OXYCUP® shaft furnace plants are proven technology for iron recovery from ferrous waste material.

The OXYCUP® process is a smelting-reduction process based on self-reducing agglomerates, so-called C-Bricks. This technology is a common development of ThyssenKrupp Steel and KÜTTNER.

During the past years Küttner has also supplied a number of large shaft furnace melt shops with focus on scrap operation. The scrap processing shaft furnace was implemented in works looking for additional hot metal supply for their existing steel making capacities or a way to decrease specific CO2 emission by supplementing ore-based BF hot metal production. Shaft furnaces are well suited for a variety of different metallic charge materials like:
• dirty heavy metal scrap HMS1/2
• galvanized scrap (bales/shreddered)
• pit scrap or iron/steel skulls
Successful tests have been realized with hot briquetted iron (HBI). Based on this it is now also available for plants with pre-reduced/direct reduced materials from rotary hearth/kiln or natural gas based reduction plants.

OXYCUP® shaft furnace technology is now also available for the recovery of Cr and Ni from stainless steel waste materials.

The engineering company, which was founded in 1949 by Dr. Carl Küttner, has evolved into a group of companies working worldwide in plant engineering and construction. The company supplies and erects turnkey installations for a wide range of process technologies, including melting and material handling in the iron, steel and foundry industries.

KÜTTNER has built different types of furnaces, like fixed bed, rotary and shaft furnaces for organic/inorganic waste, non-ferrous metals and iron processing. The furnaces presented in this field are developed from the long campaign cupola furnaces for steel mills.

The services provided include development of new technologies, engineering and design, supply, installation and startup of plants furnished with controls and data processing systems.

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KÜTTNER GMBH & CO. KG

JFE, Japan
Scrap melting shaft furnace plant 2,400 t/d

Sicartsa, Mexico
Shaft furnace producing 2,000 t/m from scrap

ThyssenKrupp Steel, Germany
OXYCUP® for recycling of 500 t/day of ferrous dust and dross material

Nippon Steel, Japan
Shaft furnace producing 1,350 t/m from scrap

JRF, Japan
Scrap melting shaft furnace plant 3,050 t/m

TISCO, China
Double OXYCUP® plant for ferrous and non-ferrous dusts, dross and skulls – shaft furnaces 850 t/m
In contrast to other alternative iron making processes the OXYCUP® melt shop directly produces liquid hot metal similar to blast furnace quality. A C-Brick may be composed of a variety of different ingredients. In particular mixtures with high iron content like BOF dust or sludge are welcome, but also mixtures with high carbon content like BF dust. The agglomerates are produced on site in the C-Brick agglomeration plant.

BoF dust contains about 65% of iron – only 10% less than high grade ores. This is the basis of the Zero Waste Concept of ThyssenKrupp Steel.

The direct-reduction of the metal oxides is mainly done by the carbon present in the brick. Compounds like lime and silica contained in the sludge determine the basicity of the slag together with about 10% cement being added as a binder.

Recycling of zinc and alkali-containing fines as well as of heavy residues of unknown analysis is now possible for the benefit of the blast furnace technology as well as for blast furnace route and converter operations.

Easy integration into a steel mill, high process flexibility with respect to charge materials and operation, low space and investment requirements are additional advantages of this economic waste and by-product processing technology.

The environment benefits as well. All emissions with respect to SOx, NOx, Dioxines, etc. are far below the legal limits.

Since start of operation in 2004 the OXYCUP® process has turned out to be a reliable proven technology. A variety of different residues has been used in C-Brick mixtures and converted to hot metal. The percentage of bricks in the charge can vary between 0% and 100%, the balance being lumpy residues like pit scrap/skulls or zinc coated bales.

**BOF pit scrap**

**pig iron skulls**

**C-Bricks from dust, sludge, ores, fines**
In contrast to other alternative iron making processes the OXYCUP® melt shop directly produces liquid hot metal similar to blast furnace quality. A C-Brick may be composed of a variety of different ingredients. In particular mixers with high iron content like BOF dust or sludge is welcome, but also mixers with high carbon content like BF dust. The agglomerates are produced on site in the C-Brick agglomeration plant.

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The direct-reduction of the metal oxides is mainly done by the carbon present in the brick. Compositions like iron silicate and silica contained in the oxides determine the basicity of the slag together with about 10 % cement being added as a binder. Recycling of zinc and alkali containing fines as well as low-iron residues of unknown analysis is now possible for the benefit of the basic oxygen steelmaking process as well as for blast furnace route and converter operations.

Easy integration into a steel mill, high process flexibility with respect to charge materials and operation, low space and investment requirements are additional advantages of the economic waste and by-product processing technology.

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**Principle of metal oxide reduction in C-Brick**

\[
\text{MeO} + x\text{C} \rightarrow \text{Me} + x\text{CO}
\]

Charged from the top into the OXYCUP® shaft furnace the self-reducing C-Bricks are first pre-heated in counterflow with the furnace gas to some 500 °C. First metallic iron is formed in the outer shell of the brick. This shell grows and secures the stability of the brick above 1,000 °C when the cement will disintegrate and direct reduction starts with the help of carbon included.

At about 1,450 °C the brick has totally converted into solid iron sponge which is melted together with other metallic charge in the hearth. The hot metal leaves the hearth continuously over an iron-slag siphon system at 1,500 °C with a carbon content of about 4 %.

**In-plant by-products**

Direct hot metal from in-plant by-products

in an integrated steel mill

in an integrated steel mill

**The WINNER: THE ENVIRONMENT**

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Easy integration into a steel mill, high process flexibility with respect to change materials and operators, low space and investment requirements are additional advantages of the ecologic waste and byproduct processing technology.

**Environmental benefits as well:** All emissions with respect to SOx, NOx, Dioxines, etc. are far below the legal limits.

Since start of operation in 2004 the OXYCUP® process has turned out to be an efficient proven technology. A variety of different residues has been used in C-Brick mixtures and converted to hot metal. The percentage of bricks in the charge can vary between 0 % and 100 %, the balance being lumpy residues like pit scrap/skulls or zinc coated bales.

**Direct hot metal from in-plant by-products**

In integrated steel works on OXYCUP® furnaces supplement the hot metal from the blast furnace. Because of the comparatively small quantities of hot metal required for steel mills the C-Brick can substitute a portion of hot metal from the OXYCUP® and then rise into filling up with hot metal content to blast furnace.

**Environmental benefits:**

- All emissions with respect to SOx, NOx, Dioxines, etc. are far below the legal limits.
- Low CO2 emissions are the result.

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**Direct hot metal from in-plant by-products**

In integrated steel works on OXYCUP® furnaces supplement the hot metal from the blast furnace.

- Because of the comparatively small quantities, torpedo cars or iron ladles first collect a portion of hot metal from the OXYCUP® and then mix it by filling up with hot metal from a blast furnace.

- After desulphurization the hot metal mixture is transferred to the steel shop.

In times of high hot metal demand the OXYCUP® can almost double its production if a high iron containing charge, like 100 % pit scrap, is employed. Only 170 - 200 kg of coke are necessary to convert pit scrap into one ton of hot metal. Low CO2 emissions are the result.

**Environmental authorities from the USA, Mexico, Japan and Germany have confirmed that all other emissions are also far below the permissible limits.**

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**OXYCUP®: HOW IT WORKS**

zerowaste: recycling saves valuable resources

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- The cleaned top gas of blast furnace quality is used in the gas network of the steel plant. In combination with electric melting the OXYCUP® can solve the residue problems of high zinc containing dusts. Charging the liquid hot metal into an electric arc furnace reduces electric power consumption. The winner is always the environment.

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During the past years Küttner has also supplied a number of large shaft furnace melt shops with focus on scrap operation. The scrap processing shaft furnace was implemented in works looking for additional hot metal supply for their existing steel making capacities or a way to decrease specific CO2 emission by supplementing conventional BF hot metal production. Shaft furnaces are well suited for a variety of different metallic charge materials like:

- dirty heavy metal scrap HMS1/2
- galvanised scrap (baled/shreddered)
- pit scrap or iron/steel skulls
- hot briquetted iron (HBI)

Successful tests have been realized with hot briquetted iron. Based on this it is now also available for plants for pre-reduced/direct reduced materials from rotary hearth/kiln or natural gas based reduction plants.

OXYCUP® shaft furnace technology is now also available for the recovery of Cr and Ni from stainless steel waste materials. The engineering company, which was founded in 1949 by Dr. Carl Küttner, has evolved into a group of companies working worldwide in plant engineering and construction. The company supplies and erects turnkey installations for a wide range of process technologies, including melting and material handling in the iron, steel and foundry industries.

KÜTTNER has built different types of furnaces, like fluidized bed, rotary and shaft furnaces for organic/inorganic waste, non-ferrous metals and iron processing. The furnaces presented in this field are developed from the long campaign cupola furnaces for steel mills. The services provided include development of new technologies, engineering and design, supply, installation and startup of plants furnished with controls and data processing systems.

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KÜTTNER GMBH & CO. KG

CUSTOMISED SHAFT FURNACE PLANTS

OXYCUP® shaft furnace plants

Recycling By-Products
Export of Surplus Gas
Additional Hot Metal
Saving of Resources
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