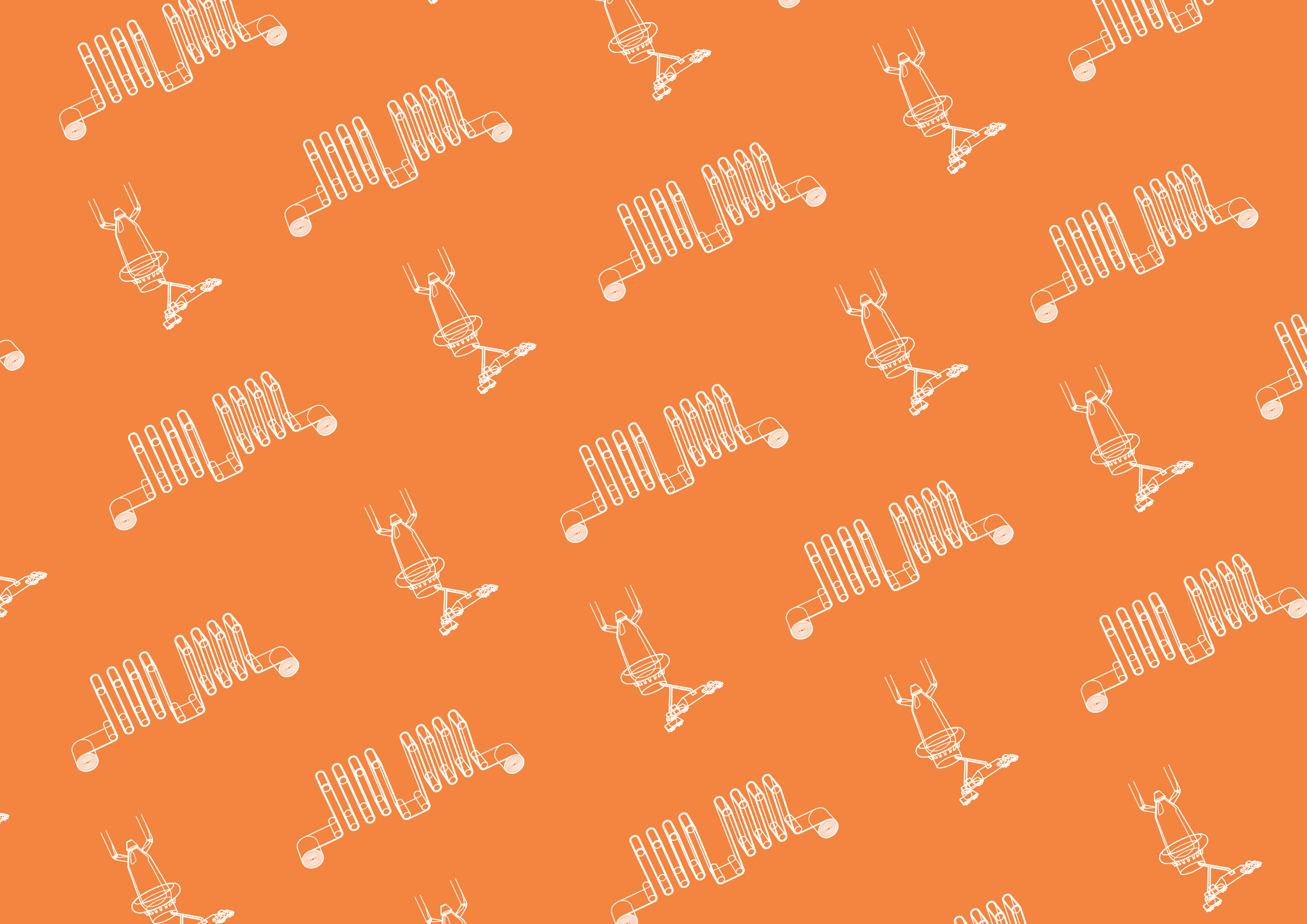
The Steel Book

SSAB



Contents

The Steel Book

ABOVE: The Iris Steel Flower by the Belgian architect and designer Michaël Bihain reflects the opportunities offered by steel for creating ingenious elegance and beauty.

ON THE COVER: Quenched steels play a key role in the SSAB product range. The SSAB steelmaking process imparts unique properties to the steel.
PHOTO: PÄR K OLSSON

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Steel – a recipe from SSAB

Blades for excavator buckets – a demanding application for steels.

JOHAN DALHALL

Steel can have many different properties. Steel can be hard or soft, tough or brittle, thick or thin, or super-strong to withstand significant wear and tear. It can also have a combination of characteristics.

The properties of steel are determined by the recipe used in the steelworks, rolling mills and after-treatments.

SSAB applies thought and knowledge to its steel production. The steels are made to meet Man's many different needs.

You want to travel safely by car with your family. We use specially produced steels of extreme strength for collision protection elements to enable vehicles to be made stronger and safer, while also being lighter. As a result, cars then have lower fuel consumption and emit less carbon dioxide.

STRONGER – LIGHTER – MORE ECONOMICAL

Trucks built of high strength steels can be made lighter, consume less energy and carry a higher payload, which reduces the number of trips for a given quantity of material. Reduced fuel consumption consequently leads to lower emissions of carbon dioxide and reduced impact on the climate. This is not a simple equation, but SSAB has the solution. And this benefits the environment.

SSAB specializes in the production of high strength steels. We choose from among 500 different "recipes" when producing the steel for your car, home, leisure products, interior fittings, large buildings, bridges, public transport equipment, machines, industrial plants or medical equipment.


PÄR K OLSSON

LEADING STEELMAKER

SSAB was first to develop the new steels for a more sensible everyday life. Today, we are the leading producer of high strength steels.

SSAB high strength steels are produced in Sweden and the USA, but sold throughout the world.

A stronger, lighter and more sustainable world

Together with our customers, SSAB will go further than anyone to realize the full potential of lighter, stronger and more durable steel products.

The SSAB brand vision

Did you know?

Steel is the world's most important structural material because of its high strength in relation to its weight and price.
Steel is produced in many forms – from thin sheet to heavy load-bearing bridge beams.
Industrial production is dependant on the availability of steel.
Steel is continually being developed and is a high-tech material.
Steel is the world's most recycled material.
Steel can be used time and time again and ensures good conservation of the Earth's resources.

A sustainable world

Steel is Man's most important structural material. High strength steel makes life a little lighter and the future brighter.

JAN GREUNE, LOOK/IBL

We are all worried by the gradual warming of our atmosphere. The UN Intergovernmental Panel on Climate Change (IPCC) has shown that human activities on Earth influence the climate to such an extent that we must be prepared for a change in our living conditions.

Many measures can be taken to reduce the emissions of greenhouse gases. SSAB high strength steels can definitely contribute to a long-term reduction in carbon dioxide emissions.

LIGHTER CAN CARRY MORE

The Vikströms Åkeri haulage firm in Luleå in northern Sweden is one of the country's large hauliers in long-haul traffic. The company's transport of goods links the northern and southern ends of Sweden. Vikströms was one of the first to test extra-high strength steels in containers for combined road and rail traffic. Vikströms then found that the payload capacity increased, weight could be reduced, traffic volumes could be cut, and their trucks used less fuel. So Vikströms continued along the high-strength path.

"In particular, durability has increased and maintenance costs are reduced," says Valle Vikström, founder of the company, who set up his own workshops for the production and maintenance of containers.

REDUCED CARBON DIOXIDE EMISSIONS

In São Paulo, the largest industrial city in Brazil, the mayor decided to tighten up the weight limits in order to force hauliers to invest in lighter vehicles and more efficient engines. This has led to a rapid increase in demand for new trucks and buses. The interest in advanced high strength steels has now grown. An investment that reduces weight quickly repays itself. Fuel consumption drops and the payload capacity increases – fewer journeys are needed for transporting a given quantity of goods. One or more extra tonnes of goods on every trip helps improve the haulier's economics, while society at large benefits from reduced emissions of greenhouse gases.

ENVIRONMENTAL VALUES

Many environmental values are linked to advanced high strength steels. The green thinking of SSAB is reflected in all product areas – cranes, forklifts, trucks, trailers, cars and all other areas in which steels can withstand demanding payloads when needed, but that can also contribute to lower weight or reduced quantity of materials and a longer, useful life.

High strength steels offer environmental benefits at all stages.

BELOW: SSAB high strength steels can contribute to a greener world. Transport accounts for a large proportion of human emissions of greenhouse gases. Constructed using high strength steels, both trucks and public transport vehicles will need less material and will have lower energy consumption.

PÄR K OLSSON

PÄR K OLSSON

Transport accounts for more than one third of society's emissions of carbon dioxide. Lighter vehicles made of stronger steels can carry more load and need fewer trips for a given transportation task.

PÄR K OLSSON

REDUCED COAL CONSUMPTION

Efficient SSAB production methods are used for producing high strength steels. So less coal is needed per tonne of steel produced. Every stage in the production process benefits since thinner steel is also easier to handle and transport. Lighter structures need less steel for you as consumer – which also saves on natural resources.

The market share of advanced steel grades from SSAB continues to grow in pace with the increasing numbers of customers who discover the benefits and find out how the new steel grades can be used in their most demanding applications. It is important to combine technology with innovation in order to achieve the optimum result. Nature benefits from this approach.

Increased payload

High strength steels in trucks lead to weight reduction, which allows the payload to be increased.
A 10 percent weight reduction on a timber truck enables the payload to be increased by 2 tonnes.

This payload increase enables 10 more saw logs to be carried on every trip. The distance traveled on a round trip is thus reduced by 5 percent. This corresponds to fuel savings and reduced environmental impact for a typical distance of 90,000 km traveled by a timber truck during its 10-year useful life.

Save fuel

Some of the energy supplied to a road vehicle is used for overcoming drag (air resistance) and transmission losses. For driving auxiliary systems, the entire weight reduction will not result in a proportionally lower environmental loading.

The distribution varies depending on the mode of transportation and type of operation. With vehicles used on public roads, the weight is of vital importance to the fuel consumption. A 10 percent weight reduction cuts the fuel consumption by 5 percent.

How is the strength of steel measured?

The strength of steel can be measured, for instance, in a tensile testing machine. In simple terms, this means that a certain force is applied to pull a steel specimen until the specimen just begins to deform. The yield strength is the stress at which the steel loses its ability to resume its original form. The tensile strength is measured in megapascal, MPa. The unit of Newton per square millimeter, N/mm2, was used in the past, the value of which is the same as MPa. A typical extra-high strength steel is Docol Super. A 100 mm wide and 0.5 mm thick piece of this steel can withstand a tensile force of 8.5 tonnes before it deforms.

The yield strength is 1,700 MPa. This means that this piece of sheet steel would be able to lift five average-size cars.

Another way of measuring the strength of steel is to determine its ultimate tensile strength, i.e., the stress at which the steel breaks. Toughness and wear resistance are important properties in heavier sizes.

Strength can be increased by using thicker steel, but the weight will then also increase.

Strength and formability of steel:

COLD ROLLED STEEL GRADES	100 mm x 0.5 mm piece of sheet steel can withstand a tensile load (without permanent deformation)
Docol 1400 M ultra-high strength steel Applications include: Side collision protection beams, safety components in cars, clutch plates, toecaps for industrial boots	7,000 kg
Docol 800 DP ultra-high strength steel Applications include: Safety parts, side collision protection beams, prams and pushchairs	2,500 kg
Docol Form 07 mild steel Applications include: Advanced deep drawing, refrigerators, electric and water radiators	750 kg

HOT ROLLED STEEL GRADES	100 mm x 4.0 mm piece of sheet steel can withstand a tensile load (without permanent deformation)
Domex 1200 ultra-high strength steel Applications include: Cranes	48,000 kg
Domex 700 MC extra-high strength steel Applications include: Parts for cranes, trucks, etc.	28,000 kg
Domex 200 mild steel Applications include: Pressed parts for cars, etc.	9,000 kg

HEAVY PLATE STEEL GRADES	100 mm x 4.0 mm piece of sheet steel can withstand a tensile load (without permanent deformation)
Weldox 1300 Applications include: Mobile and truck cranes	52,000 kg

PÄR K OLSSON

Ore-based hot metal and steel

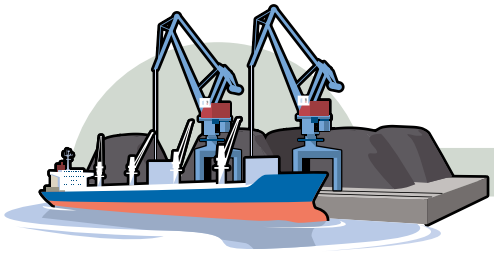
SSAB uses two different process methods for steelmaking.

Ore-based hot metal is produced in Sweden from iron ore pellets in blast furnaces in Luleå and Oxelösund. A minor quantity of scrap is also added here when the hot metal is refined to crude steel in LD converters.

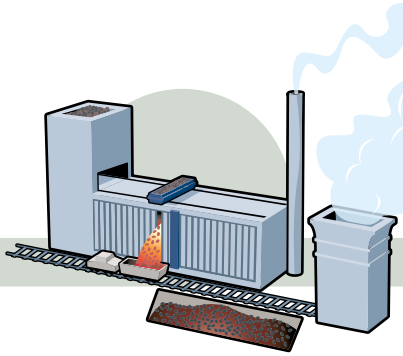
In the USA, our steelworks recycle scrap in electric arc furnaces and produce their crude steel in entirely scrap-based processes. In both cases, fine adjustment of the final composition of the steel is carried out in accordance with the SSAB recipe in ladle metallurgy, before the finished molten steel is cast and cooled in continuous casting machines to produce slabs.

SSAB produces sheet steel and heavy plate in Sweden, and heavy plate in the USA.

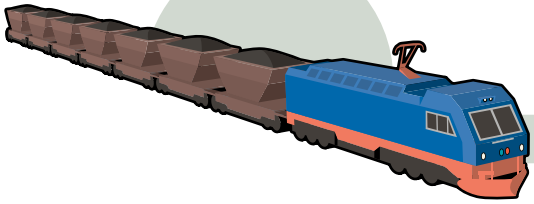
High strength steels acquire their strength by precise addition of alloying elements in accordance with the recipe, and by our manufacturing methods, such as hardening in extremely fast quenching processes. High precision is a critical condition.



1a. SSAB purchases coal from Australia, the USA, Canada and elsewhere. The coal is shipped by sea to Luleå and Oxelösund.

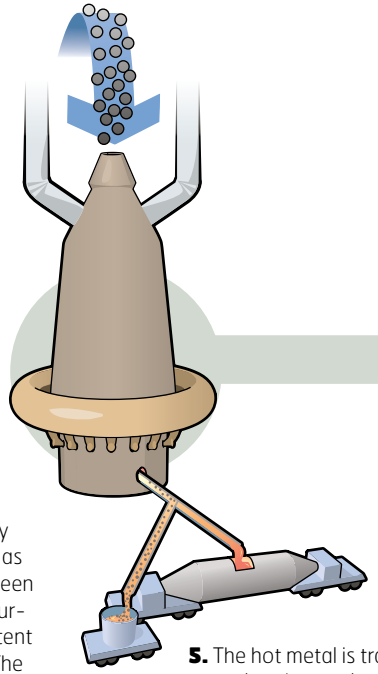


2. In the coking plant, the coal is converted into coke and gas by being heated in a battery of airtight ovens. The gas serves as a source of energy. The coke is used in the blast furnace.



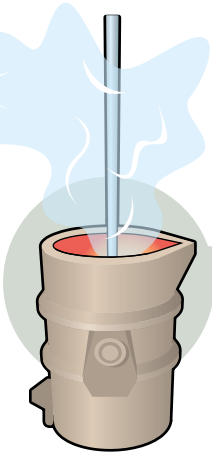
1b. Iron ore pellets from LKAB (see Glossary) are shipped by rail to Luleå and then onwards by sea to Oxelösund (see map on page 42).

3. The blast furnace is fed continuously with iron ore pellets, coke, limestone and additives.



4. The hot metal is produced continuously and is tapped as soon as the correct level has been achieved in the blast furnace. The carbon content is about 4.5 percent. The slag is skimmed off into a slag ladle.

5. The hot metal is transported to the steelworks in a cigar-shaped railcar known as a torpedo car. This can accommodate about 300 tonnes of molten hot metal.



6. The hot metal is treated to remove the sulphur and is injected with carbide or magnesium oxide during the desulphurizing process.

0 hours
Raw materials are charged into the blast furnace.

+8 hours
The hot metal is tapped.

+1 hour
The hot metal is desulphurized.


THOMAS JÄRNEHILL


BO BJÖRKDAHL

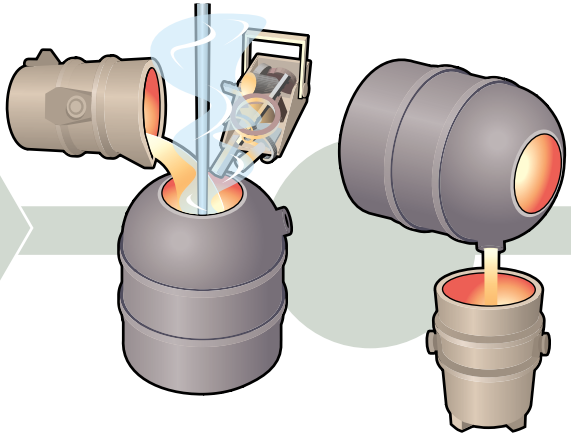

LENNART JÖNSSON

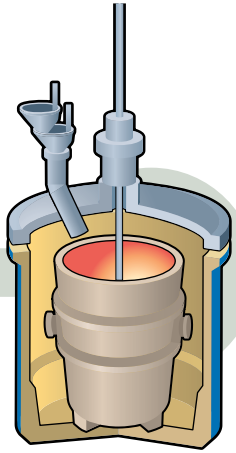

LENNART JÖNSSON

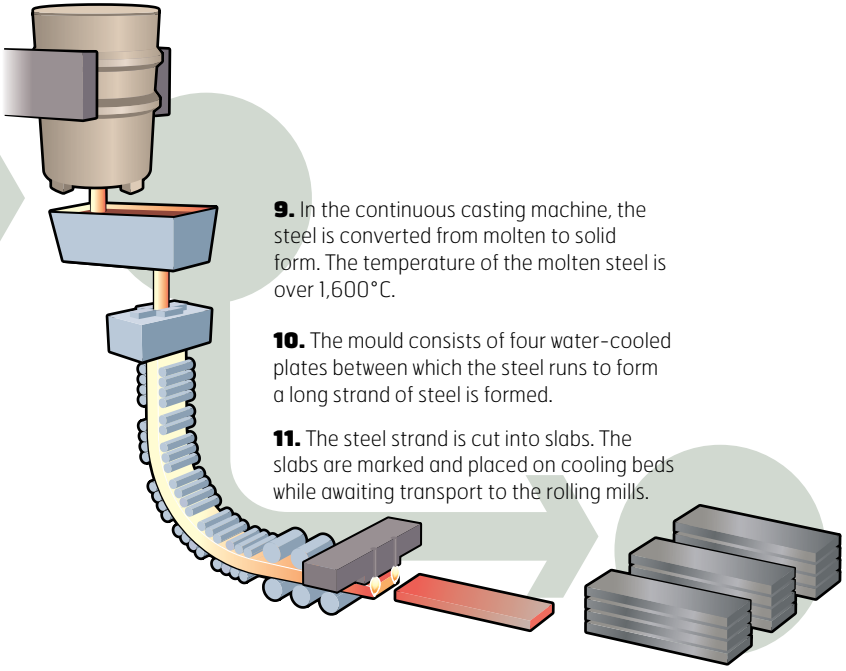
LEFT: Cleaning the coking oven doors.

CENTRE: In the hot metallurgical processes, hot metal and scrap steel are converted into molten steel. The steel is cast into heavy slabs.

RIGHT: The involvement and expertise of the personnel are critical to the success of SSAB.







7. Hot metal and cooling scrap are charged into the LD converter (for more detail, see page 14). The operator adds oxygen at high pressure by means of a lance into the steel bath. The oxygen combines with the carbon. The hot metal is converted into steel when the carbon content has dropped below 1.7 percent.

Alloying elements are added when the steel is tapped from the LD converter into steel ladles. The slag is skimmed off into slag ladles.

8. Fine adjustment of the composition and temperature of the steel is carried out in the ladle metallurgy process. The steel can also be vacuum treated. SSAB uses several different ladle metallurgy methods.

9. In the continuous casting machine, the steel is converted from molten to solid form. The temperature of the molten steel is over 1,600°C.

10. The mould consists of four water-cooled plates between which the steel runs to form a long strand of steel is formed.

11. The steel strand is cut into slabs. The slabs are marked and placed on cooling beds while awaiting transport to the rolling mills.

+1 hour
Crude steel from the LD converter.

+1 hour
Refined steel from ladle metallurgy process.

+1 hour
The steel is continuously cast into slabs.

In more detail

Ore-based hot metal and steel

COKING PLANT

SSAB uses both pulverized coal and coke for producing hot metal. SSAB metallurgical processes have coking plants in Luleå and Oxelösund. Injection coal and coke are the reducing agents in the blast furnace process.

The heart of the process in the coking plant is the coking battery comprising a number of tall, narrow ovens. Coking is a dry distillation process, i.e., combustion without access to oxygen. The coal is charged by "coal machines" above the oven battery. The ovens have brick partitions in which the heating wall channels are heated by the gas generated in the coking battery itself, possibly mixed with blast furnace gas. The coal is heated in the narrow, airtight ovens until it is in an almost flowing, plastic form. The elements that are to be removed will then be gasified. The process takes about 18 hours. The temperature is above 1,000°C, and the coal is converted to 75 percent coke and 25 percent gas.

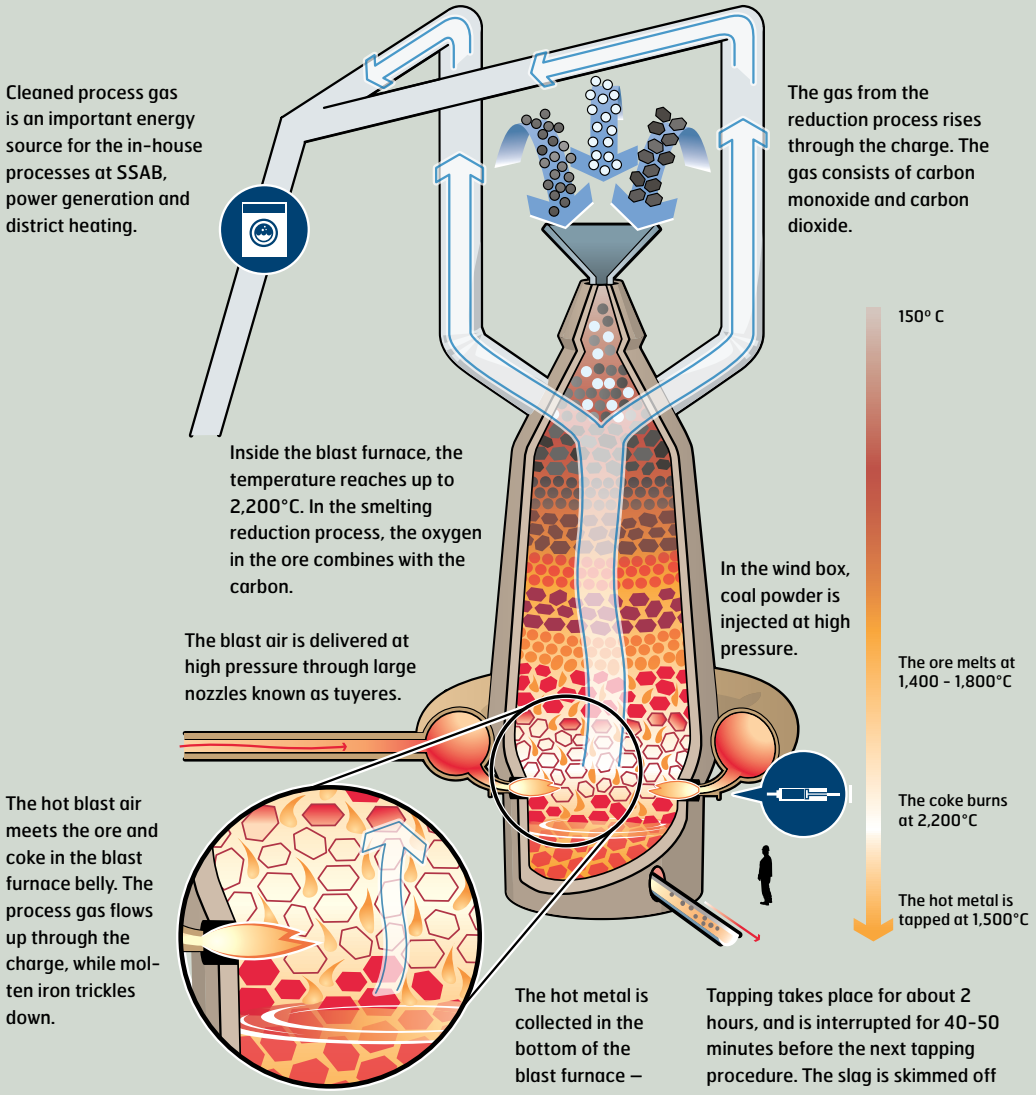
The coking plant has a number of processes in which the gas is cleaned in several stages and many raw materials are recovered. The most important is the cleaned gas that supplies energy to the processes of the coking plant itself and to other users, such as the blast furnace. But raw materials are also recovered for the chemical process industry, such as sulphur in desulphurizing, fertilizers for agriculture, tar and asphalt. The end customers of the coking plant include manufacturers of perfumes and pharmaceuticals.

BLAST FURNACES – A SMELTING REDUCTION PROCESS

About 100 years ago, Sweden had 120 blast furnaces. Combined, they jointly produced just over half a million tonnes of hot metal per year. Today, Sweden has three blast furnaces, all of which are owned by SSAB. The largest is in Luleå, and this alone produces 2.5 million tonnes of hot metal on an annual basis. There are two smaller blast furnaces in Oxelösund. SSAB's total hot metal capacity is just over 4 million tonnes.

All Swedish hot metal is produced using pellets from the LKAB ore deposits in Lapland. The LKAB pellets are produced from magnetite ore and have a high iron content - more than 66 percent. LKAB utilizes the properties of its magnetite ore in its pellets, so that a lower amount of energy is needed

Inside the blast furnace



for producing the blast furnace pellets. The high purity of the LKAB pellets provides SSAB with benefits in hot metal production.

REDUCING ELEMENTS, ADDITIVES

The oxygen in the ore must be removed for converting the ore pellets into hot metal in the blast furnace, which is known as reduction. The blast furnace process is a melting reduction process.

In the iron ore, the iron is bound to oxygen as magnetite, with the chemical formula Fe_3O_4. Fe is derived from the Latin name of iron, ferrum, and O stands for oxygen. The numerals specify the number of atoms of each element in magnetite ore. A reducing agent that will combine with the oxygen at high temperature must be added. Carbon, with the chemical symbol C, is used as reducing agent in the form of coke and injection coal.

HOT METAL FLOW AROUND THE CLOCK

The blast furnace is charged – continuously, around the clock – from the top with iron ore pellets, coke and additives.

The coke supports the large column of ore and coke inside the blast furnace. The particle size of the coke allows the molten hot metal to trickle down and the gas to rise through the blast furnace. Some of the coke can be replaced by injecting pulverized coal together with the blast air.

The blast air is supplied at high pressure though a number of large nozzles under the broad belly of the blast furnace, where pulverized coal is injected at the same time. The blast air nozzles are known as tuyeres. The blast air is heated in tall brickwork towers, cowpers or heaters, using energy recovered from the blast furnace gas and coke gas.

The reduction process takes place inside the refractory-lined blast furnace, where the temperature is 2,200°C in the hottest zone. The melting point of iron is 1,535°C, but the carbon lowers the melting point to below 1,200°C.

When the iron has been reduced and melted, it trickles down and is collected in the bottom of the blast furnace, which is known as the hearth. The blast furnace is tapped at a uniform rate. Tapping takes place during about 2 hours and is then interrupted for 40-50 minutes before the next tapping.

BUT WHAT HAPPENS TO THE MATERIAL THAT HAS BEEN REDUCED – THE OXYGEN AND THE CARBON?

They combine into a gaseous form, i.e., carbon monoxide CO and carbon dioxide CO_2, which is discharged from the blast furnace through large gas pipes to a gas treatment plant. The carbon monoxide is rich in energy, and the blast furnace gas is recovered as energy for the processes of the blast furnace itself and for other energy customers in the steelworks, and also for power generation and for district heating (see the section on Energy).

SSAB participates in research into how carbon monoxide can be recycled and used in the reducing process. At the same time, carbon dioxide will have to be separated in the future for storing in underground caverns. This EU-supported research project is known as Ulcos, is supported by the EU and is run in the LKAB pilot blast furnace at Mefos in Luleå. The project may lead to future ultra-economical blast furnaces. When the hot metal is tapped from the blast furnace, the slag is also discharged.

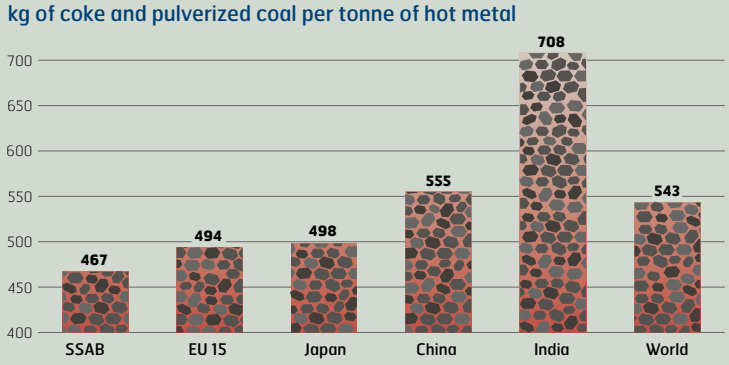
The slag consists mainly of silicon and limestone. The silicon is a residue from the ore gangue – the rock that surrounds the ore veins in the mine - and the ash from the coke and coal.

Limestone is added to the blast furnace process in order to collect silicon and other undesired substances to form a slag. The slag floats on top of the molten hot metal, is separated by the skimmer and then tapped subsequently. After it has cooled and solidified, the slag is recovered as blast furnace slag.

Efficient blast furnaces in Western Europe

In 2007, 57 blast furnaces for hot metal production were in operation in Western Europe. Out of these, 32 largely use only coke and pulverized coal as reducing agent. The others also use oil, plastics or gas with varying energy contents.

The chart shows the total quantity of coke and pulverized coal used per tonne of hot metal produced. Blast furnace No. 3 at SSAB in Luleå is the most energy-efficient blast furnace in its category. Blast furnace No. 3 also recirculates soot in the form of briquettes in its process – a way of recovering raw materials so that they are used as efficiently as possible.



Amounts of energy and reducing agents required by various blast furnaces in an international perspective. SSAB blast furnaces are among the world's most efficient, with the lowest coal consumption.
Source: World Steel Association, 2006

Casting station at Blast Furnace 3, Luleå.

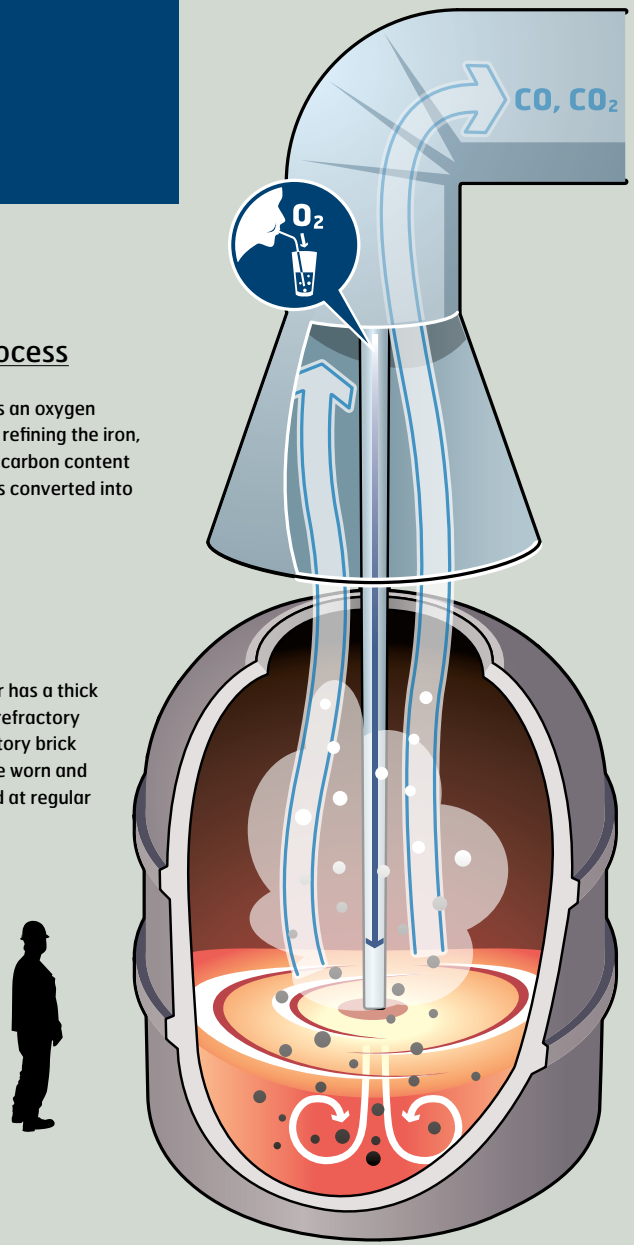
In more detail

Ore-based hot metal and steel

The LD-process

The LD process is an oxygen method used for refining the iron, i.e., lowering the carbon content so that the iron is converted into forgeable steel.

The LD converter has a thick lining of special refractory brick. The refractory brick and tap holes are worn and must be changed at regular intervals.



The cleaned process gas is very rich in energy and is used both in the metallurgical processes and as energy for other consumers. Half of the SSAB electric power demand is met by the company's own process gases mainly from the blast furnace, but also from the coking plant and the LD process.

The oxygen lance is lowered toward the melt, and oxygen is blown at high pressure onto the steel bath.

The oxygen reacts with the carbon and forms a gas consisting of carbon monoxide and carbon dioxide. Oxygen blowing continues until the ordered carbon content has been achieved. 1.7 percent is the limit between brittle hot metal and forgeable steel.

The tapping temperature is above 1,600°C.

HOT METAL – REFINING

The hot metal is transferred in molten form to the LD steelworks for refining. The hot metal is at a temperature of almost 1,500°C and is transferred from the torpedo car to ladles. The composition of the hot metal is important. It must have a uniform silicon content. The hot metal also contains 4.5 percent carbon and a small amount of sulphur. Both of these elements originate from the coal and coke charged into the blast furnace. In the first stage, the sulphur is removed in the desulphurizing process. Demands for extremely low sulphur contents of steel are becoming increasingly common.

The operators receive a recipe for every batch of steel in the ladle to be produced. The melt is desulphurized by adding a certain amount of magnesium or calcium carbide through a lance inserted into the steel bath. This binds the sulphur and forms a liquid slag that is skimmed off the molten hot metal.

THE LD STEELWORKS – AN OXYGEN PROCESS

The hot metal must be refined in order to become steel. The hot metal is converted into steel when the carbon content has dropped to below 1.7-1.5 percent, which is done in LD converters.

The hot metal is first cooled by 10-20 percent of steel scrap being added to the LD converter. The scrap is an important raw material that is melted in the LD process entirely without the addition of other


BO BJÖRKDAHL

Charging of hot metal into an LD converter.


LARS WIKSTÖ

In continuous casting, the hot, molten steel is cast into manageable pieces known as slabs.

energy, which is a very energy-efficient recycling process. The purpose of the scrap is to cool the hot metal.

The process in the LD converter is opposite to that in the blast furnace. In the latter, carbon is added to remove the oxygen from the ore. In the LD converter, oxygen is added to remove the carbon from the hot metal. This may sound strange, but the blast furnace process imparts a carbon content of about 4.5 percent to the hot metal. This must be lowered – the iron must be refined – so that the steel can be worked in subsequent processes, such as continuous casting and rolling.

OXYGEN LANCE

In the LD converter, the operator blows air at high pressure through a lance down into the steel bath. The temperature rises to about 1,600°C when the oxygen reacts with the carbon, silicon and other elements. Limestone is added to combine with silicon and other elements to form a slag.

Every steel grade has a unique carbon content. The carbon content may vary from 1 percent for very hard carbon steels, down to only a few hundredths of one percent in a steel with ultra-low carbon content. Such steel grades are soft and formable.

The addition of oxygen exerts a good stirring effect in the steel bath, so that all elements are mixed and the oxygen combines with the carbon to form mainly carbon monoxide. The LD gas is recovered to supply energy, just like the blast furnace gas.

Finally, the appropriate amount of alloying elements is added to the jet of molten steel tapped from the LD converters. This is the basic alloy in the composition of the steel to be produced.


Did you know that about 40,000 households receive heat from the district heating system theat is supplied by SSAB? Gas from SSAB is used to generate steam to run turbines that drive generators.

PÄR K OLSSON

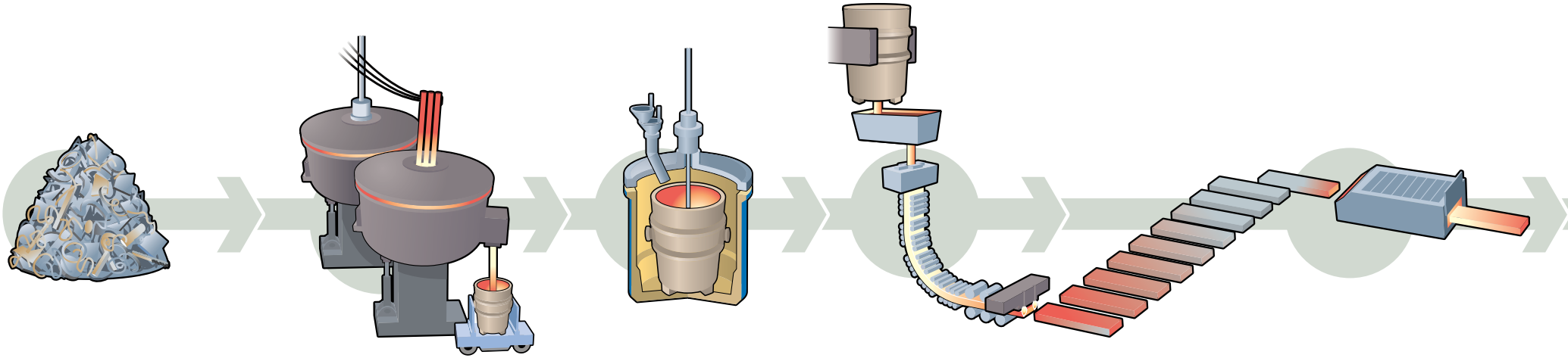
Scrap-based steel

Recycling of scrap is an intelligent way of producing steel. Scrap steel offers an energy-efficient alternative for producing new steel. In addition, it ensures good conservation of the Earth's resources.

Scrap steel is the world's largest recycling system. Scrap is always carefully sorted, since it may be alloyed and contain various additives. The scrap is selected to suit the steel grade to be produced.

SSAB operates steelworks in Montpelier, Iowa and Mobile, Alabama. The scrap is melted in electric arc furnaces. Both locations are equipped with twin furnaces.

The scrap is first preheated by means of natural gas. While the scrap is being preheated in one of the furnaces, the scrap in the other is melted with electric power. The electrodes are lowered toward the scrap bath and the voltage causes an arc to be struck. The molten scrap immediately becomes new crude steel that is tapped into ladles, while the electrodes are transferred to the other side.



1. Steel is the world's largest recycling system. Used steel from your daily life is remelted and becomes new steel for new products.

2. Twin furnaces are used in Montpelier and Mobile for scrap melting. The molten steel is tapped into ladles and is transferred to the ladle metallurgy process for refining. The scrap is preheated by means of natural gas in one of the furnaces. In the second furnace, the scrap is melted by electric arcs.

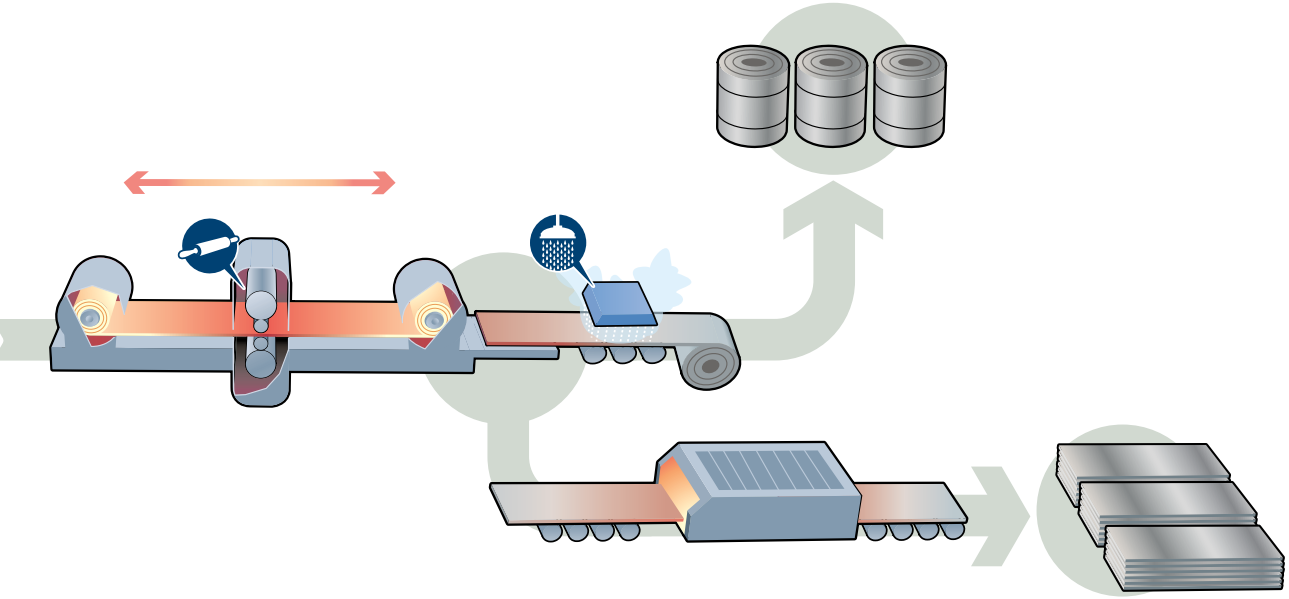
3. In the ladle metallurgy process, the molten steel is adjusted to the appropriate composition and temperature. Alloying elements are added and the carbon content is adjusted. The accuracy is measured in hundredths of one percent. Certain steel grades can also be vacuum treated to remove hydrogen and nitrogen.

4. The molten steel is continuously cast into slabs. Casting is carried out in an open, water-cooled mould. Thinner slabs can be cast in the USA plants, which offer energy savings. When the steel has solidified fully, but is still glowing hot, it is cut into slabs by means of oxygen lances.

5. The slabs are heated in the slab furnace to exactly the right rolling temperature.

LEFT: Used scrap is recovered and becomes new raw material for high strength heavy plate. Scrap steel is the world's largest recycling system.

RIGHT: Heavy plate is produced from recycled scrap at the SSAB steelworks in Mobile, Alabama.



6. The heavy slabs must be rolled into usable sheet and plate. Steckel mills are used in the USA. These are similar to four-high mills, but have coilers that roll up the heat on each side, while rolling continues back and forth.

7. Heavy plate can be heated, quenched and hardened, and then tempered to achieve the required properties.

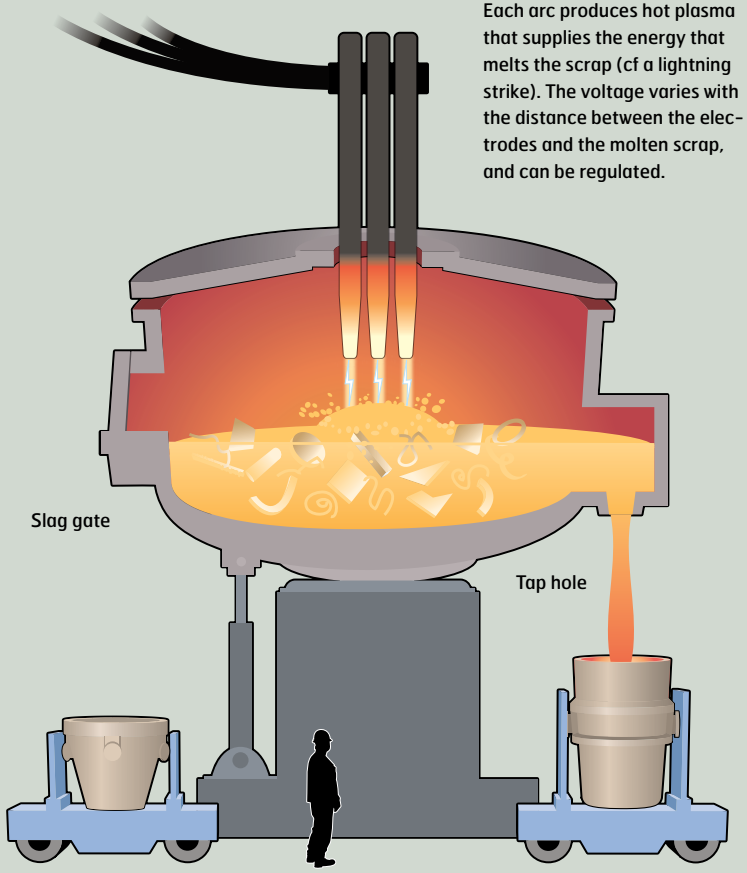
8. The plates are left to cool on a cooling bed before being painted and prepared for delivery.

Electric arc furnace

The electric arc furnace operates at a high current and relatively low voltage of 600–1200 volt, and is used for melting scrap. The power may be between 60MW and 100 MW (megawatts).

Three electrodes are used when the system is supplied with 3-phase AC, but one electrode when DC is supplied. An arc is struck between the electrodes and the scrap that is earthed through the furnace shell.

Each arc produces hot plasma that supplies the energy that melts the scrap (cf a lightning strike). The voltage varies with the distance between the electrodes and the molten scrap, and can be regulated.



When all of the scrap has been melted, the furnace is tapped to remove the molten crude steel, and the slag is separated. Every charge contains 150 tonnes (Montpelier) or 175 tonnes (Mobile) of steel.

In more detail

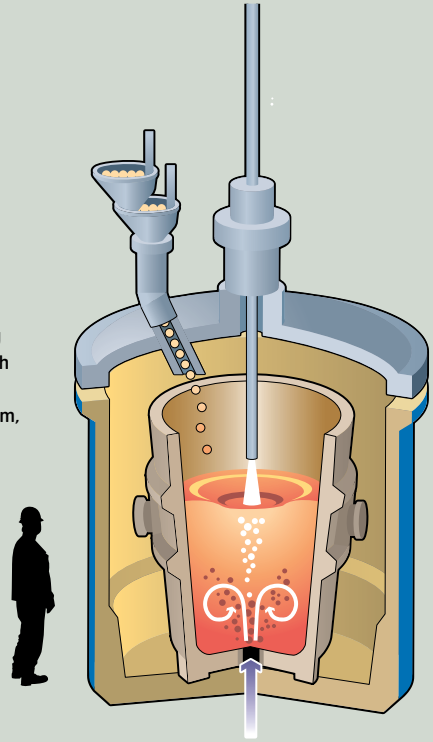
Ladle metallurgy

All crude steel is refined in the SSAB ladle metallurgy processes and is cast into slabs by continuous casting.

The SSAB recipe book includes around 500 different steel grades. The steel grades and quality requirements are continually being developed.

In the ladle metallurgy process, various alloying elements are added, such as niobium, manganese, titanium, boron, aluminum, etc.

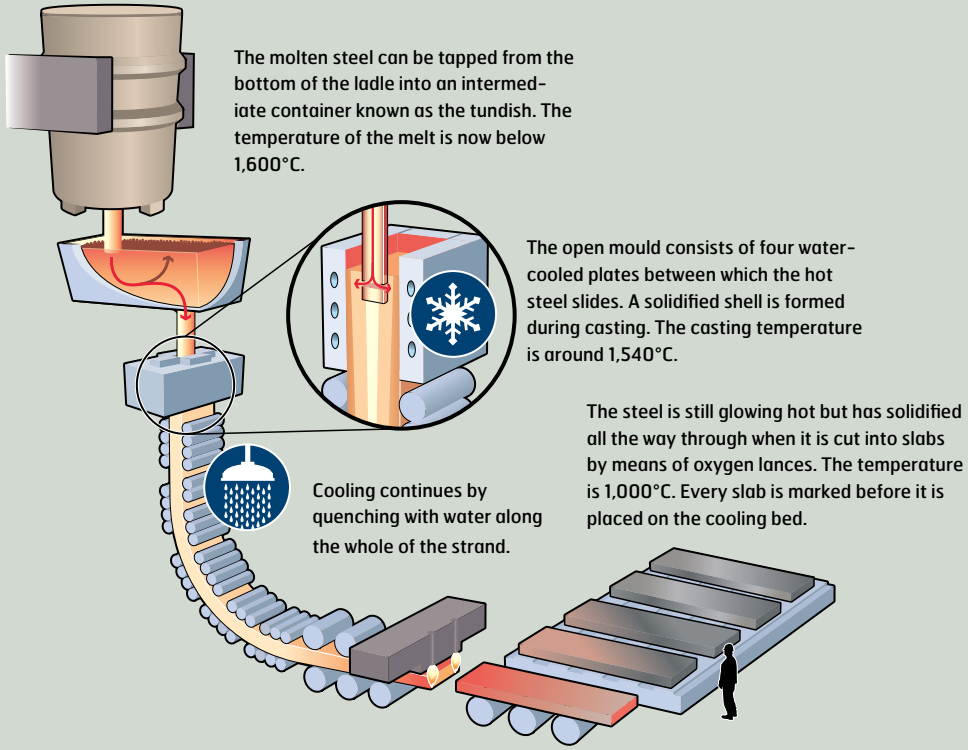
In the ladle metallurgy process, gas can be supplied both by a lance and from the bottom.



SSAB uses several different ladle metallurgy processes. Fine adjustment of the analysis and temperature of the steel are carried out here.

The recipe book comprises about 500 different steel grades. The accuracy is determined in hundredths of one percent.

Certain steel grades can be vacuum treated to remove hydrogen.



LADLE METALLURGY

Regardless of whether the crude steel is produced from ore-based or scrap-based raw material, it is transferred to a ladle metallurgy station in which the operators carry out fine adjustment of the temperature, composition and quantities of various alloying elements. The limits of composition are very close and the tolerances are tight. Every steel grade has a unique recipe that must be followed accurately. The operators use computers and analysis samples, with fast laboratory responses for checking that the steel contains the right quantities of the correct ingredients and is at the right temperature.

The ladle treatment methods vary between the four SSAB steelworks, since they use three different process methods. But the purpose, requirements and accuracy are the same.

The steel may also undergo vacuum treatment to achieve extremely high purity, e.g., for hydrogen and nitrogen removal. The composition is dependent on the field of application.

STEEL WITH PRECISION

The SSAB recipe books contain almost 500 different steel grades. The accuracy is determined in parts per thousand and sometimes right down to parts per million. Whether the steel is to be hard or soft is determined in the ladle metallurgy process. The recipe follows every ladle right back from the first steelworks treatment stage at the desulphurizing station up to the LD converters and the ladle metallurgy process.

The SSAB method of using different carbon contents, alloying with other metals and small doses of other additives produces the chemistry of the steel that yields its internal strength and formability. SSAB

high strength steels belong to the family of low-alloy steel grades. Using small amounts of additives and high accuracy, operators in the SSAB ladle metallurgy process create the composition for many different end grades.

CONTINUOUS CASTING

Continuous casting is a process in which molten steel at 1,600°C is converted into slabs of manageable size. The ladle with molten steel is placed in a holder. From the ladle, the steel is tapped through a nozzle into the tundish. The tundish is an intermediate vessel designed to maintain a constant level and allows for flying ladle changes during the course of casting in a continuous process.

Continuous casting takes place through a water-cooled mould that is open at the top and bottom.

A casting powder is used, so that the steel will slide smoothly through the mould. Intensive water cooling of the mould side plates immediately gives the hot melt a hard shell of solidified steel. The cooled steel shrinks in volume as it is withdrawn from the underside of the mould in a long strand. The strand is continuously cooled on its arc-shaped path down to the cutting station. At this stage, the steel is still hot and glowing, but is sufficiently solid to enable the strand to be cut with movable oxygen lances into pieces up to 11 meters long.

SLABS

Slabs can vary in length, width and thickness depending on the SSAB plant in which they are produced and the customer specifications. A common slab weighs about 25 tonnes. The steel from one ladle is sufficient for a handful of slabs and is the smallest quantity of a given grade of steel that SSAB can produce.

The slabs we cast in Sweden are thicker than those cast in the USA, where we can cast thinner and wider slabs. Casting thinner slabs has energy benefits, since the slabs do not need to be rolled as many times to reach the desired thickness.

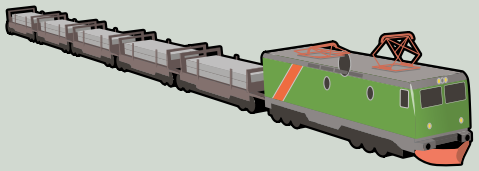
Every slab has an identity number and is a carefully recorded individual intended for a certain end product at a certain customer. Samples of the steel are taken throughout the production chain and finally also from the slab. All slabs are inspected and some after-treatment may be necessary.

The slabs are cooled in different ways. Certain sensitive steel grades require slow cooling at a uniform rate, and the slabs are left to cool under special hoods.

The metallurgy processes take about 12 hours from the time that the blast furnace is charged with pellets and the iron has passed through the steelworks, to the time when slabs are produced and ready for rolling into high strength steel plate.

"STEEL COMMUTER TRAIN"

The "Steel commuter train" is a train system in Sweden that runs from Luleå and Oxelösund to Borlänge, where the rolling mills receive the steel slabs from both SSAB metallurgical plants. In addition, Oxelösund has its own rolling mill. In the USA, both steelworks have integrated metallurgical plants with their own rolling mills.



One recipe

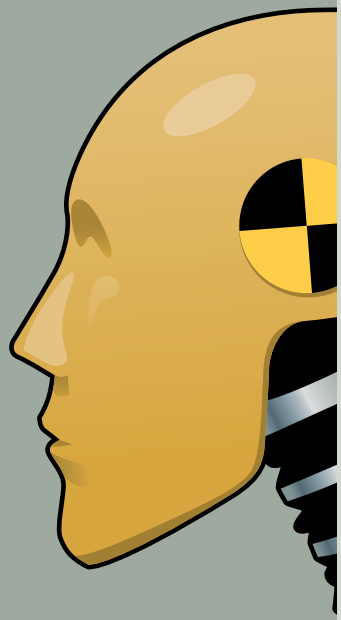
One example of an SSAB product is our Docol 1000DP cold rolled, ultra-high strength steel. This is used, for instance, for side collision protection beams in car doors, which are designed to protect the car occupants in the event of a collision.

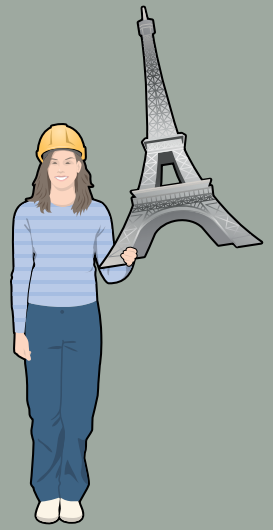
To produce this particular steel grade, we alloy the steel with carbon, manganese and silicon. In addition, other alloying elements are used in the steelworks, e.g., niobium, aluminum, titanium or boron, depending on the steel grade and the application. There is a high commitment to accuracy in the steelworks, and it is important to maintain the correct process time and temperature.

The slabs are hot rolled at 1,200°C, and the strip is still at a temperature of 600°C when it is processed onto a coil. The sheet may then be 4 mm thick. In this case, the thickness is reduced in the cold rolling mill to 1.5 mm, which is a common thickness for safety components in cars.

After cold rolling, the material is very hard and brittle. The sheet is then heat treated, which makes it formable. To achieve the highest possible strength, the sheet can be annealed and quenched at the rate of 1,000°C per second after annealing.

The SSAB specialty is to produce specific steel grades with unique properties for each customer's individual needs.





A comparison

Comparison 1: The iron in the Eiffel Tower in Paris weighs 7,300 tonnes. The "Steel commuter train" between Luleå and Borlänge carries about 7,000 tonnes per 24 hours on four trains at full capacity. Every 24 hours, the train transports steel that is almost equivalent to the weight of the Eiffel Tower.

Comparison 2: A one-metre-high model of the Eiffel Tower made of the same material as the Tower would weigh around 270 grams. This illustrates the intelligent design. The Tower was built of cast iron. Gustave Eiffel had a metallurgical laboratory at the tower during the construction period.

The cast iron available in 1889 had a tensile strength of 200 MPa (megapascal). SSAB ultra-high strength steel with a tensile strength of 1,400 MPa could be used today to construct a new Eiffel Tower.

This would reduce the weight to around 3,000 tonnes or by 241 percent. A one-metre-high scale model of the Eiffel Tower made from SSAB steel would then weigh around 110 grams.

Processing

Steel slabs are large, heavy and thick, weighing around 25 tonnes each. They must be thinner and lighter to be reasonable in use. The slabs are then processed in a rolling mill. Steel plate is classified into heavy plate and sheet, and requires different production techniques. The plate can be processed into flat plates, rolled into coils or cut to size.

The slabs are heated in furnaces until they become soft. The rolling mills operate like giant mangles or rolling pins, in which the slabs are rolled into plate or sheet.

SSAB has rolling mills in Oxelösund, Borlänge, Montpellier and Mobile.

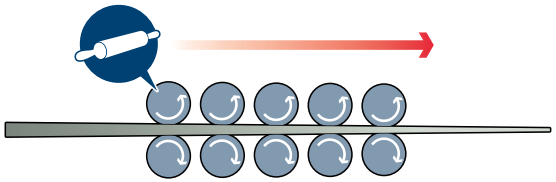
After rolling into different thicknesses, the various grades of steel can be quenched, hardened, tempered and after-treated.

Certain grades are cut to size, galvanized and painted before the sheet is processed further by our customers into end use products.

Rolling mills comprise heavy rolls for rolling the heavy steel slabs into thinner, usable sheet and plate.

A distinction is made between sheet and heavy plate and between hot rolling and cold rolling.

Rolling mills



Rolling mills comprise heavy rolls for rolling the heavy steel slabs into thinner, usable sheet and plate.

A distinction is made between sheet and heavy plate and between hot rolling and cold rolling.

SSAB produces advanced heavy plate at three sites in Sweden and the USA.

SSAB's strategic orientation toward high strength steels began in Oxelösund. Hardox has extreme wear resistance.

PÄR K OLSSON

PÄR K OLSSON

ABOVE AND RIGHT: Sheet steel is delivered on coils or as cut-to-length flat sheet.

BELOW: Hot rolled sheet steel is produced in the hot rolling mill, which is also known as the wide strip mill in Borlänge. The rolling temperature is 1,250°C.

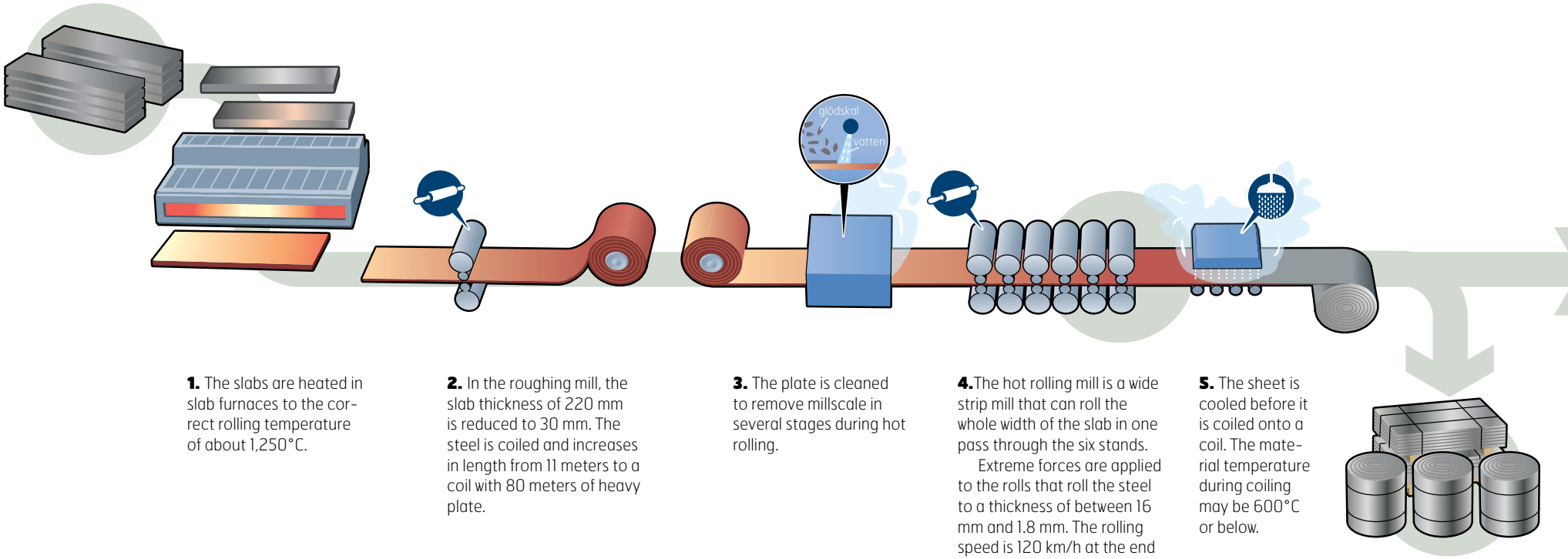
PÄR K OLSSON

Sheet steel

Rolling into thin sheet is carried out in long rolling mills in which the sheet passes through a series of stand, one after the other. The sheet is reduced in thickness on every pass through the stands. This increases the sheet's length.

While the plate is still glowing the process starts with a roughing stand and a hot rolling mill.

Some of the hot rolled plate can then be cold rolled into thinner and smoother sheet.



1. The slabs are heated in slab furnaces to the correct rolling temperature of about 1,250°C.

2. In the roughing mill, the slab thickness of 220 mm is reduced to 30 mm. The steel is coiled and increases in length from 11 meters to a coil with 80 meters of heavy plate.

3. The plate is cleaned to remove millscale in several stages during hot rolling.

4. The hot rolling mill is a wide strip mill that can roll the whole width of the slab in one pass through the six stands.

Extreme forces are applied to the rolls that roll the steel to a thickness of between 16 mm and 1.8 mm. The rolling speed is 120 km/h at the end of the hot rolling mill.

If the sheet is rolled down to a thickness of 2 mm, the sheet will have grown in length from 80 meters to 1,300 meters.

5. The sheet is cooled before it is coiled onto a coil. The material temperature during coiling may be 600°C or below.

6. Hot rolled sheet steel is sold in coils or cut to length.

In the Cold rolling mill, the sheet is rolled a second time without preheating. This makes the sheet thinner, smoother and harder.

13. Annealing and quenching can also be carried out in the metal coating lines. In hot-dip galvanizing, the strip then passes through a molten zinc bath at a temperature 455°C before being cooled.

14. Hot-dip galvanized sheet can be after-treated by painting before it is delivered to customers for further processing.

7. Cold rolled sheet from 6 mm thick can be made thinner and smoother by cold rolling. Cold rolling takes place in a tandem mill with five stands after one another. The pressures and tensions are very high.

8. Sheet steel can be rolled down to 0.3 mm thick. If the sheet is rolled down to 0.6 mm thick, the strip on the coil will be up to 4 km long.

9. Cold rolled sheet is very hard and brittle. It must be annealed to restore its formability. In the continuous annealing line, the temperature is up to 850°C

10. In order to harden the sheet, it is quenched at a rate of 1,000°C per second.

11. After quenching, the sheet is usually tempered at a lower temperature than annealing, i.e., 200-500°C, in order to make the hardened steel tougher.

12. Cold rolled sheet is sold on coils or cut to length.

In more detail

Sheet stel

A coil of hot rolled sheet can weigh about 24 tonnes.

HOT ROLLING

The steel slabs are heated up to about 1,250°C in two furnaces, using oil or LP gas as the energy source. The slab is then rolled in a roughing stand, in which the thickness is reduced to about 30 mm in five passes, back and forth. The length of the glowing slab will then have increased from 11 meters to an intermediate slab which is about 80 meters long. This is wound onto a coil in a coil box and is transferred to the adjacent hot strip mill. The material is then rolled down to between 16 mm and 1.8 mm in only one pass through six stands.

At the end of the hot rolling mill, the speed of the strip is 120 km/h. Due to the reduction in thickness, the plate must expand in length. The speed increases after every stand and is highest at the end. When rolled down to 2 mm thick, the sheet will have grown to about 1,300 meters in length, i.e., 1.3 kilometers.

HARDENING

After the last stage, the sheet is quenched. For certain steel grades, the quenching rate is very high. Other steel grades require slower cooling. In a future quenching line in the hot rolling mill, the quenched sheet steel produced will achieve the very highest strength among hot rolled strip grades. In the quenching line, the sheet is quenched at a rate of up to 1,000°C per second, which imparts both hardness and strength to the sheet. SSAB can roll the world's hardest hot rolled strip in Borlänge.

After quenching, the sheet passes through a cleaning bath in one of two pickling lines. During rolling, millscale is formed on the surface of the sheet on contact with the air. In the pickling baths, the strip is cleaned to remove the millscale. A large proportion of the material produced by SSAB is delivered to customers as hot rolled sheet.

COLD ROLLING

If the customer specifies thinner sheet than that obtainable by hot rolling, the sheet must be cold rolled. Cold rolling produces a more accurate thickness and a smoother surface.

In the tandem rolling mill, the sheet is cold rolled in five stands arranged one after the other. Every stand consists of two working rolls and back-up rolls. High roll forces and also tension between the stands are needed to produce thinner sheet. All of this is done automatically at high speed under computer control.

Cold rolling causes the sheet to become brittle and hard in the initial stage. This is because the grains in the structure of the steel have become elongated and deformed.

Cold rolled sheet must therefore be annealed. Heating to a certain temperature causes new grains to grow at the expense of the deformed grains, which restores the formability of the sheet.

HEATING AND QUENCHING

An SSAB specialty is extra-high strength steel grades. To achieve higher strength, the sheet steel must be hardened. This is done by heating and quenching. The extremely fast cooling modifies the atomic structure of the steel grains. A displacement makes it difficult for the carbon atoms to move, which is what causes the high increase in strength. The thickness of cold rolled sheet steel may vary from 0.3 mm to 3 mm, as specified in the order. Cold rolled sheet steel that is 0.6 mm thick will then be 4 kilometers long on a coil.

COATING

Cold rolled sheet steel can be further processed by coating. Hot-dip galvanizing provides good protection against corrosion. For hot-dip galvanizing, the strip is first an-


PÅR K OLSSON

The cold rolling mill is controlled by process operators who use SSAB high-tech process technology. This places strict demands on knowledge, process computers, programming and optimization.

nealed and is then cooled to 470°C before being passed through a molten zinc bath at 455°C. After final cooling, the steel strip passes through trimming and leveling rolls to provide it with the final properties. The sheet may also receive a number of paint coats in a continuous process. The paint is applied to the moving steel strip by means of rubber rollers, and the sheet then runs through drying ovens before being coiled again. SSAB has sheet steel painting lines in Borlänge, Finspång and Luleå. Laminated sheet steel is produced in Ronneby.

CUT-TO-LENGTH

Sheet steel can be delivered on coils or as flat sheet, cut-to-length. A large proportion of the production tonnage is cut-to-length, so that it immediately meets the needs of customers. This process is carried out in shearing lines in which the forces are sufficiently high enough to cut the new, stronger steel grades. To divide the wide strip into narrower strip, the material runs through a slitting line.

Structure of the steel

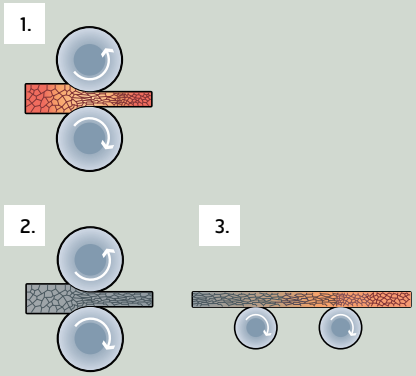
The grain structure of the steel is affected by rolling.

1. After hot rolling, the steel resumes its grain structure.

2. Cold rolling produces elongated and deformed grains. This makes the sheet hard and brittle.

3. Heat treatment causes new, unstressed grains to be formed, and the sheet becomes formable again.

A very hard grain structure is formed by subsequent heating and quenching. In the last stage, tempering by reheating increases the toughness of the steel.




PÅR K OLSSON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ABOVE LEFT: Cut-to-length sheet.

ABOVE RIGHT: A thin surface layer of zinc provides good protection against corrosion of the sheet.

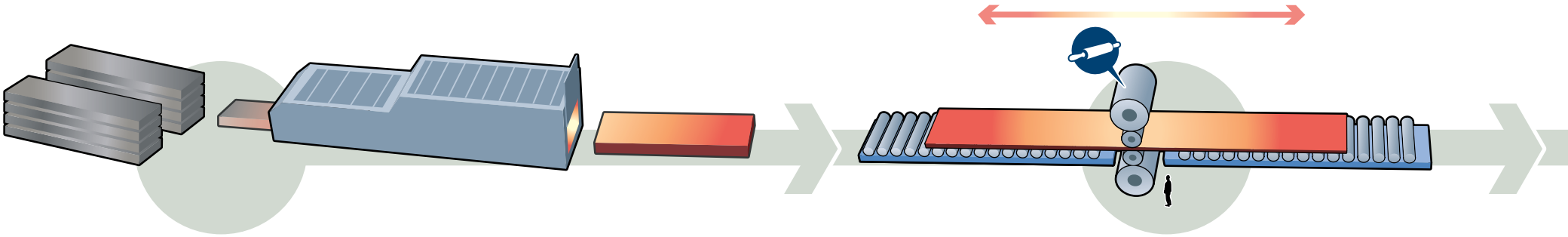
RIGHT: Galvanized sheet steel can be painted in a wide range of colors. The paint is applied with rubber rollers and is dried quickly in curing ovens.


PÅR K OLSSON

Heavy plate

SSAB's success in high strength steels began in Oxelösund with a special quenching technique. This plant also specializes in quenched and tempered steels.

A rolling mill is needed to produce heavy plate. The thick, heavy slab must be rolled into plate of the correct thickness and properties. Oxelösund represents SSAB's Swedish rolling mill for heavy plate.



1. The slabs are heated in a furnace to the appropriate rolling temperature. The rolling temperature is around 1,250°C.

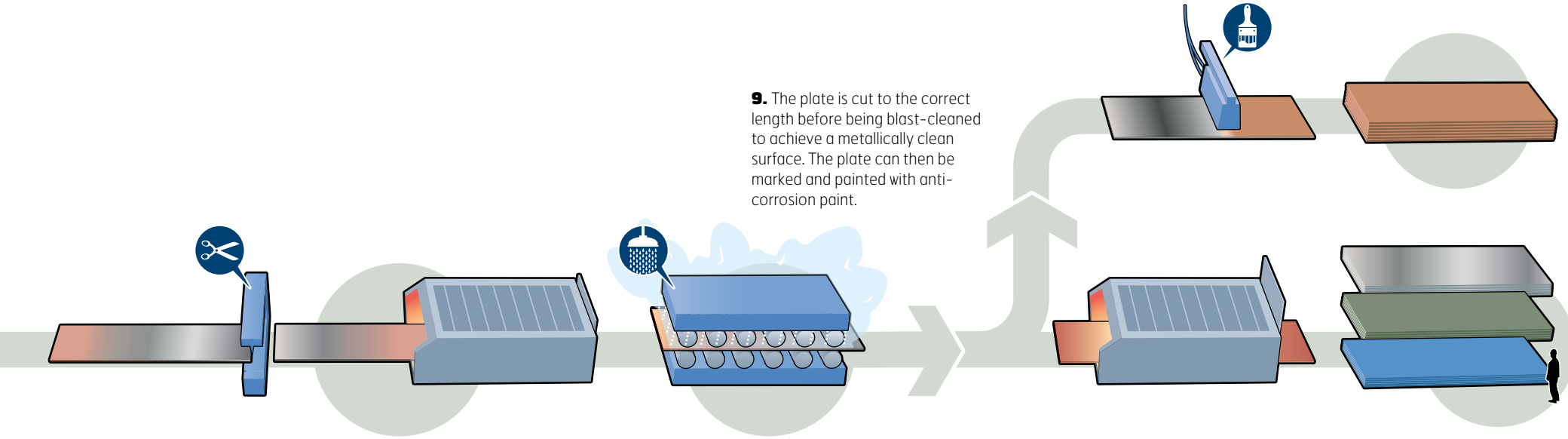
2. The slabs are cut so that the length of the plate will be correct.

3. In the four-high rolling mill, the slabs are rolled back and forth in a number of passes until the thickness of the plate is correct.

4. The SSAB four-high rolling mill in Oxelösund operates at forces of up to 100,000 kN (10,000 tonnes) and is one of the world's most powerful rolling mills.

LEFT: The heavy plate is cut into accurate lengths after rolling.

RIGHT: The finished plate is blast-cleaned, painted and marked.



5. After rolling, the hot plate is cut into accurate lengths.

6. After rolling, the plate is very hard and brittle. It is then heated to a temperature above 800°C to make it formable again. If the plate is to be hardened, it is heated to above 900°C and is then transferred directly to the quenching line.

7. Hardening takes place by very fast and uniform quenching with water. Very fast quenching with uniform subsequent cooling is carried out with high precision. This produces the required internal properties of the plate.

8. The plate is tempered by heating to between 200 and 600°C, which makes the plate tougher.

9. The plate is cut to the correct length before being blast-cleaned to achieve a metallically clean surface. The plate can then be marked and painted with anti-corrosion paint.

In more detail

Heavy plate

Heavy plate is produced from slabs that are generally of the same thickness (150–290 mm), width and length as those used for rolling sheet steel. But the slabs must be cut to a length that will produce plate of the length and thickness ordered by the customer.

The four-high rolling mill in Oxelösund is one of the world's most powerful rolling mills. The roll force is 100,000 kN (10,000 tonnes).

The slabs are heated to 1,250°C in a furnace and are cleaned to remove the millscale. Rolling is carried out in the four-high rolling mill. In four-high rolling, four heavy rolls – two working rolls and two back-up rolls – roll the plate with enormous force in a number of passes, back and forth, through the stand. A pass is one passage of the plate through the stand.

Oxelösund has the world's most powerful four-high rolling mill, in which the roll forces are 100,000 kN (10,000 tonnes). The mill rolls 290 mm thick slabs down to plate ranging in thickness between 150 mm and 4 mm. The plates are always flat and can be up to 40 meters long.

HEAVY PLATE ON COILS

In the USA, Steckel mills are used for producing heavy plate in the two rolling mills. Steckel mills are similar to four-high mills and have the same arrangement of four rolls, with working and back-up rolls in a stand, but they also have coilers with a coil box for heating the plate on each side. The plate is run from one coiler through the rolls to the other coiler, back and forth in a number of passes until the plate is of the correct thickness. Plate up to 3 meters wide can be rolled in Mobile and Montpelier, and they can be supplied either as flat plate or in coils.

QUENCHING PRODUCES EXTREME STRENGTH

Final treatment of the cooled steel is carried out in SSAB hardening lines. Hardening to extremely high strength is achieved by quenching at a rate of up to 1,000°C per second. These steel grades are very strong andhard and wear resistant. Quenching is carried out using very high water pressure. SSAB is one of the pioneers in quenched steels.

SSAB is increasing its quenching capacity to six hardening lines – five in Sweden and one under construction in the USA. Production is growing for quenched, high-strength steels.

QUENCHED AND TEMPERED STEELS

Certain hard and wear resistant steel grades are tempered after hardening in order to restore the toughness and adjust the strength of the product. The actual procedure depends on the application.

Wear steels, such as those for the blades of excavator buckets, must be prevented from cracking and are tempered at a lower temperature. Structural steels that must be much tougher and are tempered at a higher temperature.

Heat treatment is an important part of the SSAB recipe for providing the steel with its final properties.


BO BJÖRKDAHL

Tempering

Steel can occur in a variety of atomic structures known as phases that differ due to factors such as the degree of hardness and/or toughness. As a result of hardening by heating and quenching, the steel structure is transformed to a phase known as martensite, which is very hard. The steel can then be heat treated in order to increase its formability and reduce the risk of cracking.

Tempering of hardened steel is a process used for increasing the toughness of the steel and lowering its hardness. To achieve this, the steel is reheated to 200–600°C, thereby increasing the toughness of most steel types.


JOHAN DALHÄLL

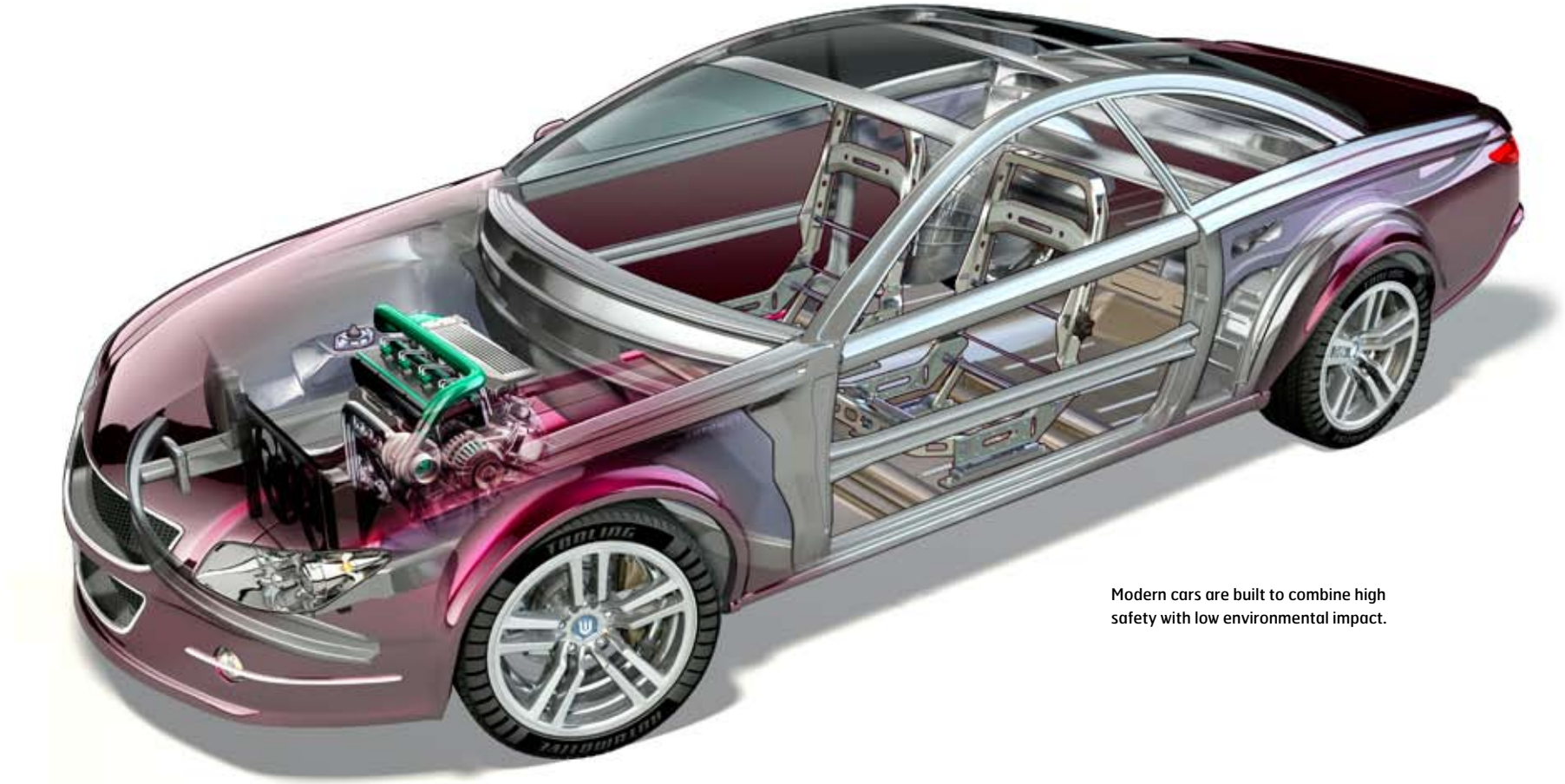

BO BJÖRKDAHL


THOMAS JÄRNEHILL

ABOVE LEFT: SSAB steels are produced with the aim of achieving different properties. As an example, Weldox is formulated for high strength and good weldability.

ABOVE RIGHT: A process operator is a specialist profession which requires a high level of expertise and knowledge.

RIGHT: Heavy plate with different properties, e.g., hardness, toughness, wear resistance, is produced in Oxelösund. Specific properties of a steel product are achieved in various SSAB processes by means of alloying elements, heat treatment, hardening and quenching.



Modern cars are built to combine high safety with low environmental impact.

Market, products, applications

SSAB produces strong steel brands for any application that makes strict demands on strength, wear resistance and formability. We do not merely sell steels – our knowledge is closely linked to our product brands.

SSAB Group's strategic focus on high strength steels is aimed at customers who operate in challenging markets. These are industrial companies and manufacturers who make strict demands on the material, expertise and service, and whose end customers are contractors and consumers who value the high strength properties, quality and safety of the steel products.

SPECIALISTS

SSAB is focused on finding solutions to challenging problems. SSAB specialists possess unique skills and expertise in all areas of steelmaking ranging from the various properties of steel grades, such as strength, production engineering aspects, forming and joining, to fatigue, wear and surface treatments. Our applications engineers work in close cooperation with our customers to share knowledge and provide new ideas and solutions.

This broadens the field of application for our most advanced steel grades, while enabling our customers to improve the performance of their products and minimize their environmental impact.

SSAB engineers work closely with our customers and serve as experts for solving difficult problems related to materials and production.

SOLVE CUSTOMER PROBLEMS

SSAB's technical customer service specialists are involved in new products and projects at an early stage. SSAB often develops a new grade of steel that is matched to a certain application. There are clear benefits in developing new products in this way. The most advanced and strongest high strength steels are put to optimum use whenever our customers' designers work closely with our materials specialists. Cooperation with SSAB applications engineers always imparts knowledge to both parties.

SAFER AND MORE ECONOMICAL CARS

A good example is the European automotive industry that has increased its purchases of advanced high strength steels during the past ten years. This has resulted in vehicles that have achieved good results in collision tests, lower fuel consumption and contributed to reduced emissions of carbon dioxide.

QUENCHED STEELS

SSAB has a leading position in the market for the most advanced quenched and tempered steels. Docol cold rolled products are often in demand for passenger cars. Customers frequently choose to combine Hardox, Weldox, Domex and Docol steels in heavy vehicles, trucks, trailers, truck bodies, containers and cranes, in order to optimize their products. This results in dramatically improved payload capacity, increases the useful life of the application and reduces maintenance costs.

There are also other business areas. Toolox is a special steel used for producing press tools.

JOHAN DALHALL

Wear resistance and extreme strength are important properties in the mining industry and heavy transport vehicle sector. Hardox and Weldox steels provide designers with leading edge products to support today's most challenging applications.

Market, products, applications

SSAB offers service and availability. With close proximity to major markets, our sales organization is established in 50 countries around the world. SSAB sales technicians often cooperate with local customer service engineers, who always have support available from SSAB's production facilities. SSAB has unique resources for handling customer questions. The strength of SSAB lies in our steel, knowledge and service.

SSAB product brand names

DOMEX® HIGH STRENGTH STEEL

Domex® is a hot rolled sheet steel used in applications such as the production of ships, bridges, buildings, machinery, vehicles, lifting devices and tanks.

HARDOX® WEAR PLATE

Hardox® is a quenched and tempered wear steel used in truck bodies, tipper bodies, containers, crushing mills, mills, excavator buckets and loading buckets.

DOCOL® HIGH STRENGTH STEEL

Docol® is a cold rolled sheet steel available in grades ranging from mild steels for pressing and bending to ultra-high strength steels.

WELDOX® HIGH STRENGTH STEEL

Weldox® is a high strength structural steel used for making products that are lighter but have the same or higher strength compared to those made of ordinary steels. Used in applications such as cranes, trailers and vehicles.

PRELAQ® COLORFUL BUILDING

Prelaq® is a prepainted sheet steel for the building industry, and is used in roofing and wall cladding, roof drainage and fittings.

ARMOX® PROTECTION PLATE

Armox® is a grade of steel that is used mainly for protection in the transportation of valuables, as well as bank counters, mine clearance vehicles, personal protection and so on.

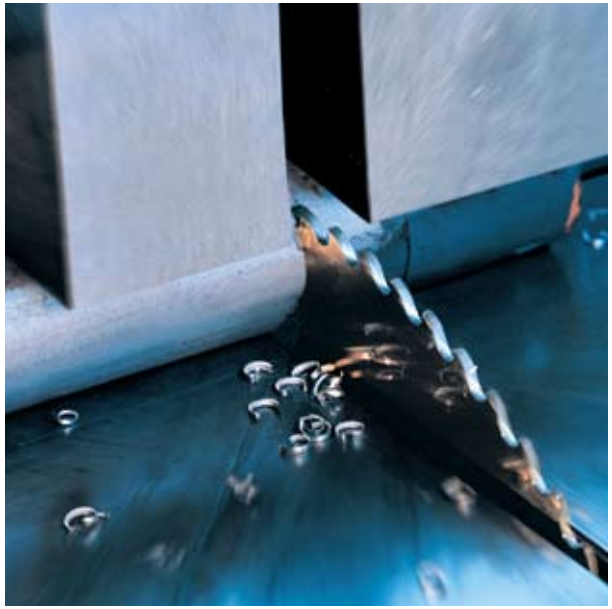
TOOLOX® PREHARDENED TOOL STEEL

Toolox® is a modern tool steel for press tools and machine parts.

Subsidiaries

Tibnor is the leading distributor of steel and non-ferrous metals to the manufacturing, process and construction industries in the Nordic region. In close collaboration with customers and suppliers Tibnor creates optimal solutions for material choice, pre-processing and logistics.

Plannja manufactures and markets products for the building market – a comprehensive range for flat and profiled building sheet steel, roof tiles, roof dewatering and sandwich wall elements.



Pre-processing of non-ferrous metals at one of Tibnor's production units.

High strength steels have many applications.

The City of Los Angeles specifies Hardox wear plate in their refuse trucks which results in a lighter and stronger refuse truck body.

Prelaq is a leader in the building and roofing industries.

Docol is a super-strong steel for lightweight end products, such as extreme competition sports equipment.

SSAB steel is often used in prize-winning interior fittings, such as the Cell bookcase by Peter Cohen.

Armox makes embassy buildings safer.

Due to its extreme strength, Weldox can increase the outreach of crane booms.

Environment, energy and recycling

The Earth's resources are finite. So it is important to conserve raw materials and use them as efficiently as possible. Above all, it is vital to recycle materials, such as iron, that have already been taken out of the Earth's stock of natural resources.

Steel is one of the materials that has, by far, the greatest influence on the consumption of resources by our society, since it is in daily use by virtually everyone. A developed society is inconceivable without steel.

Conservation of the Earth's resources demands energy-efficient processes, and the most efficient and intelligent use of the finished steel product.

SSAB endeavors to ensure that all activities are pursued in a manner that is makes the most efficient and sustainable use of raw materials, energy and other natural resources.

STRONGER, LIGHTER, MORE ECONOMICAL

SSAB's principal contribution to a sustainable world is the high strength steel produced in our plants. High strength steels require less raw materials to make a finished end product.

A lighter but stronger product needs less steel, offers a higher payload capacity and can reduce carbon dioxide emissions. This results in energy savings, good conservation of the Earth's resources and reduced impact on climate change.

High strength steels make life a little lighter with less impact on natural resources – this offers benefits to the whole of humanity.

ALL STEEL CAN BE RECYCLED

Steel is the most widely recycled material in our society. Over its lifetime, perhaps 90 percent of all scrapped iron and steel is reused or recycled. Steel scrap such as old cars, industrial machinery or railway equipment is melted, refined and made into new steel and end use products.

Steel is part of a cycle in which virtually everything can be recovered. Around one third of the world's steel production is based on scrap recycling.

But since Man's demand for steel is continuing to increase and is greater than the available scrap, new steel must also be produced from virgin iron ore.

ENERGY

The steel industry is among the world's most energy-intensive industries. Electrical energy and coal are mainly used in the steelmaking process. SSAB uses coal as the reducing agent. The process then generates its own energy by recov-

ering energy-rich gases from coking plants, blast furnaces and LD steelworks.

CLOSE TO MAGNETITE ORE

SSAB is one of the world's most energy-efficient steelmakers. This is due to several factors. The pellets we buy from LKAB consist of 100% magnetite ore. This offers major energy benefits – magnetite ore needs less energy and generates only one third of the carbon dioxide in production than competing pellets made of hematite ore.

In addition, carbon dioxide emitted by LKAB pellets is only one sixth of that produced by sintering at the ironworks.

The proximity of SSAB to LKAB is another environmental benefit, since the transportation distances are relatively short. The new LKAB ore wagons are made of SSAB high strength steel and their lower weight enables more ore to be transported.

ECONOMICAL BLAST FURNACES

Moreover, SSAB blast furnaces are among the world's most energy efficient. The amount of coal and coke used per tonne of hot metal is among the very lowest. Highly efficient processes are critical to the optimum use of resources.

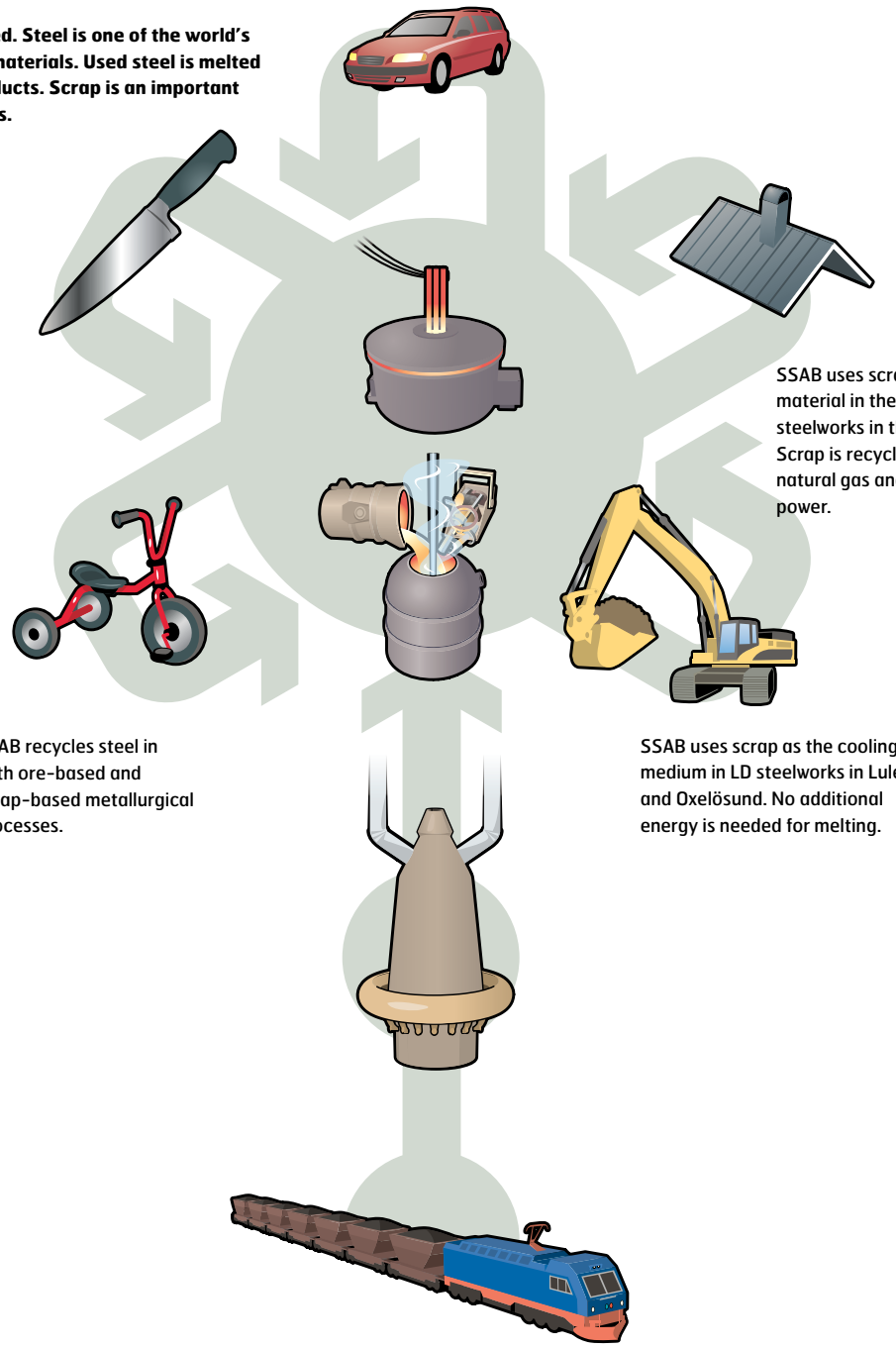
ELECTRICAL ENERGY, DISTRICT HEATING

By means of steam turbines, process gases are used as the raw material for generating electrical energy in combined heat and power (CHP) plants. This meets half of the SSAB's electrical energy needs at the production sites in Luleå, Oxelösund and Borlänge.

In the next stage, steam exhausted by the steam turbines is used for heating the water in the district heating system. In Luleå, 25,000 households are supplied with district heating water from the combined heat and power (CHP)

The steel cycle

All steel can be recycled. Steel is one of the world's most widely recycled materials. Used steel is melted and becomes new products. Scrap is an important source of raw materials.



SSAB uses scrap as raw material in the electric steelworks in the USA. Scrap is recycled using natural gas and electric power.

SSAB recycles steel in both ore-based and scrap-based metallurgical processes.

SSAB uses scrap as the cooling medium in LD steelworks in Luleå and Oxelösund. No additional energy is needed for melting.

Blast furnace slag is an environmentally efficient road building material.

plant fired with SSAB gas, and the equivalent in Oxelösund is 10,000 households. In Borlänge, heat is recovered from the fuel gases from the slab furnaces. Approximately 40,000 households benefit from district heating systems using SSAB process gases.

All of this adds up to vast energy savings, since the surrounding communities were previously heated mainly by oil. But even more energy can be recovered from the SSAB production plants.

THE ENVIRONMENT – CARBON DIOXIDE

SSAB has among the world's lowest emissions of carbon dioxide per tonne of steel produced.

Electric power generated from gases reduces the need for other power generation, and district heating has radically reduced the emissions of carbon dioxide and other harmful substances at the SSAB production sites.

STEEL WITH EFFICIENT COAL UTILIZATION

Steelmaking can be regarded as a first stage in efficient coal utilization. The coal, iron, gas, electricity and district heating production chain represents an interaction between industry and the community, with very high efficiency in the utilization of two of the world's most important raw material resources.

HOLISTIC VIEW

When considering the emissions of carbon dioxide, the calculations depend on where the system boundaries are set. Taking a holistic view of industry and power generation, the total emissions of carbon dioxide can be reduced. Moreover, additional residual energy can be recovered in the steel industry.

If coal is to be used, it should be used principally for producing steel.

NATURAL GAS

The SSAB plants in the USA use natural gas for preheating the processes for scrap recycling before the scrap is melted in electric arc furnaces. Natural gas is also used for slab furnaces in the rolling mills.

BYPRODUCTS – RAW MATERIALS

SSAB plants have lower emissions to the atmosphere and waterways, mainly as a result of many years of cooperation with the community and the environmental authorities. Efficient treatment plants separate energy gases, dust, slag, wet sludge, cooling water, process treatment water, millscale, sulphur, tar, benzene, etc.

The substances separated are collected and classified. A large proportion of these substances is recycled. The byproducts of the steel industry are an asset that can be processed and used as raw materials by new users.

Merox is an SSAB company that specializes in the recovery of byproducts. Merox processes products and raw materials for a wide variety of applications, such as building materials for roads, horseriding tracks, raw materials for cement production, fertilizers, ferrite for magnets and paint pigments. The use of byproducts as new raw materials also represents good conservation of the Earth's resources.

DUST RECOVERY YIELDS NEW RAW MATERIALS

Blast furnace soot, dust and sludge from our treatment plants can be put to use. They can be mixed together with fine fragments of scrap and chips from pellets, and are recovered as new raw material in the blast furnace process, such as in the form of briquettes.

ENERGY FROM SCRUBBED GASES

Blast furnace slag is an excellent structural material for roadbuilding, and is an important raw material for the cement industry. The high lime content (30 percent) is of great benefit. If slag is used for roadbuilding, the lime binds it into a continuous load-bearing unit after it has been watered. At the same time, the lime binds other substances in the slag, and also counteracts acidification due to its pH-raising effect. Blast furnace slag is a good example of a closed cycle in steelmaking and has multiple applications.

WATER TREATMENT WITH RECIRCULATION

All process water used for cooling is treated in several stages and reused. Discharged water is subjected to rigorous treatment and inspections.

Due to highly efficient dust filters, atmospheric emissions are very small.

Continual air sampling, fish studies and water sampling are used to ensure that the environmental impact is as low as possible.

The environmental authorities undertake extensive programs to check and monitor all emissions and ensure they are within the permissible values as specified by the regulatory bodies.

SSAB operations have been granted environmental certification.

WORKING ENVIRONMENT AND SAFETY

SSAB has a working environment policy in which safety is given priority, as it is of paramount importance to job satisfaction, employee development and general profitability of the company. SSAB in Luleå was declared 2008's Working Environment Company of the Year by the Swedish trade union periodical "Dagens Arbete".

The overriding SSAB objective is that no one should suffer an accident, injury or occupational ailment, either as employee, contractor or visitor. SSAB is committed to a systematic, group-wide approach to the working environment and safety.

SSAB is certified for quality, the environment and the working environment, and meets the requirements of the following standards:
Luleå: ISO 9001, ISO 14001, OHSAS 18001 and AFS 2001:1

Borlänge, Finspång: ISO 9001, ISO/TS 16949 and ISO 14001

Oxelösund: Quality Management System ISO 9001 and ISO 14001

Mobile, Montpelier and the cut-to-length facilities (Houston, St. Paul and Toronto) all have the following certificates:
ISO 14001 (Environmental Management Systems)
ISO 9001 (Quality Management Systems)

LENNART JÖNSSON

LARS VAKSJÖ

ABOVE: Blast furnace soot and dust from gas treatment are mixed with cement and recycled in the form of briquettes as new raw material for the blast furnace.

RIGHT: Finely crushed blast furnace slag – a load-bearing surface for equestrian sports.

People & steel – the future

This is a selection of the 200–300 occupations available at SSAB. Choose your own future.

SSAB is an attractive knowledge company represented on all continents and in 50 countries around the globe. There are now almost 300 different occupations in the organization. We are working in various international environments while maintaining a strong local presence at our production sites.

Manufacturing advanced steel products demands a great deal of knowledge and understanding of metallurgical processes. But just as important as producing steel is our ability to impart knowledge to our customers. Together, we continually develop applications, designs and products that offer new opportunities in the field of material design.

COMPETENCE DEVELOPMENT

SSAB has a holistic view of our people. As an employee, you are offered continuous competence development and there are great career opportunities throughout the Group.

Equal opportunities and work/life balance are self-evident to us. We know that an active life outside work also improves a person's ability to produce good results on the job.

THE ENVIRONMENT AND SAFETY

SSAB's demanding workplaces require a high degree of commitment to safety. We are devoted to systematic and rigorous safety programs that help create a healthy and safe working environment for all our employees.

THE FUTURE FOR YOU?

Would you consider being one of our future employees? Would you like to help create a stronger, lighter and more sustainable world?

Want to learn more?
Visit www.ssab.com and click on Career.

SSAB values

THIGPEN


PÄR K OLSSON

SSAB has adopted three values that serve as the foundation for for how our operations should be run. In addition, our values are the guiding light in terms of how the company must develop the business in close cooperation with our customers.

CUSTOMER'S BUSINESS IN FOCUS

We always take an active interest in the customer's business and seek long-term relationships. By sharing knowledge, together we create value.

TRUE

We are dedicated and proud of what we do. We build strong relationships by being open-minded, straightforward and honest, and by sharing information and knowledge.

ALWAYS AHEAD

We are result-oriented. To achieve the highest performance we always proactively seek to be innovative and enhance our expertise further.

The SSAB way of working shall always be characterized by respect for the employees, partners, countries and environments in which the Group operates. SSAB follows the UN Global Compacts advisory principles focused on companies, which applies to human rights, work conditions, outdoor environment, corruption and bribes.

SSAB has established ethical guidelines for responsible business operations.

The ABC of steel language – a glossary of terms

A

Abrasion resistance – Ability to withstand abrasive wear; wear resistance.

After-treatment – Heat treatment, cooling, leveling, etc., to give the steel certain properties; also galvanizing, painting and cutting to length.

Alloy – A metal consisting of several elements.

Alloying elements – Elements that combine with iron or other metals and change the properties of the metal.

Analysis – Chemical composition.

Annealing – Heating to a temperature above 680°C.

Application – Field of application; a product for which a certain grade of steel is used.

Applications engineers – Trained specialists in the properties and applications of materials; problem solvers and developers.

B

Blast air – Heated air that is blown into the blast furnace at high pressure.

Brand – Various SSAB product names, with origin and bearers of different material properties.

Burden – The contents of a blast furnace and the supply of raw materials, ore pellets, limestone, coke, coal and other materials.

Business area – Part of the market.

Bustle pipe – Pipe around the blast furnace through which blast air is supplied and distributed.

C

Carbon dioxide – CO_2, colorless gasContent in the atmosphere is 0.03 percent and is one of the greenhouse gases.

Carbon monoxide – CO, colorless and odorless gas that is toxic and burns with a blue flame. On combustion, carbon monoxide forms carbon dioxide.

Coil box – Mandrelless coiler for coiling and uncoiling transfer bars (intermediate product) in the production process for flat steel products, i.e., in the hot strip mill.

Coiling, coiler – Machine that receives strip from the hot rolling mill and rolls it into a coil.

Coke – A hard, porous material that is primarily pure carbon and is produced by carbonizing coal in an oven to drive off volatile elements.

Cold rolling – Procedure whereby the thickness of hot rolled plate is reduced without prior heating.

Continuous casting – Method of casting steel in long strands that are then cut into slabs.

Contractor – Company that has been retained on contract for a certain task.

Cowpers – Heaters; ceramic towers used for heating the blast air.

Crude steel – iron that has been decarburized to remove part of the carbon in the molten metal but that has not yet been refined into a definite steel grade.

Customer – A company that buys a product or a service from a supplier.

Cutting station – Station in which the steel strand is cut into slabs.

D

Decarburizing – Removal of some of the carbon from molten iron in order to make the material more ductile.

Desulphurization – Method used for removing sulphur from the molten metal, e.g., by the addition of carbide or magnesium oxide.

District heating power plant – Combined heat and power (CHP) plant – power plant that generates both electric power and heat for district heating or other heat consumers. Comprises steam turbines that drive electric generators. The steam exhausted by the turbines is used to heat the water for district heating.

District heating system – System that supplies hot water to communities from a central heat source and distributes it through hot water pipes to consumers. Can use different energy sources, such as process gases from SSAB.

Dry distillation process – Driving off volatile elements in the absence of oxygen.

Dust filter – Filter for gas or air in which the dust is separated and possibly collected for recovery.

E

Electric steelworks – Plant that uses electricity to melt iron and steel.

F

Fatigue – A phenomenon that leads to fracture of a metal subjected to repeated or fluctuating stresses.

Four-high rolling mill – A machine comprising four rolls that exert very high forces to reduce the thickness of slabs to plate in a number of passes back and forth between the rolls.

G

Greenhouse gases – Gases in the Earth's atmosphere, which absorb infrared radiation, slow down the outward thermal radiation into space and make our planet warmer. Greenhouse gases include water vapor, carbon dioxide, methane, nitrogen oxides, ozone and chlorofluorocarbons.

H

Hardening – Quenching of steel in order to make it harder (by putting to use the differences in molecular structure of the various phases and their crystalline structure).

Hearth – The lower part of the blast furnace in which the molten metal is collected.

Heat – Hot but solidified steel in the course of processing (rolling).

Heavy plate – Thick plate ranging in thickness from 4 mm to 150 mm.

Hematite – Non-magnetic iron ore (Fe203); bloodstone.

High strength steels – Very strong steels able to withstand high loads before failure. SSAB niche products are very strong steels, sometimes known as extra-high or ultra-high strength steels or advanced high strength steels. Steels that are not high strength steels are known as mild steels.

Hot-dip galvanizing – Method of applying a coat of molten zinc to the surface of sheet steel. In electrogalvanizing, the process is electro-chemical.

Hot rolling – Technique in which slabs are heated in furnaces to a high temperature – just over 1 200°C – for rolling.

I

Injection coal – Pulverized coal injected into the blast furnace at high pressure without first having been converted into coke.

Iron ore pellets – Iron ore particles rolled into small balls and compacted by heating.

K

Kilowatt-hour – Power of 1000 watts applied for one hour (e.g., operation of a 1000W fan heater for one hour).

L

Ladle – Container for transporting or treating molten metal.

Ladle change – Change-over from an empty ladle to a ladle full of molten steel.

Ladle metallurgy – Technique for fine adjustment of the exact amount of alloying elements, cleanliness and temperature of the molten steel.

Ladle treatment methods – Various methods used for ladle metallurgy.

LD converter – (BOF converter). An oxygen steelmaking process named after the Austrian towns of Linz and Donawitz. Steel is produced in a converter with a solid bottom by oxygen being injected into the molten iron bath through a lance inserted through the converter mouth.

LKAB – iron ore mining company in the north of Sweden.

Electric arc furnace – a process in which an electric arc is struck between electrodes to melt the iron and steel.

Low-alloy steel grades – steels in which low contents of alloying elements considerably change the properties of the metal. At the other end of the scale are high-alloy steels that are often stainless steels.

M

Magnetite – Magnetic iron ore; Fe_3O_4.

Material design – Control of the chemical composition of the steel by different methods or by after-treatment to meet a certain requirement on a certain product.

Melting reduction process – Process used for melting and removing unwanted elements from metal raw materials.

Metallurgy – The science and technology of metals – a broad field that includes, but is not limited to, the study of internal structures and properties of metals and the effects on them of various processing methods. (At SSAB, metallurgy is everything that happens before the rolling mill area in the production line).

Millscale – Residual scale on the surface of the plate after hot rolling.

Mill stand – A set of two or more rolls in a machine. A rolling mill can consist of several mill stands.

Modulus of elasticity or Young's modulus – Ratio of stress over strain, which shows how elastic a material is. (The modulus of elasticity of steel is around 2.1 GPa.)

Mould – A form that contains a cavity into which molten metal is poured to produce a casting of a definite shape.

O

Ore wagon – Railway wagon used for transporting lump ore, iron ore concentrate or pellets.

Oxygen lance – Tubular rod used for injecting oxygen into the molten metal.

P

Pair of rolls – A pair of rolls used for rolling down the thickness of sheet.

Payload – The useful load that a vehicle can carry. If the deadweight or the truck is reduced by high strength steels being used, the truck will be able to carry an equivalent amount of extra payload and the number of trips for any given transport task will thereby be reduced.

Phases – Steel has different crystalline structures at different temperatures, and a number of different phases depending on the heat treatment, the amount of alloying elements, hardening, cooling, etc. The best known phases are martensite (quenched), ferrite (almost pure iron), austenite (non-magnetic) and bainite (hardened and tempered).

Pickling line – Process line that uses chemicals for cleaning hot rolled sheet and plate.

Process gas – Gas from metallurgical processes, often with a high energy content.

Process methods – Methods used for recovering raw materials and making products in a continuous process without interruption.

Process water – Water used for cooling or treatment in various processes. At SSAB, always subjected to treatment and can often be recirculated.

Q

Quenched steels – Hardened or quenched and tempered steels. SSAB quenched steels are also high strength steels.

R

Recycling – Restoring used products or byproducts to a new cycle of production and use.

Reducing agent – Carbon or hydrogen used to remove oxygen from iron ore to produce iron and steel. Hot metal – molten iron with a carbon content in excess of 1.7 percent.

Rolling mill – Machinery used for rolling steel to reduce its thickness.

Roll pass – The number of times a slab or plate is passed through a stand.

Roughing stand – Two heavy rolls that press the steel plate to reduce its thickness before hot rolling.

Runner (for tapping the molten steel) - Runner with a ceramic lining for controlling the hot metal.

S

Scrap – Used material that can be recovered, such as steel scrap.

Sheet steel – Thin sheet with a maximum thickness of 16 mm; can be rolled down to 0.2 – 0.3 mm.

Side impact beams – Energy-absorbing beams fitted to car doors, for instance, to protect the occupants in the event of a collision.

Slabs – Slabs of steel used for rolling into plate.

Slag – A non-metallic material resulting from mutual dissolving of flux and non-metallic impurities in smelting and refining operations. Slag typically contains lime, silica, gangue from iron ore, ash from coal and coke, etc.

Staple industry – Industry that extracts and processes raw materials that are fundamental to the economy of a country.

Sintering – Converting iron ore powderinto a compact mass by heating to a temperature considerably below the fusion temperature.

Slab furnace – Furnace used for heating steel slabs to rolling temperature.

Steckel rolling mill – Four-high rolling mill with a roll holder at each end. The slab or plate is reduced in thickness on each pass.

Steel – Alloy of iron, carbon and other elements with a carbon content below 1.7 percent.

Steel bath – Molten steel in a container.

Steel commuter train – System of trains used for transporting steel slabs between Luleå, Borlänge and Oxelösund.

Steel slab – Raw material used for producing sheet steel or plate.

Strand – Thick strand of cast steel that is undergoing cooling as it leaves a continuous casting machine.

Strength – Ability of the material to withstand forces, e.g., tensile forces.

Structure – Shape of the steel molecules after various methods of treatment; crystalline structure of the steel.

Submerged entry nozzle – Ceramic tube that protects the steel against contact with atmospheric oxygen during casting.

Surface treatment, surface coating – Cleaning, grinding or coating of surfaces, e.g., by galvanizing and/or painting.

System boundary – The interface between a product system and the environment or other product systems.

T

Tempering – Heating to 200-500°C with the aim of making hardened steel tougher and less susceptible to cracking.

Tensile strength – The ability of a material to resist tensile forces (see Strength).

Torpedo car, torpedo – Cylindrical railcar lined with bricks and used for transporting the hot metal from the blast furnace to the steel shop (steelworks).

Tundish – Intermediate vessel used during casting to allow for changing over from one ladle to another without interruption in the process.

U

Ultimate tensile strength – The maximum stress that the material can withstand, i.e., the stress at which the material fails.

V

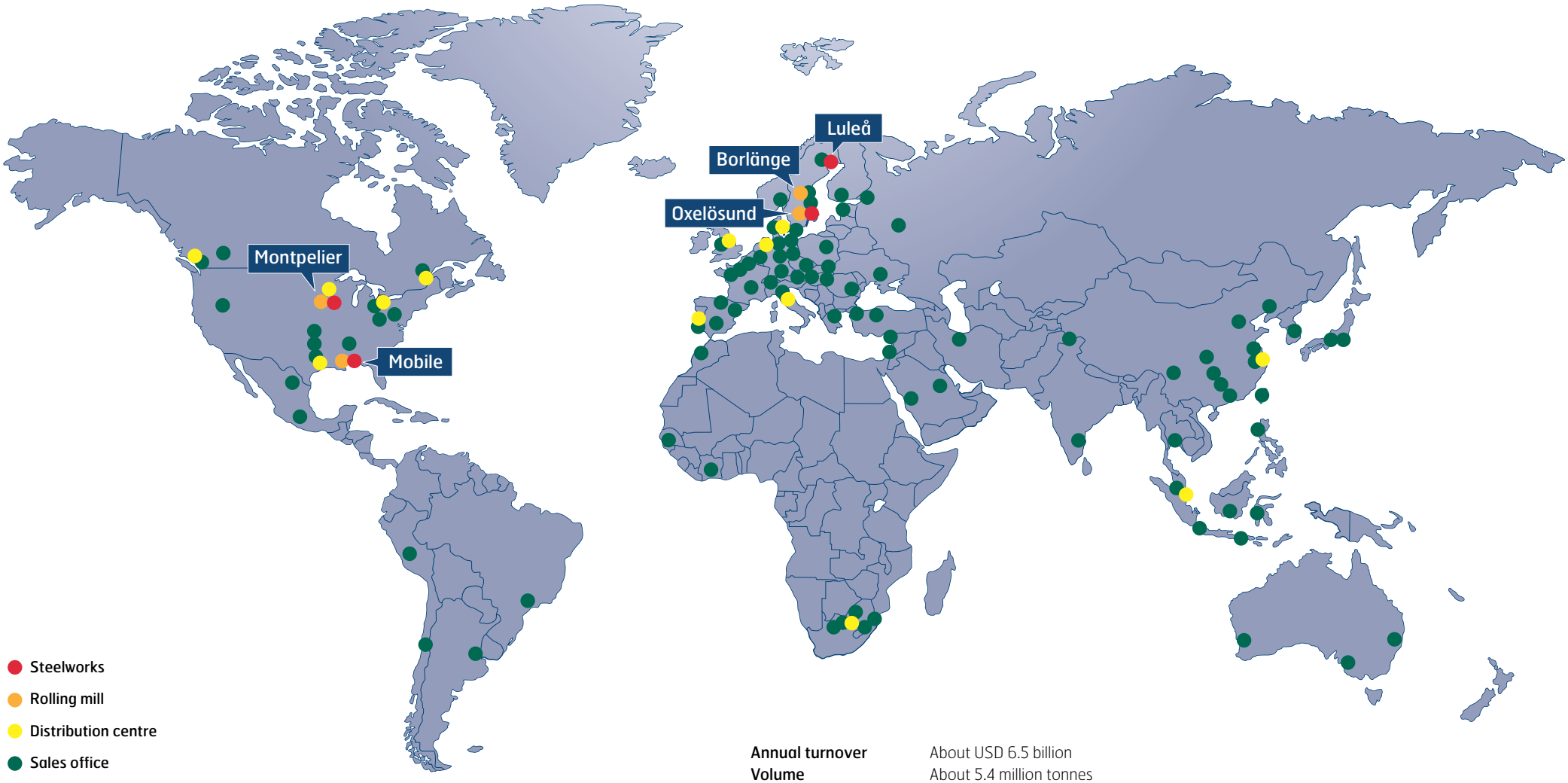
Vacuum treatment – Method used for removing hydrogen, nitrogen and oxygen from molten steel under vacuum.

W

Wide strip mill – Hot rolling mill; rolling mill for wide hot-rolled strip.

Y

Yield strength – The maximum stress that the steel can withstand without sustaining permanent deformation. On being loaded to below the yield strength, the material will deform only elastically – like a rubber band.

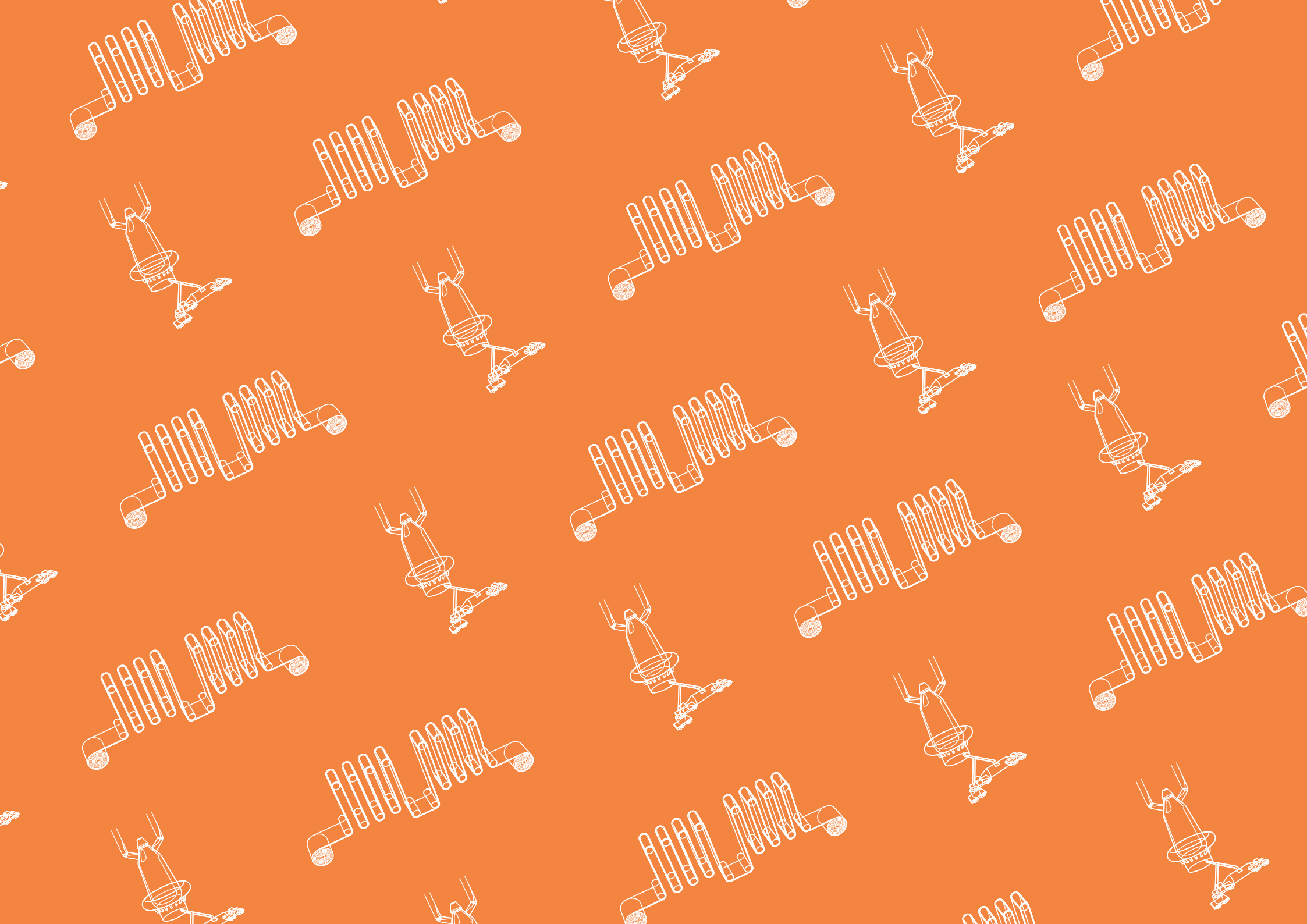


Annual turnover	About USD 6.5 billion
Volume	About 5.4 million tonnes (2.9 million tonnes of heavy plate and 2.5 million tonnes of sheet steel)
Niche products	More than 1.5 million tonnes
Number of employees	About 9,000

Major production sites

Sweden	Luleå, Borlänge, Oxelösund, Finspång
USA	Montpelier (Iowa), Mobile (Alabama)
Exports to	About 50 countries

The figures are for 2008. For the latest annual results and other factual information, see the website at www.ssab.com



SSAB Svenskt Stål AB was formed in 1978 by the merger of three commercial steelworks – NJA in Luleå, Domnarvets Järnverk in Borlänge and Oxelösunds Järnverk, and also many different subsidiaries.

SSAB was floated on the stock exchange in 1989 and was entirely privatized in the 1990s. In 2007 SSAB acquired IPSCO, a North American steel company.

From the start, SSAB focused on producing flat steel products – sheet and heavy plate. During the 1990s, this focus gradually shifted to high strength steels, which were among a special range in the earlier ironworks. SSAB has since developed into one of the world's leading manufacturers of niche products, spearheaded by extra-high strength and quenched steels.

A concentrated business strategy has placed SSAB among the world's most profitable steel companies with the most environmentally friendly steel products. SSAB's long-term strategy is to increase production volumes and proportion of high strength and niche steel products.

SSAB