Big changes often begin in small places

For Greater Insight
The Double Contact Process developed by Bayer engineers for the production of sulfuric acid, has been the recognized state-of-the-art technology for the last 50 years. But that’s now changed with the introduction of BAYQIK® from Bayer Technology Services – a new and pioneering process which can easily be integrated into your existing plant. Increase your plant’s capacity and reduce your emissions at the same time with BAYQIK® – our solution for greater efficiency and better climate protection. Find out more about BAYQIK® at www.bayertechnology.com/BAYQIK
According to a popular saying, ideas are the capital of the future. This observation especially applies to an inventive company like Bayer, which is undeniably driven by the many innovations constantly emerging from all areas of the Group.

While innovative strength is also contingent on the size of the respective budget, even more decisive are the abilities and courage of employees to shape the future. It really depends on them. Indeed, the path from an idea to an innovation is usually still very long. Added value and feasibility must be correctly assessed. Ideas only become solutions after the plan has been realized – reliably and in line with market requirements.

This is exactly what Bayer Technology Services ensures through the expertise of our specialists. Our goal is to bridge the often very wide gap between idea and innovative solution and, in so doing, to help secure the future viability of our customers.

Today more than ever, this task requires a close network of reliable partners. Here, too, Bayer Technology Services is able to oblige. Together with these partners, the company pursues a concept of “open innovation” – for the mutual benefit of all those concerned. Moreover, Bayer Technology Services has established its own platforms for major trend themes, such as nanotechnology, biotechnology and computational sciences – fields that are bound to shape the future of the world. These fascinating subjects are incidentally all dealt with in this issue of *technology solutions*.

In investigating the various topics for the magazine, it was confirmed once again that success is not only a question of extensive know-how and low prices. At least as important is the identification with our customers. If each individual in our company makes the customer’s point of view his or her pivotal perspective and strives to achieve the best for the customer, success is almost the inevitable consequence.

Just how much customer satisfaction is near and dear to our colleagues is extremely evident in this issue of *technology solutions*. When people from Bayer Technology Services refer to “we” in conversations with the editorial team, the customer is always implied as well. It therefore gives me great pleasure again to convey with this latest issue of our magazine an impression of how we tackle challenges and achieve successes. And with “we” I mean our customers, our partners and ourselves. After all, success is always the most rewarding, when as many as possible are able to share in it!

I hope you enjoy the read!

Yours, Dirk Van Meirvenne
Career Times Three
Not every employee aspires to the classical career path of a manager. At Bayer Technology Services there are other options.

Preventive Check-Ups
How often should plants and equipment be inspected? It depends, says Bayer Technology Services, while helping with the answer.

An Enlightening Shine
Sampling is not always necessary. Sometimes an optical process directly in the reactor suffices – such as fluorescence analysis.

Putting an End to Gas Flaring
Far too much natural gas is flared in offshore oil production. A new technology will turn the associated gas into a valuable asset.

Team with an Entrepreneur Gene
How colleagues from Bayer Technology Services developed a new process – and then also took charge of its marketing.

Too valuable to flare: natural gas – page 14

The suitable career path for everyone – page 10
WHAT KNOWLEDGE ACHIEVES

AutoMATically Well Sampled
How can experts facilitate the process control of the booming biotechnology industry? For example, with automated sterile sampling.

Achieving the Perfect Flow
How do you build a reactor to ensure that gases are able to efficiently react with each other? This is a case for fluid dynamics engineers.

The World Needs Smart Houses
How can old buildings be made more energy efficient? After a thorough inspection, experts can make specific recommendations.

Knowing What Hamster Cells Crave
How do you induce cell cultures to produce more of the protein crucial for people with hemophilia A? A multitalented team finds the answers.

Clean-Living for Bees
A special purification process frees honeycombs from impurities—with positive benefits for the offspring as well as for the wax quality.

Let’s Make a Model
Researchers who can reliably predict the fate of substances in the body with a computer model are in a better position to plan clinical trials.

Always the Right Printout
Companies that have to ship chemicals know a different label is needed for every order. Easily printable versions are therefore highly practical.
Each Tube Helps Save Energy

Oxygen is for us humans an important source of energy. In industry, however, this existential gas can also help save energy. For example, oxygen lowers the voltage necessary to produce electrolytic chlorine from sodium chloride or gaseous hydrochloric
When compared with the conventional electrolysis process, the application of the so-called oxygen depolarized cathode (ODC) reduces the electricity requirement by some 30 percent. With a global chlorine production of more than 50 million metric tons per year, this cut offers an immense potential for energy savings – as well as helping to reduce CO₂ emissions.

Bayer MaterialScience uses this technology, jointly developed with Bayer Technology Services, at its sites in Brunsbüttel (photo) and Shanghai, where the company produces chlorine from HCl. Pure oxygen is fed into each electrolysis cell via white plastic tubes. Bayer Technology Services, Bayer MaterialScience and other partners are currently planning the use of the ODC in sodium chloride electrolysis.
EMISSION NEUTRAL IN ASIA

With its EcoCommercial Building (ECB) Program to adapt construction to suit climatic conditions, Bayer is celebrating further successes. After its emission-neutral day-care center in Monheim, Germany, and a low-energy office building in Diegem, Belgium, Bayer opened its first ECB in Asia in early 2011 at its Greater Noida site in India. Bayer Technology Services India was responsible for the planning and realization. The new office building draws 100 percent of its electricity from a photovoltaic plant and needs some 50 percent less power than comparable buildings in the region. This shows that the ECB concept is also applicable in sub-tropical climate zones, where building insulation is primarily used to protect against heat, while in Europe the foremost concern is cold.

NEW IN MANAGEMENT

Dr. Jürgen Hinderer (46) became Head of Engineering at Bayer Technology Services on January 1, 2011. He succeeded Dr. Ralf Sick-Sonntag, who has assumed new responsibilities in Industrial Operations at Bayer MaterialScience. Hinderer formerly had global responsibility for Safety & Technology in the Industrial Operations Business Unit of Bayer MaterialScience. He has “international experience in production and technology” and leadership qualities that are crucial to further expand the business of Bayer Technology Services, says Managing Director Dr. Dirk Van Meirvenne. He thanked Sick-Sonntag for eight years of successful service, which contributed “substantially to the international standing of our company, not only in the field of engineering”.

Also from January 1 of this year, Jim Stephanou (45) assumed responsibility as Head of Bayer Technology Services Americas, based in Baytown, Texas. Stephanou, formerly Vice President of Propylene Oxide Global Asset Management for Bayer MaterialScience, succeeded Kirk M. Wilson, who retired after many successful years with Bayer. “Kirk Wilson strengthened the position of Bayer Technology Services Americas as the leading supplier of technological solutions for the chemical-pharmaceutical industry,” Van Meirvenne stressed. Stephanou has already proven his leadership abilities in various departments and companies. He has the right profile to successfully further develop our Bayer Technology Services business in the Americas region.

Dr. Günter Bachlechner (54) assumed the position of Head of Research of Bayer Technology Services on June 1, 2011. He will take over the Process Technology division as successor to Dr. Helmut Mothes, who is retiring. Mothes has worked in the Bayer Group for 27 years, nine of which were with Bayer Technology Services, says Van Meirvenne. Through his work he has made a major contribution to the worldwide standing of the company. Bachlechner, formerly Head of Research Technologies at Bayer CropScience, Research, has vast experience in development and technology. Furthermore, he has the special qualities that are so important for the expansion of the company’s portfolio and for the future business ventures of Bayer Technology Services.

The new members of the Global Management Committee (from the top): Dr. Jürgen Hinderer, Jim Stephanou and Dr. Günter Bachlechner
DREAM PRODUCTION IN A TEST

A pilot plant has gone on stream at the Chempark Leverkusen in which a new process for the integration of carbon dioxide (CO₂) in high-quality plastics is being tested on a technical scale for the first time. The process is the result of the “Dream Production” project. Within the framework of this project, Bayer is working with the power company RWE, which supplies the CO₂ required for the production. Other partners are the RWTH Aachen University and the Catalytic Center in Aachen, which is jointly operated by Bayer and the RWTH Aachen. Their researchers just recently made a major breakthrough in catalysis technology that now allows the efficient use of CO₂.

PRAISE FOR “INVITE”

Svenja Schulze, Minister for Innovation, Science and Research of the Land of North Rhine-Westphalia in Germany, visited the construction site of the INVITE Research Center, jointly founded by Bayer Technology Services and the Technical University Dortmund. The construction project received € 5 million as part of one of the Land’s economic stimulus packages. The center will be involved in the development of resource-conserving, efficient and flexible production processes. It will also develop a model of the “Factory of the Future” with European partners. Another project focuses on technologies that use carbon dioxide as a starting material for plastics production with surpluses from regenerative energy. Through this research project and cooperation, Bayer is showing “its strong commitment to innovation and sustainability,” says Schulze.

HEAT FROM THE FRIDGE

The “Peppy Fridge” is not only able to cool, it can also heat. With this special refrigerator three schoolgirls in the tenth and twelfth grades at the high school “Mädchengymnasium Essen-Borbeck” won the “Energy and Sustainability” prize of Bayer’s School Science Competition. Organized for the first time this year, the competition is a joint initiative of the Bayer Science & Education Foundation, the Bayer Cares Foundation and Bayer Technology Services. The heat loss from the “Peppy Fridge” can be used to directly heat up the water in a coiled conduit. However, the girls had to refine their invention in order to find a practical solution. The girl’s high school has established a research pavilion with the prize money of € 10,000.

Endowed Professor of Apparatus Design

In April 2011 Professor Norbert Kockmann assumed the endowed professorship of Apparatus Design at the Technical University Dortmund Department of Bio- and Chemical Engineering. Bayer Technology Services is funding the professorship with a total of € 750,000 over five years. Kockmann is a recognized expert in the field of microprocessing engineering. The cooperation with the TU Dortmund is a further step for Bayer Technology Services in the expansion of its strategic Excellence Network with universities and research institutes.
Career Times Three

Not every ambitious employee dreams of becoming a manager in the classical sense. Bayer Technology Services therefore offers two alternative career path options to climb to top positions: as experts or as project managers.

At first glance Professor Andreas Schuppert and Dr. Daniel Leineweber are two people who could not be more different. As a teenager Schuppert was already fascinated by astronomy and quietly experimented in his own small chemistry lab. At the age of 16 he won the state physics prize in “Jugend forscht”, a popular research competition for young pupils in Germany. He applied for his first patent at the age of 18.

By contrast, Leineweber already started engaging his teachers in eloquent debates at a young age. From the beginning he preferred working in a team – and especially when the task had to be completed under extreme time pressure, for example, as the editor responsible for a youth magazine.

Despite all these differences in personality, what Schuppert and Leineweber have in common is that they both work for Bayer Technology Services in Leverkusen. And as yet neither one has fitted into a typical career mold at the company. “Professional advancement at Bayer Technology Services has long been synonymous with the management career path, which is the approach of the classical manager,” says Professor Andreas Schuppert.

Professor Andreas Schuppert offers unique know-how in his field. At Bayer Technology Services he is a so-called Key Expert for industrial mathematics and has a professorship for data-driven modeling in Computational Engineering Science at the RWTH Aachen University.

You are a so-called Key Expert. Is the status of an expert for someone with your education unusual?

It is not the standard case for people with my educational background. Someone who studied a scientific or engineering discipline and joins a large company usually changes jobs after a few years. He or she then gives up the specialist job and works in production, marketing or controlling. In a way, they are widening their competencies, instead of deepening them – and are then more
Astrid Geißler, Head of Human Resources. And therein lies the problem.

Employees who pursue the management career path specifically want to take on personnel responsibility and to manage increasingly more people as their career progresses. They hope to actively help shape the organization and, if possible, ultimately influence the company strategy.

While this vision might excite some people, it may just elicit a shrug from others. “Some employees are keen to climb the career ladder, but do not see themselves as classical managers because personnel responsibility doesn’t interest them,” Astrid Geißler explains. For example, there are some people who prefer being involved in a particular field of expertise, such as industrial mathematician Andreas Schuppert. But then there are others who would rather work in a team and on different projects, such as engineer Daniel Leineweber. In the past Bayer Technology Services has never been able to offer such employees a fixed career path. There were no personnel development measures for their professional careers, no specific support for their competencies and therefore few medium- or long-term possibilities for advancement.

All this has changed since the summer of 2010, when the “perspective” career model was introduced in the company. More than just a mere change, it has virtually revolutionized career opportunities! Now two completely new career path options are offered in addition to the classical one. In terms of prestige and remuneration as well as prospects for promotion, they are in no way inferior to the classical management approach: the expert career path and the project career path.

The expert career path is ideal for people like Andreas Schuppert who want to acquire highly unique and specialized knowledge in a particular field and to use this in a customer-oriented or practice-oriented fashion. In contrast, the project career path targets people like Daniel Leineweber, who are particularly strong in planning and coordinating and who specifically want to work on projects. “Both groups can now progress along clearly defined and consistent career paths to the top positions of upper management with the respective personnel development measures,” says Astrid Geißler full of enthusiasm. “This approach is unique in the Bayer Group.”

The core of this new career concept is the so-called development dialogue, in which employees analyze, together with their superior, their strengths and preferences. They are then classified in one of the three career paths and in a “role” (see box on page 12). “The assessment is transparent and based on objective principles,” Geißler stresses. Their superiors are bound to clear rules. In the course of their career, the classification is regularly adjusted to the develop-
“People who enjoy working for Bayer Technology Services because they feel valued are a guarantee for success with customers.”

Astrid Geißler, Bayer Technology Services

Three Paths to the Top

<table>
<thead>
<tr>
<th>MANAGEMENT CAREER PATH</th>
<th>PROJECT CAREER PATH</th>
<th>EXPERT CAREER PATH</th>
</tr>
</thead>
<tbody>
<tr>
<td>● Takes on personnel responsibility</td>
<td>● Takes on project responsibility</td>
<td>● Takes on functional responsibility</td>
</tr>
<tr>
<td>● Ability to inspire others and to lead them to a goal</td>
<td>● Enthusiasm for various project requirements and complex tasks</td>
<td>● Fascination for technical details and background</td>
</tr>
<tr>
<td>● Team orientation, good communication skills and natural assumption of responsibility</td>
<td>● Interest in planning and coordinating projects as well as a command of the necessary resource management skills</td>
<td>● Interest in concentrated work on a team of experts and in exchange on an expert panel</td>
</tr>
<tr>
<td>● Leader personality and trusted reference person for one’s own team</td>
<td>● Talent for professional and comprehensive management of interdisciplinary projects</td>
<td>● Makes use of scientific research results to search for practice-oriented solutions</td>
</tr>
<tr>
<td>● Talent for entrepreneurial thinking and acting, for strategic foresight and for creating pragmatic solutions that are specifically delegated</td>
<td>● Communication strengths, competencies in target-oriented work under time pressure, pragmatic problem solving and quick decisions</td>
<td>● GOALS: expand highly specialized knowledge and utilize it for a customer-oriented and practice-oriented approach</td>
</tr>
<tr>
<td>● GOALS: utilize management competencies</td>
<td>● GOALS: utilize supervision competencies and coordination strengths</td>
<td>● ROLES: Specialist/Engineer – Expert – Senior Expert – Key Expert</td>
</tr>
<tr>
<td>● ROLES: Head of Competence Center – Department Head</td>
<td>● ROLES: Specialist/Engineer – Lead Engineer, Team Leader, Project Manager – Senior Project Manager – Program Manager</td>
<td></td>
</tr>
</tbody>
</table>

What characterizes an expert and an expert career path in comparison with a project career path and a management career path?

The expert’s job involves answering non-standard questions that have never been solved before. That differs from management responsibilities or the duties in project management. How so?

The challenge of the tasks in a management career path is to manage a high degree of complexity. The manager knows what he or she has to do for every single task. In project management, the specialist knows how to manage a project. The challenge is how to handle coincidences or disturbances. The expert has to deal with completely unstructured problems – questions in which it is totally uncertain how one should resolve them.

Is a scientist more likely to be suited for an expert career path?
Scientists are often people who enjoy solving extremely difficult problems, which include, in particular, major challenges of the future where you want to be the pioneer. This is usually not compatible with a normal career for which there are relatively clear predetermined paths.

Does the career model convince you?
For an innovative company like Bayer, it is extremely important that every employee has the maximal opportunities to contribute his or her capabilities. This career model offers a lot more flexibility. In former times many companies preferred to cultivate the “generalists”, rather than fostering individual strengths. Today, everyone should have the chance to come to the point where he or she can make use of his or her own personal strengths. So, you strengthen the strengths and see to it that any weaknesses are compensated. This is beneficial for the company – and the employee.
Putting an End to Wasteful Gas Flaring

The amount of gas flared over oilfields per year is equivalent to the consumption of Germany and France combined. The British company CompactGTL has developed a technology that turns this gas into a valuable asset. Bayer Technology Services was an important partner.
Some 150 billion cubic meters of natural gas are uselessly flared in oil production every year – more than a quarter of this amount in offshore production.
We have all seen the satellite images of the earth at night showing the brightly lit urban centers of human civilization. Other satellite images, however, reveal something quite different: mysterious light sources on the high seas. These illuminated spots are actually burning gas flares. The Gulf of Guinea in West Africa is one region where many such blazing fires can be seen.

The fires are fuelled by gas escaping from the surface during oil extraction. In terms of its chemical composition, this is, in fact, natural gas. However, since it has never been possible until now to utilize this natural resource cost effectively, the gas has simply been flared. Over the oilfields of Nigeria alone, many of which are located in the Gulf of Guinea, more than 20 billion cubic meters of this valuable raw material are lost every year. At the same time, the greenhouse gas carbon dioxide is emitted during the combustion process.

A few years ago the World Bank calculated that 512 billion cubic meters of associated gas are released from the surface of oilwell boreholes around the world. If you would collect this amount in a hollow cube, it would cover a ground surface eight times eight kilometers and would tower eight kilometers into air. This amount of gas would almost be enough to meet the entire natural gas needs of the United States.

However, instead of producing heat, electricity or chemicals from this associated gas, most of it is re-injected back into the ground. And the rest – nearly one third – is flared. Some 150 billion cubic meters are thus burned off. This is nearly 25 percent of the total U.S. consumption – and enough to cover the natural gas requirements of Germany and France combined.

The reasons for this are manifold. Firstly, many oilfields are so remote that building gas pipelines is not worthwhile. Processing to liquefied natural gas (LNG) is very rarely practicable, as it requires a certain degree of infrastructure. “Especially in the case of offshore production this is difficult to install,” says Dr. Wulf Dietrich. The German chemical engineer works in Process Technology at Bayer Technology Services. Since 2009 he has headed the Bayer side of a project focused on supporting the development of a technology that turns associated gas into an economic asset – even at remote sites. The customer is CompactGTL, a British company that is targeting remote and deepwater oilfield locations with this technology. This includes the Floating, Production, Storage and Offloading units (FPSOs), which are becoming more and more popular. These floating vessels produce oil and gas by extracting it from seabed reservoirs, processing it in facilities on board and storing...
The Geophysical Data Center in the United States has made offshore gas flares visible in colorful satellite images. Here are views of the southeast coast of Brazil (top left) and the coast of Nigeria (below left). The respective colors stand for the year of the photograph; the coastline is shown in cyan blue.

The technology solutions

The Geophysical Data Center in the United States has made offshore gas flares visible in colorful satellite images. Here are views of the southeast coast of Brazil (top left) and the coast of Nigeria (below left). The respective colors stand for the year of the photograph; the coastline is shown in cyan blue.

The Geophysical Data Center in the United States has made offshore gas flares visible in colorful satellite images. Here are views of the southeast coast of Brazil (top left) and the coast of Nigeria (below left). The respective colors stand for the year of the photograph; the coastline is shown in cyan blue.
“Heat has to be added to the first reactor, while the second reactor has to be cooled. The challenge was how to best balance all of these requirements.”

Dr. Wulf Dietrich, Bayer Technology Services

array of small, closely spaced mini-channels through which the gases flow. The modular system allows the reactor to react flexibly to gas flowrate fluctuations because the number of parallel modules can always be regulated. In addition, individual modules can easily be removed while the facility is in operation, for example, if they have to be equipped with a new catalyst.

A key part of the subsequent development was then to optimize the reactor module designs to provide the required stability and performance, but also taking into account the available and proven manufacturing processes. This included reactor channel dimensions, gas velocities and catalyst structure and activity. The space between each channel is also important because it influences how efficiently the heat fed into or released from the system can be exchanged.

The heat exchange, in general, is an important factor in the design of GTL technology. While the process in the first reactor only gets started at a temperature of more than 600° Celsius, the Fischer-Tropsch process in the second reactor releases a significant amount of heat. “In other words, heat has to be added to the first reactor, while the second has to be cooled,” says Wulf Dietrich. “The challenge was how to best balance all of these requirements.”

To clarify these questions, CompactGTL identified the need to model the reactor designs, the processes occurring and the heat transfer. For this they required additional expertise. Their search led them to the website of Bayer Technology Services, where the English team found the email address of Professor Leslaw Mleczko. So, one day the Head of Reaction Engineering & Catalysis at Bayer Technology Services discovered an email inquiry by a Iain Baxter from CompactGTL in his electronic inbox. He was also the one, together with Dr. Stephan Schubert from his team, to participate in initial discussions with CompactGTL.

Under the initial project management of Schubert, the expertise of Bayer Technology Services in reactor modeling was initially the main project focus. But subsequent projects were quick to follow. Soon CompactGTL sent the catalysts specially developed for this project to Leverkusen for testing as well. Ultimately, the German partners were also commissioned to carry out process simulations and equipment calculations. During peak periods, the Bayer team grew to 15 staff members. Wulf Dietrich took over the project management in 2009.

Partly based on the results of this work, CompactGTL commissioned a pilot plant facility at Wilton, Teesside in northern
England in 2008. “This test facility runs 24 hours a day and has been in operation for over two years,” says Iain Baxter, now Business Development Director. From the beginning, the British company had a first prospective customer for their technology: the Brazilian oil company Petrobras. A few years ago, when the government-backed company discovered probably one of largest oilfields found in recent decades off the coast of Brazil, the question of a viable use of associated gas became particularly urgent.

A commercial demonstration plant with a capacity of almost 5,700 cubic meters per day was commissioned by Petrobras in December 2010. “The use of models developed by Bayer Technology Services in combination with results from lab tests in Leverkusen, and our pilot plant at Wilton has contributed to the successful design and operation of the plant and reactors,” says Ross Morgan. Everything has been running well so far. The General Manager of Technology Development at CompactGTL also acknowledges the good cooperation with Bayer Technology Services: “The breadth and depth of knowledge, experience and expertise at Bayer Technology Services has been a great benefit in helping us to overcome several technical challenges.”

The commercial demonstration plant in Brazil is now running and under test producing up to 20 barrels per day of synthetic crude oil, or “syncrude.” This is the term used for the mixture of hydrocarbons produced by Fischer-Tropsch synthesis. Since the components of this syncrude are also contained in natural crude oil, syncrude can easily be mixed with the extracted oil. This is especially practical in offshore applications. The process thus eradicates the need for continuous flaring or the potentially damaging and costly injection of the gas into the reservoir. It also eliminates the need for separate product storage, transportation and marketing arrangements as required for other possible solutions.

“CompactGTL has ensured the commercial validity of the technology through collaboration with Bayer Technology Services and other independent strategic partners; establishing a supply chain to deliver commercial scale plants to meet client demand,” Iain Baxter says. And one thing is certain. This unit will not be visible on any nighttime satellite images.
Preventive Check-Ups

How often should chemical facilities be inspected? Bayer Technology Services helps find the optimal solution on a scale from “too infrequently” to “more often than necessary” – with equal benefits for both safety and productivity.

Although Dr. Michael Renner still feels perfectly healthy, after turning 50 he decided he should see his doctor for a general health check-up at regular intervals. Every aspect of his health is tested, as recommended for his particular age group: intestinal tract, prostate gland, heart, skin, eyes, all sorts of blood values and a lot more. Ten years ago, Renner’s visits to the doctor were much shorter and far less frequent. In general, he only went to the medical practice when he had a specific health issue.

Renner knows that it is right and sensible to observe one’s body more attentively with increasing age. “Unfortunately, the probability that something may no longer function perfectly is higher,” he admits somewhat reluctantly. And he also knows that if something is not functioning properly, it is a good idea to identify the problem as early as possible.

Renner’s appreciation for regular check-ups is this big because he also acts much the same way in his own profession – despite the fact that Renner is a materials engineer instead of a medical practitioner. At Bayer Technology Services he is Head of Materials Technology/Mechanical Integrity, and as such, he is obviously not involved with the human body, but instead works with chemical facilities. However, at second glance, the two very different fields have a number of things in common. While one field deals with the strain on joints, blood vessels and organs, in the other it is reactor vessels, pipes and pumps that are subject to stress. Wear, tear and corrosion can affect the materials over the course of time. That is why chemical plants also have to be inspected on a regular basis.

In Germany, for example, the Ordinance on Industrial Safety and Health normally expects plant operators to undertake such inspections every five years. Reactors, tanks and pipes are completely emptied in order to meticulously examine all the components of the plant – also from the inside. The aim is to detect and correct any and all safety risks well before they become an issue. This might be a hairline fracture in a stainless steel container, advanced corrosion in wiring or an imminent valve leak.

Plant expert Renner finds this safety requirement absolutely correct. However, he feels rigid regulations based on time intervals alone are too inflexible. “There are components that one can safely expect to fulfill their task under certain processing conditions longer than five years without any problem,” says Renner. “But there are other plant sections, however, which perhaps may even require more frequent checks using a very specific inspection method.”

Although many countries still adhere to time-based regulations, a philosophy is on the rise that is completely to his liking: risk-based asset management. This concept bases the frequency of safety checks for plant and equipment on the respective condition and the actual risk analysis. And it implies moving away from the conventional approach of subjecting all facilities to the same rigid inspection cycle.

Having worked himself in the United States for five years, he saw how U.S. refineries initiated the paradigm change as early as in the 1990s. “Instead of just time-based inspection management, people changed to scheduling inspection cycles according to the features specific to the process used in this particular facility and its actually existing risks,” Renner explains. “This means, you carefully examine which concrete risks with which probabilities and which hazards actually exist. Only then do you decide on the suitable inspection sched-
The frequency of chemical plant inspections depends on their respective specific risk factors. The same is true for personal health check-ups.
ules that meet the requirements of the special risks specific to a particular plant.” Applied to the example of medical exams, it is much the same as advising from the age of 45 to have the prostate screening once a year or to say people with fair skin and red hair should be checked for melanoma more often than people with darker skin.

In the meantime, this risk-based approach is limited neither to refineries nor the United States. In fact, it is also increasingly spreading throughout the chemical industry. And Bayer Technology Services is ready to offer support to all those who aim to introduce a more flexible approach to their inspection management. For this task Michael Renner has assembled a team of some 150 employees around the world in the regional Materials Technology/Mechanical Integrity departments.

“They go to our customers, make a very painstaking survey of the processes and the facilities and then calculate a risk matrix,” Renner explains. For this review each component of the facility is assessed, for instance, whether it has aged more quickly than expected or experienced a change in its condition, and then the probability of this occurring within a particular period of time is determined. The risk is classified in five different levels, which are expressed in colors from green (low risk) to dark red (high risk) in the matrix. Also included is the risk in the event of possible damage. There is obviously a big difference if acid or hazardous gas were to leak after rust perforation of a manifold rather than just tap water.

When explaining this approach, Renner often mentions the term criticality. It is the criterion for the possibility that a part of the facility or a condition is critical and a risk is to be expected. Dr. Matthias Pfaffelhuber, Head of Competence Center Risk-based Maintenance in Renner’s team, prefers the word criticality to risk. “Risk has a negative connotation and sounds as if a specific dangerous event can be anticipated,” says Pfaffelhuber. “In our approach, however, we are actually assessing only critical factors and probabilities of events.”

Downtime costs money. In plants that produce several hundred thousand tons a year, every single day of production outage can make a difference of more than one million euros in lost sales. It is therefore all the more important to plan and execute inspections involving downtime as efficiently as possible.

This is exactly what a team from Bayer MaterialScience and Bayer Technology Services succeeded in doing at the turn of the new year in Shanghai. Bayer MaterialScience has been producing MDI, the raw material for polyurethane rigid foam, at the site since 2008—currently at a capacity of 350,000 tons per year. In accordance with legal provisions, a first comprehensive plant inspection had to take place by 2011. Besides the entire MDI train, this would also have to include production facilities for basic chemicals, raw materials, preliminary and intermediate stages as well as infrastructure operations.

The team also used the plant downtime to conduct further inspections to ensure operational reliability and to execute small investment projects. Because of the optimal planning, more than 1,500 single operations could be performed within a few weeks. Dr. Mathias Benz, Reliability Manager for Bayer MaterialScience at the Shanghai site, was also pleased about the highly successful and efficient check: “We really appreciate the inspection expertise of Bayer Technology Services very much.”
Once the matrix is completed, Renner’s team extrapolates a specific inspection plan for the coming five or even 20 years. “There can be sections of a plant for which we recommend more frequent checks than in the past,” Renner explains. But exactly the opposite can also be true – in other words, less frequent inspections, for instance, every 10 years. Despite the still valid inspection provision of every five years, German authorities are now willing to reconsider if it is clear that longer inspection cycles are sufficient or that carrying out reliable, but less time-consuming non-intrusive inspection methods stand on an equally sound basis as inspections requiring excessive downtime. If necessary, the replacement of plant sections can also be timed.

Some of these alternative checks involve methods that can be implemented while the plant is in operation. Examples are ultrasound or X-ray measurements to control material thicknesses or to detect hairline fractures. Another is baycorroxxion – a measuring system that Michael Renner was instrumental in helping to develop. It records voltage flows with high sensitivity, from which corrosion occurrences can be deduced. “The results of these measurements are computerized directly into our inspection plans for updating where necessary,” says Pfaffelhuber.

Experience so far shows that on average fewer inspections are sufficient for most facilities than with the conventional, rigid interval-based inspection management system. “There are cases where we could reduce the number of routine inspections by 70 percent,” Renner remarks.

This concept might leave some operation managers with a queasy stomach and sleepless nights, but Renner stresses that having longer intervals between inspections does not mean cutting corners in terms of safety. “While rigid time-based inspection intervals are usually established on very arbitrary assumptions with little knowledge of the actual condition, the risk-based approach uses the specific analysis results.” Pfaffelhuber also points out that unlike the interval-based method, the risk-based approach takes concrete facts into consideration and knowledge supplied from various scientific disciplines.

Renner points out another factor that at first seems paradoxical: “Sometimes more frequent inspections can actually prejudice safety.” This is due to the fact that tanks, pressure vessels and pipes have to be emptied and rinsed for each test. “This can even increase the risk of corrosion.”

The proactive approach also allows certain tasks such as replacing parts or a specific inspection to be combined so that everything can be done in one short downtime. Michael Renner notes that planning optimal plant downtimes so that they are as short as possible is something he and his team can help customers organize.

Shorter downtimes also means higher plant reliability and thus fewer production losses. In one case the assessment by Renner’s staff meant a customer was able to raise facility out-
AutoMATically Well Sampled

BaychroMAT combines sterile sampling with operationally excellent analytics. This special technology offers online process analysis for biotechnology applications. With the new BaychroMAT Lab there is now a version specifically designed for development projects.

People who move from one job to another can often offer a very unique perspective to new challenges. One case in point is Dr. Martin Gerlach. For many years, the German chemist worked on analysis systems for medical diagnostics in the Bayer Group. When he then changed to Process Analyzer Technology (PAT), one thing attracted his attention almost immediately: “There were plenty of online analysis systems for classical chemical production, but only a few for biotechnological processes.” It could not have been for a lack of appropriate instruments. From his previous work, Gerlach knew of many systems capable of recording the relevant biochemical parameters.

Gerlach could not get this incongruity out of his mind. When he transferred to PAT Sales in 2004, he asked his customers whether they might be interested in an online process analysis system for biotechnological applications. They were. The U.S. Food and Drug Administration (FDA) had only just started an initiative to encourage producers of biopharmaceuticals to rely more and more on process analysis technologies.

This discovery gave new significance to the BaychroMAT process analysis platform already introduced in the 1980s. Until then, this system for online process analysis was primarily used in polymer synthesis, where it combined automated sampling with chromatographic determination of the degree of polymerization. The subsequent feeding of analysis results into process monitoring also takes place automatically. So, experts at PAT asked the question, why not use this same approach of automatic sampling with subsequent analysis and linkage to process engineering in the booming biotechnology sector? Working in collaboration with colleagues from Processing Technology and Biotechnology Process Engineering, they designed an applicable system.

The key part is a sampling valve, developed and patented by Bayer Technology Services, which can be directly flange-mounted onto a fermenter. The crucial feature here is that before the valve opens for sampling, its interior is sterilized for 20 minutes with steam heated to 121° Celsius. While it cools down, it is also scoured with sterilized air. The actual sampling only takes place after this sterilization procedure. "Depending on the customer’s specifications, very different systems can be integrated into the platform for subsequent analytics – ranging from cell counting and chromatography to classical medium determination or determining the metabolic parameters of glucose or lactate,” says Dr. Stefan Steigmiller, who is responsible for the development of BaychroMAT at PAT.

The resulting system for biotechnology applications has been available since 2008. Companies that produce, for example, therapeutic antibodies, insulin, vaccines or other protein substances in fermenters can now monitor important production parameters fully automatically. Customers typically use the BaychroMAT system in combination with devices to assess cell concentration or to measure sub-

Growing Importance

The number of “biologics” is constantly growing. More and more new therapeutic approaches are based on active ingredients stemming from living organisms or modeled on such substances. As their production is complex and thus expensive, producers are very enthusiastic about every possible process improvement.
“By taking measurements as frequently as you want, you can learn a lot about the process.”

Professor Frank Gudermann, Technical University Bielefeld

You want, you can also learn a lot more about the process and intervene far more selectively.” In addition, his students use the data collected for computer modeling. For Bayer expert Steigmiller this amount of data offers “the possibility to gain ideas for process improvements and, consequently, for higher yields”. Many customers would also like to use BaychroMAT to ensure reliable glucose controls.

The handy BaychroMAT lab system was introduced this year for development work. “With this new version, product development can also make use of automated process analysis,” says Steigmiller. For example, it can help determine the suitable conditions and the optimal medium for the subsequent production of a new antibody. As Steigmiller says, BaychroMAT thus offers support for all phases from lab development and the first pilot plant right up to the actual production fermenter. The system is equally suitable for stainless steel, glass and disposable fermenters. And Dr. Martin Gerlach, who is now Head of PAT, is particularly pleased that such a successful product has developed from his insistence on following up on an initial idea.
What Knowledge Achieves

Achieving the Perfect Flow

Thanks to a new process, Bayer MaterialScience now consumes 60 percent less energy for the synthesis of toluene diisocyanate (TDI). Fluid dynamics engineers from Bayer Technology Services helped with the modeling of the new reactor.

On the yellow sign attached to the lattice fence it says “Sprudelstand” in German, which indicates an air-water bubble test facility. After entering the gate next to the sign, you will suddenly find yourself at the foot of a massive transparent plastic pipe, which juts vertically some 10 meters into the air. Bubble tests have clearly not taken place here for quite a long time. Most recently Bayer Technology Services mainly used this apparatus at the Chempark Leverkusen for mixing tests with gases.

Dr. Volker Michele is one of the people who is responsible for performing such bubble tests. The fluid dynamics engineer works in Reaction Engineering & Catalysis at Bayer Technology Services. His expertise comes into play when, for example, someone in the Bayer Group wants to know how two reaction components will mix with each other in a reactor.

Michele points to the upper end of the facility structure. “Up there, we have two inlets through which air is fed into the pipe. We then observe how the two streams of air mix together along the pipe.” The fluid dynamics engineers make use of a trick to allow the two streams of air to become viewable: mist is mixed into one air stream so that it is easily visible to the naked eye. With a camera Michele and his team then record the trails of mist left in the pipe. However, that is not all they can see. The short white wool threads attached to the inside wall of the pipe also provide important information. During the experiment their free ends flutter with the airflow. If the threads do not angle downwards properly, it is a sure sign that something has to be changed in the mixing configuration.

These tests, performed with simple air as a substitute for other components in normal ambient temperatures, are called cold-flow experiments. For fluid dynamics engineers like Michele such an experiment is an important tool in his work. The plastic pipe represents a reactor, and the airflow will show him how the two gaseous reaction partners will later behave in the reactor.

Something similar was the very assignment of a project with Bayer MaterialScience. They had the idea to change the final reaction step of the multistage TDI synthesis, which until now had been performed in a liquid solvent. The plan was to have the reaction partners come together in gaseous state instead. The advantage is clear: since the solvent does not have to be distilled off after the process is completed, one can save a lot of energy compared with the previous method – as it turned out, up to 60 percent. With a savings of this magnitude, weighing the pros and cons is clearly unnecessary! However, implementing the plan was

Material for Foam

The Bayer MaterialScience plant in Shanghai will have the capacity to produce 250,000 metric tons of toluene diisocyanate (TDI) per annum. Adding this to the capacities of its TDI plants at other sites around the globe, the company is among the world’s biggest producers of this important starting material for the production of polyurethane foams. Among the areas of applications are mattresses and upholstered furniture, shoe manufacturing as well as the textile and automotive industries. TDI production capacities worldwide are currently more than two million metric tons per annum.
For modeling on his computer, fluid dynamics engineer Dr. Volker Michele also relies on a practical experiment: the air-water bubble test performed here in Leverkusen.
far from easy. It took more than 10 years for the general idea of a gas-phase reaction to culminate in the construction of an actual facility. This summer Bayer Material-Science will commission its first TDI plant in Shanghai based on this new technology (see also technology solutions 1/2010, page 30).

Although Michele has never been in Shanghai, he definitely put his mark on the new production plant. The reactor geometry and process control are largely the result of his work. In addition to the cold-flow experiments, he needed the computer in his Leverkusen office – and the right data for computer calculations.

**There are several critical issues** to be considered if you want to produce TDI in the gas phase. One important aspect is that the two reaction partners do not react immediately to form TDI. An intermediate stage forms at first, after which TDI then develops in a second step. Consequently, the length of the reactor should not be too short, because otherwise the reaction time will not be sufficient to proceed beyond the intermediate stage. On the other hand, if the reactor should be too long, byproducts can develop, which would then have to be separated painstakingly from the desired main product.

“We consider what individual chemical reactions can take place, what materials can form and then disappear again and, above all, what kind of influence this can have on the respective situation in the reactor.”

Dr. Volker Michele, Bayer Technology Services

**Checking the Flow**

The Fluid Dynamics team at Bayer Technology Services is concerned with everything that goes into reactors – regardless of whether it is gaseous, liquid or solid. Using a computer and the appropriate data, the fluid dynamics engineers can simulate, for example, at what point in the course of a reactor it comes to what chemical reactions, as well as how temperature and pressure change in the process. The computer simulation produces pictures like the two adjacent illustrations that depict the joining together of reaction partners. The color gradients show the different speeds (right) and temperatures (left) in the mixing zone.

The work of fluid dynamics engineers involves not only new plants, such as the TDI project in Shanghai or the carbon nanotube production unit that began operations in 2010. The continuous improvement of existing facilities is also among their responsibilities. Depending on the particular case, the focus may be optimizing mixing processes, or it can often be a matter of improving separating and refining processes.

Complex proceedings inside the reactor: each color stands for a different temperature (left) or a specific speed (right).
The idea is to design a reactor and its process conditions, such as temperature, pressure and mixing intensity, so that as much TDI as possible is ultimately produced at the end of the reaction route. considering all this complexity, Volker Michele cannot rely alone on cold-flow experiments. All sorts of computations are also necessary in order to realistically simulate the processes in the reactor. “In such cases we carefully consider what individual chemical reactions can take place, what materials can form and then disappear again and, above all, what kind of influence this can have on the respective situation in the reactor.” After all, some of these reactions are accompanied by volume expansion and can also release a lot of heat. Both these factors will change the conditions in the reactor.

From his colleagues working in Kinetics, Properties & Modeling, Michele received the kinetic data covering all conceivable reactions and substances intermittently occurring in the reactor. He fed these data into his Computational Fluid Dynamics model and let the computer make the calculations. He specified reactor geometry and varied, for example, the temperatures and flow rates for the starting materials. The software then delivered copious data sets on, for example, the distribution of temperature in the reactor or the concentration fields of the individual components. In this way, he was eventually able to deduce the optimal conditions.

Dr. Steffen Kühling, Head of Production & Technology Isocyanates at Bayer MaterialScience, is particularly pleased with the work done by Volker Michele and his colleagues. “You do not very often find this combined know-how in both cold-flow experiments and computational fluid dynamics,” says Kühling. “As a consequence, Bayer Technology Services was a particularly helpful partner in this project.”

Friedhelm Steffens agrees. At the Isocyanate Technology Center of Bayer MaterialScience he shares responsibility for implementing innovation in TDI production processes. Although the gas-phase reaction had never been realized in a plant of such dimensions, Steffens was absolutely convinced it was going to be a success even before the start-up in Shanghai. So, his department has long been thinking ahead and is striving to introduce the new process at other TDI production sites because of the enormous energy savings. “As the next step, we are planning a similar facility in Dormagen,” Steffens said.
Team with an Entrepreneur Gene

The development of innovative processes, such as BAYQIK, is one thing, but marketing this development can be quite another. The key is to think and act with an entrepreneurial approach – just like the sulfuric acid team at Bayer Technology Services.
nce Bernd Erkes starts telling his story, there is no stopping him. His enthusiasm is reflected in his voice and his smile, and his blue eyes sparkle. Erkes is someone you enjoy listening to because with every gesture he emphasizes how thrilled he is about his job. “But the best thing is when we succeed in inspiring our customers’ enthusiasm as well,” he says.

And this is the very thing he manages to do with great regularity because he embodies the character of both the inventor and the salesman. “But somewhere I also seem to have an entrepreneur gene, which, to be honest, is very useful.”

Erkes is quite sure where it comes from. He was brought up in a family of craftsmen. His father, a self-employed carpenter, included the entire family in all of his business decisions. Whether it was a matter of investments or participating in a trade fair, whether contacting suppliers or approaching customers – “by the age of 14 it was already clear to me how much responsibility always comes with making decisions.” And Bernd Erkes was also very quick to discover what really mattered: “Making business with good ideas.”

However, he also learned that while you can manage small tasks on your own, you need a first-class team to handle the big challenges. “And that is what we have here,” he is visibly pleased to say. Each colleague on his team is an outstanding professional, whose individual capabilities cannot be praised enough. The team consists of Martin Kürten, the expert in sulfuric acid technology, Torsten Weber, the project manager responsible for product development, and Klaus Stemmer, responsible for marketing and sales. In addition to several
others, each of these individuals contributed enormously to the success of the product. The product in question is no less than a complete sulfuric acid plant.

The first time this kind of plant was supposed to be sold, the team ended up having a real problem on their hands. Shortly before the end of the weeklong negotiation period, the negotiating partner discovered that the allotted time would not suffice to conclusively discuss all their open questions. After all, they were going to be the first company to acquire a process for which there were no other reference plants as yet.

The edginess was definitely mutual. Bayer Technology Services had financed the process development – with no guarantee that they would eventually secure the business. As the company was committed to supplier contracts for a limited period of time, on the last day of negotiations it was decided heavy-heartedly to give the customer the choice: either an agreement is reached today or negotiations will have to reopen from the beginning. Shortly after midnight everything was resolved, and the team had the commission for a new sulfuric acid plant all sewn up. With this new plant, the company Berzelius Stolberg intended to increase production capacity by at least 30 percent. Both companies pledged to work in close cooperation and agreed that each respective partner would assume responsibility for certain risks.

The process is to be marketed under the name BAYQIK. As co-inventor Kürten says, “It is an obvious choice” because speed is an important aspect of this innovation. Kürten likes to compare its effect to that of autocatalyst, which ensures that the process that takes many years in nature occurs immediately: the conversion of nitrous oxides to nitrogen and oxygen.

It is similar in the production of sulfuric acid. Under normal conditions, the chemical process progresses only very slowly. Conversion of sulfur dioxide and oxygen to sulfur trioxide, from which sulfuric acid is produced, can take weeks or even months. The innovation is that the process can be considerably accelerated with the help of BAYQIK – with a “sufficiently high conversion volume,” as Kürten stresses. A major advantage is that there are no longer any restrictions on the level of sulfur dioxide (SO\textsubscript{2}) inlet concentrations for the catalyst, which leads to a substantial reduction in sulfur dioxide emissions. And the existing plant capacity is increased by at least 30 percent.

Experts refer to this process as quasi-isothermal catalysis, and the respective first letters of the German version of this term are used to form the product name BAYQIK. The process has been known for a long time, but the conventional
approach only can be used with sulfur dioxide at a maximum concentration of 13.5 volume percent. Higher concentrations would irreversibly destroy the catalyst used.

However, higher concentrations are now possible thanks to the new process. The heat produced during the process is discharged so that the catalyst can be used at much higher SO₂ concentrations – without reaching or even surpassing its temperature limits. “Effectively, what we have done is to significantly expand the operating range of this commercially available catalyst,” as Kürten explains innovation.

The entire metallurgical industry worldwide stands to benefit from BAYQIK. It makes no difference whether the companies produce copper, nickel, lead or zinc – they all need sulfuric acid technology to treat their off-gas streams.

This is also the case with Berzelius Stolberg GmbH, the biggest lead manufacturer in Europe. The first industrial-scale plant based on the new technology in the world was built in Stolberg, near Aachen. “We chose the BAYQIK technology for several reasons,” says Managing Director Dr. Urban Meurer, when explaining the company’s decision. “Robustness, process reliability and cost benefits” all clearly played a role. Everything Bayer promised turned out “to be completely true” he confirms. In some respects the goals were even surpassed.

Converting an entire production plant would normally involve lengthy downtime – resulting in enormous costs. As a consequence, these so-called refitting times are feared by every production plant. That is why Berzelius was even more pleased when they discovered that the planned, and already very short refitting time of a week could even be undershot, says Meurer. Today, he has plenty to say about the advantages of the new plant, and he has many opportunities to do so because the experts at Bayer Technology Services are always showing potentially interested parties the reference plant for the BAYQIK process in Stolberg. “And it is naturally particularly pleasing when the obviously satisfied Managing Director describes that the plant has operated from the first day exactly as it was planned,” says Torsten Weber.

Bayer Technology Services provided for virtually everything at the Stolberg reference plant: engineering, equipment, construction, procurement. Nothing was left to others. “From the beginning, we wanted to be sure that the plant would run exactly as we had planned,” Weber explains. “And if you want to design everything, you must also take on the full responsibility and do a lot more.”

After this experience the experts have long set their sights on the next goals. For instance, they have audited prospective customers for a similar plant in China, and the process is already under patent protection in the United States. Erkes also sees “great potential” in North and South America. The team has more ambitions for further technological developments. For example, a better catalyst may open new possibilities. In addition, one can imagine that the two-step sulfuric acid catalyst can be consolidated in a single step, which would further increase the energy efficiency. “This work will still take a number of years,” Erkes estimates. “But we all are itching to get started!”

There is a team behind every success. In the case of the new technology for the production of sulfuric acid, BAYQIK, the core team was a quartet (from left to right): Klaus Stemmer, Torsten Weber, Martin Kürten and Bernd Erkes.
Clean-Living for Bees

Bee larvae grow in wax brood frames also used for storage. This is why these frames have to be kept free from disease-causing bacteria and residues. But sometimes the nursery area can become contaminated. This can now be quickly rectified thanks to a simple process.

The way to purified wax takes just five simple steps: First, the beeswax is melted. Five stainless steel vessels have been installed at Groß Süstedt for this purpose. They have a combined capacity of some 4,000 liters. Müller then adds activated carbon in powder form to the liquefied wax. The third step is the production of a homogeneous mixture, which is subsequently left to rest for 30 to 90 minutes. Afterwards, this suspension is filtered in a pressure filter under a pressure of four to six bar. What remains is clean wax, together with a concentrated filter cake containing the impurities, which can then be burned.

Andreas Müller is thrilled by this simple process that has since passed the first practical test in his company and now offers him a competitive advantage. “Finally, we can supply wax that is completely free of bacteria and impurities.”

Hives in Danger

Varroa mites and why they are so dangerous

Varroa mites are the worst enemy of honeybees. This parasite made its way to Europe in 1977 – probably with imported bees. The mites sit on the brood and suck their blood.

Although nature has provided the insects with an effective immune system, as soon as the 1.7 millimeter varroa mite begins its blood sucking, the parasite switches off the bee’s immune system. Additional disease-causing viruses can infect the insect through the wound. The young honeybees are thus already weakened during hatching and die shortly thereafter.

In the meantime even the UN has raised the alarm: a recently published report of the UN Environment Program – UNEP – shows that bee mortality has now become a global problem. The UN even sees impending danger for basic human food resources.
When bees die, humans lose more than just honey

At least 100 commercially grown crops are currently pollinated almost exclusively by European honeybees. According to the FAO, the value of pollination by these useful insects is estimated at more than 200 billion dollars worldwide.

If increasingly more bee colonies are wiped out by diseases, the yields of many crops, including apples, peaches, raspberries, blueberries and rapeseed, will decline dramatically. Nowadays, humans would probably not starve without this pollination, but they would certainly be dependent on the wind. So, in a future world without honeybees, the wind will determine what we eat and how we dress.

A lot doesn’t always help a lot – this is also true of controlling varroa mites. In their desperation, many beekeepers are now even turning to unregistered agents in the fight against varroa mites. Or in other cases, they are not keeping to the applications recommended by manufacturers, which can result in residues in beeswax.

This is reason enough for some manufacturers of pharmaceutical products to do without beeswax altogether. However, wax that has been purified with the patented process developed by Bayer Technology Services can be used without hesitation. The wax treated with this method even meets the strict purity standards prescribed by law for raw materials used in pharmaceuticals.

In beekeeping the process of building honeycombs is greatly facilitated by adding a prefabricated brood frame about one millimeter thick.
Let’s Make a Model

With its Systems Biology & Computational Solutions global competence center, Bayer Technology Services helps customers better plan their clinical trials. This makes drug development more efficient – and patients stand to benefit as well.

Of course, it undoubtedly costs money to ask for support from the Systems Biology & Computational Solutions competence center at Bayer Technology Services. Then again, the work of these experts can also help save money – indeed, quite a lot of money. In some cases, customers can even be spared from needlessly spending hundreds of millions.

It is a simple fact that drug development is an expensive business. On average, pharmaceutical manufacturers have to fork out more than one billion US dollars for the development of product from the screening of a potential candidate compound to approval of the drug. Most of this expenditure is allotted to clinical trials, in which an active ingredient is tested on patients. The later in the development process it is discovered that the substance in question does not fulfill expectations, the more money is spent. In a worst-case scenario, the trials are concluded, but the drug then fails the application for approval.

This happened to a company that thought it had come up with a much-improved drug to treat hepatitis C. However, drug authorities in the United States and also in the European Union rejected the drug application in 2010. Their explanation was that a sufficient effect had not been proven.

Head of the competence center Dr. Jörg Lippert likes to cite this example because it demonstrates the value of his team’s work. “With our capabilities today, we could have recognized in 2002 that this product might not have functioned as expected,” he says, while pointing to a diagram with three green curves. All three start from the same point above left, but they slope down to the right to different degrees. Two lines – one dotted – drop similarly to the right, whereas the third is clearly beneath the other two.

The curves show the level of concentration of the assumed anti-hepatitis substance in monkey’s blood – at the time of the injection to the left and then to the right in the hours thereafter. The upper curve is based on the actual measured data in 2002; the two remaining ones stem from the computers of Lippert’s work group.

And this is where you have to listen very carefully. “The lower curve is what our model determined for the case that the active ingredient interacted in the same way as precursors with its target structure,” he explains. “However, if we disregard this interaction in the model, the dotted curve arises as a result – in other words, the one that comes very close to the experimental data.”

So, Lippert is saying the following: In the actual animal experiment, the concentration of the active ingredient in the blood only remains this high because it is not performing as expected. But exactly that would probably be necessary for it to show the anticipated efficacy.

The compound went through all the clinical trials after 2002, only to ultimately fail the application for approval. Eight (costly) years passed after the monkey experiments – a failure that perhaps could have been avoided, if only the researchers had had a decent computer model back in 2002. Indeed, one like Lippert’s workgroup can now provide.

In fact, the reason why Lippert’s team is concerned with this subject at all is due to Pfizer. The pharmaceutical company was working on a novel therapy for the treatment of hepatitis C. Their experts approached Lippert’s team and provided additional data. The computer model was further developed and allowed for predictions to be made of outcomes in humans even before clinical trials were run. “The model provided us with a new tool to predict the attributes of novel molecules at a very early stage of our drug discovery program, and it helped us select clinical candidates and design our first clinical trials,” recalls Dr. Piet van der Graaf, Senior Director Pharmacometrics and Research Fellow in the Department of Pharmacokinetics, Dynamics and
Although it may look like a railway network, this graph actually shows the complex interplay of substances during blood coagulation. System biologists calculate the corresponding mathematical equation for each line.
Metabolism at Pfizer. “It really increased our confidence in the approach and helped us make investment decisions. In addition, the model gave us new insights into the biological mechanism that generated hypothesis for new experiments and potentially new approaches.”

Clearly, it is no easy task to get a computer to reliably describe the behavior of compounds in an organism. For physicist Lippert it is “clearly defined, factually based, hard scientific work.” And, ultimately, it is a question of the available data. After all, everything is subject to certain rules, and they can be expressed mathematically—with a bit of effort. The more bodily processes are recorded in this way, the more precise the assertions of the models deduced from them are going to be. And this is exactly what Systems Biology is attempting to do. Although it is formally a sub-discipline of biology, this particular competence center at Bayer Technology Services is nevertheless a collecting tank for scientists and engineers of all disciplines. And one thing is clear: The good two dozen colleagues on Lippert’s team have no difficulties dealing with mathematical formulas or biological, physiological and pharmacological relationships.

Just how complex this study can be becomes clear in the process of blood coagulation. The relational network of the participating substances is comparable to a national railroad network, in which each train station represents a substance and each connection a concrete biochemical process.

The requisite expertise of the competence center has grown steadily since its beginnings more than 10 years ago. At first the focus was on basic questions of pharmacokinetics. How quickly is a substance absorbed in the blood or in individual organs? How is it broken down in the body? How is it eliminated via the kidneys? And so on. With PK-Sim, Bayer Technology Services has been marketing a software platform that perfectly simulates (Sim) such pharmacokinetic processes (PK) for eight years now. The respective contracting client usually supplies the substance-specific data that are important for accurate modeling, such as a compound’s solubility in water or fat or the speed of degradation in contact with different liver enzymes. In addition to the software, Bayer Technology Services also offers the actual modeling—both for the human organism and also for all the established animal models used in drug development, whether for mice, rats or monkeys. The spectrum even includes farm animals, such as cattle, which has proven helpful in the development of veterinary products.

The most frequent inquiry from customers involves determining the proper dose of a new active ingredient for trials with animals or humans. Of course, it is possible to approximate the optimal dose experimentally, but with theoretical preliminary work one can often substantially reduce the efforts involved. Clearly, this is also beneficial for the well being of the patients who do not need to be given over an extended period of time doses of substances that have no therapeutic value or are higher than the required amount.

A project with Bayer HealthCare illustrates how useful the work of systems biologists can really be. The company is currently testing its approved anticoagulant rivaroxaban for a further indication called acute coronary syndrome. Several thousand patients have already participated in the phase II clinical trials; for the phase III trial currently underway it is a five-figure number—at an enormous expense. For this reason it is absolutely crucial that such trials are very precisely planned and carried out within a medically acceptable dose range. “Even though we performed the phase II trial with several different doses, it should still be clear beforehand in which range the optimal dose is to be expected,” says Dr. Rolf Burghaus, Head of Modeling & Simulation in the Clinical Pharmacology Department of Bayer HealthCare. The models produced by Bayer Technology Services allow not only prognoses about this range, but also about the most promising dose. “By the end of our study, the exact dose already favored by the model actually turned out to be the optimal one,” Burghaus reports.

“When it comes to questions related to systems pharmacology, we prefer to cooperate with our experienced colleagues at
Child-Oriented Medicine

What dose should be used to treat young children and adolescents? For a long time, physicians had to answer this question on the basis of vague assessments. They then prescribed, for example, half a tablet in cases where adults took a whole one.

Today, national health authorities demand that pharmaceutical manufacturers investigate the proper dose for children already during the development process of a new active ingredient. They are also required to carry out the appropriate clinical trials. This is no easy task and can even be precarious for ethical reasons. Depending on the age of the patient in question, the liver, for example, can react in a totally different way. Incorrect assumptions can quickly lead to over- or under-dosing – neither of which would be in the interest of an under-age trial participant.

"With our models we help ensure that a proper dose is administered in such trials right from the beginning," says Dr. Jörg Lippert, Head of Systems Biology at Bayer Technology Services. Some results may at first surprise an outsider. For instance, one case showed that at a certain phase of preschool age, an antibiotic should be administered in a higher dose per kilogram of body weight than with adults. The reason: At this age the liver constitutes a relatively high share of total body weight. In other phases and with different active ingredients, the influence of the liver can be exactly the opposite.

In Lippert’s opinion, the ideal case would be if such considerations occurred before drug approval. “Approaches using systems biology should be incorporated into the development of every active compound – right from the beginning.”
The World Needs Smart Houses

With their energy checks, experts from Bayer Technology Services help make “dumb” buildings more “intelligent” in terms of energy consumption. Modern technology offers them valuable support.

The Bayer “Kasino” is ablaze. Bright red flames flare from the windows of the building closely knit with the history of the company’s headquarters in Leverkusen. Oliver Krug aims the thermographic camera at the entrance hall of the complex housing the company’s hotel and guest restaurant. “In this case, red stands for a high energy loss,” he says, explaining the image on the display.

Krug is carrying out an “energy check,” which he and his team have been offering in-house and external customers since 2008. With long-term effects: “We help optimize buildings in terms of their energy consumption, which in a way is making them more intelligent,” says the architect about the service of the Civil, Structural & Architectural Engineering team of Bayer Technology Services. Indeed, many buildings are urgently in need of an efficiency test. Most of them achieve average grades at best in terms of energy consumption.

To make “unintelligent” buildings smart, Krug’s team of experts investigates the situation using special scientific methods. They analyze energy efficiency/consumption and determine the potential for savings. By the end of the analysis, they are ready to propose recommendations for improvements – resulting in a building that equally protects the climate as well as the wallet of the owner.

This is also the hope of Rolf Mehrwald, who is responsible for operational maintenance and planning of the restaurants of the Bayer Gastronomie GmbH Restaurants. “We have our building evaluated by experts to implement proper maintenance measures.” The team from Bayer Technology Services is still in the early stages of its work. The first step is to collect all the relevant data pertaining to the energy consumption of the building. This includes information related to the heat transfer “shell,” which means, for example, the material and structure of the outer walls, the quality of the windows and the condition of the roof. Another important aspect is the ratio of the surface area to heated or cooled air volumes as well as the position and alignment of the rooms. For instance, rooms that are facing south heat up faster due to the direct sunlight.

Details of the technical systems and uses are also crucial. How is the building lighted and heated? How does the ventilation system work? How are the rooms used, and how does the use influence the energy-engineering demands?

“The diversity of the Bayer Kasino’s uses is huge,” says utilities engineer Jan Bäuscher, who, together with his colleague Christian Stahl, was involved in the check. The complex includes just about everything imaginable – from the industrial kitchen to hotel rooms, from the reception hall to conference rooms, from the wine cellar to the canteen. All in all some 9,500 square meters of usable area.

But the team has already sure about one thing: the casino does not get such bad marks in terms of energy consumption. “As with many other Bayer buildings, our building is heated with steam from the company’s own power station,” Mehrwald explains. “We use the residual heat left over in the condensate for our warm water heating.”

However, with the know-how of the energy efficiency team the building can be improved.
made even more exemplary. In the next few weeks Krug, Stahl and Bäuscher will produce a computer image of the building complex with special software that shows its energy efficiency. The experts will then simulate various optimization measures using the virtual model and calculate the respective potential for savings of each one. For example, it can be a matter of renewing the roof insulation, replacing the windows or installing a new ventilation system.

“**When it comes to energy savings**, most people immediately think of insulation,” says Christian Stahl. But there is also great potential for savings in the building’s service facilities. Many installation options for heat recovery systems are available – especially for industrial complexes. The heat is transferred from the used air inside the building to the air coming from outside, thus keeping the thermal energy in the building.

The team will soon propose a catalogue of measures to Rolf Mehrwald: category A will list the “small changes with a big effect.” “These changes may not cost much, but save a lot of energy, for example, reducing the room temperature at night,” says Jan Bäuscher.

Category B includes measures that may be technically more complicated and do not bring savings as quickly, such as insulating cellar ceilings or roof areas. Category C consists of measures that only offer long-term results, such as insulating whole frontages. But the important thing is that for every suggestion they calculate when the implementation is amortized. In the case of the huge Bayer Kasino complex the calculations will no doubt turn out to be particularly substantial. We will carefully assess the potential for savings of each measure, says Mehrwald. After all, nothing should be squandered – neither energy nor investments.
It is a complex task to optimize biotechnological production processes. Bayer HealthCare and Bayer Technology Services closely cooperate in this work.
Knowing What Hamster Cells Crave

At Bayer HealthCare in Berkeley cell cultures produce a very special protein that allows people with hemophilia A to live an active life. Colleagues at Bayer Healthcare and Bayer Technology Services are collaborating to find ways to make these cells even more productive.
hey haven’t got a contract of employment, and they don’t ask for wages. And yet they work 24 hours a day, seven days a week for months on end. The workaholics in question are cells – whose parent cells, which are a stable, reliable and well-known source in the biotechnology industry, were originally extracted from the kidney of a baby hamster. These cells now thrive in head-high stainless steel containers in Berkeley.

Bayer HealthCare has several such fermenters at its Berkeley site in California. Each one holds 200 liters of a reddish brown solution brimming with billions of these hamster cells. And each cell functions like a tiny bio-factory.

The special feature of these cells is a modification in their genotype. In the 1980s the genetic code of a particular protein was inserted into their precursor cells. On average, this protein, i.e. the blood coagulation factor VIII, is deficient in one of every 10,000 males, thus leading to hemophilia A. Thanks to this additional gene, these hamster cells now tirelessly produce the factor VIII protein, which is how Bayer HealthCare obtains the active ingredient for its hemophilia A treatment Kogenate FS. The company is one of the world’s leading suppliers of hemophilia A products – and one of only three manufacturers of a genetically engineered product.

Although the cells carry out their duties without payment and unceasingly, they do have certain demands regarding their working conditions. They thrive at 37° Celsius, the pH value should be slightly below 7.0 and oxygen must also be present. In addition, they have some favorite food. So, a solution of nutrients including amino acids, sugar, vitamins, insulin and much more is constantly fed into the fermenters. The greater the well-being of the cells, the more eager they will be to multiply – and the more factor VIII they will produce.

But how much more are we talking about? The annual production in Berkeley amounts to just a few hundred grams of pure factor VIII, and for this the hamster cells consume many thousands of liters of nutrient solution every day – at an immense expense.

Bayer HealthCare has continuously improved productivity for many years – and not only because of cost efficiency. The company has also had to meet an ever-increasing demand, as Kogenate FS gained approval in more and more countries. To put their ideas to the systematic test and for the resulting optimization of the production processes, they found a partner in Bayer Technology Services.

Joint projects have been successful for more than six years now. During talks, Jörg Heidrich, Head of Product Supply Biotech at Bayer HealthCare, likes to show a chart that best illustrates the results. The curve in the diagram extends from the upper left-hand corner down to the right. It demonstrates how production costs have decreased significantly over the past years. Also, the annual write-offs due to defective batches have been reduced tremendously, Heidrich says. This de-
“The successful collaboration between Bayer Technology Services and Bayer HealthCare Product Supply resulted in efficiency gains and supported growth and innovation for Bayer HealthCare.”

Jörg Heidrich, Bayer HealthCare

Just a few decades ago there were still no treatments for people with hemophilia A. Blood transfusions helped in some cases, but this was not considered a standard therapy. Early in the 1970s saw the introduction of treatments containing the protein that is largely deficient in people with hemophilia A. Thanks to such products, children with hemophilia A, like four-year-old Julian (left), can lead an active life without fear of articular hemorrhaging.

Bayer HealthCare has been among the leading manufacturers of such products for more than 35 years. In 1993 the company launched Kogenate, a genetically engineered hemophilia A product.

One of the transferees is Chris Williams, who used to be Process Analytical Technology Manager with Bayer HealthCare. Working with Ghosh, he installed state-of-the-art inline measurement devices in the manufacturing process. Decreasing operator errors and reducing product wastage through sampling resulted in operational savings.

Ultimately, all this led to a significant reduction in production costs. But that is not all. The team has the ambitious goal to raise productivity even further in the coming years. “We are always looking for ways to increase each cell’s production by improving the nutrient solution or, in other words, by providing a more balanced diet for the cells,” Dr. Paul Wu from Global Biological Development at Bayer HealthCare explains.

This is where one particular strength of Bayer Technology Services comes in handy: first testing process parameters on a small scale. “The high costs for the nutrient solution alone are reason enough not to test every change on a large reactor scale,” says Dr. Thomas Daszkowski, Head of the Process Technology Healthcare team at Bayer Technology Services in North America, to which Ghosh and Williams belong as well. The trick is to design the miniaturized tests so that the results can be transferred to large-scale dimensions.

As there is so much to test, the team in Berkeley has requested support from Germany. They now regularly send frozen packages to Leverkusen. One of the recipients of these packages is Dr. Volker Möhrle, who works in the Enzyme & Fermentation Technology Group at Bayer Technology Services in Leverkusen. His laboratories are outfitted with equipment that replicates the production process in Berkeley – except these units are scaled down by a factor of 200. Möhrle and his colleagues feed the cell cultures and the nutrient solutions from the packages into these devices. After concluding the tests, they in turn send parcels with their product yields back to Berkeley for evaluation.

Another project involves the recovery of the factor VIII protein. “Just one false condition, and it is damaged,” Thomas Daszkowski observes about the sensitivity of the protein molecule. For this reason, it has not been possible so far to harvest all of the protein produced by the hamster cells safely for further processing into the finished product. A double-digit percentage is lost in the process.

A team consisting of colleagues from Global Biological Development and Product Supply at Bayer HealthCare and Bayer Technology Services is currently working to improve the yield. Initially, this work entailed painstakingly evaluating the data from the past three years. The data mining has...
already delivered some ideas to increase yields, which the team is implementing as we speak, says Daszkowski.

Other examples of improvements are related to the device through which air is permanently fed into the nutrient solution to supply the hamster cells with oxygen. “We developed a new mechanism that, firstly, clearly reduces the amount of work required for preassembling and secondly, allows an influx of 30 percent more oxygen,” says Juri Seletzky from Bayer Technology Services. As a consequence, the cells are better supplied and raise their metabolism, thus increasing product yields.

Although each improvement is very different, one aspect remains the same: “We always begin in the laboratory,” says Yuval Shimoni, who is with Manufacturing Science at Bayer HealthCare. The first level is at a scale of 50 milliliters; the next is a scale of one liter. Ultimately, the tests are performed in a 15-liter reactor. Only then is the most promising process upgraded to an industrial scale, i.e. the 200-liter fermenter. If all of the results are confirmed here, too, the company will then apply to global regulatory authorities for approval to use the modified process in regular production.

Clearly, all this is a complex and time-consuming process. The Bayer Technology Services team has therefore designed a new 15-liter reactor that replicates the conditions in the 200-liter production reactor. The final goal is to do this so perfectly that 15-liter runs might instead be accepted by the authorities. “We can then project the results and dispense with the test in the 200-liter reactor,” Ghosh reports. That will save not only money, but also testing time. If all goes well, the 15-liter reactor will be available this year.

Admittedly, realizing this design has not been so simple. “Reactor geometry, mixing and also the sheer stress caused by the stirrer must correspond exactly to the conditions in the subsequent production reactor,” says Ghosh. “The ultimate goal is to make sure that the cells experience the same ‘micro-environment’ in the smaller reactor as they would in a production-scale reactor.”

Since Bayer HealthCare launched its first hemophilia product more than 35 years ago, it has remained committed to improving treatment. Bayer HealthCare is currently working on the next generation of treatment that will allow the factor VIII protein to remain effective in the body for a longer period so that it does not have to be administered so often. The clinical trials are already underway. When Bayer applies for approval, the company must also demonstrate its competency for production. Colleagues from Bayer HealthCare and Bayer Technology Services are working together to create the pre-requisites for this task.

So, an extensive cooperation has now evolved from the initial projects. “This collaboration supports growth and innovation for Bayer HealthCare,” says Jörg Heidrich. It is thus no surprise that Bayer Technology Services has a relatively big team at the Berkeley site. Although these employees may be separated from their customer both in terms of organization and spatially, Thomas Daszkowski attaches great importance to their teamwork: “One can truly say that Bayer HealthCare and Bayer Technology Services in Berkeley work together as a single large team.” And this will no doubt continue for the time being, as the two companies signed a new three-year contract in 2010 for their projects in Berkeley.
When shipping chemicals, it is not sufficient to simply write the sender and recipient on the consignment. The product name and amount as well as the batch number must also be identified. In the case of hazardous goods, details of possible hazards and safety data must also be printed on the label, as well as the relevant hazard symbols and warnings. But that is not all: due to the varying provisions depending on the country of destination, the type of information required can also be different – as well as the language. The appropriate hazard symbols must also be taken into account for materials that need special handling during shipping. All this means that labels can look quite different depending on the product, order, consignee and mode of despatch. This is a particular challenge for companies – especially if the shipment is urgent.

What inspires Partners

Many companies stockpile certain pre-printed labels in order to be able to react quickly. This ties up storage capacities, and some labels later end up in the trash. Due to the wide variety of labels, it is hardly possible to keep all the perfectly suitable labels in stock that might be necessary at a later date. Another problem is that many businesses put together their own labels – often using Word or Excel. This is a complicated procedure and often prone to error. A simple typographical mistake can lead to customs authorities raising issues at country borders. In such situations, new labels have to be sent again – and in some cases the company may have to pay a fine.

With LEXSY LabelPrint, thanks to this software, companies are able to react specifically to every individual order and print out the exactly suitable label – quickly and directly on site. LEXSY LabelPrint is, for instance, linked to databases from which the relevant data on hazards and safety can be imported in the respective language for each hazardous substance and for every country. The software accesses the respective company software, for example through its SAP system, for information specific to a particular order, such as consignee data, customer number, order number and so on. With these respective data imports it is also possible to avoid typographical errors.

Stephan Voß, Global Procurement & Logistics at Lanxess

We use LEXSY LabelPrint in more than 100 facilities around the world. Some 300 printers are connected to the system. Formerly, we did not have this globally harmonized label design system. The possibility to print combined labels containing information on both the product and the relevant hazards of the substance is particularly practical and cost effective. In addition, the link to the respective databases guarantees that changes in the material classifications or the legal situation can automatically be taken into account. The conversion to the new Dangerous Substances Directive of the EU in compliance with GHS was therefore not a problem for us.”
What Success Creates

An Enlightening Shine

No sampling, no loss of time and, naturally, non-destructive – that is considered process control at its very best. With fluorescence analysis Bayer Technology Services is able to offer an effective technology that achieves just this.

Any disco club revelers will no doubt have experienced the embarrassing moment when the DJ turns up the control knob for the black light with the result that not only toothpaste flecks and detergent specks shine brightly white on one’s clothes, but also signs of unsightly dandruff. This phenomenon is called fluorescence (see box). However, fluorescence is far more than just a show effect at a dance club. For example, banknotes are equipped with fluorescent security features to prove they are genuine. In biochemical analyses, specific reagents are coupled with a fluorescent dye. Under suitable irradiation, this procedure subsequently shows how much of a particular substance was bonded by the reagent.

It will soon shine in chemical production facilities too. “Fluorescence analysis is a sensitive and also a substance-specific verification procedure,” says Dr. Nina Schwalb, who heads the optical engineering team in Process Technology at Bayer Technology Services. The physicochemist is well acquainted with using optical processes to look into the innermost areas of things. As part of her doctoral thesis, she processed biomolecules with light pulses only a few femtoseconds in length – such a tiny size that it is truly difficult to imagine: a quadrillion femtoseconds, i.e. one thousand trillion femtoseconds pass before the second hand moves.

In comparison to these time lengths, the light pulses Schwalb would like to use in her current project last almost an eternity. The idea is for these light pulses to make any undesirable byproducts of a polycarbonate melt process visible at intervals of milliseconds, i.e. one thousandth of a second.

Depending on the application, polycarbonate is a polymer that has to meet high requirements in terms of purity. For example, byproducts that form insoluble particles in the melt process are absolutely taboo if the polycarbonate is going to be used in the production of, for instance, optical materials such as DVDs. For this reason, the melt process at Bayer MaterialScience undergoes a filtration, followed by a lab analysis to ensure there are no unwanted particles in the product. Unfortunately, this analysis is complex. An online analysis would make this lab test unnecessary.

In the meantime Schwalb, together with her team, has designed an apparatus that emits light pulses directly into the polycarbonate melt, which has a temperature of more than 300° Celsius in the reactor. A special camera installed at a right angle registers any occurrences of fluorescence. “The undesirable particles are transparent and thus invisible to begin with,” explains Christoph Hermansen, who played a decisive role in designing the analysis system for Bayer Technology Services. “We induce them to fluoresce with the right radiation wavelength – and make them visible.” The results can then be fed directly into the process control system.

Obviously, the procedure is not quite so simple as it initially sounds. For example, the automatic analysis system first

--

Atoms and molecules cannot only absorb light, but can also release it again. This emission of light is called fluorescing. The radiation wavelength is characteristic for each substance. This principle is used in fluorescence analysis – which means when fluorescent light is recorded with an optical analysis system.
Fluorescence analysis is a sensitive and also a substance-specific verification procedure.

Dr. Nina Schwalb, Bayer Technology Services

Absorb light and then shine in a very specific color: what these fish are capable of doing thanks to a genetic modification can also be utilized in process analytics.

has to learn to reliably differentiate between the fluorescence of the undesirable particle and other light effects. And then there is the sensitivity. “We have to be able to record the illumination of a single particle per milliliter to guarantee the sufficient purity of the polycarbonate,” says Schwalb.

This is quite a different scale than with biological sampling, where sometimes thousands or even millions of particles shine per milliliter. A sufficiently high sampling rate must also be established. “If the pauses between light pulses are too large, there is an increased danger that a moving particle will be overlooked,” says Schwalb. However, it is not possible to do without these pauses either, as the analysis system needs time to process the photos taken.

A first test of this analytical principle is currently being prepared in a real process environment. “If a continuous control succeeds, it would bring clear savings in time and complexity,” Jochen Mahrenholtz, Head of Polycarbonate Production at the Uerdingen site of Bayer MaterialScience, confirms.

The Optical Engineering team has long supported the production of plastic film and sheet with online analytics. Any imperfections are reliably detected – even at high production speeds. If necessary, the uniform distribution of the processed substances can be controlled in the plastic material in combination with a substance-specific verification such as the fluorescence method, says Schwalb. Water/oil emulsions are a particularly interesting area of application. In the case of unstable emulsions, fluorescence analyses may also be able to help monitor droplet sizes or the transport processes between aqueous and oil phases. “For example, it would be possible to control reaction processes at phase boundaries with this method,” says Schwalb. In fact, she can imagine a lot more possibilities for making things visible in running processes that would otherwise be inaccessible to the naked eye.
Would You Believe It?

25 percent – this is the share of women among all the people hired by Bayer Technology Services in Germany in 2010. The trend is therefore continuing that the proportion of female new hires is steadily increasing – even in markedly technical professions. In fact, more than 40 percent of the newly hired academics receiving a permanent employment contract from Bayer in Germany in 2010 were women. The company has generally set the target to further increase the percentage of women – especially in middle and upper management positions.

320,000 different compounds can be tested every day at Bayer Healthcare in Wuppertal regarding their possible efficacy with respect to a certain target structure. This so-called high-throughput screening takes place fully automatically, around the clock. However, it is not only the high throughput numbers that are so impressive. Thanks to a special fluorescence intensity analysis, jointly developed with Bayer Technology Services, these tests also deliver results with a high level of detail. Within milliseconds, the analysis system records for each screened substance not only whether the compound candidate has been effective, but also exactly how effective it has been. This detailed information is extremely helpful for the development of new drugs because experts are able to make correct decisions at an early stage about which active ingredients are worth pursuing.

0.9 lost-time incident rate per million working hours was recorded for Bayer Technology Services worldwide in the year 2010. This is another all-time low – and thus an outstanding success for the company’s efforts in accident prevention and occupational safety. In 2009 the lost-time incident rate per million working hours was 1.7, and that was already a very good result in the relevant sector. Regular safety instructions (photo) have also contributed to the positive development. However, the target of every single Bayer organization is zero accidents.

IMPRINT: Published by Bayer Technology Services GmbH; Responsible for the Contents: Dr. Arnold Rajathurai; Editor-in-Chief: Birgit Neumann; Concept, Texts and Editing: Widera Kommunikation, Cologne; Editorial Council: Joe Benzenhoefer, Joanna Liu, Dr. Ariane Firus-Göing, Astrid Geißler, Dr. Martin Gerlach, Dr. Edwin Roth, Siegfried Schmidtke; English Version: Cromwell-Ahrens Communication Services, Etchingham; Design: MagazineFactory.de; Final Editing: Wilm Steinhäuser; Reproduction: Reprostudio Kroke; Production: Das Druckteam Berlin; Editorial Address: Bayer Technology Services GmbH, Corporate Communications, Building K9, 51368 Leverkusen, Germany; Email: info@bayertechnology.com; www.bayertechnology.com

BRAND NAMES: baycorroxxion, BaychroMAT, BAYQIK, Kogenate FS, LEXSY, PK-Sim

PHOTOGRAPHS: p. 1: P. Ginter; p. 3: M. Sandmann; p. 4: Corbis; M. Sandmann; p. 5: P. Ginter; fotolia; p. 6: P. Ginter; p. 8: Bayer; BTS (3); p. 9: Bayer (2); TU Dortmund; p. 10-13: M. Sandmann (3); p. 14: Corbis; p. 16: NOAA (2); p. 18: BTS; Corbis; p. 19: CompactGTL (3); p. 21: fotolia; p. 22: BTS, P. Ginter; p. 23: BHS; BTS; J. Bindrim; p. 25: J. Postberg; private; p. 27: Jelinski; p. 28: Jelinski; V. Michele (2); p. 29: Corbis; Bayer; p. 30/31: fotolia (2); p. 32: Pixelio; p. 33: M. Sandmann; p. 35: fotolia; p. 36/37: BTS; p. 38: Pfizer; M. Berger; p. 39: BHC; fotolia; p. 41: Bayer; Jelinski; p. 42: P. Ginter; p. 44/45: Jelinski; M. Jung; BHC; p. 46: Jelinski; p. 47: BTS; p. 49: Corbis; p. 50: Bayer; BHC; BTS; p. 51: fotolia

FORWARD-LOOKING STATEMENTS: This publication may contain forward-looking statements based on current assumptions and forecasts made by Bayer Group or subgroup management. Various known and unknown risks, uncertainties and other factors could lead to material differences between the actual future results, financial situation, development or performance of the company and the estimates given here. These factors include those discussed in Bayer’s public reports, which are available on the Bayer website at www.bayer.com. The company assumes no liability whatsoever to update these forward-looking statements or to conform them to future events or developments.
Creating value and providing a distinctive competitive edge for our customers – that is the mission of Bayer Technology Services as a fully integrated technology partner. 2,700 employees worldwide work on this aim – at 21 locations in 10 countries. As a Bayer company, we combine longtime experience and close ties to operators with supreme innovative capabilities. Along the entire lifecycle – from developing processes and products through engineering and building plants to automating and optimizing processes – our know-how delivers high-performance technology solutions. With the objective of sustainably increasing our customers efficiency – **Powering Your Performance.**