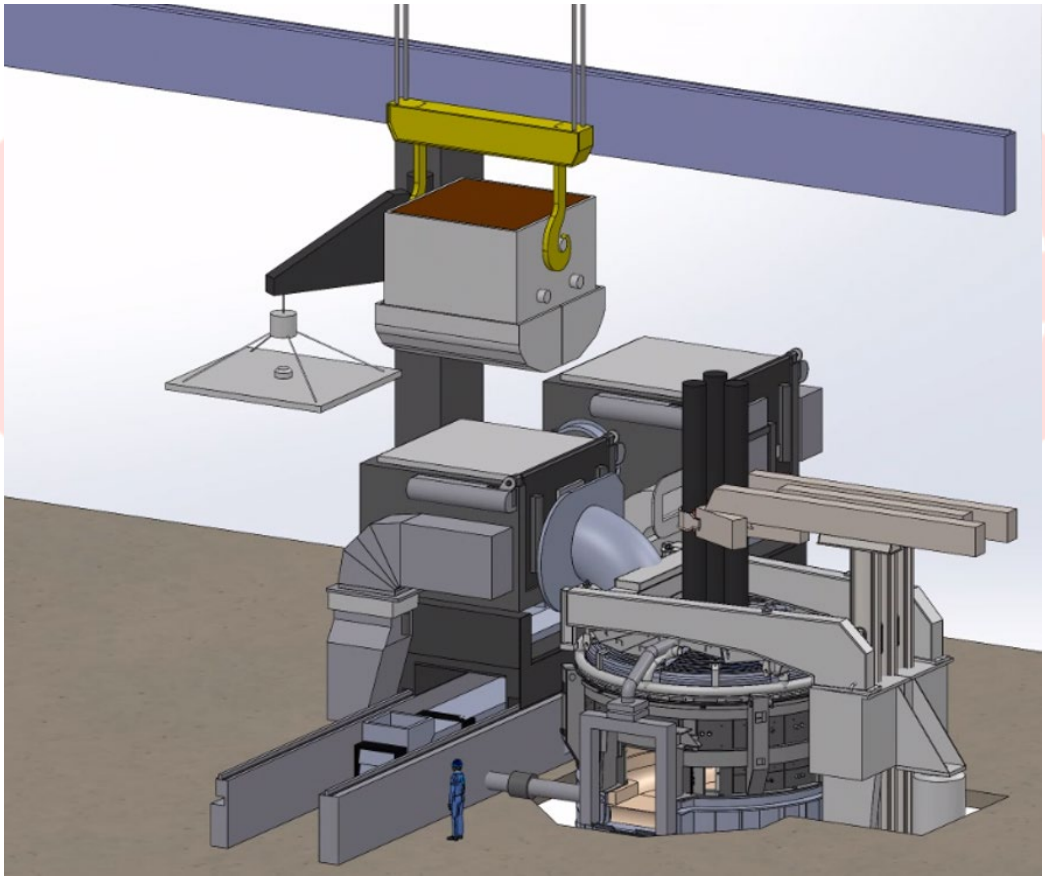
ecology economy

CLESID LORBER

ECOFEEDER – the pragmatic solution of an ecological and economic scrap preheating



Clesid Lorber SAS
53, rue Sibert
F-42400 Saint-Chamond, France
www.clesid.com | +33 477 57 42 97

eco-e AG
Kantonsstrasse 155a
CH-8807 Freienbach Switzerland
www.eco-eag.com |+41 55 280 60 66

Content:

Rev	Keyword (what has changed?)	Page(s) (where?)	date

Basis

The ECOFEEDER is a pragmatic approach to scrap preheating for all steel mills with a traditional furnace arrangement.

ECOFEEDER is a member of the ECOSHAFT family. With the ECOFEEDER, we are aiming to maximize energy recuperation and minimize energy losses, burn the pollutants and their compounds in time to avoid the subsequent treatment required in other preheating plants to prevent the spread of toxic substances to the environment. In this way, it can be guaranteed that the plant provides the lowest possible amount of energy to the environment.

We have found that this is only possible if the off-gas treatment is fully integrated into the scrap preheating process.

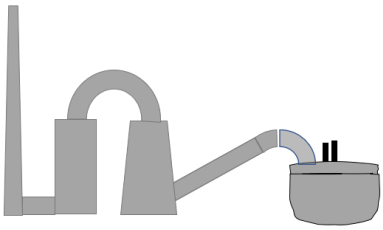
To this end, we will deal with the following sub-processes: the preparation of scrap, the incineration of pollutants and reactions when the scrap is loaded into the furnace, the afterburning of the incomplete reactions produced during the melting of the scrap, the transfer of heat to the scrap, the retention of the hot scrap and the transport of the scrap to the melting zone.

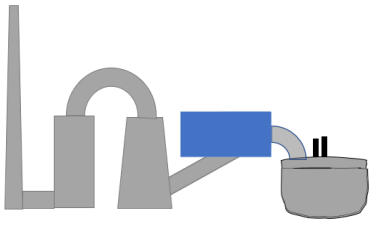
Our goal is:

- Minimize the structural and process-related effects on the steel works,
- Make as few changes as possible to the existing plant,
- Maintain the traditional steel-making process as much as possible,
- Prepare the plant for future expansions and improvements,
- Give production planning the greatest possible freedom,
- Nevertheless, produce all the necessary qualities and qualities.

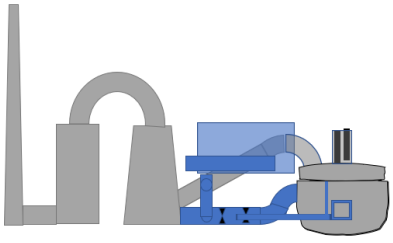
1 BASIC IDEA AND FUNCTION

Take the material addition system, the furnace, and the off-gas system as it is and add the preheating mantle.





We add two containers ...



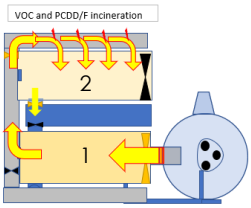
and supplement the furnace with a by-pass off-gas duct for the ECOFEEDER (suction during position change of the containers, air curtain for slag door and electrodes).

That's all!

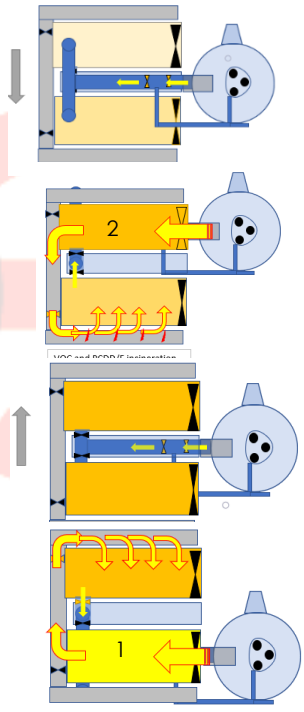
In the light of the above objectives, the following procedure is proposed:

Depending on the scrap quality and density, the process is based on a three-basket or four-basket filling. In the present consideration, a hot heel of about 60% of the tapping weight is assumed.

- The furnace can be started at any time, provided the two containers and the furnace are filled with the necessary amount of scrap.
- During the first 20 minutes, the furnace is heated by the heat produced by the arcs. The contents of container 1 will reach approx. 200°C. This is roughly the temperature at which the burning of the impurities and reactions begins. The analyzer detects this and starts the burners. In the meantime, the melting of the first filling continues. The heat generated by the burning of the pollutants and by the arcs further heats the contents of the container 1 to approx. 400°C (this takes about 4 minutes (2°C/sec)). The off gas, heated by the burners and the combustion of the impurities and reactions, heats the scrap in container 2. The scrap in container 2 is heated to approx. 200°C (1°C/sec) at the same time.

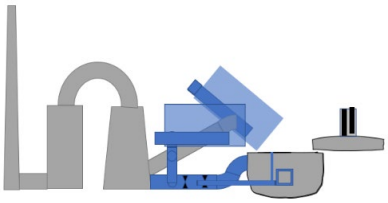


- As soon as the Impurities in the first container are burned, the containers are moved so that container 2 comes to stand in front of the furnace. During this short transfer period, the furnace off-gas is reduced. As soon as the container 2 in in front of the furnace, the melting is resumed at full power.
- The scrap in container 2 is now cleaned (burning of the impurities and reactions). The analyzer detects this and starts the burners. The burners energy and the residual heat in the off gas heats the scrap in container 1 to approx. 600°C, during which the scrap in the container 2 heats up to approx. 450°C.
- As soon as the pollutants are burned, the containers are moved again. In turn, the furnace off-gas production is reduced. As soon as the container 1 is in front of the furnace, the melting process in the furnace is continued at full force.



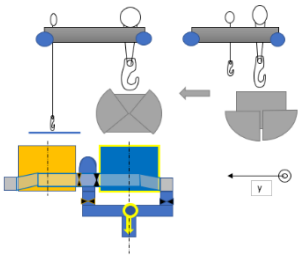
- After complete melting of the first filling, the scrap is container 1 will have reached about 900°C. The scrap is now sufficiently preheated.

- The furnace is loaded with an open roof. First, the roof lifts. Then, after a short break, the container begins to lift. The scrap begins to slide at an angle of about 36° and flows into the middle of the furnace (no asymmetric loading).

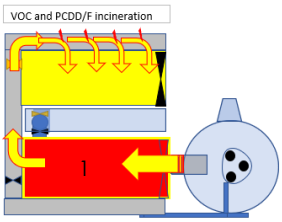


The above-described process refers to the building of a hot heel in cold furnace or for the first furnace filling.

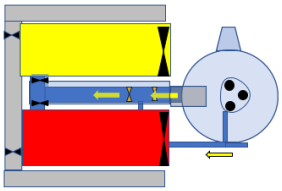
All subsequent fillings are limited to two steps: heating and cleaning of the cold scrap in one container and the actual preheating in the other container.



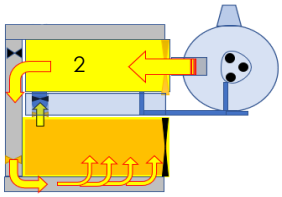
- Immediately after the container has been tipped (loading the preheated scrap into the furnace), the same container is loaded with a new scrap load. For this purpose, the roof of the container is lifted off and the scrap is loaded by means of a specially designed rectangular scrap basket. Charging takes only a few seconds, as the crane can be ready with the full basket. The scrap in the other container is already cleaned and is ready for preheating (approx. 600°C).



- After loading the scrap into the still warm container 1, the melting process can be started immediately. The first step is again to heat the cold scrap to approx. 450°C. This can take up to 2 minutes as the container is already hot and the point at which the burning of pollutants starts is reached very quickly. The analyzer in the off-gas range starts the burners as soon as the combustion of pollutants is detected. After the impurities have been burned, i.e., after about 2 minutes, the shot temperature in the container 2 has reached about 800°C.
- As soon as the outlet temperature of the container 1 has reached 400°C, the container is moved to change their positions in front of the furnace. Now the container 2 is in front of the furnace.



- Until the second filling is completely melted in the furnace, the scrap in container 2 will have reached about 900°C due to the off-gas heat. The scrap is now sufficiently preheated. In the meantime, the scrap in container 1 has reached a temperature of approx. 600°C.



The same procedure is applied to the third fill. After the third filling has been loaded into the furnace, the two containers are preheated for the next batch. The next batch can therefore easily be made according to a different scrap recipe or contain a different scrap quality. The preheating of scrap in any case reduces the energy input, the electrical and the chemical input.

Depending on the prerequisite and production concept, a hot heel is used. This helps to melt the scrap faster.

During melting, carbon monoxide (CO) is produced in the furnace. This gas, the main part of the furnace off-gas, reacts to CO_2 under certain conditions. One of these conditions is that there is enough free oxygen. Another condition is that the temperature in the reaction range is between 700 to 1000°C. These conditions are met at the exit of the fourth hole, i.e. at the entrance of the respective container. Several oxygen nozzles are embedded in the bottom of the container. As a result, the off gas is enriched with oxygen in the reaction area, which triggers the afterburning directly in the scrap. Since the gas flow in the tanks slows down considerably, the residence time of the unreacted off-gas is long enough to react completely.

2 ADVANTAGE

Like the ECOSHAFT, the main advantage of the ECOFEEDER lies in two areas:

- In scrap preheating (main argument of all shaft furnace formations)
- In the off-gas treatment (main disadvantage of all shaft furnace formations)

Scrap preheating, or energy recovery, is the main and most important element in modern steel production. Studies for the Energy Strategy 2030 and 2050 show the importance of scrap preheating in secondary steel production. Scrap preheating is a prominent part of the feasible ways of using energy efficiently, but the off-gas treatment, which is necessary due to the technology used to comply with the Air Pollution Control Ordinance, draws the track record into negative.

2.1 SCRAP PREHEATING

Since the 1960s, developers have been trying to channel the furnace's hot off gas into the scrap, with the aim of preheating it to the ground in such a way that the energy input can be positively influenced, i.e., less melting energy has to be added.

In the traditional shaft furnace (finger shaft), the energy recirculation is approx. 45kWh/t liquid steel. This is quite good given the technology used (vertical design (chimney effect) and water-cooled restraint). Other preheating devices have poorer energy return values.

Thanks to the changed configuration of the ECOFEEDER (bicameral system (staggered preheating), horizontal design, variable gas flow control, no retention devices), the energy recirculation is much better and reaches values of approx. 70kWh/t, i.e., instead of a total energy input of 635kWh/t, or 725kWh/t (see below) in the shaft furnace, the ECOFEEDER reaches values below 590kWh/t.

The advantage of scrap preheating, however, lies not only in energy recycling, but also in higher productivity, i.e., the melting time is shorter thanks to the higher scrap temperature. However, shorter melting times do not always have to be transferred to more production, but can also reduce the melting process, in which e.g., production times can be summarized and thus shortened, with the effect that energy purchasing can be positively influenced.

2.2 OFF-GAS TREATMENT

A big difference is also in the off-gas treatment. When scrap is melted, the evaporation of impurities frees up molecular chains that are toxic or are noticeable by unpleasant odor development. This environmental impact is always due to basket, shaft or continuous filling, but it is not always measurable. In the case of the shaft furnace, this environmental impact is measurable and must be prevented, as it is cyclical. There are three ways to prevent the leakage of these molecular chains, either bind them into activated carbon, or you heat them up to over 823°C (cracking) and then abruptly reduce the temperature to below 300°C and thus prevent the reformation of the molecular chain, or you burn the dissolved molecular chain. The most common method for preventing this pollution is 'cracking' with subsequent shock cooling (quench). However, this method is very expensive, as it takes up about 90kWh/t for the burners and shock cooling.

In the two-chamber system of the ECOFEEDER, the molecular chain is burned after the 'cracking', like at the cement production, so that no such additional costs can be incurred.

3 SCHEDULING

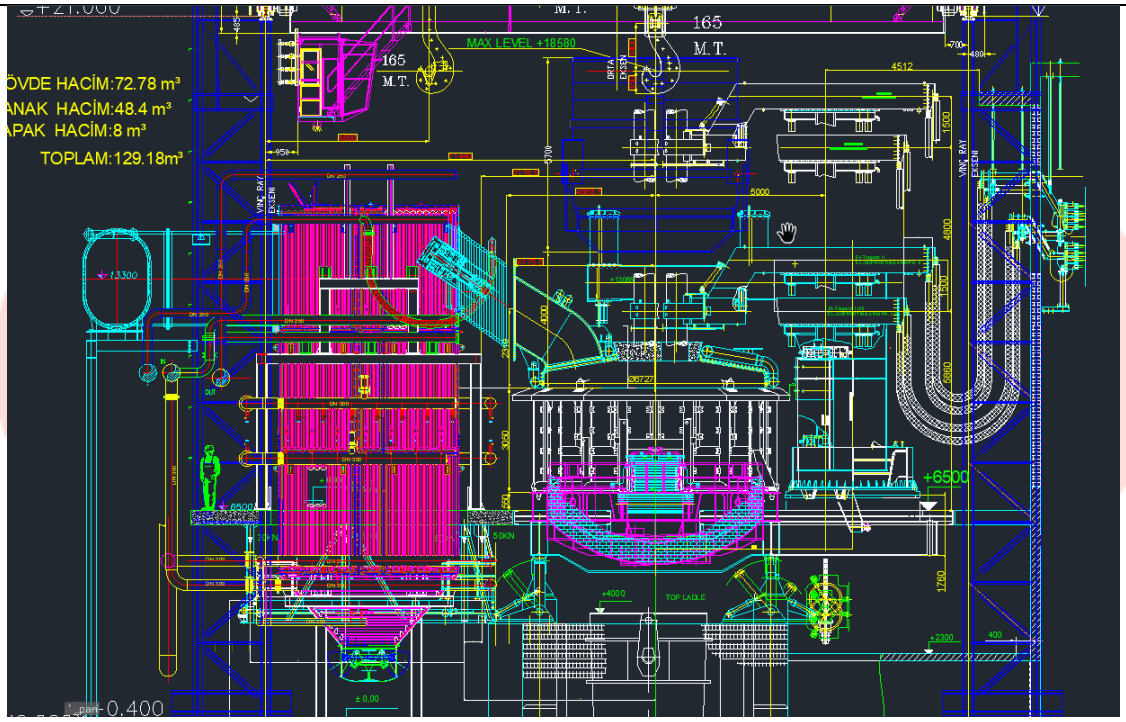
The necessary space for the installation of the ECOFEEDER is available in most cases, either by moving the nearby combustion chamber or by using the free space next to the off-gas duct that derives from the 4th hole.

Example:

A steel plant with a 120t EAF and a combustion chamber directly nearby.

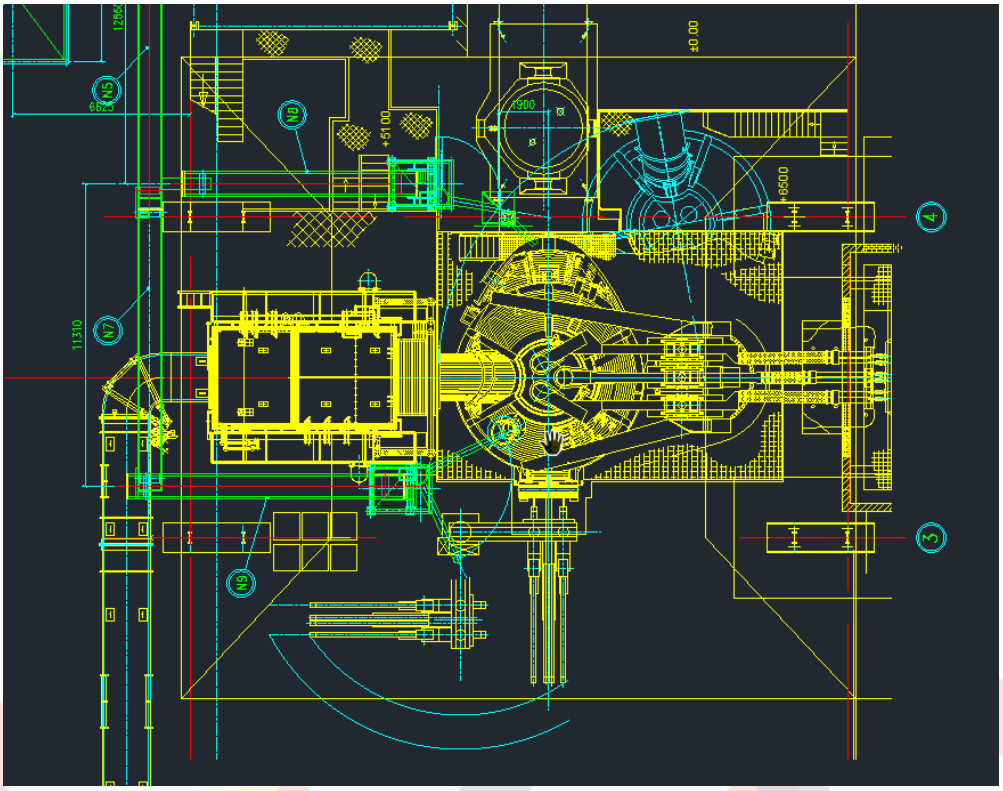
The distance between the columns and the 4th hole is 6900mm and the height of the 4th hole is 12419mm, the ladle rim is at 10100mm (6500mm (platform level) + 550mm (sill level) + 3050mm (upper shell)).

The post-combustion chamber (in pink) can be moved outside of the building and rotated by 90°, so that the output can be connected directly to the off-gas duct (light blue). There are very tight space conditions.

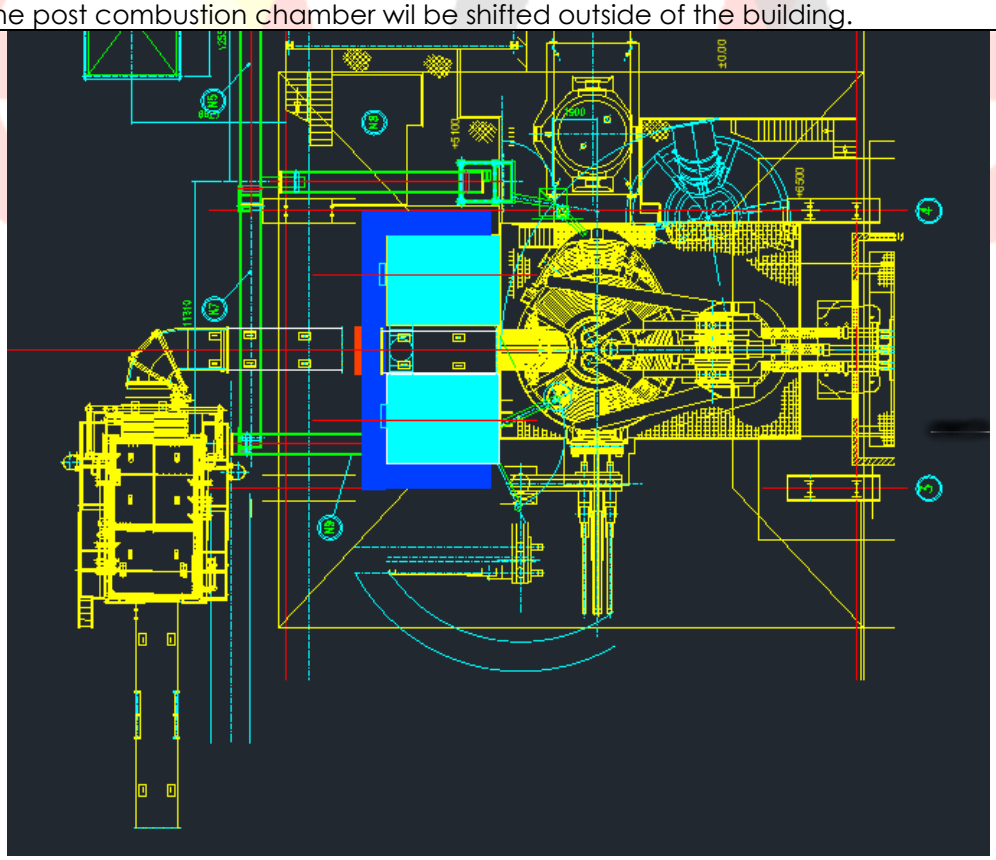


The cutting view of the steelworks; Hall width = 24640mm (wall to wall)

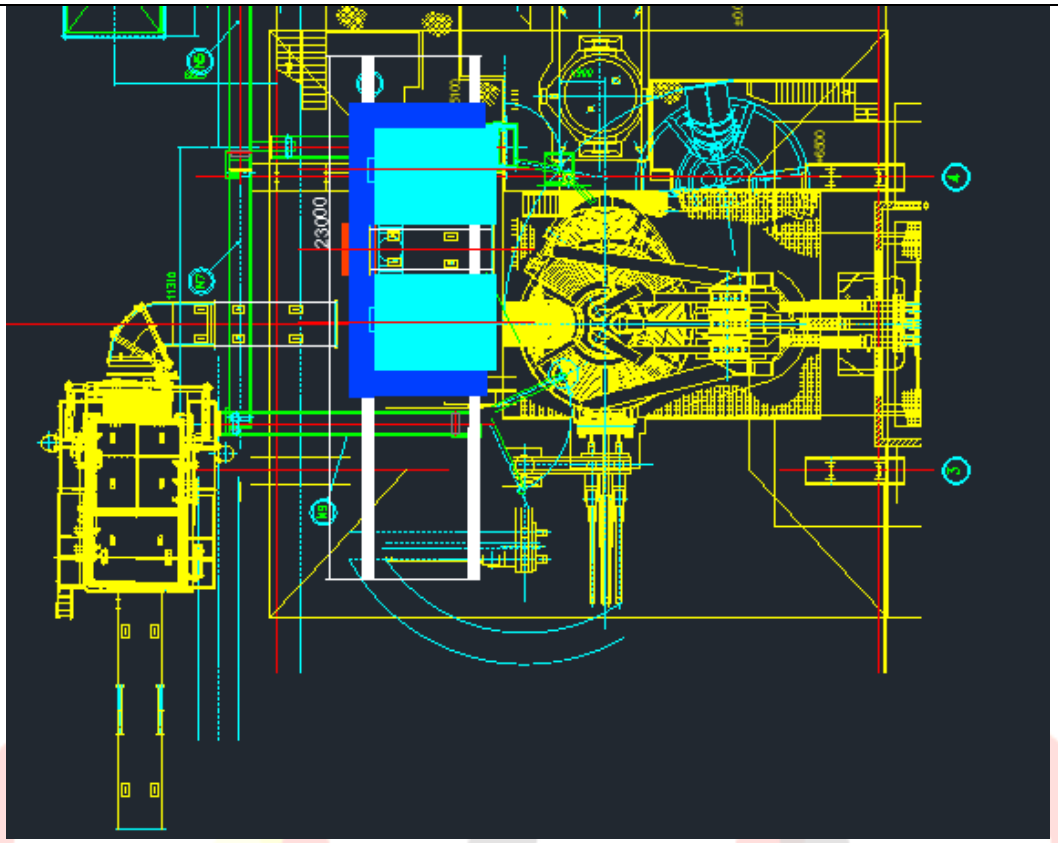
Furnace				Container				Scrap basket			Yield
Cap. (t)	Ø (m)	Upper shell height (m)	Volume (m^3)	Width (m)	Height (m)	Length (m)	Volume (m^3)	δ (t/m^3)	Weight (t)	#	#
120	5.60	3.05	75.08	3.90	2.59	4.90	49.59	**0.55**	27.27	5	0.88
120	5.60	3.05	75.08	3.90	2.41	4.90	47.78	**0.70**	33.44	4	0.93
120	5.60	3.05	75.08	3.90	2.56	4.90	38.22	**0.90**	34.40	3	0.91



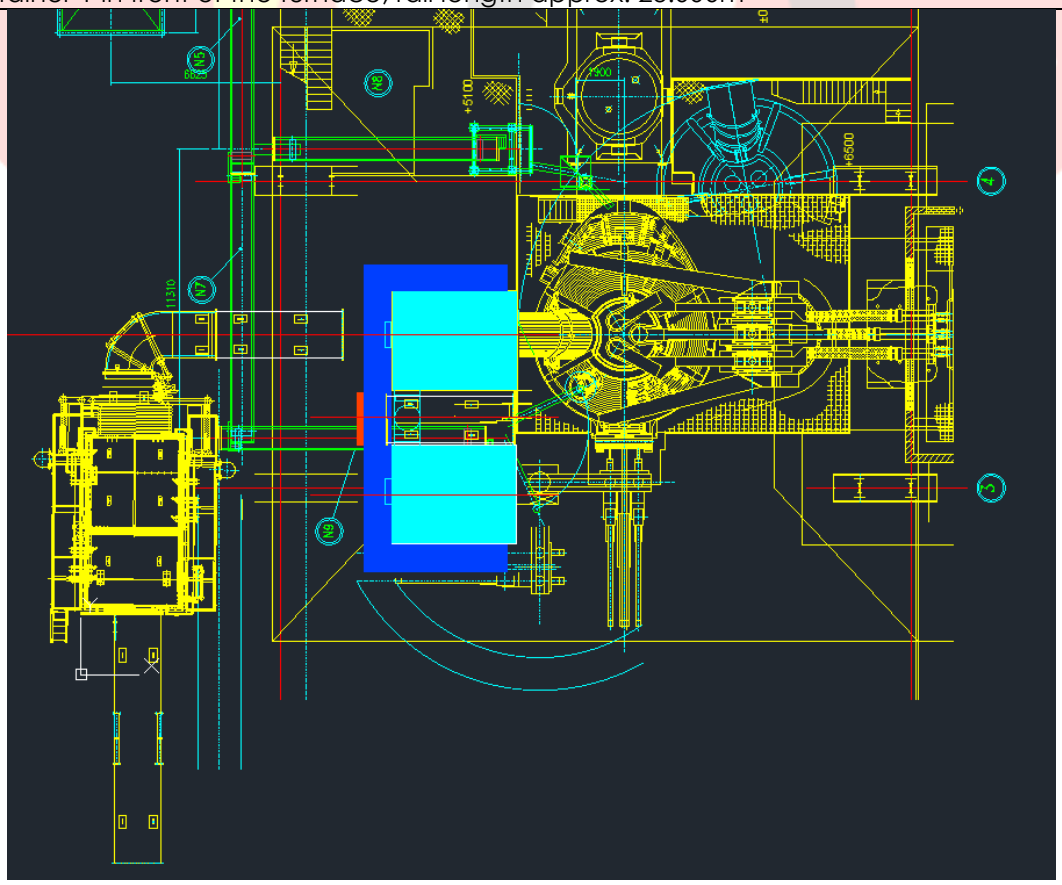
First, the post combustion chamber wil be shifted outside of the building.



Then the ECOFEEDER is added (measurements according to the table above). This picture shows the middle position with the original off-gas duct in front of the furnace.



Container 1 in front of the furnace; rail length approx. 23.000m



Container 2 in front of the furnace.

4 SIZING

The size of the scrap containers depends on different values.

Scrap density is one of them. The scrap offer varies and is hardly predictable. The design of the preheating containers is such that a variety of scrap can be preheated from "roads"-scrap (0.4t/m³) to structural scrap (1.10t/m³).

Another important value is the number of required or desired scrap baskets. The number of baskets depends on the space available to install the ECOFEEDER. The size of the container, the dimensions of the car, which eventually define the required space, also depends on the capacity and geometric conditions of the furnace, and most importantly is the crane lifting height and its side access.

A third influencing value is the production requirement. High production requires short tap-to-tap times. The hotter the preheating, the shorter the melting time. The best results can be achieved with scrap fillings, which compact "roads"-scrap with a bale press scissor to a density of approx. 0.6-0.7t/m³ and provide them in packages.

5 SPEED

Basically, there are three important movements for the construction: the opening of the furnace roof, the tilting the containers and the lateral movement of the container cart. These figures determine the power-off times, respectively the times with reduced furnace activity. Two of these are design data of the ECOFEEDER, the tilting and the lateral movement of the container cart.

The lifting, opening, closing and lowering times of the roof mechanism are values that influence the charging time of the furnace.

example:

action	Time (sec)	Roof move. Start (sec.)	Roof move. End (sec.)	Waiting time (sec)	Tilting Start (sec.)	Scrap flows (sec.)	Tilting End (sec.)
Roof lift *)	12	0	12				
Roof open *)	24	12	36	5			
Tipping container on	40				17		57
Discharge (at approx. 36°)	2					53	
Tipping container off	20				57		77
Roof close *)	22	60	82	5			
Roof lower *)	10	82	92				

*) Measured times.

Important: The roof opening must start before the container can be lifted (5 sec. waiting time) and the lowering of the containers must be completed before closing the roof (ideally also 5 sec.).

The lateral movement of the container cart is not problematic, as the furnace roof is closed during this process. For energy-saving reasons, however, this interruption should be as short as possible.

6 AVAILABILITY

Important questions are: how long does the production to be interrupted for the construction of the plant, or what happens during maintenance work, or what happens in emergency or abort situations?

6.1 INTERRUPTION OF PRODUCTION

Production does not need to be interrupted, and the production unit can continue to operate as planned. The ECOFEEDER can be completely pre-assembled in the workshop. The foundations for the basic structure of the ECOFEEDER (rails and their supporting structure) can be produced during normal production or during production stops.

6.2 ASSEMBLY

Construction phase: The structure of the ECOFEEDER (rails and their supports) is installed first, followed by the media room (valve station for burners), hydraulic room and electric room. Then the off-gas connection and the off-gas bypass are built with the connection for the air curtain. At the end, the prefabricated ECOFEEDER is placed on the rails, the hoses are connected, the hydraulics are cleaned and inserted, the electrical cables are connected between the two junction boxes. After that, the installation is ready for cold testing and commissioning.

6.3 MAINTENANCE

Maintenance: The maintenance of the furnace is not affected by the ECOFEEDER, the replacement of a container can be accomplished in a few working days, any maintenance of the ECOFEEDER has no influence on the production. However, safety rules must be complied with. Otherwise, there are no other influences.

6.4 EMERGENCY AND ABORT SITUATIONS

In the event of an emergency at the furnace or at the ECOFEEDER, or in the event of the need to stop the preheating of scrap, there is no danger to humans or material. The production unit can continue to produce or cool down via the traditional off-gas-system. In the event of interruptions or system errors, the ECOFEEDER can move to the middle position and the production unit can continue to work without any problems.

6.5 EXPANSION

The ECOFEEDER can subsequently be converted into an ECOSHAFT II (Mover). For this purpose, the adjustment of the round electric furnace (lower and upper shell), the furnace cover and the replacement of the off-gas bow (4th hole) by a shaft with an elbow is sufficient.

For more information, please contact us at: rvm@eco-eag.com or clesid@clesid.com or call us at the given numbers (1st page).

If you need a tailor-made offer for your steelworks, please download the questionnaire from our homepage www.eco-eag.com/downloads, fill in therequested information and send it together with ar cut- andan accessof your furnace area (dwg or similar electronic files) by e-mail to one of the above addresses.