Customized scrap processing

Heiner Guschall* talks us through a range of scrap processing systems

A successful German scrap recycler once said: "The first ton of steel was made from ore, the last ton from scrap." It's not quite that simple, but scrap has become increasingly important over time and is considered the key raw material in the context of global decarbonization efforts in the metallurgical industry. Nevertheless, the potential of scrap use is, unfortunately, still underestimated or even ignored in many cases. While the scrap grade list in the US is highly differentiated and has over 125 grades (with an EAF share of over 70% in 2024), the scrap grade list in Europe is greatly reduced and contains only 11 quality grades (with an EAF share of only about 45% in 2024). For example, no Cu content is specified for grade E40, shredder scrap; only density and Fe content are specified. Every quality inspector in steel mills knows that this does not allow E40 to be specified with sufficient accuracy, which is why there are often separate quality agreements between suppliers and customers. Shear scrap E1, comparable to HMS $^1/_2$, is essentially described by its length and material thickness. In practice, dirt and unwanted accompanying elements can reach 10% or more in this grade, while the scrap grade list specifies an inert material content of <1%.

The point here is that the types of scrap are not defined precisely enough for optimal direct metallurgical use. There is a lack of clear and measurable quality criteria. Whether qualified scrap processing takes place in the steelworks or at an independent scrap recycler is ultimately secondary if the quality criteria are co-ordinated and a traceable procedure for checking them (necessary online analysis!) exists. Customized scrap processing must be tailored to the exact requirements of the smelting operation and aims to minimize energy consumption, i.e., maximize yield and meet the analytical requirements of the crude steel quality to be produced. In some cases, purely mechanical processing of the scrap to be used is sufficient, while in others, targeted removal of unwanted components is necessary. This involves higher processing costs. If the steel industry is serious about its decarbonization efforts, more focus must be placed on scrap quality!

The simplest solution for scrap processing is shredding using scrap shears. Inclined bed shear technology has proven particularly effective for length reduction in steel mills. Shearing forces of up to 2,500 tonnes are possible, although sizes between 1,000 and approximately 1600 tonnes generally offer the best cost-benefit ratio. These shears can be combined with a cleaning system to separate inert fine particles and exposed waste as well as non-ferrous metals. These shears are particularly suitable for the processing of recycled scrap.

Inclined bed shears

Inclined bed shears

In converter steelworks, the compaction of scrap metal is often of interest in order to maximize scrap utilization. However, compaction is often carried out without prior cleaning, so that a large part of the intended positive effect is offset by unnecessary slag and foreign matter entering the melting furnace. In addition, wear in the baling press is increased.

Exemplary continuous scrap baler

In most electric steel mills for long steel production, the proportion of shear scrap, often E1 or HMS $^1/_2$, in the scrap mix is well over 50%. Therefore, this is where the focus should initially lie. Since the processing standards of scrap processors vary greatly, and thus also the quality delivered to the plants, it has become increasingly common for shear scrap to be further processed in steel mills, either by mechanical cleaning alone or in combination with pre-shredding.

Scrap metal after cleaning

Cleaning systems for scrap metal are available with throughput rates of up to 300 tonnes/hr. This means that electric steel mills that accept scrap in bulk can clean and evaluate entire loads immediately after unloading. Cleaning means that at least 99% of the inert, waste and non-ferrous components liberated and exposed are separated. This is achieved by a clog-free screening system that accelerates and circulates the shear scrap, as well as powerful magnetic technology. Older plants often combined pure vibration conveyor technology with magnetic separation. This leads to reduced throughputs, makes it

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Scrap metal after cleaning


HMS Cleaning Advanced with dust suppression system

more difficult to control uniform feeding, and results in reduced and fluctuating cleaning efficiency. Regardless of long or flat steel production, the Fe content of the scrap grades to be used must be maximized. Many electric steel mills, especially those dependent on scrap imports, operate with yields of only 86-90%. This clearly indicates the significant input of non-Fe metals. This is no longer considered acceptable and is easily avoidable.

HMS Cleaning Advanced with dust suppression system

An increasingly popular variant of HMS Cleaning Advanced is the use of a slow-running shredder as a pre-crusher. The best cost/benefit ratio, also in view of the achievable throughputs of up to 150 tonnes/hr, is offered by 2-shaft shredders with feed and tearing shafts, which are also used in shredder processes, preferably with fully electric high torque drive such as the EcoRip™ Neo from SICON. These machines can be adjusted to the desired particle size and are particularly suitable for tearing open and sizing compacted or pressed shear scrap. This further optimizes the cleaning efficiency of the downstream HMS Cleaning Advanced. They are insensitive to foreign objects and, therefore, enable high availability at very low maintenance costs. This significantly increases the cleaning efficiency of an HMS Cleaning system. In addition, it also opens up new sourcing opportunities for scrap use for the steel mill without taking any production risks.

EcoRip™ Neo with hydraulic drive

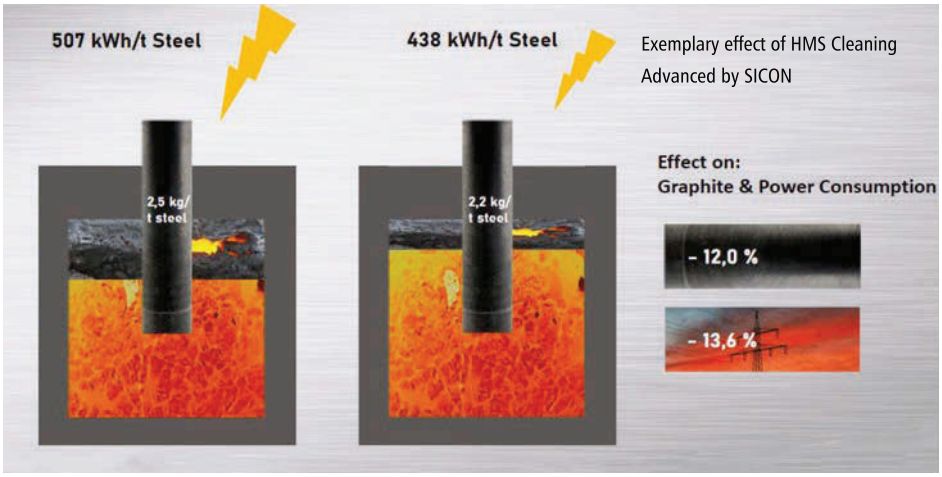
EcoRip™ Neo with hydraulic drive

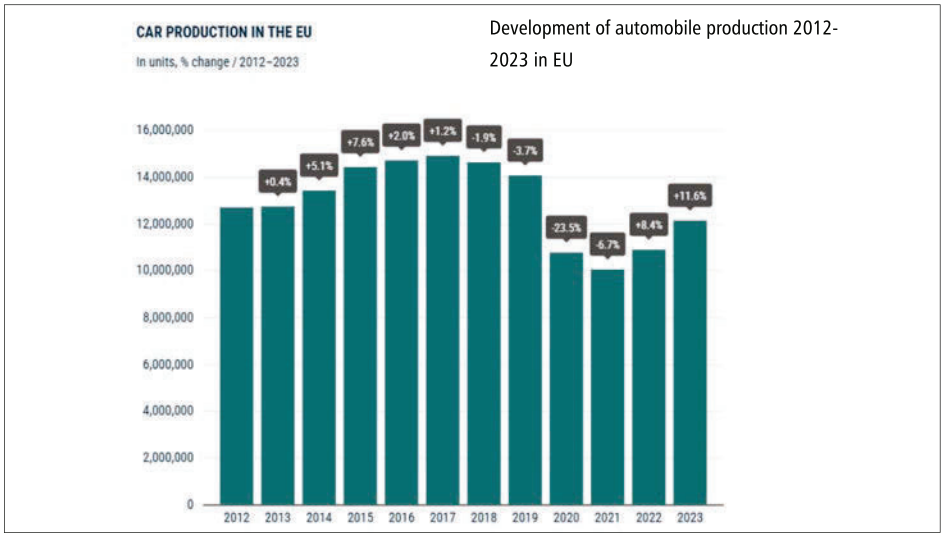
The ideal processing plant for sheared scrap, therefore, starts with a pre-shredder before the actual cleaning process. However, the economic potential of such a plant can only be exploited if the separated residues are also processed. The waste separated by the magnet, referred to here as coarse non-ferrous waste, contains up to 20% non-ferrous metals (stainless steel, aluminum, copper), which can be completely recovered for added value via eddy current and induction separation, even in mobile plants if multiple locations are to be served.

The organic components can also be processed in such a way that they can be used as carbon carriers in electric arc furnaces (alternative slag foaming agent). The fine waste usually also contains 3-5% non-ferrous metals, which can be separated. The non-organic fraction, which often contains up to 50% iron oxide, can be briquetted, even together with other steel mill residues such as filter dust or oil-containing scale.

A formula is developed for the melting unit, an electric arc furnace, which enables separation during melting into pig iron, largely inert slag, and Zn-rich dust (usually >50% Zn content). This process, called ReSmelt® from SICON, has been tested and is available to steelworks that want to maximize the internal recycling of residues. This is likely to become much more important in the future.

Non-ferrous coarse and fine waste from HMS Cleaning prior to further processing





Development of automobile production 2012-2023 in EU

Non-ferrous coarse and fine waste from HMS Cleaning prior to further processing

This type of processing is ideal for many electric steel mills with long products containing more than 0.20% copper. For example, with a typical separation rate of approximately 10% waste, the following exemplary effect results (see illustration at the top of this page), which of course must be considered separately in each individual application. However, payback periods of less than 12 months are usually achieved.

Exemplary effect of HMS Cleaning Advanced by SICON

HMS Cleaning Advanced with a downstream refining step can then use an AI-based camera system to separate out unwanted components such as closed containers, batteries, and other unwanted scrap parts, thereby further increasing the quality of the scrap and its potential uses. The final step is online analysis, where XRF technology has proven particularly effective due to its measurement accuracy, among other things.

In the production of steel grades with copper contents of <0.20% to less than 0.10%, production scrap with defined chemical properties is predominantly used today. At least in Central Europe, a decline in scrap generation can be expected. One example is the development of automobile production in the EU area from 2010 to 2024.

Development of automobile production 2012-2023 in the EU

In Central Europe, there is a strong focus on replacing blast furnaces with DRI plants, which are to be powered by hydrogen in the medium term, although no one knows when it will be available, in what quantities, or at what cost. This is a gamble on the future that is being subsidized with billions of taxpayer-funded money. DRI/HBI as a substitute for scrap will probably be sourced from the MENA region in the future, which will in turn make the steel industry in Europe dependent on this region.

Quality not quantity

There is sufficient scrap available in the EU, but not in the qualities that will be needed in the future. With targeted processing, even these qualities can be made usable for the new electric arc furnaces. This brings us to the latest designs in shredder plants, which can be flexibly adjusted to different target qualities. Scrap produced in this way is called “bg.” Here, the smelting plant specifies the required quality. A control loop between online analysis with EcoScan® Online by SICON and automated sorting (EcoFlip CXRF by SICON) ensures that the target quality is consistently achieved. This flexibility is important because no one can predict the future cost difference between ‘green DRI/HBI’ and quality-assured shredder scrap. The only certainty is that such scrap can be made available with manageable investments. ■

Shredder scrap TSR 40™ with secured analytics