
Analysis of prevalent scrap yard layouts – finding the optimum level of efficiency, flexibility and operational cost

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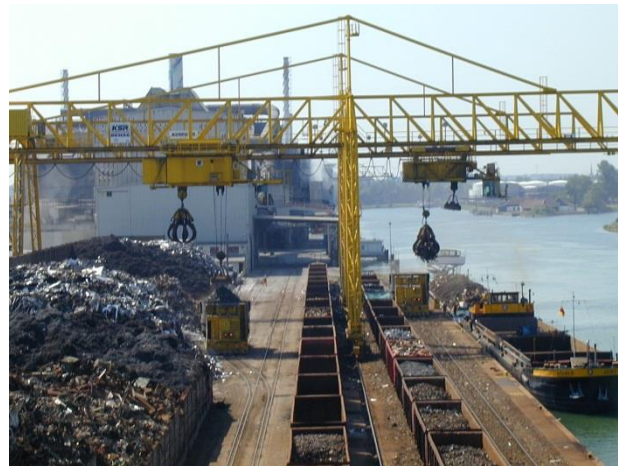


Figure 1: Scrap yard at BSW / Germany

Introduction

In these days, lots of attention is paid to the raw material costs, representing the largest single cost factor (>50 %) in mini-mill operations.

Especially when taking into consideration a global economic environment surrounded by uncertainties and risks, e.g. structural imbalances in the European Union as well as a high volatility regarding raw material and steel prices, taking care about which types of scrap to use, finding possibilities for substitution of expensive raw material sources and the usage of standardised charging recipes become increasingly evident.

However, raw material costs not only include the raw material costs themselves, but also often neglected but equally important costs for scrap purchasing and inventory management as well as for scrap yard logistics and operations, i.e. material storage and material handling.

Without any doubt, the scrap storage policy and the material flow have a major impact on production figures and operation costs, for example double handling of scrap and up- and downstream waiting times.

As a result, a steelmaker's overall success is critically dependent on the efficiency of its scrap purchasing strategy, scrap yard logistics and operations. Ideally, a scrap yard should be customised and tailor-made as to the requirements of the plant.

Various Criteria for design and operation of a scrap storage facility

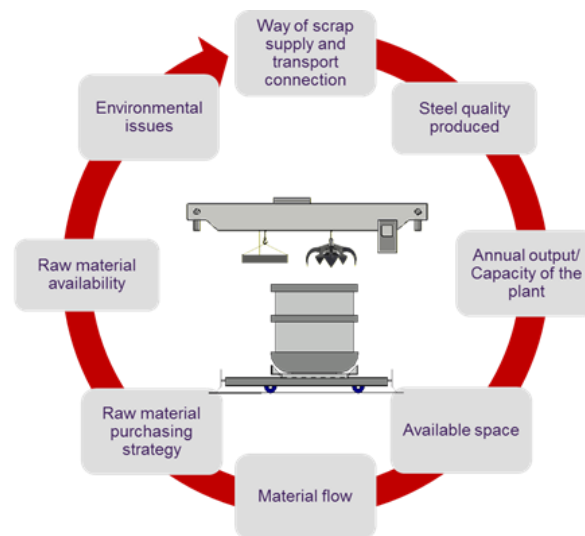


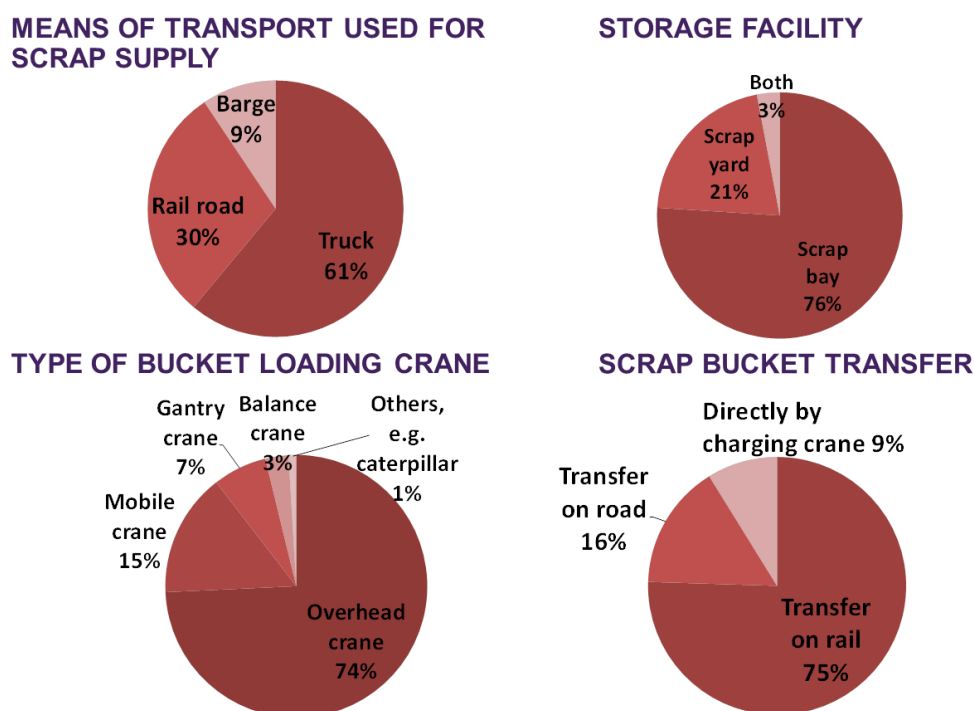
Figure 2: Criteria for design and operation

The way a mini-mill's scrap yard is designed, organised and operated depends on lots of different criteria such as:

- ⊙ Way of scrap supply, i.e. railway, truck, barge
- ⊙ Steel quality produced, e.g. number and amount of different scrap types
- ⊙ Plant capacity as well as planned annual output
- ⊙ Available space strongly influencing scrap handling and storage design
- ⊙ Plant design and material flow, e.g. way of bucket transfer to melt shop and number of EAFs
- ⊙ Raw material purchasing strategy and availability on the market
- ⊙ Environmental issues and governmental regulations, e.g. noise limitations and radioactivity measuring regulations

As a result, almost every scrap storage facility around the world is unique. This proves also a statistical evaluation of 100 scrap storage facilities around the world conducted by BSE in February 2013. In the statistical evaluation the following topics have been covered amongst others:

- ⊙ Means of transport used for scrap supply
- ⊙ Storage facility
- ⊙ Type of bucket loading crane
- ⊙ Scrap bucket transfer



Comment: Sample size: 100, data collected by BSE between 1993 and 2013

Figure 3: Statistical evaluation of scrap storage facilities world wide

Regarding the means of transport used for scrap supply, a big change in comparison to earlier times becomes evident. Whereas in earlier times scrap was predominantly supplied by railroad, the situation has changed drastically. Today, trucks are the most preferred means of transportation, followed by railroad on second place and barge on third place. (Remark: Lots of plants dispose of a combination of different means of transportation leading to the possibility of multiple nominations.) However, 61 % are using trucks for scrap supply, thereof 48 % exclusively, i.e. by 100 %. 30 % are using railroad, thereof only one plant as exclusive means of transportation, the others only in combination with other means of transportation. 9 % are using barges, but in BSE's sample size, there is no plant which uses barges for 100 %, i.e. barges are always used in combination with other means of transportation.

As to the storage facility for bucket loading, 76 % are using scrap bays, thereof 50 % are equipped with a roof. 21 % of the plants are equipped with a scrap yard and 3 % dispose of a combination of both for loading of the scrap bucket. In addition to the internal scrap storage facilities, 21 % have an additional external scrap yard actively used in order to supply the internal scrap storage facility limited in capacity. Another 22 % dispose of an external yard they mainly use as a strategic one, i.e. not for bucket loading, but for buffer in times of high raw material prices, limited availability of special raw material types, etc.

For the analysis of the type of the bucket loading crane used, multiple nominations have been possible, because some plants have a combination of overhead and mobile cranes. 74 % of the plants have overhead cranes in place, thereof 6 % are using both, overhead and mobile cranes at the same time. Another 15 % are equipped with mobile cranes, followed by 7 % with gantry cranes, 3 % of plants are equipped with a balance crane and only 1 % of all plants of the sample uses other vehicles like e.g. cater pillars and thus no cranes at all.

As to the scrap bucket transfer between storage facility and melt shop, 75 % of the plants do it by rail, 16 % by road and 9 % without any moving scrap car. In this case, the transportation of the scrap bucket is directly done by charging crane, i.e. the scrap bucket is fixed at a certain place of the melting bay, charged by a truck (which gets of course charged before by a crane) and afterwards moved to the EAF by the charging crane. Thus no transfer on road or rail via scrap car is necessary. However, the regional distribution may look very different. Whereas in the US lots of plants are doing their bucket loading without any moving scrap car, in other parts of the world this way of bucket loading is very seldom.

Of course, the layout of each and every steel plant around the world is influenced by the side conditions stated before. However, one outcome of the statistical evaluation is that most of the scrap storage facilities can be grouped into one of the three “typical” layouts described in the following.

Internal scrap bay with fixed scrap car

The first layout (**Figure 4**) shows a traditional scrap bay built inside the melt shop as a single bay with fixed scrap car. This layout is very common in the steel industry worldwide.

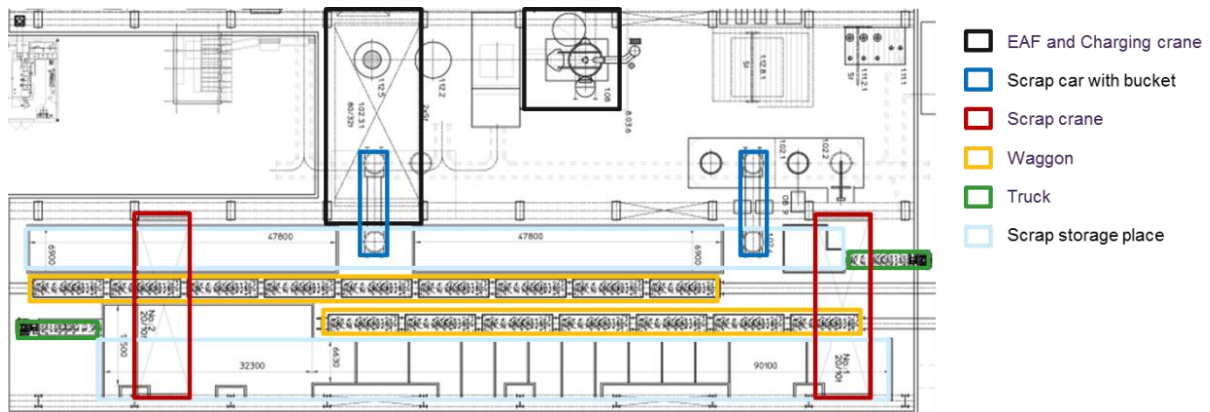


Figure 4: Traditional scrap storage capacity



Figure 5: Example of internal scrap bay

As the sketch shows, the scrap bay is located in front of the melt shop bay, i.e. a vertical arrangement of the single bays. The bay is closed, meaning that there exists a housing including a roof. Scrap supply takes place predominantly via railroad.

For some smaller amounts of scrap, delivery by truck is also possible. But in this case, it has to be taken into consideration that the scrap bay is accessible by truck only at the front sides. This leads to a limited possible number of trucks either parking place wise or storage place wise due to the fact that the scrap cranes have to carry the unloaded scrap to the right boxes beside loading the scrap buckets and unloading the waggons.

Furthermore, the bucket loading is done either directly from waggon or from storage places by two overhead cranes. A huge disadvantage of this layout is the fixed scrap bucket leading to longer crane cycle times and thus a longer bucket loading time. Even worse: The more expanded the bay, the longer the cycle times. In addition, the cranes often interfere mutually.

Besides, the scrap storage capacity is limited according to the size of the bays. Therefore, lots of plants are building so-called scrap bunkers. But these bunkers adhere

to other problems like further increase of cycle time, dirt accumulating at the bunker's bottom, difficult cleaning and the use of magnets will compress the scrap in the bunkers.

The fixed scrap bucket is moved by a scrap car on rails to the melt shop bay and afterwards emptied via charging crane in the EAF. In general, this traditional layout often implies double handling: The scrap cranes have to load the scrap buckets and empty the waggons. Very often, each waggon carries a different kind of scrap. The waggons are then unloaded according to the bucket's charging recipe. As a consequence, not every waggon is unloaded at the same time in general. Thus, sometimes waggons carrying types of scrap not used so often have to leave the scrap bay partly still loaded, because other scrap types are missing and the scrap crane has no time to unload it into the scrap storage place. This causes lots of problems, delays and double handling.

Scrap yard with movable rail-bounded scrap bucket

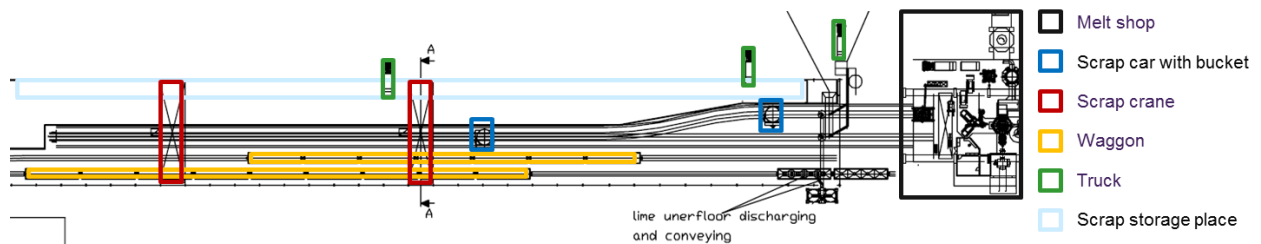


Figure 6: Scrap yard with movable rail-bounded scrap bucket



Figure 7: Example of scrap yard with movable rail-bounded scrap bucket

The second layout (**Figure 6**) shows a scrap yard with movable rail-bounded scrap bucket. The scrap yard located in front of the melt shop bay is open, i.e. without roof. The material flow from scrap yard to melting area is thus organised in a horizontal way. This time, the storage place is also easily accessible via truck, not only rail. Thus, this layout successfully combines scrap supply by rail and truck. In the scrap bay, the railroads of the scrap bucket transfer car are merged in order to save space and thus increase the yard's storage capacity. Both scrap cranes and scrap buckets are movable:

- ⊙ The scrap bucket that can be moved by a scrap car to the single scrap storages
- ⊙ The scrap car including the scrap bucket is remote-controlled by the crane driver and moving between railroads and storage boxes

As a result, the crane driver can easily move the scrap bucket to the scrap quality he needs.

A huge advantage of this scrap yard design is that the cycle time of the crane and thus loading time of the bucket decreases. However, the scrap storage capacity is still limited due to the limited overhead crane width (standard for this kind of scrap bays amounts to 31 m, maximum 35.5 m), but can be extended by scrap bunkers, 2 opposed bays or a lengthened scrap bay, which then leads to a longer scrap bucket loading time! The fully loaded scrap bucket is transferred by the scrap car to the melting bay on railroad.

Flexible scrap yard

Nowadays, a third layout possibility (**Figure 8**) is also very common: More and more scrap yards are operated only by mobile cranes.

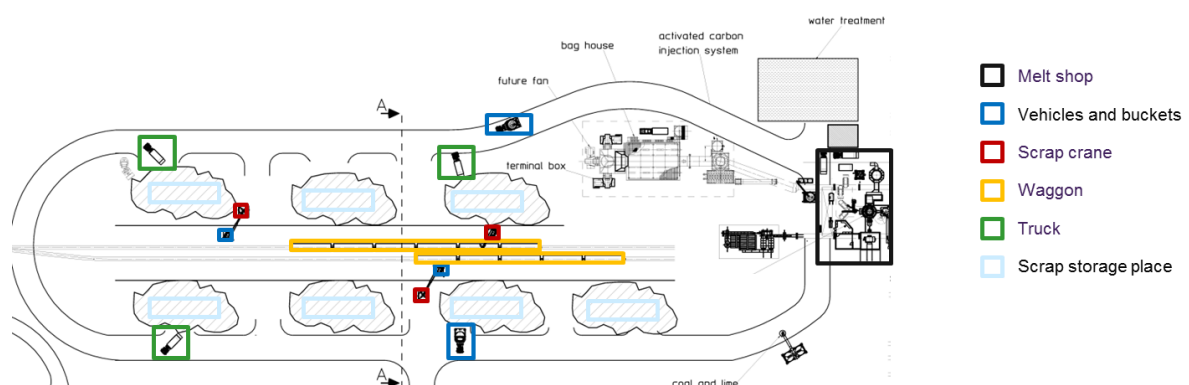


Figure 8: Flexible scrap yard



Figure 9: Example of scrap yard with mobile equipment

This layout shows a scrap yard that is operated exclusively by mobile equipment. The scrap yard is positioned in front of the melt shop; the material flow from scrap yard to melt shop is organised horizontally. The scrap supply can be carried out either by truck or by rail way. Thanks to its mobile equipment, the scrap yard disposes of a high flexibility. Not only the cranes are movable, also the scrap buckets are transferable to each storage place or to the melt shop by towing vehicles or pallet carriers. A disadvantage of this mobility is the high wear of roads. Generally said, railroads are more suitable for heavy loads. In addition, it is not possible to have remote-controlled scrap cars on road. Therefore, a higher manning level is required. Besides, usually more mobile cranes than overhead or gantry cranes are needed for operating such a scrap bay, resulting in a further increase of the manning level. Furthermore, a high degree of coordination between crane driver and towing vehicle or pallet carrier driver is needed, which can lead in worst case to delays. As to the operation costs, they are in most cases a little bit higher due to the short lifetime of mobile cranes (about 3 years), the higher diesel consumption and its higher wear. Also some environmental issues have to be taken into account. For instance employees have to cope with the high noise level caused by the mobile equipment. But of course, this layout has also lots of advantages:

First of all, the performance of the mobile cranes is quite satisfying, especially if they can stay for a longer time at one scrap storage box and do not have to move from one box to the other. Lots of moving implies a loss of crane performance due to the low driving speed of the cranes and the considerable amount of time needed to make them ready for operation, e.g. stabilisation. In addition, the investment costs of mobile cranes are quite low compared to those of gantry or even overhead cranes. Besides, mobile scrap yards are very favourable for outsourcing, because they guarantee high flexibility, low investment and short set-up time. To summarise, this scrap yard is characterised by a high degree of flexibility: flexible cranes, flexible scrap cars, flexible scrap buckets and good access via rail and truck. Experience shows that in the last years, more and more overhead cranes have been replaced by mobile cranes. At the same time, these plants

also decided to outsource their yards. This shows that mobile cranes and outsourcing are closely linked together.

Conclusion

When looking for the layout of the optimal scrap storage facility or when comparing different layouts with each other, various criteria have to be considered:

- ⦿ Capital and operational expenditure
- ⦿ Logistics and infrastructure, such as storage capacity, ways of scrap delivery, crane performances and way of bucket transfer
- ⦿ Reliability of equipment like scrap cranes and transportation vehicles
- ⦿ Others such as required manpower, environmental issues and the flexibility to adapt to a changing environment

At the end of the day, each steel plant will have particularities that have to be taken into consideration when evaluating a plant's layout and its ability to serve a highly productive steel plant. For sure, the perfect scrap storage facility can be rarely found: Either the premises and conditions on-site do not allow building the optimal solution, or too less attention has been paid to this topic when building the plant. Experience shows that mistakes done in the planning phase of a scrap storage facility very often lead to technical bottlenecks and higher operation costs the plants have to live with day by day. Moreover, there is very often no possibility to eliminate the drawbacks in a late stage. Thus it really makes sense to spend enough time in the planning phase on the material flow topic in order to save delay time when being into operation.

In addition, it is worth to analyse the scrap yard logistics and operation methods in place very carefully during the operation phase. By doing this, almost every plant around the world will get pretty sure aware of neglected improvement and thus saving potentials.

And never forget: The success of every steel plant starts at the scrap yard!



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