcinogenicity, reproductive toxicity). Other substances can be included on a case-by-case basis provided that the need for such action at Community level can be justified.

Classification and labelling inventory

The Classification and Labelling Inventory is a further instrument which aims at consistent classification within the EU. Any classification within the EU has to be notified to the new European Chemicals Agency (ECHA) which publishes these classifications. At the same time the Agency has to inform all notifiers in case their classifications differ from each other. The notifiers then are supposed to agree on a consistent classification.

The transitional periods are phased for substances and mixtures. Substances have to be labelled according to the GHS-Regulation from December 1st, 2010 on and mixtures from June 1st, 2015 on. Before the end of these transitional periods labelling may already be done according to the GHS-Regulation.

During the transitional periods the Safety Data Sheet must also contain information about the classification according to the current Substances and Preparations Directive so that downstream users are able to classify mixtures which they manufacture according to the "old" system if they have not yet changed to the GHS. After June 1st, 2015 the Substances and the Preparations Directive are supposed to be revoked. ■

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Classification and labelling inventory

The Classification and Labelling Inventory is a further instrument which aims at consistent classification within the EU. Any classification within the EU has to be notified to the new European Chemicals Agency (ECHA) which publishes these classifications. At the same time the Agency has to inform all notifiers in case their classifications differ from each other. The notifiers then are supposed to agree on a consistent classification.

The transitional periods are phased for substances and mixtures. Substances have to be labelled according to the GHS-Regulation from December 1st, 2010 on and mixtures from June 1st, 2015 on. Before the end of these transitional periods labelling may already be done according to the GHS-Regulation.

During the transitional periods the Safety Data Sheet must also contain information about the classification according to the current Substances and Preparations Directive so that downstream users are able to classify mixtures which they manufacture according to the "old" system if they have not yet changed to the GHS. After June 1st, 2015 the Substances and the Preparations Directive are supposed to be revoked. ■

Let's go to *India*

Pharmaceutical and biotechnology companies are increasingly outsourcing early-stage research and clinical studies driven mainly by rising R&D costs and the need to improve R&D productivity. With cost savings of around 30–50% compared to Western costs as well as an abundance of talented scientists and easy access to raw materials, India is seen as a key location for outsourcing research and manufacturing in the area of drug discovery and development.

GUNTER FESTEL

Since 1995, India's total pharma industry R&D spending has risen from around USD 30 million to more than USD 495.2 million in 2005. The vast majority of the national pharma industry's R&D expenditures on new drug discovery and development is conducted by a limited number of companies, e.g. Dr. Reddy's (2005: 14% of annual sales) and Ranbaxy (2005: 7%).

India's biotech sector is among the fastest growing knowledge based sectors, growing from USD 800 million in 2003 to USD 1.45 billion in 2005, and reaching USD 2 billion in 2006. Over the past few years, the biotech industry has invested around 25% of its revenues with a high proportion of the investments going into the setting up of infrastructures, followed by R&D.

India's growing contract research market

In 2005, global outsourcing expenditure amounted to USD 34 billion of which 60% was spent on contract manufacturing, 33% on clinical research and 7% on custom chemical synthesis.

India's contract research and manufacturing market grew from USD 0.5 billion in 2005 to USD 0.9 billion in 2006 and has been contributing close to 8% to the total Indian pharmaceutical business over the last five years. Experts believe it will reach USD 2.7 billion by 2010 with Indian companies having the capacity to gain between 35% and 40% of the global contract research and manufacturing market.

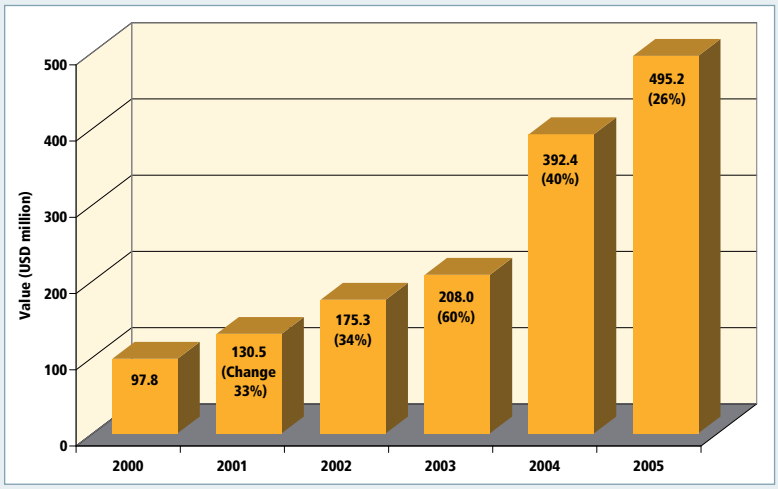
From an estimated USD 75 million in manufacturing contracts in 2004, the Associated Chambers of Commerce and Industry of India (ASSOCHAM) expects the contract manufacturing market to reach USD 900 million by 2010. India's API manufacturing industry is already the third largest in the world with sales of USD 2 billion in 2005 and expected to reach USD 4.8 billion by 2010 with an average annual growth rate of 19.3%.

Gunter Festel, Festel Capital, Hünenberg/Switzerland

For pharma contract research, India has become one of the preferred outsourcing destinations as reflected in its annual growth rate of 20–25%. Clinical trials make up 65% of all pharma contract research business with the remaining 35% in the field of new drug discovery. According to Business Insights, clinical trails conducted in India are to grow from 1.5% of global clinical trials in 2006 to 5% by 2008 and 15% by 2011. Indian contract research organisations offering small-scale discovery and development services generally also have the capacity to take on limited formulation and manufacturing scale-up activities.

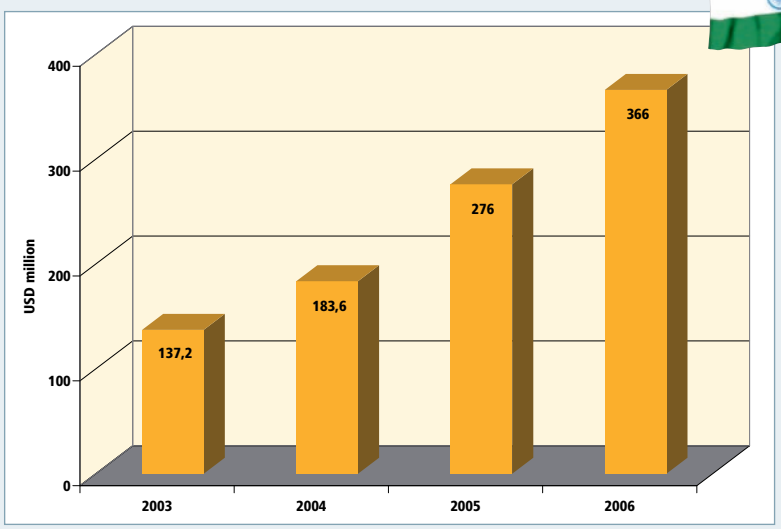
In the custom synthesis market, with the shift from generic to innovative drug discovery, an annual growth rate of 20–25% is expected for innovator companies while a growth rate of 10–15% is expected in the generic industry. Services in synthesis, drug design, analytical and medicinal chemistry, and assay development are being offered by an increasing number of Indian vendors, such as Mithros Chemicals, and a number of major multinational companies, such as Abbott, Bayer, Glaxo Smith-Kline and Merck, are already outsourcing various chemical synthesis projects to Indian service providers.

With the growing demand for outsourcing services, Indian companies have made acquisitions in the contract research and manufacturing sector, in order to scale up rapidly and have adequate infrastructure in place. Types of acquisitions include manufacturing facilities in China to access low cost APIs; contract research organisations in Europe to leverage on existing



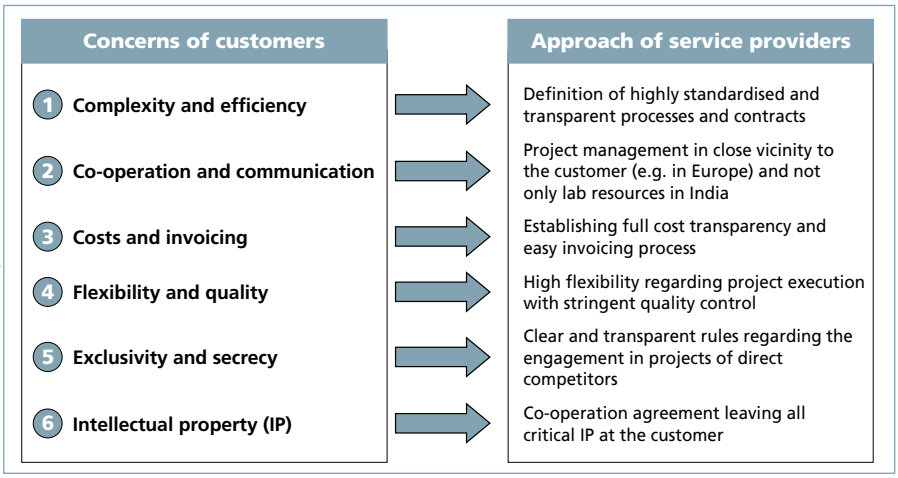
India's pharma R&D expenditures from 2000 to 2005

Source: Associated Chambers of Commerce and Industry of India



Biotech investment track from 2003 to 2006

Source: IMaCS Consulting



Source: Festel Capital analysis

Approach of service providers to the concerns of customers

client relationships of acquired companies; acquisitions to bride the gaps in the service offerings and become full service players; acquisitions to gain access to newer technology platforms for high-end custom synthesis and clinical research work and new clients.

India as attractive outsourcing location

Major international companies have identified India as a key location for various drug discovery and development projects, such as custom synthesis. With a large pool of talented scientists – especially in synthetic chemistry – at R&D personnel costs around a third of those in Europe, availability of low cost, high quality production, easy access to raw materials and faster approval of drugs than those produced in Western countries, multinational pharma and biotech companies can achieve cost savings of around 30–50% when outsourcing projects to India.

Pharma outsourcing ranges from a one time supply to a partnering agreement, whereby, according to a market study conducted by Festel Capital and Taros Chemicals on outsourcing chemical synthesis to India, the trend is towards long term relationships between the Indian pharma companies and the multinational companies leading to a preferred vendor status for the Indian companies. Multinational companies, such as Abbott, AstraZeneca, Eli Lilly, GlaxoSmithKline, Merck, Novartis, Pfizer and Solvay, are all using the services of contract research organisations.

There are various key attributes for Western pharma companies when looking for an Indian partner, such as, effective and rapid decision making, the ability to solve day to day as well as strategic issues, and understanding and appreciation of "business norms" in Europe and US. One of the main concerns of multinational companies when considering outsourcing to India is inefficient intellectual property (IP) protection. Many are concerned about threats to IP and the risk of losing IP rights. In recent years, India's patent act and rules have been amended significantly in view of the Indian Government's international commitment under the TRIPS (international agreement on trade-related aspects of intellectual property rights) agreement, and with its last amendment in 2005, the patent act conforms to the TRIPS agreement, including the grant of product patents. Alternative statutory protection in India, especially for sensitive R&D data and know-how from the discovery phase, is provided by India's Contract Act and related laws that correspond to those of similar statutes in the UK. In recent years, the government has also introduced policies, such as stringent regulations, mandatory good manufacturing practice (GMP) compliance and improved legislations for clinical trials. ■

Examples of acquisitions made by Indian companies

Indian company	Asset acquired	Year
Dishman Pharmaceuticals and Chemicals	Synprotec Carbogen and Amics Solvay's cholesterol, vitamin D and analogs business	2005 2006 2007
Jubilant Organosys	Trinity Laboratories Hollister-Stier	2005 2007
Nicholas Piramal	Avecia Pharma Bio Syntech Pfizers Morpeth UK-based manufacturing business	2005 2005 2006
Shasun	2 UK-based Rhodia plants	2006

The Jurong Island, a sporadic collection of seven islets into an integrated island with an area total of about 32 km², is a well-integrated modern complex; a world-class chemicals hub in the region.

As the chemical hub of Southeast Asia, Singapore's chemicals industry overtook the electronics sector to become the top contributor to manufacturing output.

Singapore's chemicals industry on the fast track

PETER LEE

In Singapore, the idea for an integrated chemicals hub was mooted in the 1980s, when it became evident that the chemical cluster was capable of contributing significantly to the economic growth of Singapore. Singapore is currently the leading oil trading hub in Asia (third in the world after New York and London) and the world's third-largest oil refining center behind Houston and Rotterdam.

The chemicals cluster in Singapore includes the petroleum, petrochemicals and specialty chemicals industries, with firms involved in roles ranging from manufacturing, logistics and trading to services like power generation. Today, Singapore ranks amongst the top three global centers for oil refining, oil trading, and price discovery. It is also one of the world's top ten petrochemicals hubs.

The Jurong Island, a sporadic collection of seven islets into an integrated island with an area total of about 32 km², is a well-integrated modern complex; a world-class chemicals hub in the region. Today, Jurong Island is home to over 88 leading petroleum, petrochemical, specialty chemical and supporting companies with more than S$24billion in fixed assets investment on Jurong Island. Industry luminaries such as ExxonMobil and Shell have already established a strong presence on Jurong Island and are poised to reap the benefits of comprehensive infrastructure and production synergies from this unique cluster development.

Well-established infrastructure

There is a strong reason for the impressive portfolio of companies that are currently on Jurong Island. It is the well-established infrastructure on the island. Companies on Jurong Island are vertically integrated and interlinked by the common pipeline service corridor to create synergy and efficiency. Feedstock and products are supplied and dispatched from plant to plant via the network of pipelines, as the output of one plant is the input of another as a result of the cluster manufacturing arrangement. On top of plant to plant synergy, companies on the island reap economies of scale, enjoy increased operational efficiency and cost savings. All these are the benefits of the minimal requirement for storage facilities and long-haul distribution brought about by the intelligent infrastructure.

Peter Lee, Manager Industry Development, ASPRI Secretariat, Singapore

As the chemical hub of Southeast Asia, Singapore's chemicals industry overtook the electronics sector to become the top contributor to manufacturing output in 2006. The cluster's 2006 output reached S$74.7 billion, or 33 per cent of total manufacturing output. The pharmaceuticals industry also did exceptionally well in 2006 contributing to 91 per cent of the total output by the Biomedical Sciences (BMS) industry, which reached S$23 billion, according to figures released by the Singapore Economic Development Board (EDB). This translated into S$20.93 billion in pharmaceutical output, a 32 per cent rise.

In addition to the growing scenario in the chemicals cluster, Singapore will be an excellent potential as a center for Asian biofuel production, with a central location in terms of product and feedstock flows. The Finland refiner Neste Oil will be building a palm oil-based biodiesel plant in Singapore due in 2010.

Elsewhere in the ASEAN region especially in Malaysia, Thailand, Vietnam and Indonesia, the chemical industry is also enjoying strong growth with large number of projects coming on stream. This buoyancy has translated into opportunities and challenges for the regional process industry, which is expected to boom through 2010. To effectively capitalize on the many business opportunities, industry players are exploring innovative solutions to take advantage of the surge in demand.

Riding high on increasing demands in the region, the Association of Process Industry (ASPRI) representing the supporting industry for the chemicals sector, has taken the lead to initiate an international platform for players of the process industry to network, update and upgrade. Developed by the industry for the industry, ProcessCEM Asia 2008, the International Exhibition & Conference on Plant Construction, Engineering & Maintenance for the Process Industry will be held in Singapore at Suntec Singapore from 22 to 24 October 2008. ■

ProcessCem Asia 2008

ProcessCEM Asia 2008 is a multi-faceted platform that features showcase, experience and expertise sharing, site visits as well as networking opportunities for the international process industry.

For more information, please log on to the web site at: www.processcemasia.com

or contact ASPRI:
(Association of Process Industry):
Phone: +65-65604885
e-mail: processcem2008@aspri.com.sg

or MP Asia/Pico Event Management
Phone: +65-63930237
e-mail: sales@processcemasia.com

with modest investment and rapid paybacks. But getting the message across requires a professional approach that does not appear to push particular products or manufacturers, a recent large study in Germany found.

Energy saving will increasingly make use of "intelligent components": learning systems that are able to adjust to external requirements by themselves. Pumps and pump systems, for example, can be instrumented and linked by a fieldbus to a central monitoring station, allowing them to be "self-servicing". The picture shows bus-enabled Grundfos CR series high-pressure centrifugal pumps in use.

Picture: Grundfos

Energy efficiency at the Pump Users International Forum 2008

The Pump Users International Forum, organized by the VDMA's Pumps + Systems Association, takes place on October 28/29, 2008 in the Düsseldorf Congress Center. It will offer an unrivaled platform, especially for plant engineers and users of pumps and pump systems, to learn about all the latest developments in this area.

Pumping partners

The campaign Energy Efficient Systems in Industry and Production was set up and carried out by Deutsche Energie-Agentur GmbH (dena; the German Energy Agency) and the Pumps + Systems Association of the VDMA (German Engineering Federation), and sponsored by the Federal Ministry of Economics and Technology. The industrial partners were AGO AG Energie + Anlagen, Danfoss GmbH, the German Copper Institute DKI, Grundfos GmbH, KSB AG, Sulzer Pumpen GmbH and Wilo AG.
The campaign focused on improving the energy efficiency of pump systems, along similar lines to that of the European Union's "Motor Challenge Program" (MCP) for energy savings in the field of motor driven systems. It was part of the Energie Effizienz (Energy Efficiency) initiative for the efficient use of electricity. This is supported by dena and the energy companies E.ON Energie AG, EnBW AG, RWE Energy AG and Vattenfall Europe AG, and sponsored by the Federal Ministry of Economics and Technology.

Contact:
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VDMA e.V., FV Pumpen + Systeme
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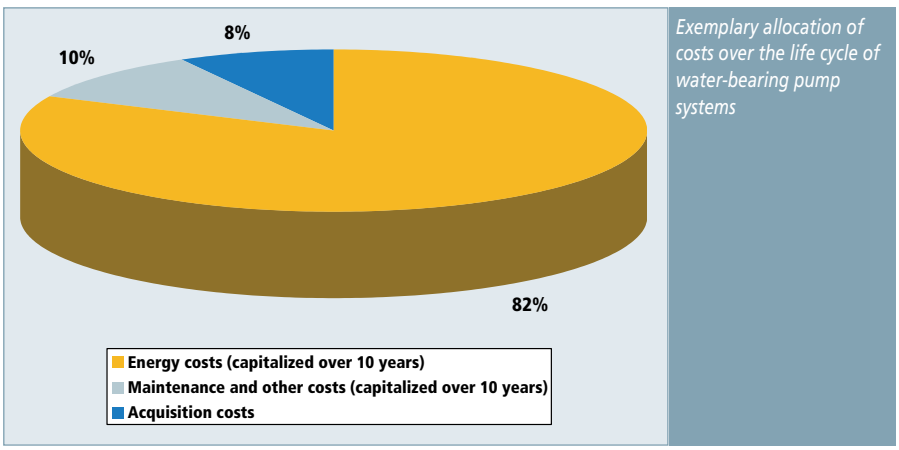
such as systems analysis and sustainability also featured.

Convincing figures

The launch year of 2004 was not an ideal time to be selling energy saving; energy prices had not yet really begun to soar, and the unexpectedly powerful resurgence in the German economy was yet to materialize. As a result, initial responses to the campaign were lukewarm.
However, pump users persuaded to take part in a first consultation soon started to give positive feedback. Calculations confirmed what the partner companies had always known: savings could be made, at expected levels, in virtually every industrial sector. And as expected, each of the ten analyses in the more extensive second consultation stage revealed even higher savings potential.
A big advantage of the campaign lay in its neutral presentation. While the consultants were all provided by the partner firms, they operated as representatives of the VDMA/dena campaign. As such, and because the recommended measures were not tied to specific products, they met significantly less resistance on the part of the users.
Even so, approval for implementing the proposed measures only really came when the short payback times of the measures were clearly spotlighted.

Pumping trends

Energy saving will increasingly make use of "intelligent components": learning systems that are able to adjust to external requirements by themselves. Pumps and pump systems, for example, can be instrumented and linked by a fieldbus to a central monitoring station, allowing them to be "self-servicing".
In the case of mass-produced pumps, the trend will be increasingly towards lower performance, countering the past tendency to provide operating margins that are more generous than necessary. To ensure that pumps match their operating conditions, manufacturers' competence in pump systems will become increasingly important. ■



Exemplary allocation of costs over the life cycle of water-bearing pump systems

Source: dena, VDMA

UK aims to optimize *bioscience opportunities*

The UK Government is currently gearing up to implement a new marketing strategy for promoting the UK's expertise in the biotechnology, pharmaceutical and healthcare sectors. The new strategy aims to bring together Government and business to give the UK's Life Science sectors the loudest possible voice on the world stage.

MIKE DAY AND PAUL CARTER

The UK is a global centre of Life Science creativity and in investment terms, the UK leads in Europe and is second only to the USA. The pharmaceutical industry alone contributed over £12billion to UK exports in 2006.

Many of the key tools of bioscience, such as genomics, proteomics, nanotechnology, and bioinformatics, all address numerous medical challenges and have attracted significant investment from both smaller biotech companies and larger pharmaceutical manufacturers. The nations and the companies that will gain the most from the resulting bioscience revolution will be those that implement the best strategies to optimize the successful convergence of these varied bioscience technologies.

Developing global healthcare solutions is the prime motive force for the majority of bioscience companies. Drug development, diagnostic testing, biomarkers and new generations of medical devices and surgical implants are all stimulating huge growth in biotechnology and pharmaceutical markets.

Technology convergence

There are a number of key technologies driving the bioscience industry. They include: genomics, proteomics, nanotechnology, bioinformatics and advanced imaging techniques.

■ Genomics: The sequencing of the genomes of viruses and bacteria is useful tool in the fight against infection. Genomics – the study of an organism's entire genome – is helping to predict the complex interplay of genes in a body. From that understanding come clues to potential ways to treat particular medical conditions as well as helping to create diagnostic tests for specific illnesses.

■ Proteomics – the study and comparison of the full protein complement of cells and their interactions, using large-scale methods for the simultaneous analysis of many proteins. Proteomics research techniques such as Polymerase Chain Reaction (PCR), and RNA interface are enabling the manipulation of genes in order to study their function or for industrial or therapeutic purposes. Advances in the ways biotechnologists can look at proteins are helping the correlation of protein expression with states of health. Using gene chip arrays researchers can determine which genes are "switched on" at any moment and which proteins are being produced.

■ Nanotechnology is increasingly being utilized in the development of biosensors, medical devices and drug delivery methods, and looks set to play a vital role in many areas of healthcare that will drive further bioscience developments.

■ Bioinformatics is also having a significant impact on the way bioscience is being implemented and how the research community operates and in-

Pictures: U.S. Department of Energy Genome Programs (http://genomics.energy.gov), archives; [M]-Kansog

Mike Day is ACHEMA's UK and Ireland representative and is responsible for helping to increase the number of international exhibitors signing up for ACHEMA 2009.

Paul Carter of Phoenix Marcom, a marketing communications company specialising in the science and industry sector, is supporting Mike Day in his task. Phoenix Marcom has a proven track record with high tech companies, especially in the laboratory and analytical sector, which was the largest British exhibition group at ACHEMA.

teracts. The research and development laboratories are increasingly relying on IT for data capture, analysis, modelling and sharing. The increasing popularity of Laboratory Information Management Systems (LIMS) is a case in point. Bioscience often requires pooling the efforts of large, international research teams collaborating and sharing knowledge and results data via LIMS across wide area networks.

■ Advanced imaging techniques particularly those based on fluorescence are enabling researchers to see molecular reactions take place in real time and in vivo. These advanced analytical techniques enable scientists to study the impact of biopharmaceuticals on the body and provide essential feedback to drug developers.

The UK bioscience perspective

In the UK the prime engine driving bioscience is the industry's significant drug development pipeline. The UK has the largest biological medicines development pipeline in Europe. There are about 30 per cent more products in development in the UK compared with its nearest European competitor.

There are about 200 drug candidates currently in development in the UK with about ten percent of them well advanced and now in Phase III clinical trials.

The UK biotechnology sub-sector features about 400 companies and generates revenues of about £5 billion. More than 25,000 people are employed by UK biotechnology organizations. The majority of bioscience employees are based at small, young and privately held companies. If the UK's bioscience industry growth rates continue the figures in terms of sales and employees are likely to have tripled by 2015.

The UK is ahead of its major European rivals in Switzerland, France, and Germany. The UK position compared with its European rivals is also strengthened when you take into account the bioscience activities of major multinational pharmaceutical companies. Although the UK pharmaceutical industry accounts for about three per cent of world sales the country accounts for ten per cent of the world's pharmaceutical R&D expenditure.

Biopharmaceuticals based on natural macromolecules, such as human proteins, are beginning to make a substantial contribution to the healthcare sector. Indeed, biopharmaceutical drugs account for about ten per cent of total pharmaceutical market sales, and are the fastest growing part of the market. They will be an increasingly important factor during the next decade. A third of all drugs currently in development are now biologics.

Key advantages of UK bioscience

The UK bioscience sector has a number of competitive advantages compared with its other European rivals. One key advantage is the relative maturity of UK companies in the bioscience sector. In an industry that suffers from lengthy product development timescales, the UK already has established a number of profitable public companies and a growing number of actively marketed products. Rival companies in Singapore, Ireland, India, and China are still relatively young compared to those in the UK. Another plus point for the UK is that it supports a strong bioscience research base. More than 20 Nobel laureates have been awarded for biomedical research at UK research institutes during the past 40 years. There is also the major presence of several large pharmaceutical companies engaged in bioscience research and manufacturing in the UK and the unique influence of the NHS has the potential to make undertaking clinical trials of the new generation of biopharmaceuticals in the UK an attractive proposition for many drug developers. Many of these benefits have resulted in the UK building a pool of experienced scientists, senior managers, investors, and serial entrepreneurs who have played roles in multiple companies. The UK Government's new Life Science marketing strategy is formulated to be a catalyst for the continued promotion of the UK Life Science sectors to a global audience. The new marketing strategy includes:

■ establishing a marketing strategy board by Spring 2008 that is made up of business and government leaders charged with implementing the marketing initiatives;

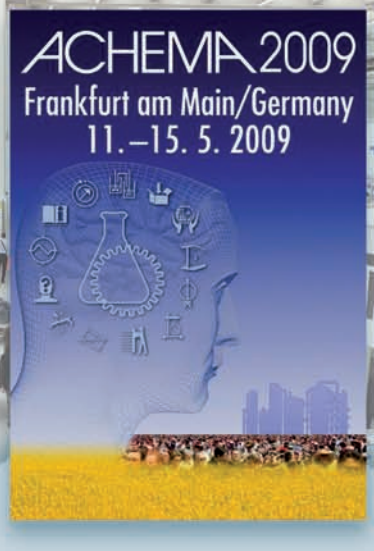
■ developing a shared marketing charter to help Government and business sell the UK's Life Science sectors consistently and persuasively around the world to potential buyers and partners or potential inward investors;

■ developing individual marketing campaigns for each of the three sectors – biotechnology, pharmaceuticals, and healthcare;

■ working in partnership and pooling resources between business, trade associations, cluster and research organisations, universities and Government to sell the strengths of the UK as the location of choice for inward investors.

Leading the way forward is bioProcessUK, which has identified there are a number of UK universities with strong academic capabilities in bioprocessing research capable of delivering skilled candidates for the bioprocessing sector, which could be developed into Centres of Excellence that will reinforce the UK's position as a global hub of education in bioprocessing.

The UK already has a strong reputation in certain areas of bioprocessing, such as cell therapies and tissue engineering, and in formulation and drug delivery. ■



ACHEMA 2009:
Brisk exhibitors' demand and exciting conference topics

Meeting point of experts

THOMAS SCHEURING

Having finalized the first step in ACHEMA's booking routine recently it is already now obvious that ACHEMA 2009 will benefit from the current strong position of the global chemical industry. After several years of focussing on cutting costs in the process industries we now witness a broad trend to either invest in new plants or to upgrade existing ones. This willingness to implement new technologies is being triggered by the need to catch up for the years of restrained investments, and supported by the positive economic situation of the chemical industry worldwide.

Equipment and service suppliers to the process industry, the key target group of ACHEMA's exhibitors' clientele, have read the signs of the times and book exhibition space well in advance to get their prime choice.

Innovative concepts for the use of resources and energy

While it is still too early to identify topical trends on the part of the exhibitors it is evident that innovative concepts for the use of resources and energy, the issue of this year's special show, will, in a wider sense, run through ACHEMA 2009 like a thread. The spectrum of exhibitors targeted by the special show itself includes industrial ("white") biotechnology as well as plants for the production of biofuels and biogas, biorefineries, bioplastics and biocomposites. The field of photovoltaics with its special materials and applications as well as photobioreactors, solar-chemical processes, chemical and thermal processes are also focal points of the special show.

Independant from that, and based on the feedback from DECHEMA's scientific community and networking, the key issues of the conference program have in the meantime been defined as follows:

General Topics

- New Reaction Pathways and Advanced Reaction Technology
- Mixing and Separation Technology
- Plant Components: Apparatus, Piping, Reactor
- Plant Controlling: Systems, Field Devices and Concepts
- Processes and Apparatus for Pharmaceutical Production
- Laboratory and Analysis Techniques
- Safety
- Materials for Apparatus and Plants

Special Sessions

- Industrial Biotechnology
- Chemistry and Biotechnology of Renewable Materials and Energy Resources
- Chemistry and Process Engineering for Power Supply
- Food Processing
- Formulation Technologies
- Gas Separation by Membranes
- High-throughput Technology
- Industrial Water Technologies
- Integrated Energetic Use of Biomass, RDF and Waste
- Ionic Liquids in Process Engineering
- Laboratory Reactors to Study Catalysis and Processes
- Materials and Energy Flow Analysis
- Microchemical Engineering
- Minimization of CO_2 Emissions
- Modelling in Process Engineering – Status and Perspectives
- Nanotechnology/Nanomaterials
- Process Analytical Technologies
- Process Intensification
- Separation Technology
- Smart Packaging
- Solids Process Engineering
- Waste Treatment

ACHEMA conference applications are requested in form of a single page abstract via **http://www.achema.de/congress** (max. 200kB). Lecture time is 20 minutes; the congress language is English.

DECHEMA's Congress Office can also be reached via e-mail for further information at **lecture@achema.de**, or by telephone **+49/(0)69/7564-333**. Application deadline is August 31, 2008. ■

You need more information?
Just browse through **www.achema.de** or simply send an e-mail to **bukatschek@dechema.de** for the official brochure 'Announcement ACHEMA 2009' which comes hot off the press with all relevant details for exhibitors, congress attendees and visitors. And last but not least: While exhibition space is still available in each exhibition group it is evident that options are getting scarce the longer you wait. So save disappointments and book your exhibition booth now!

Dr. Thomas Scheuring,
Head of Exhibition Congresses, DECHEMA e.V.,
Frankfurt am Main/Germany

INTERNATIONAL CONFERENCES ORGANIZED BY DECHEMA

March 10–11, 2008: High Pressure meets Advanced Fluids, Aachen/Germany
March 10–11, 2008: International Workshop Molecular Modeling and Simulation in Applied Material Science, Frankfurt am Main/Germany
April 2–4, 2008: 11th Annual Conference of the European Biosafety Association, Florence/Italy
April 22–25, 2008: EuroPACT, 1st European Conference on Process Analytics and Control Technology, Frankfurt am Main/Germany
May 25–28, 2008: 47. Tutzing Symposium: Modelling and engineering of complex systems – from molecular assembles to biological networks, Tutzing/Germany
September 7–10, 2008: 7th European Symposium on Biochemical Engineering Science (ESBES), Faro/Portugal
September 7–11, 2008: EUROCORR 2008 – European Corrosion Conference, Edinburgh/UK
September 21–24, 2008: ISPPP 2008 – 28th International Symposium on the Seperation of Proteins, Peptides and Polynucleotides, Baden-Baden/Germany
September 28–October 1, 2008: Green Solvents – Progress in Science and Application, Lake Constance, Friedrichshafen/Germany
September 28–October 2, 2008: 5th International Conference on Combinatorial and High-Throughput Materials Science,Kloster Seeon/Germany
October 8–10, 2008: Conference on Metalorganic Frameworks and Open Framework Compounds, Augsburg/Germany

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