3/2013

energy innovation austria

Current developments and examples of sustainable energy technologies

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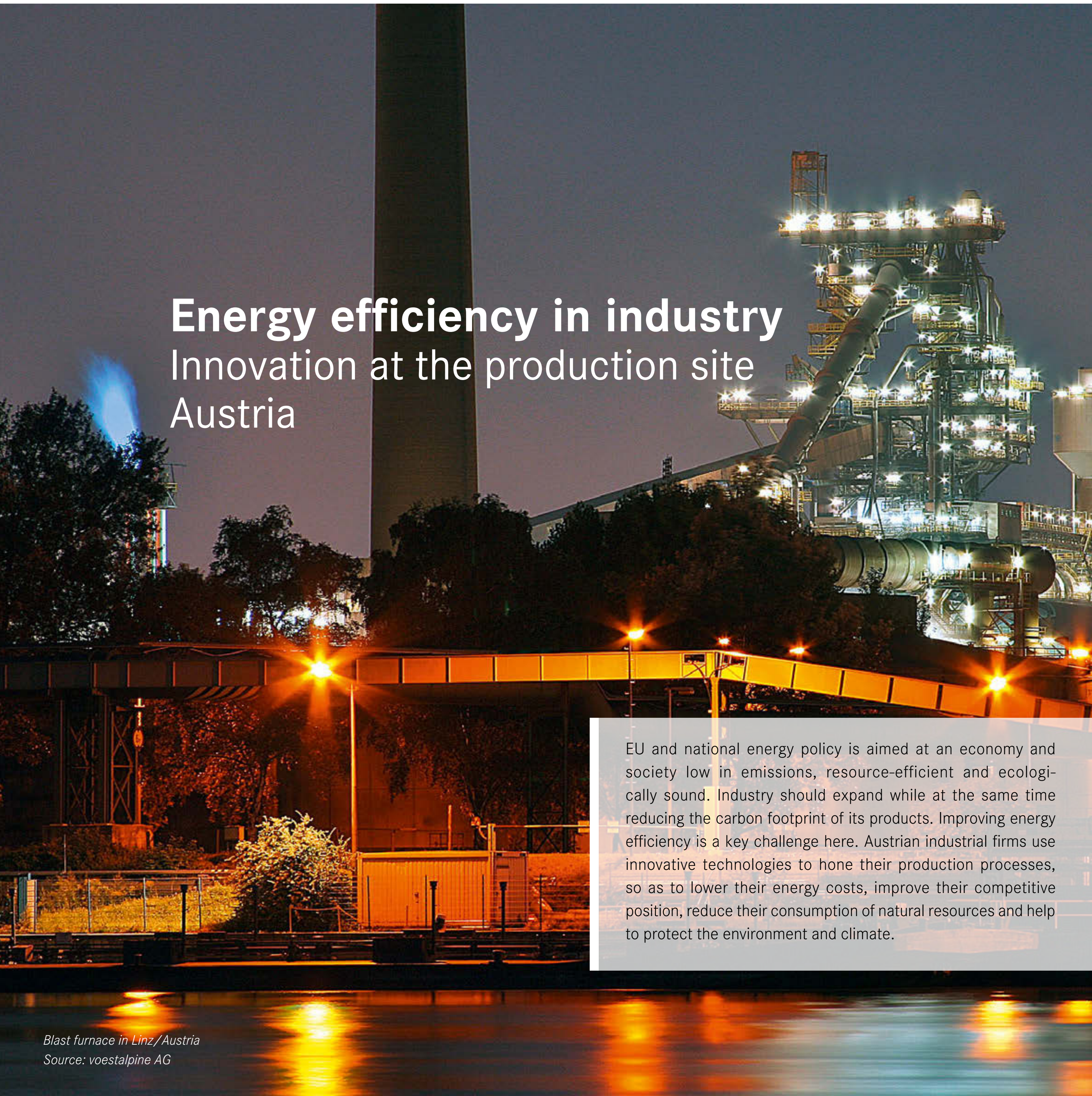


Energy efficiency in industry

Innovation at the production site Austria

EU and national energy policy is aimed at an economy and society low in emissions, resource-efficient and ecologically sound. Industry should expand while at the same time reducing the carbon footprint of its products. Improving energy efficiency is a key challenge here. Austrian industrial firms use innovative technologies to hone their production processes, so as to lower their energy costs, improve their competitive position, reduce their consumption of natural resources and help to protect the environment and climate.

Blast furnace in Linz/Austria
Source: voestalpine AG

HBI (Hot Briquetted Iron)
Source: voestalpine AG

Low-carbon industry
Future opportunities resulting from using energy efficiently

The European Union aims to make a decisive contribution to Europe's international competitiveness, to the reliability of supply and to achieving its 20-20-20 climate protection goals by means of strategies and concrete steps to improve energy efficiency. Large-scale savings are possible mainly in energy-intensive sectors such as buildings, manufacturing industry, energy conversion and transport.

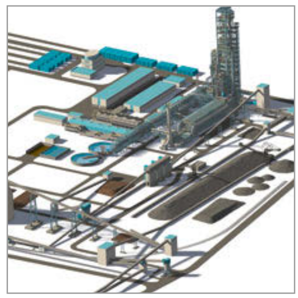
In 2008 the EU member states resolved to cut their consumption of primary energy by 20 %, reduce their CO_2 emissions by 20 % from the 1990 level and increase renewables' share of total energy consumption by 20 %, all by 2020. In 2012 the EU Commission adopted a new energy efficiency directive aimed at accelerating the rate at which energy consumption is reduced. The directive covers most of the areas in which energy is involved, from conversion via transport to final use, and envisages numerous actions which the member states should take to improve energy efficiency.

Energy-intensive industries such as iron and steelmaking, chemicals and petrochemicals, non-ore mining, glass, paper and printing have a vital part to play in achieving these goals. End-use energy consumption is constantly increasing in these sectors; in Austria it was 40 % higher in 2011 than in 1996. In relation to the production index, though, these sectors were a good 15 % less energy-intensive in 2011 than in 1996. If energy is used efficiently in industrial production processes, significant savings are possible: a vital contribution to achieving energy policy targets. At the same time costs go down and international competitivenesss improves.

Many industrial processes involve heat, cold and mechanical energy on a large scale. This demand for energy is met mainly by means of fuels and electricity. Because industrial processes are so diverse, there are any number of starting-points for improving efficiency. To take full advantage of the opportunities, new technologies and specially adapted processes are needed.

Today Austrian industry is among the most energy-efficient anywhere in the world. For decades Austrian firms have been developing technologies and products for low-carbon industry, and are doing a great deal to push resource efficiency up, cut costs and thus improve their chances in international markets. In some fields of industry Austrian companies have taken a clear technological lead with cutting-edge innovations. Research and development focussed on using energy efficiently help to buttress Austria and Europe as locations for industry, promote innovation and growth, and create jobs.

As part of the funding programs managed by the Climate & Energy Fund (e.g. New Energies 2020 and e!Mission) and by the Federal Ministry for Transport, Innovation and Technology (BMVIT), projects concerned with innovations to improve energy efficiency in industrial processes are constantly being implemented, and brand-new technologies put to the test in practice.

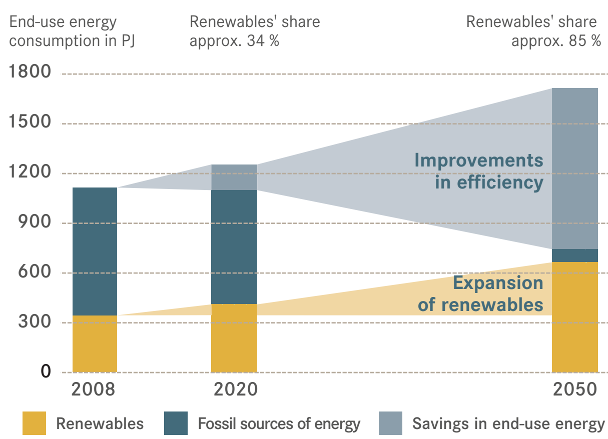


Source: voestalpine AG

Source: Brau Union Österreich AG

Modelling the development of energy consumption up to 2050

The energy research strategy defined by the Austrian Council for Research and Technology Development in 2010 outlined recommendations for action at national level up to 2050. Improving energy efficiency has been a central aim of Austrian energy research and technology policy for decades, and its importance was underlined again in the Energy Research Strategy (see also interview on page 8).



Source: Austrian Council for Research and Technology Development

Minimizing CO_2 emissions in hot-metal production using pre-reduced sources of iron

All over the world the blast-furnace process dominates in hot-metal production: more than 95 % of hot metal is made in blast furnaces. The main task in the process is to reduce the iron ores in a chemical reaction designed to remove the oxygen present in the ore. Reduction, and providing the necessary reaction energy, are primarily the job of carbon and hydrogen; these are fed into the process in the form of coke and alternative reducing agents such as natural gas, fuel oil, carbon or possibly plastic waste. In contrast to combustion, in which only heat and CO_2 result, carbon in blast furnaces is converted to carbon monoxide, which does most of the work of reduction. Here CO_2 is formed as a product of the reducing reactions in progress.

In recent years the blast-furnace process has been successively improved; as a result, consumption of reducing agents is currently at the possible thermodynamically minimum. Per tonne of pig iron a modern blast furnace requires in the best case roughly 450 kilograms of reducing agents. This volume of reducing agents generates roughly 1450 kg of CO_2 emissions per tonne of pig iron. This constitutes a lower limit for cutting process-related CO_2 emissions. Further improvements on the emissions front will be possible only if new technologies are deployed.

Replacing conventional sources of iron with pre-reduced material

Pre-reduced sources of iron are produced in direct reduction facilities, mainly in the MIDREX and the ENERGIRON process. Here iron ores are reduced by a mixture of H_2 and CO (reformed natural gas), typically resulting in DRI (Direct Reduced Iron, 92 to 96 % iron). If this material is briquetted, it is known as HBI (Hot Briquetted Iron).

As part of a research project, and with the support of the Climate and Energy Fund, the Austrian metallurgy combine voestalpine AG tried using pre-reduced sources of iron in the blast-furnace process. A thermodynamic audit model was employed to compute the impact of using HBI, which was then tested on a large scale with several tens of thousands of tonnes of HBI in blast furnaces in Linz and Donawitz. It was established that pre-reduced sources of iron can be used successfully in a blast furnace.

Source: voestalpine AG

“Research and development for resource- and energy-efficient production processes help to cut costs and improve our chances in international competition. Direct reduction is a major step toward a low-carbon economy. Employing natural gas in the reduction process instead of coke greatly diminishes the process‘ carbon footprint, and is important if we are to achieve our ambitious energy and climate-policy goals.”

Wolfgang Eder
Chairman of the Board and CEO of voestalpine AG / Steel Division Management

Natural gas as reductant

If pre-reduced sources of iron are used in the blast-furnace process, less reductant is needed there, because a portion of the sources of iron is largely reduced upstream in a separate direct reduction process. In contrast to the blast-furnace route, based on coke, direct reduction uses exclusively natural gas (which has much less environmental impact) as a reductant; this means that the reduction gas contains a large proportion of hydrogen, and unit CO_2 emissions go down in consequence. Employing 200 kg HBI per tonne of hot metal saves about 180 kg CO_2 per tonne.

Early in 2016 voestalpine AG intend to start up a brand-new direct reduction facility at their Corpus Christi, Texas/USA site. The plant is meant to produce two million tonnes of DRI/HBI annually, half of which will go to the voestalpine sites in Linz and Donawitz/Austria. The Austrian steelmaking centres will then have access to an inexpensive, environmentally unobjectionable feedstock; steelmaking in Austria should thus stay competitive and maintain a technological lead for the foreseeable future.

Source: Brau Union Österreich AG

"Reducing the carbon footprint of our operations and in our value chain is a key element of Heineken`s "Brewing a better future" strategy. Energy efficiency, something we have already successfully worked to improve for many years, is a key driver for CO_2 reduction. But focusing on consumption reduction alone will not get us to our target. So we encourage all our breweries to develop innovative ways to adress this challenge. Breakthroughs are required and amongst the leading breweries within Heineken is the Göss brewery (in Styria, Austria) with the initiatives they put in place to achieve CO_2 neutrality."

Marc Gross
Heineken, Chief Supply Chain Officer

Green Brewery
Using solar energy for process heat in breweries

The solar technologies available these days on the market can provide solar process heat at up to 400 °C for industrial processes. Making use of solar heat is economically particularly interesting in the case of industrial processes requiring temperatures below 100 °C. Conditions are therefore favourable in breweries, where the required temperatures are mainly in the range 50 to 100 °C.

In 2009 AEE INTEC conducted a research project which combined approaches to increasing energy efficiency with strategies for employing solar energy in breweries. On the basis of production volume, location and range of products, practical measures to improve energy efficiency, integrate heat and use renewable energy sources were devised for three of Brau Union Österreich AG's breweries (since 2003 part of the international Heineken Group); to some extent they were actually implemented. In the course of this various possibilities of hydraulic process integration (e.g. preheating, heat transfer to reflux, direct supply to process) were spotlighted and employed for different types of heat-transfer medium (air, water, heat-transfer oil, steam).

Brewing a better future

The idea of a "Green Brewery" is one of the Heineken Brewery Group's long-term objectives. As part of the EU project "Solar-Brew" (co-sponsored by the Austrian Climate and Energy Fund) industrial-scale solar processing applications for breweries and malting facilities are currently being implemented for capacities above 1 MW_{th}.

Under the project supervision of AEE INTEC the Heineken Group is implementing large solar facilities for various production steps (mashing, pasteurising and drying) at three of its European sites. The project consortium includes solar collector manufacturer Sunmark A/S and GEA Brewery Systems GmbH in the area of plant construction. The Austrian brewery in Göss was chosen together with sites in Valencia (ESP) and Vialonga (POR) for implementing the new approaches.

In recent years considerable progress has been made toward the goal of a "Green Brewery" in Göss. For example, since 2006 biogas has been obtained from the waste water processing plant. In 2007 a connection was made to the district heating grid, and an inhouse hot-water grid was built in order to make use of redundant steam and hot water within the brewery. Currently 55 to 60 % of the required thermal energy and 100 % of the electric energy comes from CO_2-neutral sources. The aim is to achieve 100 % by the end of 2014.

Solar facility at the Göss brewery
Source: AEE INTEC

Solar-assisted mashing process

As part of the EU project the idea of a solar-assisted mashing process is being implemented at the Göss brewery with a collector surface area of 1375 m^2 connected to a 200 m^2 energy storage unit. Until now the energy to heat the mashing tun in Göss was supplied via split pipes welded to the bottom and the frame of the tun. Heat was transferred exclusively by steam generated in two natural-gas-fired boilers.

Apart from various other measures to reduce energy consumption, switching the energy input for the mashing process from steam to hot water was an essential step, without which the thermal solar facility could never have been integrated at all. To make this switch it was necessary to equip the mashing tun with heat exchanger plates (so-called "dimple plates") inside. According to simulations, about 30 % of the remaining energy required for the mashing process can be provided by solar-derived thermal input. In order to run the mashing process entirely on renewable energy sources, it was decided to supply the extra heat needed from the adjacent biomass cogeneration plant.

Source: Brau Union Österreich AG

Multiplier effect of the "Green Brewery"

As all breweries and malting facilities have basically similar energy requirements, implementing the pilot scheme is expected to generate a multiplier effect throughout the industry. The intention is to reap extensive insights from the monitoring program accompanying implementation and operation. The Heineken Group has plans to introduce the results of solar process integration and of the accompanying analysis of process data into staff training, to further promote the implementation of the strategy throughout all Heineken breweries. ◘

E3ICP
Embedded Energy Efficiency Industrial Controller Platform

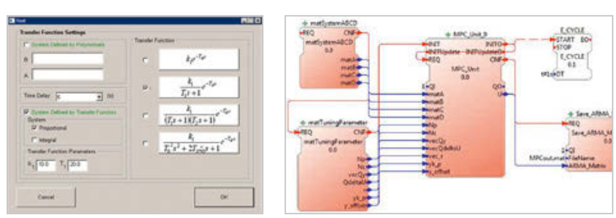
Typically, industrial facilities such as energy conversion systems and production units in all sectors reach maximum efficiency (as regards energy consumption, yield and cost effectiveness) at design capacity. Because of safety restrictions, though, industrial facilities are particularly difficult to control in this region.

To fulfil the tight requirements applying to the performance, efficiency, duty factor and reliability of industrial facilities, complex automation solutions are needed. This is particularly true where embedded systems are employed in large-scale and specialized apparatus engineering, such as energy conversion systems, where flexibility and efficiency in production and fabrication are decisive. Other factors that affect how production facilities are operated include rising energy costs, more emphasis on environmental issues, and government incentives (CO_2 certificates). Classical (rigid) automation systems cannot satisfy these complex, partially divergent requirements, or only to a limited extent.

At Vienna University of Technology (ACIN – Automation and Control Institute) in cooperation with VOIGT+WIPP GmbH a new infrastructure is currently being developed to make it possible to combine modern control algorithms with classical control functions, so as to improve energy efficiency in a wide range of industrial applications.

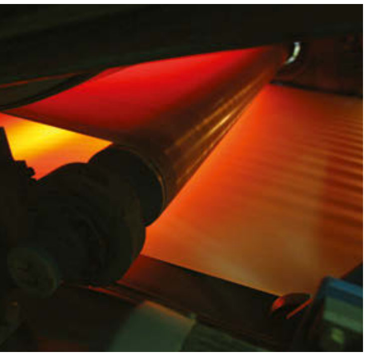
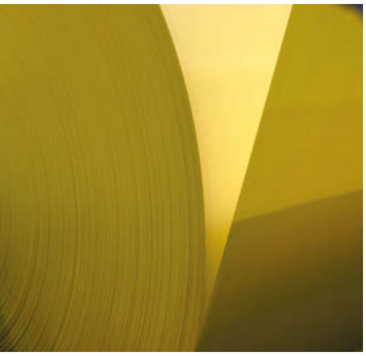
With the E3ICP a platform for optimization control on the basis of the IEC 61499 standard (international standard on function blocks for industrial automation), applicable to all sorts of automation systems, is being developed.

With the control structures employed (model-predictive control (MPC), fuzzy expert systems, internal model control) it is possible to fulfil the diverse requirements for stable operation at maximum efficiency, even under awkward conditions and in the case of malfunctions. With additional components evaluating the quality of control and system stability accurately is straightforward. In the meantime this control and optimization infrastructure (with real-time capability) for industrial applications has been demonstrated in a pilot biomass combustion facility; the results from this project can now be adapted to other sectors, such as the paper and timber industries. ◘



Source: Vienna University of Technology (ACIN – Automation and Control Institute)

Integrated Ecopaper
Optimal use of energy in papermaking

Source: all Mondi Frantschach GmbH

Papermaking is an extremely energy-intensive process, because huge amounts of water have to be extracted from the fibre as the slurry is turned into a web and dried. In a series of steps mechanical and physical methods are used to turn a 0.2 % suspension of fibre in water into paper with 93 % dry matter. These steps are primarily responsible for energy consumption in papermaking.

To improve energy efficiency significantly, innovative technologies are needed to improve the water removal and drying steps. As part of the project "Integrated Ecopaper" the papermaker Mondi Frantschach GmbH is now developing a new energy-efficient process to make high-grade packaging papers using local renewable raw materials. Manufacturing a tonne of sack paper consumes 0.9 MWh of electricity and 1.7 MWh of thermal energy, all of which Mondi Frantschach is already providing from biomass. The pioneering process relies on intelligent sensors and new system approaches, and is expected to yield substantial energy savings.

Improving the water removal process

The energy-intensive process of removing water is spread over three sections ("wet end", "press section" and "dryer section"). Starting from new research-based insights, the aim is to make the individual process stages more energy-efficient and match the three sections to each other better, using a holistic approach.

The project partners are the Institute of Paper, Pulp and Fibre Technology at Graz University of Technology and Wood K plus, a competence centre. The main thrust: applying new techniques to shift the process limits such that the water content at the end of each stage is lower than previously achieved. Shifting water removal toward the "wet end" and the "press section", which consume comparatively little energy, is intended to reduce energy consumption overall.

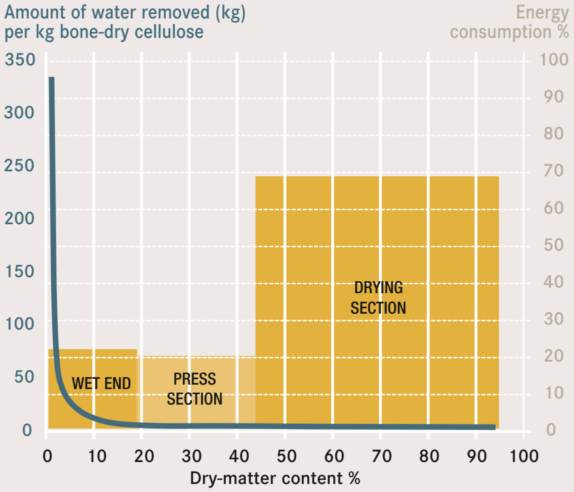
Savings are achieved in terms both of electricity and of thermal energy. Total electricity savings in the sectors wire drive, press drive and vacuum pumps are planned to add up to more than 1600 MWh/year; measures taken in the sectors process air, steam, wire and press (where more water is to be removed) are planned to save more than 4000 MWh/year of thermal energy. ◘

TECHNOLOGY

Improvements in 3 process stages

Using dry strength agents and flocculants to improve water removal in the "wet end" can result in significant energy savings. This approach, already tried and tested for other types of paper, is to be tried out and adapted for sack papers as part of the project.

In the press section an improved design of felts increases the amount of water removed in the press, while reducing energy consumption for drives and suction boxes. In the drying section improved control of steam pressure by means of model-predictive control (MPC) is expected to result in energy savings.



Source: Mondi Frantschach GmbH

TOPPUMP
Large heat pumps to heat and air-condition industrial buildings

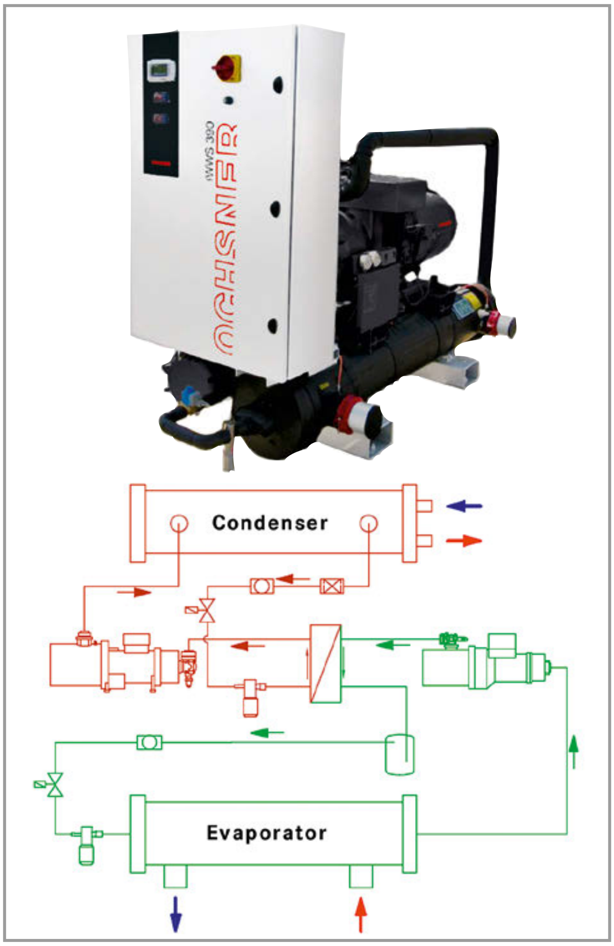
Employing heat pumps to utilize ambient warmth is a technology which has so far been used mainly for single and multiple-unit residential buildings. For large-volume buildings heat pumps as an economical and environmentally friendly alternative to conventional heating and cooling systems are still a fringe phenomenon. Industrial-scale heat pumps (> 100 kW) and high-temperature heat pumps (up to 98 °C) can bring about a considerable reduction of energy consumption and emissions in industry by utilizing not only groundwater or ambient air but also heat emitted from server rooms, airing and air-conditioning systems, cooling grids and drains.

Pioneering air-source heat-pump technology

As part of the TOPPUMP project Ochsner GmbH has developed a new technology for efficient air-source heat pumps with which large-volume buildings can be heated and cooled at very reasonable cost. The new range of industrial-scale split-layout air-source heat pump models delivers up to 300 kW and thus achieves a new dimension in air-source heat-pump technology. The advantage of the split layout is that the heat pump is located inside the building, where it is protected, while the evaporator is outdoors, where it taps the heat source there without any losses. Building expense and space requirements are therefore comparatively limited.

Indoors the Ochsner Toppump measures 1400 mm in height, 2750 mm in width and 1280 mm in depth, and is equipped with a shell-and-tube condenser. Each heat pump has two outdoor evaporators, each equipped with a copper/aluminium fin package and four axial ventilators; for compression ultra-efficient rotary screw compressors are used. This technology has leapt ahead in recent years, with efficiency increases of about 10 %.

The minimum outdoor temperature for a Toppump with 300 kW rated output is -15 °C; it delivers inflow temperatures up to 50 °C. During service at air temperatures below 0 °C, if the evaporators need to be defrosted, this is done thermodynamically: the cooling circuit is reversed. Defrosting is managed very economically by an electronic control unit. ◘



Standard industrial heat-pump (water)/two-stage cycle process
Source: Ochsner Wärmepumpen GmbH

IEA heat pump program

Within the framework of the IEA Research Cooperation, Austrian researchers and companies participate, inter alia, in the International Energy Agency‘s Implementing Agreement “Heat Pump Program”. This international program launches research projects, holds workshops and conferences, and provides the information service “IEA Heat Pump Center”. The aim of Annex 35 (“Application of industrial heat pumps”) is to promote more widespread use of heat pumps in industry by presenting the current state of the art and by documenting facilities already implemented.

Energy Research Strategy
Measures for 2050

Gi-Eun Kim, Expert on biotechnology at the Seokyeong University Seoul and member of the Austrian Council for Research and Technological Development

Energy efficiency is a mainstay of sustainable economic activity. What is the significance of improved efficiency in industrial production?
Greater energy efficiency will be very important in future in order to be competitive on the global market. It is also important with regard to the Carbon Tax, despite the currently low cost of emitting CO_2. Improved energy efficiency in the production process influences the share price of any company, as energy, water and raw materials savings are an essential part of annual company reports.

What steps are necessary on the path to a future "Low Carbon Industry"?
Above all, we need a long-term roadmap for technological development, plus an equally long-term investment plan for putting technologies to work in the production process.

How does Austrian research and development compare internationally in this area?
Austria's forte is clearly developing technologies and implementing them in actual products. Austria has a global lead in the fields of energy and environment, not least because many small and medium enterprises in Austria have reached the necessary technological level. But these activities are insufficiently publicized - Austria should be even more active on the world market. For this appropriate long-term political and strategic support is needed.

In 2009 the Council formulated an Energy Research Strategy focussed on 2050. What are the key recommendations for the coming decades?
The council's main recommendation is to increase the energy research budget significantly, i.e. a steady annual increase for R&D in the field of energy to at least 150 million Euro. In this context it is important that continuity and a dependable framework for planning as regards research funding are guaranteed and that focal points of research are defined; what matters here is establishing a suitable mix of bottom-up, structural and thematic programs in line with requirements. Of course it is also essential to promote young researchers, provide facilities for acquiring further qualifications in energy-related fields, and ensure adequate funding for research infrastructure.

energy innovation austria presents current Austrian developments and results from research work in the field of forward-looking energy technologies. The content is based on research projects funded by the Austrian Federal Ministry for Transport, Innovation and Technology and the Climate and Energy Fund.
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INFORMATION

Minimizing CO_2 emissions in hot-metal production
voestalpine Stahl GmbH
Contact: Christoph Thaler
christoph.thaler@voestalpine.com
www.voestalpine.com

Green Brewery
Brau Union Österreich AG
Contact: Andreas Werner
a.werner@brauunion.com
www.brauunion.at

AEE INTEC – Institute for Sustainable Technologies
Contact: Christoph Brunner
c.brunner@aee.at
www.aee-intec.at

E3ICP - Embedded Energy Efficiency Industrial Controller Platform
Vienna University of Technology
ACIN – Institute of Automation and Control
Contact: Georg Schitter
schitter@acin.tuwien.ac.at

Integrated Ecopaper
Mondi Frantschach GmbH
Contact: Leo Arpa
leo.arpa@mondigroup.com
www.mondigroup.com

TOPPUMP
Ochsner Wärmepumpen GmbH
Contact: Karl Ochsner
karl.ochsner@ochsner.at
www.ochsner.at

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