

## EuroFEX trials show the right mix

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Newsprint on demand is very suitable for delivering fresh individualized news to those at international fairs.

## Latest news directly onto newsprint

Is there truly a place for 'newsprint on demand' in a time when we can reach the latest news anywhere in the world, simply with a click on a computer. According to researchers Erik Blohm and Marianne Klaman, the rapid printing of newspapers could well be part of the media community.

"If it's possible to be informed as rapidly in a newspaper as on a monitor, a newspaper would be preferred. Investigations have shown that we have greater confidence and trust more what is in a newspaper than what is seen on the Internet," states Marianne Klaman.

Today, it is possible to publish the news at your own request, but only in black and white and on the usual office paper. However, there are many who would like to have a traditional newspaper, preferably in colour. The printing technology being studied in an STFI-Packforsk research project is consequently ink-jet on newsprint.

"Most of all, we wanted to find out what the properties were that we should be trying to achieve in the paper for it to be ideal when it comes to high speed ink-jet printing," says Erik Blohm.

According to him, the increased know-how in the field of paper is well aligned with the developments in the equipment that can deal with it.

The project has also studied the marketing aspects for this new technology. For it to be profitable, production must be high. One solution to this is that it must be possible to produce a number of different individual products in one and the same locality. Marianne Klaman mentions some areas where the potential is greatest. Examples of this are fairs,

exhibitions or conferences, where participants from all over the world could receive their own fresh news in the form of a daily newspaper, printed in their own language. This is a consumer group that is not especially price sensitive either.

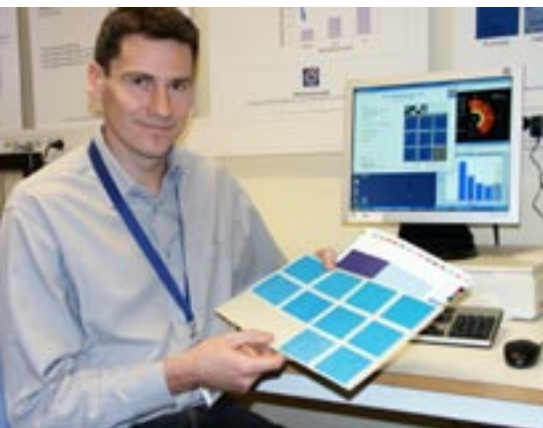
Marianne Klaman concludes, "At a tourist resort, a winter-sports resort in the Alps for instance, several international newspapers could share the same equipment. This would, not least, be kinder on the environment. ●"

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**Idag kan vi nå** av senaste nyheter från hela världen bara genom några få klick på datorn. Undersökningar visar dock att om det skulle gå att få informationen lika snabbt på tidningspapper som på skärm, föredras papperstidningen. I ett forskningsprojekt har inkjet på tidningspapper studerats för att ta reda på vilka egenskaper som är eftersträvarvärda hos papperet för att det ska vara idealiskt för höghastighets-inkjet.

För att den nya tekniken ska bli lönsam måste det vara fråga om hög produktion och en lösning är att man vid ett och samma ställe kan producera en mängd olika individuella produkter; t ex vid mässor och konferenser eller på turistorter.



Hans Christiansson in the Image Analysis Laboratory.

## New version of popular software

The software programme, STFI-Mottling, is a result of the implementation of research studies in combination with customer specifications. The programme is an easy way of keeping check of the level of mottling, while it does not make any great demand on equipment nor require any special expertise.

The new version, STFI-Mottling Expert, comprises a list of new functions, such as it is possible to:

- determine mottling in an alternative way, e.g. contrast sensitivity with better adaptation to our eyesight, where it is possible to register the desired viewing distance. This is significant depending on whether the final product is to be read or to sit on store shelves.
- save individual settings, which is especially good for producers of various qualities where the appropriate settings in the programme differ.
- use more easily and have the possibility to compare levels of mottling among different samples directly on the monitor.

For white-top users, there is a further possibility of making scanner calibrations in order to obtain the same level in values, even when changing scanners. This is invaluable when making comparisons among the different mills in a corporation.

Another very significant change is that the programme is now compiled and therefore no longer requires MATLAB for running it.

Apart from print mottling and mottling on unprinted paper, it is also possible to use this method for such different things as assessing optical formation, coating

variations (using burnout) or variations in non-woven products.

"The simplicity of the programme has had a great influence on its international popularity. The fact that this method has shown good correlation with visual assessments makes it reliable as well," comments Hans Christiansson at the Image Analysis Laboratory. Now on offer is a slimmed-down version called STFI-Mottling Light, where the number of settings is substantially limited. ●"

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**Den nya versionen** av STFI-Mottling har inte bara blivit enklare att använda, den innehåller även en rad nya funktioner. Med STFI-Mottling Expert kan man bl a beräkna flammigheten på alternativa sätt, t ex kontrastkänslighet med bättre anpassning till vårt synsinne där man även kan ställa in önskat betraktavstånd. Det är nu också möjligt att spara individuella inställningar och att direkt på bildskärmen jämföra flammighetsnivåer mellan olika prover.

En betydelsefull förändring är att programvaran numera är kompilerad och därmed inte längre kräver MATLAB för att kunna köras. Nu finns också en slimmad version kallad STFI-Mottling Light.



Teresita Quinteros from Acreo and Peter Hansen from STFI-Packforsk hope that the applicability of a new on-line measurement technique will be verified.

# Working together for a new measurement technique

The research into measurement techniques at STFI-Packforsk takes, as a starting point, the unsolved problems and requirements that the mills present to us. The aim is to increase knowledge about processes and to provide access to new on-line measurement systems. In this way, there will be greater opportunities for raising the quality of production and reduce both the use of resources and energy consumption. However, developing new measurement techniques can often be a very costly story. There is therefore a lot to gain in developing and using a technology that can be utilised in different lines of business.

This is one of the reasons why STFI-Packforsk and Acreo are together running a research project for verifying the applicability of a new measurement technique for the drying section in a paper mill.

Peter Hansen, the Measurement & IT Section Manager, comments, "There are areas in paper mills that are considered to be neglected when it comes to measurement technology. This is often due to the fact that the properties that one wants to measure are, in fact, very hard to measure for diverse reasons. A drying section is one such area."

"The properties in the thickness direction of a paper web alter during the production process. We have theories as to how different changes can cause prob-

lems with cockling or curl, for example, but these theories have so far been too difficult to verify when good measurement data is lacking. This is going to be a fascinating nut to crack," he adds.

He is therefore hoping that the new technique being developed jointly with Acreo will be able to be used to produce such information. This will be seen now, when the first technical development comes to a close and the project enters a verification phase. If the verification results show that the technique meets the requirements made for industrial application, it will be possible to develop a prototype.

Examples of industrial requirements are that the measuring apparatus must

be reliable, with dependability and with little maintenance under the climatic conditions that prevail in a drying section. Because of this, it was decided to utilise optoelectronics, optical components, which can be encapsulated so as to cope with such tough demands made by the surroundings. It is also important, in the most practicable way, to avoid moving parts and to be able to separate the sensor from the control unit and the electronics.

Measurement technology must not be too costly either. That is why only standard components are being used, which are readily available and already being used in the telecommunications industry.

### Interdisciplinary sciences finding new fields


This project had its origins in a collaborative agreement between STFI-Packforsk and Acreo. Its aim was to identify and set up a collaborative project in the field of sensors and measurement systems, among others. This fortunately coincided with a request from IRECO that was looking for a collaborative project among the Swedish industrial research institutes.

"We identified a number of areas where Acreo know-how and technical expertise in optoelectronics could be utilised for issues in our industry," relates Peter Hansen who then emphasizes the importance of seizing knowledge and transferring it from areas where technical developments have taken other paths.

From the Acreo point of view, the collaborative work is seen only as positive when it leads to the development of new components.

"It's always good to discover new areas of need, where sensor technology can be utilised," says Teresita Quinteros. ●

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 **Med kunskap** om processen och tillgång till nya on-line mätsystem ges utökade möjligheter för att höja produktkvaliteten och minska resursanvändning och energiförbrukning. Av ekonomiska skäl finns mycket att vinna på att utveckla och använda sig av teknik som kan nyttjas i flera branscher. Det är en av anledningarna till att STFI-Packforsk tillsammans med Acreo nu driver ett forskningsprojekt för att verifiera tillämpbarheten av ny mätteknik för pappersbrukens torkparti.

För att uppfylla industrins krav på tillförlitlighet, driftsäkerhet och underhåll, har man valt att utnyttja optronik – optiska komponenter – som kan kapslas in för att klara tuffa miljökrav. Eftersom tekniken inte får vara dyr används endast tillgängliga standardkomponenter. Om verifieringen visar att tekniken uppfyller kraven kan det bli aktuellt att utveckla en prototyp.

# EuroFEX trials show the right mix



The control room at EuroFEX.

The choice of additives was an important matter in connection with the expansion of the APRIL (Asian Pacific Resources and International Holding Ltd.) mill at Riau on the Indonesian island of Sumatra. A new large paper machine was being built for the production of fine paper, based on pulp from acacia. Since paper made from acacia has a very smooth surface but not such a high bulk, the taking of measures to give improved bulk could have a positive effect on quality. Imerys, a supplier of fillers, called attention to the fact that if PCC (precipitated calcium carbonate)

was used as the filler it should produce a higher bulk than GCC (ground calcium carbonate). With that, the comprehensive performance of the paper could well be among the best in the world. The technical management at APRIL agreed that PCC would have positive effects on the properties of the paper. At the same time, they understood that there was a need for a solid technical basis before decisions were made that would lead to any alterations to the composition of the paper.

Imerys and APRIL made a decision to jointly carry out trials on the EuroFEX

Pilot Paper Machine. At STFI-Packforsk, plans were made together for a series of pilot trials using different amounts of PCC and GCC, in one and the same pulp. Metso Paper, the machine supplier, also participated, since APRIL wanted to test the press technology in connection with the trials being made on EuroFEX.

“EuroFEX is very professional and painstaking when it comes to planning and carrying out trials,” commented Ann Burman, the Technical Manager at APRIL, at the time. “Together with Imerys and Metso Paper, my three Indonesian col-



Anna Wiberg and Torgny Persson describe EuroFEX as an extremely well equipped box of tools, when it comes to applied R&D in the field of papermaking process technology.

## World leading box of tools for the paper industry and its suppliers

EuroFEX is a pilot paper machine with unique qualities, offering a number of very advanced technical resources. But, above all, the EuroFEX plant offers know-how and knowledge about how to set up a trial or a project, so that its customers receive the maximal dividend out of their development projects. At EuroFEX, there is a staff of 30 who are qualified and experienced in fields such as mechanical construction, pulp and paper technology, innovative measurement techniques and advanced paper chemistry. EuroFEX also includes several very experienced project managers who have the necessary skills and expertise demanded.

“In our project work with the industry, researchers from all of STFI-

Packforsk naturally take part,” declares Torgny Persson, the Division Director of EuroFEX. “For our customers from mills or supplier companies, this all means that they are given the appropriate assistance with planning and carrying out whatever project they want to. It may be, for example, a tailor-made trial run or lab test, a project in a mill environment that will lead to a technology or technique of the future or a project involving marketing. We are able to assemble the appropriate people and the right technology for each individual project.”

Exceptionally project focused

The most well-known technical tool at EuroFEX is naturally the pilot paper

leagues and I were given tremendous support with planning the trials for realising what we wanted to achieve. The trials provided us with excellent results. We were given concrete answers to our questions as well as the basis we needed for motivating an investment by the APRIL management in a PCC plant. This plant is currently under completion, ready to be connected to the new machine.”

#### Realistic trials

Imerys was also very pleased with the trials held on the EuroFEX Paper Machine. “Our aim was to find an optimal blending of GCC and PCC,” related Per Svending, Product Manager at Imerys. “APRIL and Imerys understood that we needed to run trials under reasonably realistic machine conditions. The EuroFEX Paper Machine was a very good solution since, among other things, it’s possible to run it at the speeds that were relevant to our needs.”

Per Svending emphasised that, for Imerys as well, it was important to have a solid foundation on which to base the decision, even though it was strongly felt that the solution was to use PCC in the production at APRIL in Riau.

“On our part, it would have been more secure to invest in an enlarged production of GCC in the plant we are already operating at the mill,” continued Per Svending. “But we wanted to take this opportunity of introducing a new technique and, as a result, assist our customer in creating even higher levels of quality.”

Anna Tubek-Lindblom is the Project Manager at EuroFEX who co-ordinated the trials with PCC and GCC.

“It’s so challenging and stimulating to work in a multifaceted project such as this,” she said and went on to conclude, “In this way, the role of EuroFEX as an independent plant is shown to its full advantage. It’s such a great feeling to be able to provide results to a customer, results that not become only the foundation for product developments but also strategic investments.” ●

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**Valet av fyllmedel** blev en viktig fråga i samband med att papperstillverkaren APRIL expanderade sitt bruk vid Riau på Sumatra i Indonesien. Man skulle bygga en ny stor pappersmaskin för finpappersproduktion, baserad på massa från akacia. Eftersom akacia i sig ger ett papper med mycket slät yta, men inte så hög bulk, önskade man finna en optimal blandning av fyllmedel som skulle ge en förbättrad bulk med positiva effekter på kvaliteten. Tillsammans med leverantören Imerys genomfördes en försöksserie på EuroFEX med olika mängder av PCC och GCC i en och samma massa. Även maskinleverantören Metso Paper deltog, eftersom APRIL även ville testa pressningsteknik i samband med försöken vid EuroFEX.

– Både APRIL och vi ansåg att vi behövde köra tester under någorlunda realistiska maskinförhållanden. Då fungerade EuroFEX pappersmaskin väldigt bra, bland annat för att den gör det möjligt att köra i relevanta hastigheter, säger Per Svending, Imerys.

machine, which gave the Division its name. However, at EuroFEX, there is also a very flexible pilot machine, LINDA, used for the study of paper webs. There are still other important resources, such as the pilot refiner, the fractionation lab, the refining loop and a comprehensive laboratory for pulp and paper testing.

“Our organization at EuroFEX is extremely project focused,” continues Torgny Persson. “Everyone that works here is concentrated on working with customer oriented projects. Our projects are close to the reality and technology that our customers currently work with. Because of this, we need to work at a fast tempo in the projects, with close customer contacts and short time schedules. In cases where we work with trouble shooting or take part in projects on site in the mills, consideration to time is especially important and we most often find ourselves working against the clock when carrying out these projects.” ●

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**EuroFEX är** en pilotpappersanläggning med unika egenskaper. Här finns ett antal mycket avancerade tekniska resurser. Men framför allt, här finns kunskapen om hur man lägger upp ett försök eller ett projekt så att kunden får maximal utdelning på sina utvecklingsprojekt. Möjligheten att sätta samman rätt människor och rätt teknik för varje enskilt projekt gör EuroFEX till en extremt välutrustad verktygslåda för FoU inom området pappersprocessteknik.

Den mest kända tekniska verktyget vid EuroFEX är förstas pappersmaskinen. Men här finns även en mycket flexibel pilotmaskin för studier av pappersbanor, LINDA. Andra viktiga resurser är pilottraffinören, fraktioneringslabbet, malslingan och ett omfattande laboratorium för pappers- och massaprovning.

**Read more about EuroFEX pilot plant on** [www.stfi-packforsk.se/eurofex](http://www.stfi-packforsk.se/eurofex)

## Profile



Bo Norman

Professor emeritus Bo Norman started working with paper in 1968. Since then, he has been one of those pointing the way in the pursuit for the perfect sheet of paper.

“I’ve certainly been in the right place at the right time,” says Bo. “What we have achieved since 1968 could not have been done anywhere else.”

In 1968, Bo had just obtained his licentiate degree in Fluid Mechanics. He became a group manager for the forming unit at STFI and the forming of paper sheets has been his focus ever since then.

In 1974, Bo and his colleagues seriously began to map out what the STFI Pilot Paper Machine should look like at the prospect of pursuing the paper sheet of the future. The result of this was FEX, now called EuroFEX. Bo got the forest industry to invest SEK 20m, with an equal amount coming from the government. It was in this way that, in 1982, STFI and Sweden had themselves a unique paper machine. For his significant scientific contribution in the field of forming, Bo was conferred the prestigious distinction of being awarded the Ekman Medal in 2004.

In 1979, he became a professor of paper technology and a very involved and appreciated lecturer at the Royal Institute of Technology (KTH) in Stockholm.

“Needless to say, I have always had research into forming as the central focus in my work,” comments Bo today. “The collaboration between KTH and STFI-Packforsk makes it possible to combine research and educating, which has been crucial for creating an interest in paper technology in students of technology.”

It is quite evident that paper technology is of enormous interest to Bo. If there should be any time left over, he devotes a lot of it to his houses on Runmarö in the Stockholm archipelago and on the Baltic island of Öland, where he likes to carry out renovations or build something new. ●

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# Södra and STFI-Packforsk collaborating on short fibres

Pulp producer, Södra Cell, wants to master the fibre blends that can be important for the pulp market of the future. In Asia, this means, among other things, having good knowledge about fibres from non-wood plants.

“In China, they are well established at producing pulp from straw and bamboo,” states Bengt Wiberg from Södra Cell. “When we have discussions with Chinese companies, we need to know how our softwood fibre works in various combinations with non-wood fibres.”

About one year ago, in order to build up new knowledge, Södra Cell began collaborative work with the EuroFEX Division at STFI-Packforsk. From Södra Cell, there was Sten Holmberg, CEO, and representatives from the Marketing Department and R&D. In the STFI-Packforsk team, there were Torgny Persson, Manager of EuroFEX, Anna Tubek-Lindblom and Anders Sörås, the Company Vice President. All of these have done a great deal of research into the paper market of the future.

## Top notch co-operation

Laboratory trials were interspersed with creative project meetings. The discussions dealt with how various fibre mixtures would work for paper production, what paper properties could be attained and what paper qualities the pulps could be used for.



Bengt Wiberg from Södra Cell presented the project at the Research Seminar for STFI-Packforsk Partner Customers.



Anna Tubek-Lindblom shows a sample of wheat straw pulp.

The project has now come to an end, after a year of a dozen or so meetings in the project group and countless numbers of laboratory trials using different fibre blends.

“This collaboration was top notch,” comments Bengt Wiberg today. “The resources at STFI-Packforsk make a very good complement to Södra Cell, with your deep theoretical knowledge and advanced analytical resources. Together, we were able to come further in discussions about pulp properties as well as possible markets. When we at Södra Cell hold discussions with Chinese customers, it is vital that we have a very good knowledge foundation to stand on. This provides us with the possibility of carrying on constructive discussions about fibre blends that would work on the Chinese market.”

## New uses for fibre know-how

For the business at EuroFEX, this project has presented a new opportunity of utilizing its knowledge about fibres in a completely new field.

“We are expert at analysing and evaluating the properties in fibres and fibre blends,” comments Anna Tubek-Lindblom from EuroFEX. “This joint project with Södra Cell has meant that we’ve had the chance of making use of our knowledge for analysing raw materials that we

haven’t studied as much as we have studied spruce, pine or birch. We’ve encountered new problems connected with the use of non-wood fibres. This project with Södra Cell has been extremely interesting and has also raised our level of knowledge.”

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 **Massatillverkaren** Södra Cell vill behärska de fiberblandningar som kan bli viktiga i framtidens massamarknad. I Asien innebär detta bland annat kunskaper om ettårsgrödor. För att bygga upp sina kunskaper startade Södra Cell för cirka ett år sedan ett samarbetsprojekt med STFI-Packforsk med syfte att undersöka samverkan mellan sk non-wood fibres och skandinaviska långfibermassor. Diskussionerna handlade både om hur olika fiberblandningar skulle fungera vid papperstillverkning, vilka pappersegenskaper man kan nå, och vilka papperskvaliteter massan kan användas till.

– När vi i Södra Cell diskuterar med kinesiska kunder är det viktigt att vi själva har en god kunskapsbas att stå på. Det ger oss en möjlighet att föra konstruktiva samtal om vilka fiberblandningar som kan fungera på den kinesiska marknaden, säger Bengt Wiberg, Södra Cell.



From 24 to 27 October in Gothenburg, Scanpack, Scandinavia's biggest packaging fair, was held for the 15th time. Interest in this year's Scanpack Fair was enormous. STFI-Packforsk had a stand there with 677 other exhibiting companies, which included representatives from 24 countries. This Fair is arranged every third year. One of the more experienced people on the organization committee is Anders Sörås, Senior Vice President of STFI-Packforsk.

Anders commented, "Even if the total number of visitors to this year's Fair didn't break the record, we have observed an increase in the number of decision-makers from trade and industry. And that is extremely gratifying!"

At the STFI-Packforsk stand, there were examples of commissions that we have carried out for our customers in the recent past. For example, there was the new Rottneros wood fibre based food tray, where the task for STFI-Packforsk

ranged from the initial market research all the way to the production line being started up. Another example was Tempix, with its intelligent labels for frozen goods, in which the labels tell whether the chain of freeze for a packaged article has been unbroken up to the store shelf. STFI-Packforsk contributed with its technical expertise in the development of temperature indicators.

Another feature that was appreciated was an episode from Swedish TV's Hjärnkontoret, loosely translated as The Upper Storey. This is a children's science programme. In the particular episode, Mikael Gällstedt at STFI-Packforsk shows how to make plastic film from prawn shells, a technique that he defended for his doctor's thesis and which received a great deal of interest in the field of sustainable development. ●

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Meeting place STFI-Packforsk.



On show at the STFI-Packforsk stand were new fibre based food trays and new intelligent labels for frozen goods.



Testing helps to ensure the safety and quality of carrier bags. Hjärnkontoret on the TV set.



**MERRY CHRISTMAS**

## COMING EVENTS

### JANUARY

- 10 Meeting of COST E36, Modelling and simulation in pulp and paper industries
- 18 Informationday arranged by the office for Swedish EU support
- 22-24 Packaging Diploma Course, III
- 30 Course: Packaging and the environment

### FEBRUARY

- 1-2 1st Packaging Discussion Group (PDG)
- 8 Small packaging education

### MARCH

- 5-7 Packaging Diploma Course, IV
- 21 Innovood Seminar
- 22 Symposium in celebration of the 50th anniversary of Gunnar Sundblad's Research Fund

For further information on coming events, see [www.stfi-packforsk.se](http://www.stfi-packforsk.se)

## Have you changed address?

Let us know by sending an e-mail to [info@stfi.se](mailto:info@stfi.se).

# B



# Second generation of biofuels being developed

“It concerns the same process actually, the breaking down of an organic substance into oil. But what nature takes to do in 10 million years, we will do in just a few hours,” says researcher Niklas Berglin.

Less than half of the raw material, used in producing chemical pulp, remains in the final product in the form of pulp. In other words, there is a great deal of value in the other flows that are either treated in or exit from a mill. A lot of work is consequently being concentrated on to increase the refining value of these particular flows, while not competing with pulp production.

Niklas Berglin comments, “It’s more about increasing the total value of the pulp production by utilising the by-products that are produced too.”

According to him, almost two thirds of the energy value ends up in the black liquor and other offshoot flows. Today, black liquor is used as fuel in a pulp mill but it only provides a value of approx. € 100 per tonne of pulp, compared with the pulp, which is worth five times as much.

“With new areas of usage and processes, its value could increase to € 200 or even up to € 400. This could take place through an increase in electricity production, for example. However, the production of fuel is an alternative that is looking more and more interesting in line with the rise in demand for green carbon atoms.”

In the main, there are two alternative ways for converting biomass to a fuel that can be used in engines. One way is biochemical, where fuels such as ethanol, rape methyl ester (RME) and natural gas are produced through fermentation, for example. The other way is thermochemical which involves decomposition by means of heating and then a synthesis for obtaining the product wanted.

Up to now, only biochemical production has been possible, the production of

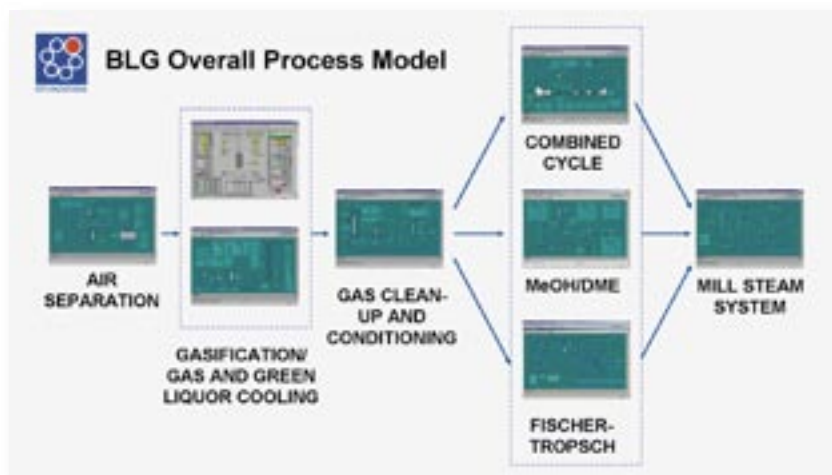
ethanol from grain, for example. Making the same thing from raw wood material is considerably more challenging, since wood contains lignin and hemicellulose.

Apart from producing ethanol from cellulose, the second generation of biofuels is expected to include fuels produced thermochemically. In this latter method, biomass is gasified to a synthesis gas that can be used for several different products, such as methanol, dimethyl ether (DME) and Fischer-Tropsch (FT) diesel, among others. STFI-Packforsk is participating in several projects that, hopefully, will lead to the development of new commercially marketable fuels that can replace fossil fuels. However, in order for this to be viable, biofuels must be able to compete in the long term on their own without subsidies, which is something that current ethanol production is dependent on.

“The production costs for the second generation of biofuels could be considerably less than for ethanol today,” maintains Niklas Berglin, implying that the forest industry has a key role to play in these developments.

“By integrating the plants with pulp and paper mills, the waste heat can be utilised, which makes for very good efficiency.” ●

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STFI-Packforsk has constructed detailed models for the most important stages in the processes for producing synthesised fuels and for how they work together with a pulp mill. With their help, it is possible to find out what effects gasification, for instance, would have on the entire energy and material balance in a mill and, in the long-term, to optimise the process designs for particular mills.

 **Mindre än hälften** av råvaran vid kemisk massaframställning blir färdig produkt i form av massa. För att öka det totala värdet görs nu mycket för att öka förädlingsvärdet även på sidoströmmarna. Ett intressant alternativ är att producera drivmedel av svartlut. Processen är ett exempel på termokemisk bränsleframställning där biomassan förgasas till en syntesgas som kan användas till flera olika produkter; bl a metanol, dimetyleter (DME) och Fischer-Tropsch-diesel (FT). Hittills har endast biokemisk framställning, t ex etanolproduktion från spannmål, varit möjlig. Till den andra generationens biodrivmedel räknas även etanolproduktion från cellulosa vilket är betydligt mer utmanande eftersom veden innehåller lignin och hemicellulosa.



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