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Buyers Guide -
In search of added value
We transform ... the world of copper

Copper working process – from the melting bath to the final product

SMS group has been active in the copper field for more than 50 years. Our business partners benefit significantly from our comprehensive portfolio. Our employees know every step in the copper working process, from the melting bath to the final product. We connect individual machines to form integrated systems which meet all requirements of the customer. At the same time we offer our customers configurations in which all the components are ideally coordinated – both technically and economically.

Our integrated solutions are a byword for robust and reliable state-of-the-art technology. And we never stop trying to become even better. The raw material prices for copper are high – which is why we are continuously looking for new ways to reduce material use and material loss during production. Close tolerances, top quality and efficient processes – that is what you can expect from our plants.

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We transform ... the world of copper
Where to find markets for innovations

Data released in February by the International Copper Association, Ltd. (ICA), shows that continued economic development in Asia may drive significant growth in several key markets, resulting in an estimated additional 31 million tonnes of demand for copper up to 2030 in the region. The study highlighted urban infrastructure, clean power, electric vehicles and rail transportation to fuel the projected growth.

The study, commissioned by ICA from The Warren Centre, examined key economic sectors to determine the expected level of investment and activity in the region. Amongst others, the study used census data from the United Nations Department of Economic and Social Affairs to define demographic indicators in these areas and to determine the expected population and density.

The study found that India is expected to see a 17% increase in total population from 2015 to 2030, with a significant jump in urban population from 420 million to 583 million, or a 39% increase. China is estimated to see an even more extensive population increase of 150 million over the same timeframe, but the shift to urbanisation is significant, with 70% of the population expected to live in urban areas by 2030. The growth in population and shift towards urbanisation play critical roles in the expected use of copper.

Both India and China are travelling down parallel tracks as they plan to satisfy a population that is growing in size and wealth, with a migration towards urban environments. Increased material and copper use is forecast as their governments look towards clean technologies such as electric vehicles and renewable energy to mitigate pollution, according to Colin Bennett, Market Analysis & Outreach, ICA. Some parameters for development of demand for copper are:

- Significant basic infrastructure investments are expected to be US$ 211 trillion over 2030
- Asia is predicted to account for 50% of the world's electricity by 2030 (23% from China) and there will be an overall need for increased availability of energy
- Copper demand from clean power generation is expected to be 6.6 million tonnes from solar photovoltaics and 3.6 million tonnes from wind
- The future of electric mobility is likely to be light vehicle solutions and more extensive public transport solutions to combat urban congestion
- Cumulative production of electric vehicles and plug-in hybrids in Asia between 2016 and 2030 is expected to be 75 million. This will result in 6.6 million tonnes of light EVs alone, with additional copper demand in charging equipment.

The International Copper Association (ICA) brings together the global copper industry to develop and defend markets for copper and to make a positive contribution to society’s sustainable development goals. Its Copper Alliance® programs and initiatives are executed in nearly 60 countries. ICA will be a featured presenter during the CRU 16th World Copper Conference (see page 19) held during CESCO Weak in Santiago, Chile from 3 – 5 April 2017. More information can be found on www.copperworldwide.com.

Holding onto innovation leadership

The IMCh Smelter and Refinery Seminar which took place in Calama, Chile on 20 -21 October 2016 asked ‘Does an environmental standard lead to economic development?’ To remain competitive the Chilean domestic smelter industry has collect to last at 95% of the sulphur and arsenic entering at the smelter feed at each facility.

It is advantageous to view the the four Codelco, one ENAMI, Chagres Mines and the-refiners and the refiners in terms of a new business model on a case-by-case basis. The leaders are there, as the wealth. To safeguard and capitalise on its knowhow and employment in research and employment, Chile now feels it must develop policies and regulations that avoid the outflow of copper concentrations to other countries.

A smelter association could help in bringing the smelters and refiners to their nominal capacities. They really need to expand their business into recovering up to additional elements and stop being limited to just anodes, cathodes, smaller dusts, anodes sludge and sulphuric acid. Strategic alliances and joint ventures with other world producers and processors were recommended.

An apparent low availability and utilisation of furnaces and equipment at some state-owned installations was cited as causing low productivity. Maintenance programs on facilities due for a ‘some day’ upgrading can suffer, so exchange visits and cross-audits were proposed to enable benchmarking and activation of improvement programs. It is possible to achieve full optimisation by avoiding the duplication of equipment (e.g. one production line processes 100% of output) and reaching full capacity (maximum availability and utilization) with online controls. Automation and remote control of operations are the essential tools to facilitate this. The development and qualification of smelting/ refining specialists at the level of plant managers and maintenance engineers is a compelling need.

Ranking sustainable economies

The 5th edition of the Global Sustainable Competitiveness Index (GSCI®) 2017 was launched in December 2016. The GSCI is based on an inclusive competitiveness methodology, analysing 109 indicators. All are measured from the World Bank and ILO databases as well as from the United Nations.

The only non-European economies in the top 20 rank are New Zealand (12) and Japan (15). Japan has been adept at setting and working towards its Sustainable Development Goals. The GSCI 2016 is topped by Sweden, followed by the 4 Scandinavian nations, while countries from Northern Europe, the Baltic States and Eastern Europe dominate, including Germany (14). Of the BRICS countries, China scores highest (37), with Brazil (41), Russia (45), India (153), and South Africa (158). From the Americas, the top performers are Canada (22), Peru (20) and USA (32). Other copper producing nations include Poland (25), Australia (26), DR Congo (61), Chile (62) and Zambia (120).

Members of the International Copper Committee (Copper 2016 June page 21)
**Welcome to the Glasgow flash furnace era**

A special launch ceremony took place at the Glasgow Copper Smelter/Refiner on 20 January 2017 to mark the beginning of the modernised Glasgow Copper Smelter/Refiner took place on the 20th of January 2017. After a series of full-scale trials of the flash furnace’s feeding loading and subsequent charging, the plant’s first continuous charging of copper concentrate was announced. The commissioning programme started on 15 October 2016 with a handover of material to the smelter. Commissioning of the Glasgow Copper Smelter/Refiner will be completed in the first quarter of 2017. ICSG projections for 2016 released in October indicated the market could be in surplus, while in 2017 ICSG forecasted around 160,000 tonnes surplus in view of new mine output that compares with a deficit of 55,000 and a surplus of 20,000 for 2016 and 2017 respectively forecast in its March 2016 meeting.

**Project acceptance high on Study Group agenda**

Metals study groups of the International Copper Study Group and International Nickel Study Group have the aim of building shared value with communities and stakeholders. A 13-page report entitled ‘Social Acceptance of Metal Mining and Metals Industry’ has been prepared at the request of ICSG member countries.

**Keeping in touch with MIDAS**

The MIDAS project ran from 2013 to 2015 and was led by a wide-ranging team, all aimed at helping the nascent deep-sea mining industry. The MIDAS project team established a number of forums and workshops specifically designed to discuss the potential impacts of mining on deepsea ecosystems. A final summary report of the “MIDAS Highlights” has been published, and the MIDAS study areas included the mid-Atlantic Ridge (SMG), the Gulf of Guinea (ZMG), the Exclusive Economic Zone of the central Pacific ( nodded), the Black Sea, and the Norwegian and Swedish continental margins (gas hydrates). Additionally, the Canary Islands, Paimpolo Seamount (central Mediterranean), Norwegian fjord and Portimão Bay in Spain were used as sites for various projects in the field experiments. More comprehensive and technical summary of the MIDAS project will be available in early 2017 as part of the ICSG’s Technical Series?

**In brief…**

The International Copper Study Group has produced its 2016 yearbook. Yearbook covering world copper supply and demand data for the 2006-2015 period. The yearbook is included as part of the ICSG Monthly Bulletin annual revision. The 2016 ICSG yearbook was released at the 15th Annual Copper Meeting held in Shanghai. The yearbook includes detailed data on all member countries.

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Refining electrolysis operations

The Electrolysis 2016 conference at the Annual Conference of Metallurgists (55th COM) and XVIII International Mineral Processing Congress (IMPC) held in Quebec City, Canada yielded some interesting presentations.

Investing in forecast growth in e-mobility

MKM was successfully certified in November 2016 for the ATS 16/99 system, of critical importance for automotive and capital goods industries. Seeing further scope for development opportunities within the growing e-mobility market, MKM is investing in production technology, development of new products, quality and work processes to capitalise on them, according to CEO Roland Hannig. There is already up to 6 kg copper cable in the electrical system of standard cars, and this is set to rise significantly. In hybrid cars this quantity doubles, in electric cars it is increased to up to 20 kg. Compared to conventional cars using around 24 kg of copper, this means a rise to 75 kg per car.

According to the Fraunhofer- Institut, by 2050 around 20 per cent of the global demand for copper will be for the automotive industry. MKM has recently had its IAT 2008 renewed.

Market in surplus for January to November 2016

According to WBMS Market Balances released in January 2016, the copper market recorded a surplus of 17 kt in January to November 2016, which follows a surplus of 35 kt in the whole of 2015. This surplus was mainly during November and closed 23 kt lower than at the end of December 2015. The surplus is caused by increased production and a surplus in the first half of 2016. A significant factor is the increase in the Chinese government stockpiles. World mine production in the period was up 7.0 per cent y-o-y to 18.78 Mt. Global refined production rose 2.7 percent y-o-y to 21.37 Mt, with China up 422 kt and Spain up 14 kt. Global consumption for January to November 2016 was 18.78 Mt. Global refined production has been supported by lower copper scrap supplies and weaker copper prices at sulphuric acid due to increased acid production. This means a smaller footprint for a given tonnage, and refining recently increased the present limiting cathode, METTOP-BRX Technology of Austria has significantly increased the present limiting step with, in effect, a ‘designed’ technological breakthrough. METTOP has now successfully established this system in two commercial plants, the copper refinery of Xianguang Copper Co., Ltd., in China (Figure 1) and the copper refinery of Montansehle Reiding in Austria, with each plant operating at 420 A/m2.

Tankhouse renovation program at UMMCC

JSC ‘Uneltechmetallurgical enterprise’ of UMMC Group is setting about realising a major investment project in its copper refining facilities at Verkhnyaya Pyshma. During a new copper tankhouse in three stages, by around 2018 UMMCC aims to achieve production capacity of 450-500 ktpy. The first and second stages are to have 150 ktpy capacity each, and the third, depending on the market and raw material balance, 300-400 ktpy. The total capacity of the new tankhouse production technology is used in the second stage as with the first stage.

The technology provides application of permanent stainless steel tanks instead of disposable starting sheets. After starting up of the second and third stage, copper production capacity will increase from 150,000 to 300,000 tonnes annually. The total capacity including Chinese refineries, the period rose by 27.3 kt to 31.37 Mt. China consumed 21.35 Mt compared with 20.78 Mt for the same months of 2015. The total consumption in China increased in January to November 2016.

Construction and basic engineering was provided by Outotec (Finland), with detailed engineering provided by ‘Uralmetaldshove’ design institute (the structural division of UMMCC). The new tankhouse is in accordance with state of the art and standards concerning equipment and technology. Construction is planned to be completed in 2017. According to UMMCC, the budget of the second stage tankhouse project will exceed 4.5 bn rubles. At the same time within this project, JSC ‘Uralelectromet’ is carrying out design work for its copper sulphate and chemical-metallurgical plants, copper smelter shop, gas emission and by-products facilities.

References:

Author: Philipp Mackey

In brief…

Copper Worldwide Vol 7 No 1

Some 4.0 million tonnes (21%) of world mined copper comes from leaching followed by solvent extraction-electrowinning. Several proven practices for optimising this mining operation came from Hathc (Toronto) and Colorado-School of Mines, whilst CSIRO (Melbourne) delivered simulation results in two presentations. The Missouri University of Science and Technology discussed lead- and base-metal smelting processes, whilst a paper from China covered permanent stainless steel cathodes.

Current density data operating came from Los Bronces courtesy of Anglo American, whilst a surplus of 35 kt in the whole of 2015. This surplus was mainly during November and closed 23 kt lower than at the end of December 2015. The surplus is caused by increased production and a surplus in the first half of 2016. A significant factor is the increase in the Chinese government stockpiles. World mine production in the period was up 7.0 per cent y-o-y to 18.78 Mt. Global refined production rose 2.7 percent y-o-y to 21.37 Mt, with China up 422 kt and Spain up 14 kt. Global consumption for January to November 2016 was 18.78 Mt. Global refined production has been supported by lower copper scrap supplies and weaker copper prices at sulphuric acid due to increased acid production. This means a smaller footprint for a given tonnage, and refining recently increased the present limiting cathode, METTOP-BRX Technology of Austria has significantly increased the present limiting step with, in effect, a ‘designed’ technological breakthrough. METTOP has now successfully established this system in two commercial plants, the copper refinery of Xianguang Copper Co., Ltd., in China (Figure 1) and the copper refinery of Montansehle Reiding in Austria, with each plant operating at 420 A/m2.

As discussed at Electrolysis 2016, a recent breakthrough in technology now modern day factory today of a system of 340-350 A/m2. This is a key development in establishing the copper output for a given size of plant. The upper value of current density while still feasible is limited by current crowding at the cathode, METTOP-BRX Technology of Austria has significantly increased the present limiting step with, in effect, a ‘designed’ technological breakthrough. METTOP has now successfully established this system in two commercial plants, the copper refinery of Xianguang Copper Co., Ltd., in China (Figure 1) and the copper refinery of Montansehle Reiding in Austria, with each plant operating at 420 A/m2.

New developments and advances in this interesting system were discussed by Andreas Filzwasser et al. in a paper entitled, “FAQs with regards to operating a copper tankhouse above 400 A/m2 using the METTOP-BRX-Technology”. It is believed that this technology will gradually be embraced by the industry as it means a smaller footprint for a given tonnage, or in some cases a significant increase in copper cathode, METTOP-BRX Technology of Austria.

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In brief…

**China’s copper output was down 645,000**
copper tons in August, four times the period amount, China’s refined aluminium an 8% increase in usage in H1 2016 – copper saw a 12% drop.

Glencore knowhow applied to Kansanshi smelter

Outotec has agreed with National Copper Company Ltd (NCCO) on the delivery of two of the art sulphuric acid plants for the Sarchashma and Khabsun Abad copper smelters in the Karman province in Iran. The value of the order was not disclosed, but is around $50 million. Scope of delivery includes engineering, main process equipment installation, commissioning for the acid plants, as well as spare parts and supervisory services for installation.

The Kansanshi smelter in Zambia – the 24th International Trade Fair for minerals and metals with 500 exhibitors from 25 countries, the Kuzbasskaya Yarmarka Exhibition Center in Novokuznetsk, Western Siberia. Russia, will be held from 19 to 23 November 2017 in the Kuzbass Exhibition and Congress Center in Novokuznetsk, Western Siberia, Russia. There were over 500 exhibitors from 23 countries and over 27,000 visitors, in 2016.

The Sepon tankhouse in Laos – in 2016 Sepon (LXML) produced 78,492 tonnes of copper cathode.

Bespoke refining solutions

Machester-based G Corner is a global leader in the supply of DC Electrical systems and other specialist refinery equipment to the base metal refining industry. In the early 2000’s, the refined production of copper saw a substantial growth of around 7% per annum from 2000 to 2005 to just over 2 Mt by 2005. A significant proportion of this growth was through the development of electrorefining; moving from the more traditional electro-refining process. G Corner were selected by the Newcrest Mining in the supply of SX technologies. The company works with customers on specific process issues to do with plant operation and develop products such as electrowinning shorting frames, which are able to increase plant operational performance by reducing plant downtime.

The G Corner HQ in the UK co-ordinates with manufacturing facilities in India and China and representatives in Kazakhstan and Russia. G Corner now offers travelling expertise in design engineering solutions for large and small base metal refinery projects, including the supply of SX/EW technology.

**The cost burden of SX/EW only mines** was cashflow negative compared to concentrator mines (1%).

On the other hand, average SX/EW mine costs were 36% higher than the equivalent concentrates mine when compared on the above net basis. On top of this, Electrowinning cathode producers also have lower variable costs compared to a large proportion of concentrator producers.

**Dias d’Avila reaches cathode milestone**

On 22 December 2016, the Dias d’Avila unit of Paranáspuma in Brazil reached the 6 million tonne of cathode production milestone. To commemorate the occasion a special cathode stamping number was displayed on the entire copper cathode roll, displaying 2016. The plant operates a sequential rolling sequence with a capacity of 7 Mt/yr.

The Dias d’Avila plant increases the production capacity of 280 kt of cathode. The plant generates coproducts with the copper, anode mud and cathode dust, anode mud and granulated slag.

**Time for an ion exchange?**

Leaching, ion exchange and electrowinning. According to Iontech, despite the wide acceptance of SX, it does use large quantities of volatile organic substances, SX extractants have to be handled with environmental awareness, and organic losses from the liquid organic phase are a potential hazard to water ground. Also, rigid creation in the SX process requires special facilities and has been a major economic and downtime impact. Solvent extraction is also sensitive to low temperatures, which can cause bad phase disengagement times and reduced process performance.
Get the benefit from control systems

Most plants do not track their systems’ performance. Optimisation is the easiest way to benefit from your control systems. A 4-step approach is demonstrated here by Michel Ruel of BBA Inc. in Québec.

Maximising what you already have is the best investment to remain competitive. This article aims to show the benefits of a systematic approach using modern tools to improve plant performance. We at BBA suggest dividing the work in four phases, and a subsequent phase can begin when the previous one has progressed: Assess, Remediate, Stabilize, Optimize or add advanced control. This approach has been successfully applied to several sites. Examples and illustrations from these plants demonstrate how this step-by-step method is applied and generates results. Under the BBA method, there are 4 questions to answer before moving on to the next step. For each control strategy, you should ask the following questions:

1. Assessment: Does it work?
2. Remediation: Do you use it?
3. Stabilization: Is it stable?
4. Optimization: Does it perform? Do you need advanced control?

The first phase is to assess all equipment to determine the performances of instruments, valves, variable speed drives, and other equipment. To carry out the project, a database will be used to collect and store all the information. The second phase is to remediate instrumentation problems, including the ones pertaining to valves, variable speed drives, analysers, transmitters, etc. When equipment is in order, loops are put back in automatic mode. If a loop oscillates, use standard default values for this type of loop.

The third phase consists in validating the control strategies, properly configuring the systems (control system, programs and parameters, HMI, alarms), and then tuning the loops and control strategies. Soft sensors should be validated also. The fourth phase consists of analyzing the process and expected performances to optimise the control loops and control strategies. When mixing products for instance, each flow loop should move at the same speed to ensure proper recipe when increasing the total flow. If performance is not sufficient, a decision tree will be presented to determine the right approach: advanced regulatory control, model predictive control, or fuzzy logic control.

Once all steps have been completed, control performance monitoring software is used to sustain the results and pinpoint equipment or loops not performing as stated. The first phase will remediate problems identified during the first phase. The second phase will remediate problems identified during the first phase. The fourth phase consists of designing new control strategies and adding more equipment to improve performance. If an advanced control system is used, this system will be optimised. If performance is not sufficient, advanced control will be added: advanced regulatory control, model predictive control, or fuzzy logic control. Finally, once all steps are completed, monitoring tools are used to sustain performance and results.

Table 1: Savings in production costs associated with different process control categories

<table>
<thead>
<tr>
<th>Process control categories</th>
<th>Savings in production costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit operations control</td>
<td>0.8%</td>
</tr>
<tr>
<td>Advanced control</td>
<td>1.4%</td>
</tr>
</tbody>
</table>

Table 2: Typical control loop problems and performance issues

| Control valves of poor quality or in poor condition | 30% |
| Instruments not installed properly               | 15% |
| Controller in manual mode                        | 30% |
| Poor loop design                                  | 15% |
| Poor controller tuning (unacceptable values)      | 30% |
| Poor controller tuning (not selected according to the performance goal) | 85% |
| Control loop not performing according to objectives | 85% |
| Loops that perform better in automatic mode than in manual mode | 25% |

Instrument auditing

This objective under Step 1 is to audit every instrument in the selected areas. The following tasks must be performed:

- Visual inspection
- Configuration
- Analyses using historical data
- Analyses using control software (control performance software) or through testing
- Observations and recommendations
- Remediation needed: calibration, configuration, reinstallation, repair, replacement, or re-design.

For example, see Figure 1. A magnetic flowmeter with its grounding wire missing means the signal will be noisy and erratic, it is neither working normally nor performing as expected.

Remediation process

In the second (remediation) phase, the

The third phase will start when enough equipment in a given area is performing well. This third phase consists of tuning control loops and optimising control strategies.

The fourth phase consists of designing new control strategies and adding more equipment to improve performance. If an advanced control system is used, this system will be optimised. If performance is not sufficient, advanced control will be added: advanced regulatory control, model predictive control, or fuzzy logic control. Finally, once all steps are completed, monitoring tools are used to sustain performance and results.

Improving what you already have is not the only way to improve performance. Improvements are made through adding new equipment, changing existing equipment, or reprogramming existing equipment to perform better. The first step to ensure that all equipment is properly installed and used at a maximum is to Audit every instrument in the selected areas. The following tasks must be performed:

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- Configuration
- Analyses using historical data
- Analyses using control software (control performance software) or through testing
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The BBA approach in action

The 4-step approach was applied at a concentration plant. Initially, four loops were selected, but all the other areas were added to the project later on. The project team comprised:
- A process and instrumentation control expert, also acting as project manager
- A process control engineer responsible for tuning loops and new control strategies
- One engineer from the plant (part time, management)
- Four engineers and technicians from the consulting firm for assessment and remediation
- Six technicians from the plant for remediation

This more than 25 year old plant had increased its capacity and modernised its equipment through several projects. In the early years, maintenance of the plant equipment was performed according to best practices and an expert system was used at the grinding circuit. Unfortunately, in the last 12 years, maintenance was reduced and the expert system was abandoned. More than 40% of loops were in manual mode at the beginning of the project. Approximately 38% of the instruments required remediation.

System stabilisation

The third phase will start when equipment in a given area is performing well. This phase consists of tuning control loops and optimising control strategies. Control performance and tuning software is recommended. This will identify equipment problems and control loops that are not performing well. If the loops are in automatic mode, the software will identify a model for many of these loops. This model will be used to determine tuning parameters for the PID controller.

If no model is available for a loop, BBA will conduct tests to tune the loop according to its objective. Using a specialised tool, we conduct tests in automatic mode and many loops can be tuned at the same time. Alternatively, these tests can be carried out in manual mode.

Performance evaluations are before and after use, and key performance indicators, for example:
- Service factor (% of time in normal mode, no malfunction)
- Standard deviation of PV
- Response time
- Relative performance index (actual versus expected)
- Oscillation index

Control optimisation

The fourth phase will consist in designing new control strategies and adding equipment to improve performance. If an advanced control system is used, this system will be optimised. If needed, an advanced control system could be added using guidelines to select the proper approach. For each area, all control strategies will be reviewed to ensure that the process is under control.

These control strategies will be designed for normal conditions, but also to handle abnormal situations, start-ups, and shutdowns. The strategies are optimised to achieve process goals. Once everything has been optimised, we will evaluate other alternatives: soft sensors, addition of equipment, advanced control, expert systems.

Control project organisation

The consultant and client personnel should work together as a team, comprising:
- Process and instrumentation control expert, also acting as project manager
- Process control engineer responsible for tuning loops and reviewing control strategies
- Engineers and technicians for assessment and remediation

Estimation will require preliminary work (100 to 400 hours):
- Collection in the plant
- Select and prepare the database
- Populate the database
- Control project organisation

References:
period in 2015. Therefore, total production of all copper products improved to 1,390 kt in the period, compared to 1,233 kt in the year-earlier, a noticeable gain of 5.5%, and much better than the underlying macroeconomic situation would appear to warrant.

Net trade balance gains

Red and white and brass mill products trade is the main explanation for stronger performance of German mills, as they have been gaining market share both domestically and in the export market (see Figure 2). Imports of copper wire rod and drawn wire into the German market have fallen while exports to third markets have expanded. Similarly, imports of brass mill products have dropped slightly while exports have grown. In each case this has led to a more favourable net trade position in 2016 compared to 2015. As the chart illustrates, this is no one-year trend. German net exports of copper wire rod and drawn wire and those of brass mill products have been on a four-year upward trend since 2012. This has improved Germany’s net trade balance by almost 175 kt, helping to explain why the country has been Europe’s strongest performing copper consumer during this period of economic and political uncertainty.

Trading partner variety

Germany’s country trading partners in semi-manufactured products reflect many factors aside from simple geographic proximity. Export destinations can sometimes be those for inter-company transfers for local resale, or simply where the quantity or quality of local production is insufﬁcient relative to that country’s demand. In copper wire rod and drawn wire, Poland, Italy, Austria, Romania, Saudi Arabia and France rank in the major export destinations. Most imports are attracted from Poland, Sweden, Belgium and Italy, some of which again may reflect inter-company transfers or more competitive product pricing. For brass mill products, the United States, the Netherlands, Italy, France and the Czech Republic are the leading export destinations. As sources of imports, Italy, the Netherlands, Poland, France, Belgium and Austria feature most highly.

Leading semis groups

In no particular order the leading companies involved in German copper industry are: Aurubis, Wieland Group; KME Group, Deutsche Giessdralr, Mansfelder Kupfer & Messingwerk, Diehl Metall, Schwermetal, Halbzeugwerk and Nexans Deutschland, as well as a host of smaller fabricators. Further downstream, Nexans, Prysmian and the Wilms Group are signiﬁcant wire and cable manufacturers, while Germany is also headquartered to Leoni, a major global player in the automobile harness business.

Outlook for 2017

The German government expects GDP growth to slow a little in 2017 compared to 2016, and certainly based on the current end use indicators and the unusually cold winter now being experienced, it is unlikely that the first quarter will see little if any expansion compared to the prior year period. If Germany is to remain one of the stronger performers amongst European national consumers, then it must look to secure further gains in its net trade position by remaining cost sensitive in its domestic market, while striving to be price competitive in its European and international export business.

Extruded profile KME plate coolers

About 50 per cent of all blast furnaces in use worldwide today are cooled by copper staves. Copper plate coolers have also been used for many decades, but up to now these copper cooling plates have solely been manufactured by sand casting, which carries the risk of blowhole formation in the material. A leak in the cooling circuit may cause serious problems in manufacturing. Whilst KME has become a leading supplier of copper staves, it has always been keen to also solve the problems with plate cooling.

In close cooperation with Salzgitter Flachstahl GmbH, KME Engineering has now developed an economical production method for plate coolers made of copper profiles. Instead of sand casting, these profiles are manufactured in a reliable extrusion and drawing process. In addition to their fine grain and blowhole-free structure, the new products also offer considerably improved thermal and mechanical properties. Practical application in blast furnace A at the Salzgitter Flachstahl plant in Germany has delivered outstanding results since 2014, proving that the new plate coolers are a convincing alternative for furnace cooling. The main characteristics of the new plate cooler compared to the sandcasted plate cooler are:

- Fine grain sized copper, no risk of blowholes
- Higher thermal conductivity compared to as-casted material
- Use of asymmetrical copper profile to reinforce the wear out zones
- Significantly reduced water channel area reduces the water leakage risk and increases the new plate cooler’s lifetime in the different Blast Furnace zones
- High conductivity refractory to ﬁll the gaps between the water circuits
- Welded copper bottom plate and top plate design to protect the refractory inside the plate cooler
- Simple water channel design avoids ‘dead water’ or re-circulating water corners
- Easy design change from sand-casted to new plate cooler.

www.kme.com
The capacity expected to be operational in 2016 with some certainty was less than 50.8 million tonnes (Mt), according to the ICSG Directory of Copper/Alloy Fabricators Capacity 2016, which also found that copper wire rod has 59 percent of the world share by product.

The next largest product group is copper and alloy flat rolled PSS with a 14 percent share, with Rod Bar RBS and Tubes both at 10 percent each. The total listed capacity is 53.52 Mt across 2,319 plants. Of these, a total of 4,544 reported in the 2016 survey. There were 114 new plants reported between 2015 and 2016 and representing 19.04 Mt of new capacity. In contrast, the operational status of 51 percent of pre-2010 plants is uncertain.

The global leaders in terms of reported fabrication capacity in 2016 are a group of 11 countries with a total capacity of 42.4 Mt or almost 80% of the capacity reported. China, with 21% in 2012, also gaining market share in 2015 to 779,000 t. The company has grown production by 30,000 tonnes from 21% in 2012, also gaining market share in China. Production reached 212,400 t of rod in 2015. Large cable companies that maintain an upstream presence by owning wire rod mills in the world with a production of 80,000 tonnes in 2015 to 779,000. The company has grown market share in Europe (excluding Russia) rapidly to 27% of total production, up from 21% in 2012, also gaining market share in Africa and the Middle East.

The next three largest producers Jiangxi Copper, Juchipilo Copper and Cahill Copper are all based in Asia. After expanding capacity and production of wire rod aggressively in recent years, Jiangxi Copper’s production stabilized in 2015 at around 750,000 tonnes. The company operates two wholly-owned wire rod mills, one Southwire technology and one Continet technology, and owns a 51% stake in a third mill. Third placed Jianguan copper is the largest non-upstream-integrated wire rod producer in the world with a production of 620,000 in 2015. The company employed a strong performance in 2015 operating at 98.5% capacity utilisation. The operation of the Two-step process is based.

Main tube producers

In 2016 China reported to the ICSG Directory of Copper/Alloy Fabricators Capacity around 2.5 Mt of copper and alloy tube production, followed by North America (700 kt), Western Europe (713 kt), NE Asia ex China (550 kt), SE Asia India/Indonesia (387 kt), Eastern Europe and Central Asia (173 kt), South and Central America (148 kt), Middle East and North Africa (114 kt), and Africa Southern and Central (25 kt). The period 2010 - 2015 around 579 kt of new copper tube capacity was installed globally, or 6% of all new capacity by product. Expansion for tube plants scheduled in 2016 included the CNMC Albetter Bronze Co. Ltd 110 inky Tube Plant Project, the Zhejiang Haishuang 25 inky Tube Plant in Guangdong Province, and a 15 ktpy expansion at Mueller Industries in Bahrain.

Two-step copper smelting process

The first commercial application in China of the SLS copper smelting technology developed by ENP and Fangyuan copper smelter in Shandong Province, China. This 500,000 tonnes of concentration per year plant which commenced operations in December 2008, was based on the use of a horizontal smelting furnace fitted with the SLS technology - special converters, but which allowed the injection of tonnage oxygen accounted by a controller of air via a shrouded section of the tuyere. The start-up of the Dongying plant followed the successful commissioning in 2005 of the first SKS commercial smelter at the Shengquan copper smelter in Vietnam (rated at 50,000t of concentrate). The SLS unit, which operates akin to a ‘third generation’ Noranda reactor with high oxygen enrichment, top-concentrate feeding and side-tapping of high grade matte, soon established itself as an important process adapted to conditions in China. The first vessel at Shengquan was sized (inside steel) at 3.1 m diameter by 11 m with a rated capacity of 7 to 8 tonnes of concentrate/hr, while the larger Dongying vessel was sized 4.1 m diameter by 16.5 m long, with a rated capacity of 70 tonnes of concentrate/hr.

The operations of the Two-step process is described below.

Separate bins are provided to hold copper concentrate, slag concentrate, silica flux, dust etc. prior to feeding the smelting furnace. These materials are then fed to the smelting vessel at controlled rates through one of the three feed ports located at the top of the barrel section and towards the vessel ‘feed end’. Oxygen and air are injected through the nebuliser mounted concentric nozzles in the preheated gas stream with the added feed to form a high grade matte containing 73-78% Cu content, as slag averaging 2.5% Ca and a high-strength SO2 off-gas.

Two converters, which operate in batch mode, function alternately to allow for overall continuous operation. A typical sequence of the converter units is as follows: The No. 1 converter is charged with matte by launder transfer. When charging is complete, blowing commences to convert the charge to copper. At this point, the No. 2 converter starts to receive high grade matte. After slag skimming at the No. 1 converter, copper converter commences, then the slags of a sample of copper shows the anode copper is ready, casting commences. At the end of casting, the No. 1 vessel is ready to receive high grade matte. When the converter ready for finishing, followed by anode casting. Two vessels average anode analysis (3).

Global Copper use capacity update

The capacity expected to be operational in 2016 with some certainty was less than 50.8 million tonnes (Mt), according to the ICSG Directory of Copper/Alloy Fabricators Capacity 2016, which also found that copper wire rod has 59 percent of the world share by product.
**2 Two-step vessels in the Dongying Fangyuan process**

Dongying Fangyuan, a wholly-owned subsidiary of China Nonferrous Metals Co., Ltd., is to be congratulated on the development of this ingenious new copper smelting technology. With the SKS/BBS process, which entered into service in 2010 with the aid of ENFI, a wholly-owned subsidiary of China Metallurgical Group Corp. It independently commissioned in 2010 with the aid of ENFI, Air Liquide’s Engineering and Construction teams, using state of the art technologies that offer energy efficiencies as well as optimal reliability and safety. It will support Shandong Fangyuan’s ongoing large-scale expansion plan to increase smelting capacity at the Dongting site from 400,000 tonnes to 700,000 tonnes per year by 2017.

Air Liquide, the world’s leading supplier of oxygen, nitrogen and argon, has reportedly good energy and environmental performance. Dongying Fangyuan Nonferrous Metals Co., Ltd. is to be celebrated on the development of this ingenious new copper smelting process and the copper world awaits news of further developments.

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**Arsecnic mitigation**

Fangyuan Copper Smelter Phase I was commissioned in 2010 with the aim of ENFI, formerly known as China Nonferrous Engineering and Research Institute, a wholly-owned subsidiary of China Nonferrous Metals Co., Ltd. It is independently operated by Air Liquide’s Engineering and Construction teams, using state of the art technologies that offer energy efficiencies as well as optimal reliability and safety.

**Air Liquide**

Air Liquide announced a long-term contract with Shandong Fangyuan, China’s leading privately-owned copper smelter, in June 2015. Air Liquide will invest around EUR 60 million in the construction of the art-Se (Air Separation Unit) with a capacity of 2,000 tonnes of oxygen per day, expected to be commissioned in the second half of 2017. The new ASU, located in Dongying, Shandong province, will be built by Air Liquide’s Engineering and Construction teams, using state of the art technologies that offer efficiency as well as optimal reliability and safety. It will support Shandong Fangyuan’s ongoing large-scale expansion plan to increase smelting capacity at the Dongting site from 400,000 tonnes to 700,000 tonnes per year by 2017.

In 2015, global blister production from smelters totalled 16.1Mt contained copper against total refined copper production as new standalone blister production growth outpaced that of refined copper production. Much of the blister is processed to anode electro-refined production of 18 Mt of cathode copper. The shortfall was filled by high-grade scrap. The recovery of copper from high-grade scrap is estimated to have totalled 1.59 Mt, and the intermediary market for copper blister was therefore approximately balanced. In 2016, blister production growth outpaced that of refined copper production as new standalone blister production capacity has been brought on stream and used up, while cathodes to electro-refined production in Africa have not been matched with equivalent cathodes for blister production. CRU forecast 2019 blister production at 16.96 Mt (up 4.6% y-o-y), compared to a 2.4% increase in electro-refined production.

An increase in blister stocks of some 300,000 t contained copper will support a continued strong growth in refined copper production in 2017, reflecting the impact of the higher concentrates production growth. CRU’s analysis determined that much of the stock build was in Zambia and China, and this is supported by data on international trade flows. A major underlying factor has been the establishment of new smelting capacity with strong growth in refined copper production supported by data on international trade flows. A major underlying factor has been the establishment of new smelting capacity with strong growth in refined copper production.

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**Oxygen supply to the Two-step process**

CRU analysis: Copper blister surplus emerging

To conclude this roundup, here is an example of a significant piece of CRU Analysis by CRU Principal Consultant Christine Melton released in December. It declared that in 2015, global blister production from smelters totalled 16.1Mt contained copper against total refined copper production of 18 Mt of cathode copper. The shortfall was filled by high-grade scrap. The recovery of copper from high-grade scrap is estimated to have totalled 1.59 Mt, and the intermediary market for copper blister was therefore approximately balanced. In 2016, blister production growth outpaced that of refined copper production as new standalone blister production capacity has been brought on stream and used up, while cathodes to electro-refined production in Africa have not been matched with equivalent cathodes for blister production. CRU forecast 2019 blister production at 16.96 Mt (up 4.6% y-o-y), compared to a 2.4% increase in electro-refined production.

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**Wednesday 5 April**

Metalurgical Sulphur, Acid Seminar 13:30 - 16:30

• Ores - minerals and metals processing technology, industrial water treatment
• Zinc/lead - seawater method for gas desulphurisation, water purification, sewage treatment

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**Copper Worldwide Vol 7 No 1**

Copper Worldwide Vol 7 No 1
in brief...

Oxotex has received 18 million euros order from Iberdrola for the delivery of concentrate process equipment, comprising grinding, thickening, flotation and filtration equipment. Oxotex will supply spare parts and installation supervision services and training for the delivered equipment. Delivery is expected by the end of 2017.

www.oxotex.com

The HII Supervisory Board has appointed Bert Schouten as Chief Operating Officer and Chief Technology Officer of the Management Board of HII for a period of five years from 1 January 2017. He will support the Management Board team in the course of the planned contribution of RH and Magnesia. Mr. Frans Buddean has stepped down.

www.rieulgas.com

Vincent Figyvers will be overseeing the finance department of AMO in its future role as CEO and will report directly to CEO Roland Haringts. He will succeed Gerhard Krickstein, whose contract expires in April. Vincent Figyvers started working at AMO in January. Most recently he was head of recycling at Noveon Europe and managed Noveon’s Nuremberg factory.

www.amo.me

Wetolinc Technology has recently been awarded the Reusable Ignatable Catalyzer Award presented at the IMARC. Gail Dincer in Melbourne, along with project partner Core Researches. The award recognises the successful installation of the Albox® Process™ treatment plants for GeoFiltrating Gold’s GPM Gold.

www.glencoretechnologies.com

Jordi Wagner has left his position as General Manager of La Farga Tub, and will leave his 35 years’ exceptional service experience in April 2017. The new General Manager of La Farga Tub in Manresa, will currently Sales Manager (with 14 years’ sales experience). Sales Management is now under the direction of Victor Corbet, for the past 4 years the company’s Export Manager.

www.lafarga.es

Applications for the CEO Medal, an annual award intended to recognise and celebrate outstanding published papers, articles or studies demonstrating beneficial strategies for energy efficient commissioning, will close on 15 March 2017. More information on the submission requirements, improvements and financial benefits, achieved or potential, are key interest.

www.coolcommissioning.org

Copper Worldwide Vol 7 No 1
Positive tone at the Kobe gathering

With the world facing increasingly troubled times, the Copper 2016 conference concluded on a somewhat positive note. There is a reasonable outlook on future copper demand and for mine-smelter-refinery sustaining developments to match in the near to long-term. Summary by Phillip Mackey.

Outlook

Copper is a valued commodity that can be found in a variety of industries, including electronics, construction, and manufacturing. Copper’s unique properties make it an essential component in many products, and its demand is expected to continue growing in the future.

The Copper 2016 Conference held in Kobe, Japan, was the first to be held in Asia in its 40-year history (see Table 1). Successfully, there were 272 papers in total on all key areas of copper metallurgy. The conference attracted over 747 delegates from 41 countries. Around 70% of the delegates were from Asia, with the balance from Europe (33%), North America (7%), Central and South America (4%), and Australia (4%). New and improved technologies in all production areas were presented and discussed.

Table 1: Last five and upcoming Copper Conference venues

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<thead>
<tr>
<th>Year</th>
<th>City/Country</th>
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<tr>
<td>2000</td>
<td>Santiago, Chile</td>
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<td>2004</td>
<td>Kobe, Japan</td>
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<tr>
<td>2016</td>
<td>Vancouver, Canada (planned)</td>
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Conference keynote

The schedule included 10 plenary lectures, short courses on Arsenic and Recycling, and a workshop on Bottom Blowing Technology presented by delegates from China. The event included a successful Trade Show with 35 exhibitors. Post conference tours were well attended and included an incursion on Japanese copper (IPPC), Nishinomiya (Kobe) and Toyohashi (Sumitomo). The successful event reflected the remarkable growth in the copper industry in the region. By 2015, the copper smelter production in Asia approximated 11 Mt of copper (40% of world output). Some of the key findings outlined in plenary presentations and others given at Copper 2016 included the following:

- World copper demand is presently about 23 Mtpy and is expected to go to 25 Mtpy over the next two decades. Brownfield expansions are already announced – will meet part of this demand, but new mines will need to be developed. This growth rate suggested the equivalent of a new 300,000 tpy smelter-refinery each year for the next 20 years (see below and Figure 3).
- With growing demand in mind, several plenary speakers highlighted the role of sustainability in all areas of copper operations.
- The conference was informed that wind turbines, electric and hybrid cars will all require significant amounts of copper.
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BHP Billiton continues Samarco remediation

One year after the Samarco tragedy, BHP Billiton CEO Andrew Mackenzie has paid his respects to the people affected by the dam failure and provided an overview of the remediation work. Mr Mackenzie said: “The Samarco dam failure was a terrible tragedy and our thoughts remain with those affected. The emphasis has shifted to the Renova Foundation which will implement the long term programs to restore the environment and rebuild the communities.” More than 3,000 people have been mobilised to rebuild infrastructure, provide community and social services and prepare for the wet season. The findings from the external investigation into the causes of the dam failure were published in August 2016 and shared with the industry. BHP Billiton is creating a new global tailings dam standard for its operations.

Maintenance roles

The new BHP Billiton website launched in December makes company news and information easier to find and promotes job opportunities on the homepage. The company has already been recruiting globally-focused roles in its Maintenance Centre of Excellence (MCOE) hubs based in its Adelaide, Brisbane and Perth offices. Each MCOE has been created to remotely yet collaboratively support sites to deliver safe, sustainable improvement focussing on equipment performance.

Occupational safety awards for Metso

Metso has been recognised with two awards for its proactive and dedicated efforts in occupational safety. One of the awards was presented to Metso for its outstanding management in preventive security by the National Safety Council of Chile, and the other one to Manuel Guzman, Manager, Health and Safety at Metso Chile, who received the Management Award for Prevention presented by the Institute of Occupational Safety. Metso is continuously looking for new innovative ways to enhance occupational safety and well-being at work. One of the most important initiatives implemented by Metso’s Pacific Rim market area in 2016 was the immersed virtual reality training system, where risk situations can be trained for in a 3D factory environment.

Acid topics are up for discussion

The 2017 Sulfuric Acid Roundtable will take place from 5-6 April 2017 in The Woodlands (Houston), Texas. The 2015 Workshop attracted more than 180 participants from around the world. Presentations will be given by event co-sponsors on a variety of topics relevant to the industry, including:

Maximising Energy Recovery in Metallurgical Acid Operations
Speaker: Hannes Storch, Outotec

Selecting the Correct Concentrator Design
Speaker: Gray Cooper, NORAM Engineering & Constructors

HAZOP - Hazard & Operability Reviews, Are We Safe?
Speaker: Len Friedman, Acid Engineering & Consulting

Shredder housing design expedites maintenance

Metso has developed a new housing design that cuts service downtime, facilitates the maintenance of recycling equipment and makes it easier to keep the machinery in top shape. Available for almost every Metso LindemannTM shredder model, the new solution enables multiple maintenance operations to be performed conveniently, swiftly and at one time. The most significant improvement in Metso’s new housing model is the detachable front wall. The removable unit provides easier access to wear parts and speeds up the replacement of worn components. The new housing design also enables several maintenance tasks to be carried out at the same time. With the detachable front wall lifted out of position with a crane, the rotor adjustment and the replacement of wear plates can be conveniently handled simultaneously.

Banyard LFi Seminar on extrusion

Inductotherm Group colleagues from Europe, Russia, USA, Taiwan, Japan and China, India and Korea, joined a two day technology masterclass at Inductotherm Heating & Welding Ltd in Basingstoke, England in December. Inductotherm is home of the Banyard brand for the Non Ferrous and Steel sectors, in particular Banyard induction solutions for the Extrusion Industry. Banyard approaches 50 years in these market sectors. This important learning event took place to focus on the markets development for the singularly exceptional LFi products. Inductotherm has a dedicated centre of excellence in the UK that supports its Banyard global reach in engineering, process calculation, layout design, sales and after sales. The goal is to maintain a position as a leader in the Aluminium and Steel extrusion markets and to have Group companies manufacturing to compete locally.

The seminar colleagues were given the opportunity to gain insight into the design criteria, topology, characteristics and benefits as well as the features of the LFi power supply and its many application uses, learning about:

• Multiple zone heating, aplit technology, taper gradients, phase locking, inverter power
• Control, digital connectivity, communication, diagnostics
• Temperature control, pyrometers, and thermocouples
• Multi-turn and multi-layer coil design benefits
• Digital connectivity and its operation in maintenance and planned service.

With 2016 installations in India and Korea, the hosts shared the experiences of the projects, proving the equipment, responding to queries and providing results that have provided a repeat order through the community of Inductotherm Group companies. Recently Banyard Sales and Engineering staff undertook an Extrusion Technology training course and the event provided a detailed overview of the lesson learnt and where working closer with the integrators of press manufacturers can present the most efficient, cost competitive solution, whilst still achieving all customer’s needs. Access was provided to the Inductotherm Heating & Welding Test bay to view, control and present an LFi 750 kW Unit with dedicated heating exercises. This application based on a 6” Aluminium Billet Heater, is available to view until the end of February 2017.

www.inductotherm.co.uk
Daily lives...Detlef Neumann, Director Sales, Danieli Fröhling

Renowned for its planning, design, manufacturing and supply of strip processing lines and cold rolling mills, worldwide customers speak highly of their long lasting “Fröhling” machines.

It is before 6 in the morning when my alarm clock rings. It’s time to get up and start the day with a fresh coffee. Lotta, our dachshund, favors still being curled up on the sofa but decides that it’s too early for a walk. I usually like to have the first cup of coffee standing on our terrace and have a look into the garden. Gardening is one of my hobbies and I enjoy especially that time of the year when I can spend some time outdoors planting something, pruning the roses or just sitting on the lawn chair with a cold beer and watching birds and bees. I snatch up my tablet and check the daily news as well as the weather forecast before I get to the car and drive to our company. It takes me about 50 minutes to drive from my home to the office. I like to have radio during the ride, normally news and background reports about politics and business rather than music.

Danieli Fröhling is located in Meinerzhagen, a small town not far from Cologne. Josef Fröhling, a German engineer, founded the company right after WWII when industry in Germany was down and reconstruction of the country was getting off the ground. Everything at this company started with a small workshop in a private house, but soon grew to a mid-size company providing equipment and services for the metals industry. Fröhling, shortly after its foundation, became specialised in cold rolling mills and cutting lines. Our equipment may be found on 4 continents, and is used in steel, mining and cutting lines. Our equipment may be found in various positions in an engineering company acting mainly in the steel sector. In 2004, I was appointed the Sales Director of Danieli Fröhling, and since then I have been leading the sales teams for complete lines as well as for revamping projects, spares and services.

First thing in the office is to check and answer my emails. We have business partners and offices around the world and naturally emails are received overnight from China, the Americas or wherever. Some of my colleagues are on a sales trip and may need support from home. Our Chinese colleague reports about a new potential project and wants to have advice how to follow it up. Then there are the latest reports from our building sites that need to be studied and discussed. I discuss both technical and commercial matters to make sure of finding the optimum solution. Every colleague has his dedicated experience and sharing is essential in order to learn from each other and improve our own knowledge.

Later, the Managing Director to whom I report is asking me to explain the monthly sales report and outlook. We need to prepare the planning for the next months and discuss latest trends in the market and how to adapt best. The high workload and need for additional, qualified personnel is a topic as well. I can receive some positive comments about the latest results of “my” Spares & Services Department - a plaudit that I will pass on to the team because they deserve it.

Of course, travelling belongs to my professional life as well. I always enjoy business trips, meeting customers and colleagues from other divisions of the Fröhling family. Unfortunately within a standard business trip there is usually not much time to see more than airports, taxis, plants and offices. But if a free weekend day or evening can be found, I try to absorb as much as possible of the local flair, discover the regional cuisine and try to see some of the sights. The day then continues with discussions amongst our colleagues about new technical offers, how to deal with some special requirements made by that specific customer and how the layout might look best for that case. Another daily task for me is to check and confirm cost calculations and commercial offers. Luckily I have such a good team and experienced colleagues that I can very much rely on their diligence, so that I rarely need to change something. Nevertheless, we as a team like to discuss both technical and commercial matters to make sure of finding the optimum solution. Now I write or a last call made before I go home to see the family. On the way back, thoughts are still going on and I am ready to discuss both technical and commercial matters to make sure of finding the optimum solution. Every colleague has his dedicated experience and sharing is essential in order to learn from each other and improve our own knowledge.

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COPPER IS THE ELEMENT, PROPERZI IS THE ROD LINE

Is it your dream to resurrect copper scrap into high quality and high performance rod? No problem! Properzi has consolidated technology and first class equipment for this.