# *Mines and Metals Engineering GmbH*

*MME GmbH is officially established and registered company in Düsseldorf, Germany since 1996 to provide engineering services for mining and metals industries worldwide*

*MME GmbH can provide consultancy and support, development in projects from feasibility study guiding customers from concept to commissioning to realize their targets with high quality*

***MME fields:***

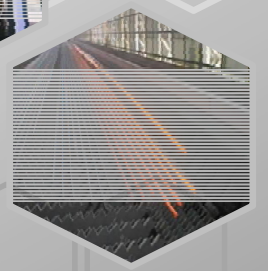
***Iron Mines Industries***

***Iron Making Industries – Direct Reduction***

***Steel Making Industries***

***Pelletizing plant***

***Rolling Mills***



# PERED®

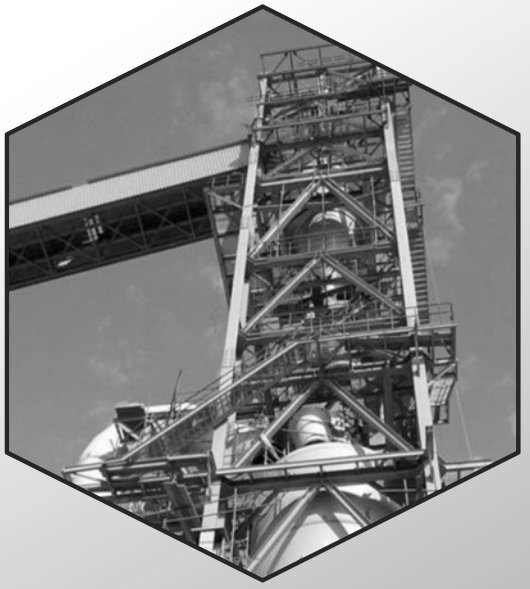
*Is the Direct Reduction Technology*

*invented and patented*

*by*

*Mines and Metals Engineering GmbH*

The **PERED®** Direct Reduction Process converts iron oxides, in the form of pellets or lump ore, to highly reduced product suitable for steel making..




# PERED®

*The technology improves direct reduced iron process for making DRI*

*To economize* → *energy*

*To economize* → *resources*

*To create a flexible technology for producing direct reduced iron*

# PERED®

LOWER

- CAPITAL COST
- WATER CONSUMPTION
- MAINTENANCE COSTS
- ENERGY CONSUMPTION

# PERED®

**FLEXIBILITY**

- TO USE LUMP ORE UP TO 50%
- END PRODUCT HDRI / CDRI / HBI
- TO USE HIGH SULPHUR ORE
- TO USE LOCAL MATERIAL

# PATENTED IN GERMANY

***The MME process has been invented and developed by the experts having rich experience in every field of Direct Reduction process, which has ensured that all the flows of other processes are taken care in this process and provides the optimum and efficient results***

BUNDESREPUBLIK DEUTSCHLAND

URKUNDE

über die Erteilung des

Patents

Nr. 10 2006 062 689

IPC
C21B 13/02 (2006.01)

Bezeichnung
Schachtofen für die direkte Reduktion von Eisenoxid

Patentinhaber
MINES and METALS Engineering GmbH (M.M.E.), 40474 Düsseldorf, DE

Erfinder
Najmossadat, Seyed Mohammed Reza, Teheran, IR

Tag der Anmeldung
21.12.2006

München, den 22.01.2009

Die Präsidentin des Deutschen Patent- und Markenamts

Rudloff-Schäffer

# PERED®

*The reduction of iron oxide in direct reduction process is accomplished by the following reducing agents*

- *carbon monoxide (CO)*
- *hydrogen ($H_2$)*

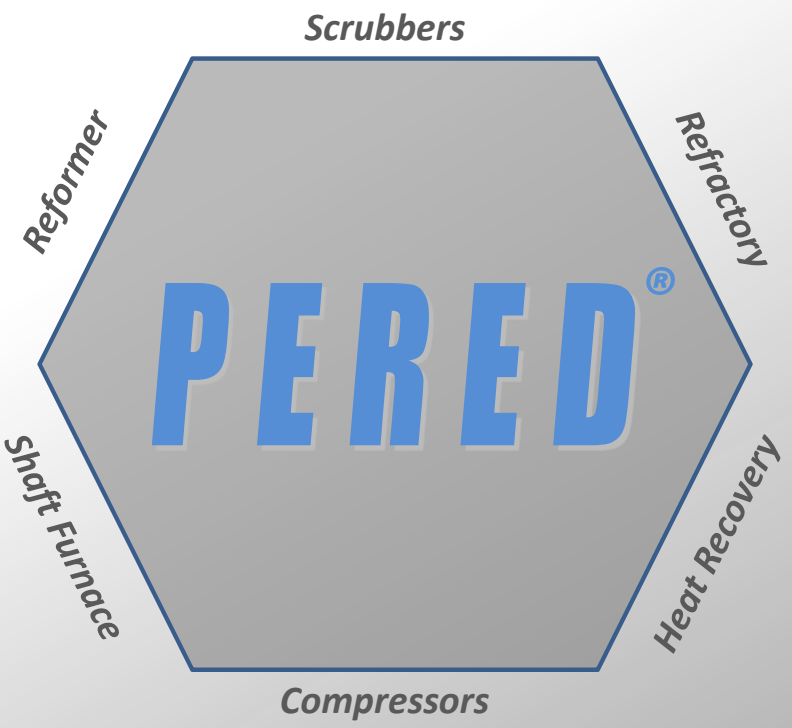
*Fe (Oxide) + CO and/or $H_2$ ==> Fe (Metal) + $CO_2$ and $H_2O$*

# PERED®

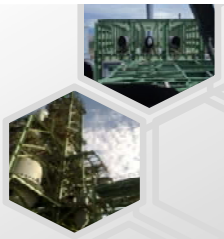
***PERED® technology for DRI production***

- ***Is an improved energy efficient technology***
- ***Is created flexibility to work with different raw material and different energy sources***
- ***Is reducing the overall cost***

# Where We Innovated




# DRI PROCESS BLOCK DIAGRAM



NG

NG STATION

MATERIAL HANDLING OXIDE

COMPRESSOR HOUSE

CORE PLANT

RW

RO PLANT

W T P

PRODUCT HANDLING

BRIQUETTING PLANT

LABORATORY

WORKSHOP

CONTROL ROOM

MSP

Mines & Metals Engineering GmbH

FEEDSTOCK OPTIONS

100% Oxide Pellets

Up to 70% Lump Ore

Up to 10% Solid Fines

REFORMER OPTIONS

PERED Reformer

Steam Reformer

ENERGY OPTIONS

Natural Gas

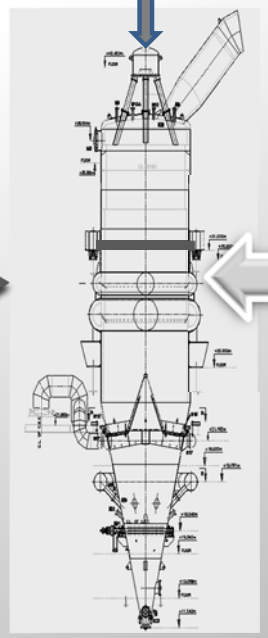
Coal

COAL GAS OPTION

Gasifier Syngas

COREX ® Offgas

Coke Oven Gas



Shaft internal diameter 5,65m to 6,65 m

MODULE CAPACITY OPTION

*300.000 tpy to 2.000.000 tpy*

Cold DRI

HBI

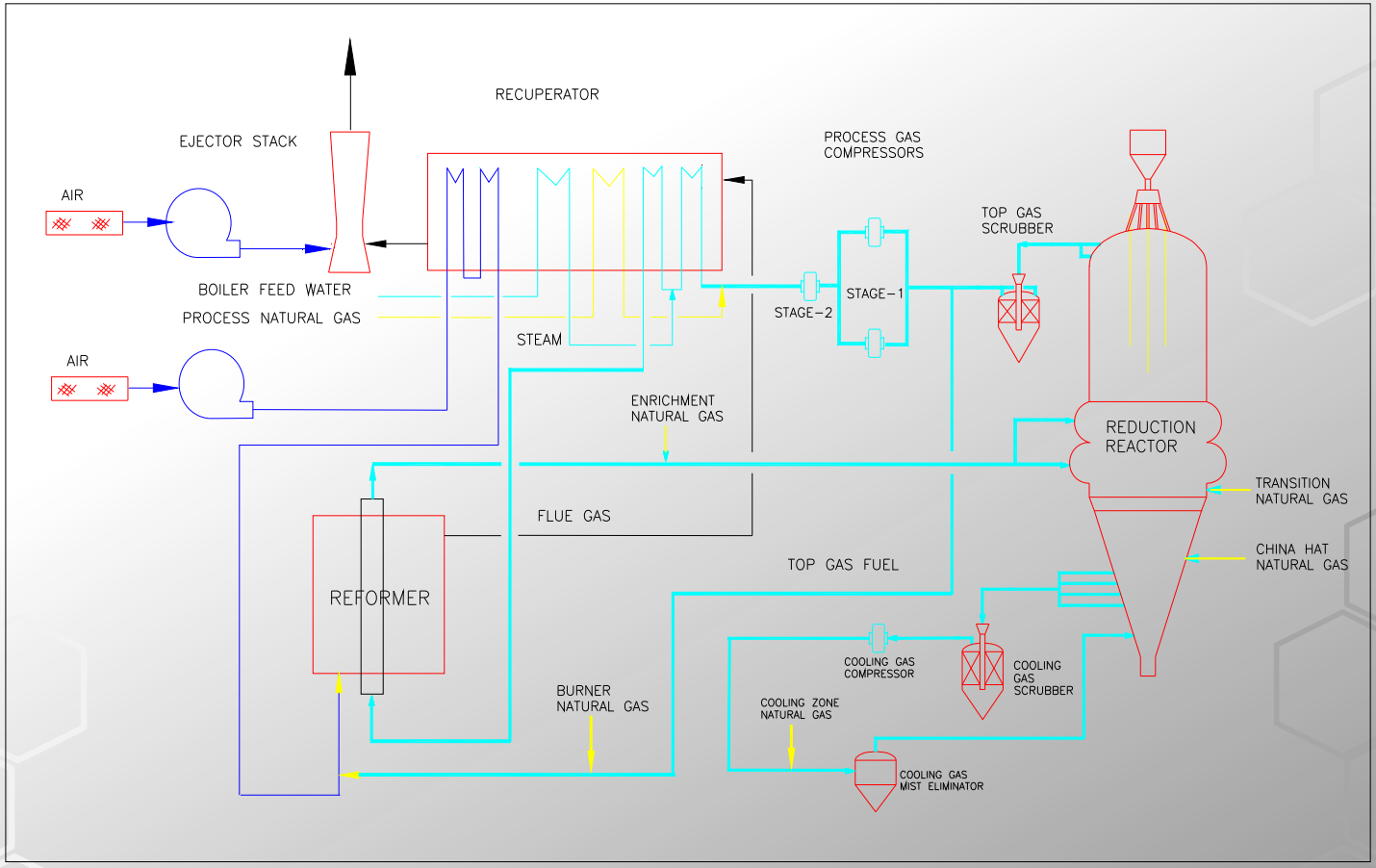
Cold DRI and HBI

Hot DRI and Cold DRI

Hot DRI and HBI

PRODUCT OPTIONS

# DRI PROCESS FLOW DIAGRAM



# PERED®

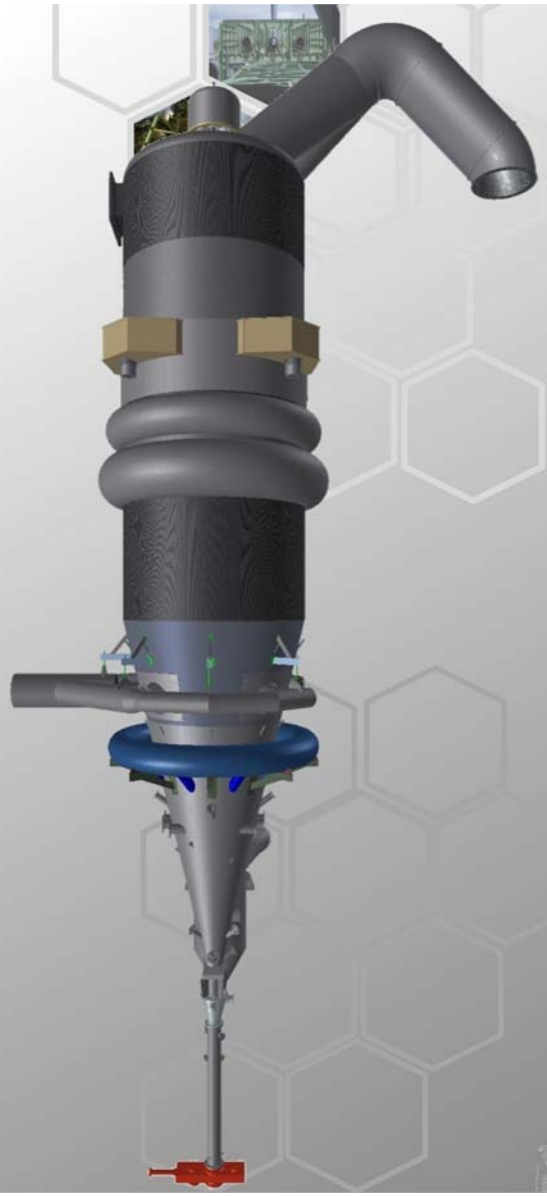
*MME innovation and review on main equipment starts from*

## *VERTICAL SHAFT FURNACE*

***PERED® Vertical Shaft Furnace is unique of its kind***

***Designed to improve the solid & gas flow patterns to improvise the reaction being taken place***

***Designed to have higher production rate / volume of reduction zone.***

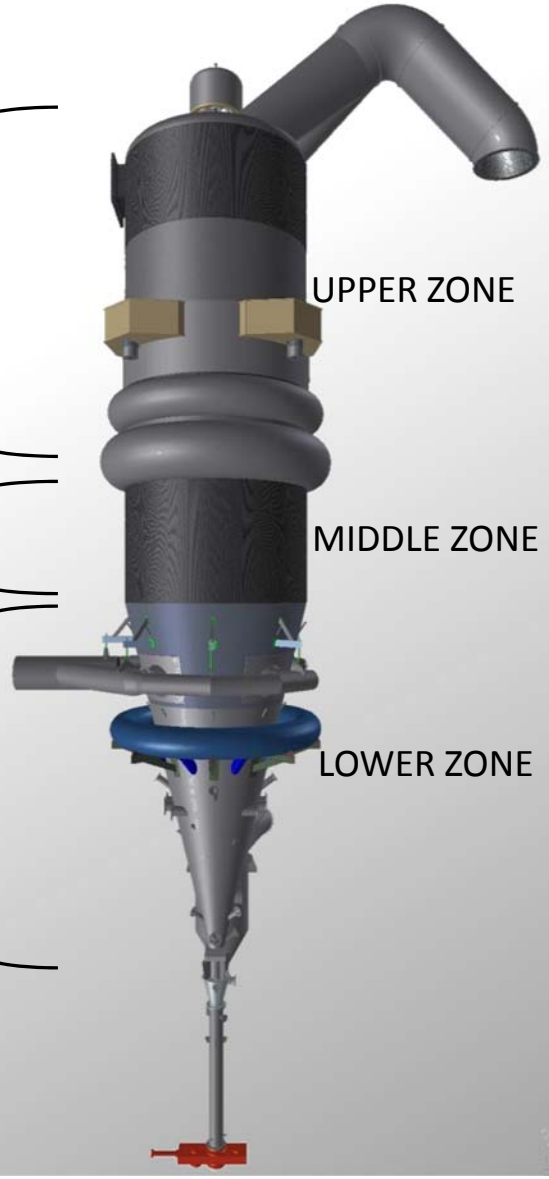


# PERED®

REDUCTION

TRANSITION

COOLING



UPPER ZONE

MIDDLE ZONE

LOWER ZONE

## Shaft Furnace

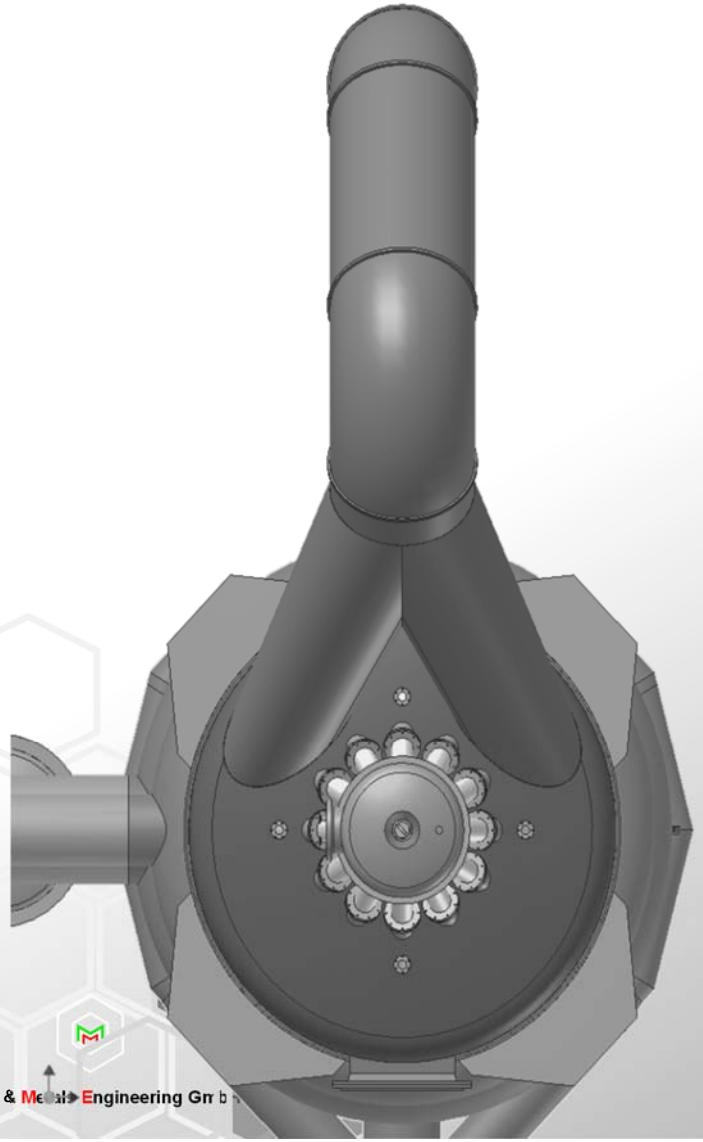
*Top ( Reduction ) Zone*

*Oxide feeding & distribution inside the furnace by special feed pipes.*

*Optimizing the ratio of height to diameter which improves utilization of the furnace.*

*Optimizing reduction reaction with:*

- ⇨ *No equipment in the furnace reduction zone*
- ⇨ *Reduces fines generation*
- ⇨ *Improves material distribution inside the furnace*
- ⇨ *Increase effective reduction volume*
- ⇨ *Eliminates possible pollution due to gas leakage*
- ⇨ *Capital cost reduction*
- ⇨ *Maintenance cost reduction*



# *Shaft Furnace*

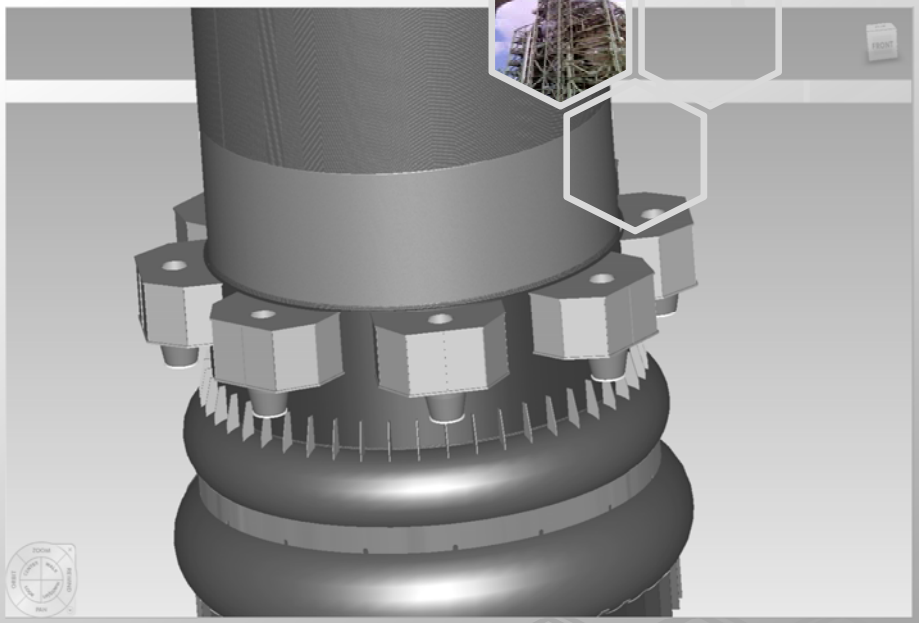
*Top ( Reduction ) Zone*

*Design characteristics:*

- ⇨ *Dual top gas off take design from the top dished end*
- ⇨ *Better burden temperature profile to achieve uniform product quality*
- ⇨ *Reduce fines/pellet carry over & thus improves the refractory life at top gas duct*
- ⇨ *Optimise furnace size/ réductions zone volume*
- ⇨ *Lower off take température due to improve efficience thus lower load on scrubbers*

# Shaft Furnace

## Reduction Zone



**Design characteristics:**

- Dual reducing gas injection
- Flexibility to have different gas composition and temperature with oxygen injection
- Better utilization of the bustle gas
- Improves distribution of gas in the furnace
- Improve productivity and quality
- Uniform bed temperature across the furnace
- Eliminate clustering possibility
- Flexibility to use lump ore
- Rectangular bustle ports design
- Tapered refractory construction to take care of DRI swelling

**Bustle Port arrangement**

*Specially designed ports for better gas injection and better maintainability*

# Shaft Furnace

## Reduction Zone

### In-situ reforming

*Hot bustle gas with a certain percentage of $CH_4$ and $CO_2/H_2O$, in contact with metallic iron, which acts like catalyst generates additional reducing gas inside the shaft furnace, in fact, the shaft furnace acts like a reformer*

*In-situ reforming reactions are:*

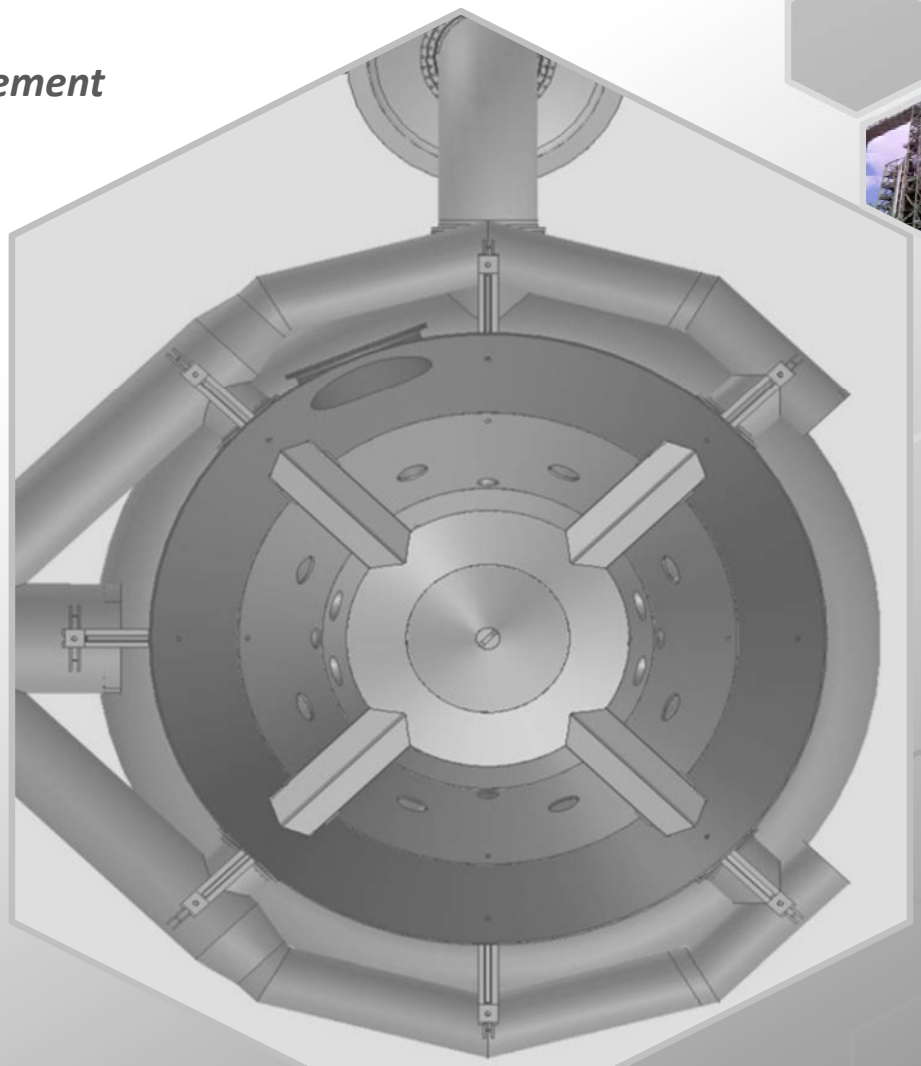
$$CH_4 + H_2O \rightarrow CO + 2H_2 \quad DH>0$$

$$CH_4 + CO_2 \rightarrow 2CO + 2H_2 \quad DH>0$$

*On one hand, the endothermic In-Situ reforming needs high bustle gas temperature. On the other hand, pellet/lump degradation, fine generation and clustering in the bustle area will occur at higher bed temperature.*

*State of the art PERED® double bustle port optimizes the amount of $CH_4$ in the bustle gas which is required to control the bed temperature.*

# *Cooling Gas Off Take Arrangement*



## *Shaft Furnace Lower*

***Cooling Zone***

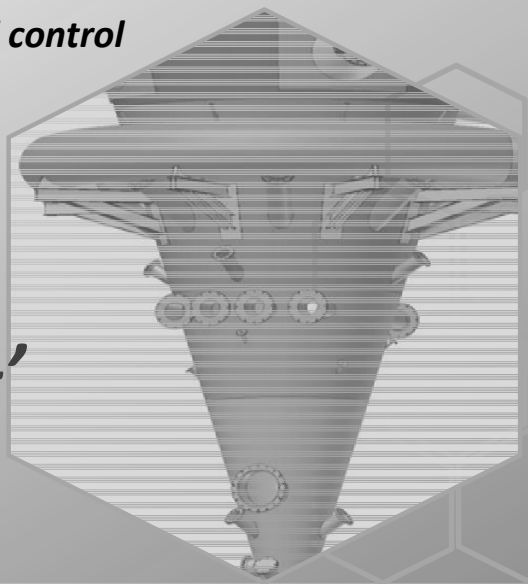
***Design caracteristics:***

- ***State of the art 360 degree rotating burden feeders***
- ***Better and uniform performance***
- ***Feeding burden with 4 independently controlled rotating shafts***
- ***No water jacketing as it is in the cold zone***
- ***Dislodging of cluster if formed, by reverse rotation and speed control***

***Cooling gas Offtake and China hat***

- ***Injection of cooling gas to cone from outside header***
- ***Uniform hot cooling gas collection by shaped Offtake***
- ***No refractory in the header which can cause failure***

***'+'***

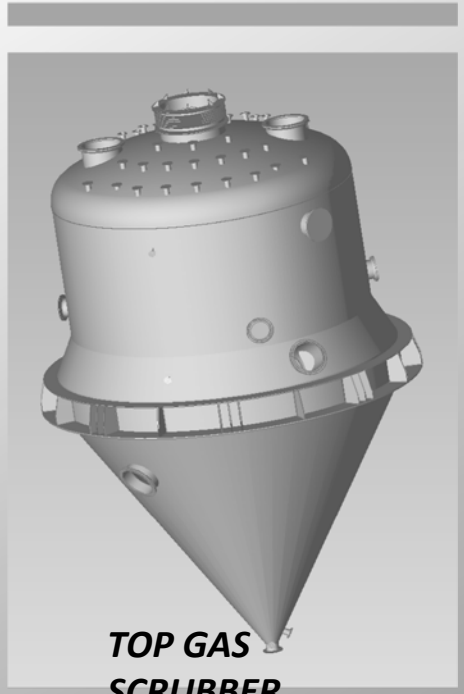


# *REFORMER*

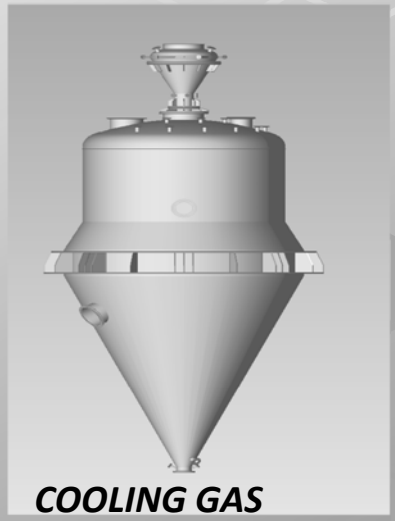
- *Reduction gases .i.e. H2 & CO are Producded in Reformer by reacting with Carbon dioxide and Steam*
- *Usage of Super Active PERFORMEX Ctalysts*
- *Safe Reformer operation with High H2/CO Ratio*

# Top Gas Scrubber & Cooling Gas Scrubber

- ***Scrubbers with high efficiency to remove the fines in Top Gas & Cooling Gas***
- ***Impoves the Life of Ducts, Refractory & Compressors***



***TOP GAS SCRUBBER***



***COOLING GAS SCRUBBER***

## *Compressors*

***Operation with higher pressure by proven system***

***Dry process gas leads to higher gas flow with the same system, which in turn increases the production or for same production reduces power consumption.***

## *PERED® technology brings the following advantages*

- ***Lower capital investment***
- ***Lower energy & operation costs***
- ***Lower environment pollution***
- ***Jumbo module for more than 1 MTPY***
- ***Option for hot DRI / HBI / HDRI and combinations***
- ***Flexibility to use high sulphur ore***

# The construction

Reduction Furnace

Reformer & Heat Recovery

Gas Compresors

Rotating Burder Feeder

Reduction Furnace

# The PERED® plants

Mines & Metals Engineering GmbH

# The PERED® plants

Plant nominal capacity of **800,000 TPY** of oxide pellet 5mm ÷ 35mm

| Main specification data | Value |
|---|---|
| Max diameter | Approx 5.5m |
| Total Height | 52m approx |
| Hourly produciton rate | 105t/h |
| Plant operating time | 8000 hrs/year |
| Operating temperature of furnace | 850°C |
| Normal furnace operatingpressure top | 0,6kg/cm² g |
| Normal furnace operatingpressure bottom | 2.1kg/cm² g max |
| Reduction gas requirement | 170000 Nm³/h |
| Reduction gases per ton of product | 1600 Nm³ |
| DRI density | 1.7 t/m³ |
| Oxide density | 2.3 t/m³ |

# The PERED® plants

## Performance Specification Features of PERED DRI Plants

| Main specification data | Unit | Value (Achievable) |
|---|---|---|
| Capacity | MMTPY | 0.3 -2.0 |
| Metalization | % | 92 - 95 |
| Carbon | % | 1.5 -3.0 |
| Consumption Oxide | T/Ton of DRI | 1.42 or less |
| Consumption Natural Gas | Gcal/Ton | 2.35-2.65 |
| Consumption Power | kWh/Ton of DRI | 90-120 |
| Consumption Water | M3/Ton of DRI | 0.9-1.3 |
| Flue Gas Exit | Deg.C. | 250-280 |
| Maintenance Cost | Euro/Ton of DRI | 3.5 |
| Man-hour | Manhr/Ton of DRI | 0.3 |
| | | |

# THE PERED® DRI PROJECTS

- SHADEGAN **PERED®** (0.8 MTPY) Turn Key – In Operation
- MIYANEH **PERED®** (0.8 MTPY) Engineering & Equipment Supply – In Operation
- NEYIRIZ **PERED®** (0.8 MTPY) Engineering & Equipment Supply- In Operation
- BAFT **PERED®** (0.8 MTPY) Turn Key – Under Construction
- CSTM **PERED®** (0.3 MTPY) Engineering & Equipment Supply - With Syn Gas From Coke Oven – P.R. of CHINA – Under Construction

# THE PERED® DRI PROJECTS

SHADEGAN STEEL COMPLEX **PERED®** (0.8 MTPY)

- Commissioned on 21st June 2017
- Production until June 2018 > 500,000 MT
- Maximum rate achieved so far 105 T/H
- Met. 92 to 95%. Carbon 1.5-3.0 %
- NG Consumption  at rated capacity 2.45 Gcal/Ton
- Power Consumption at rated capacity 105 kWh/Ton
- Water Consumption at rated capacity 1.0 m3/Ton

# THE PERED ® DRI PROJECTS

MIYANEH STEEL COMPLEX **PERED®** (0.8 MTPY)

- Commissioned on 05th September 2017
- Production until May 2018 > 500,000 MT
- Maximum rate achieved so far 108 T/H
- Met. 92 to 95%. Carbon 1.5-2.0 %
- NG Consumption  at rated capacity 2.45 Gcal/Ton
- Power Consumption at rated capacity 105 kWh/Ton
- Water Consumption at rated capacity 0.85 m3/Ton

# THE PERED ® DRI PROJECTS

NEIRIZ GHADIR STEEL COMPLEX **PERED®** (0.8 MTPY)

- Commissioned on 24th January 2018
- Production until May 2018 > 275,000 MT
- Maximum rate achieved so far 100 T/H
- Metn 92 to 95%. Carbon 1.5-2.0 %
- NG Consumption 2.45 Gcal/Ton
- Power Consumption 105 kWh/Ton
- Water Consumption 0.9 m3/Ton

***Positive observations during first commissioning of PERED®***

***DRI Plants in coherence with Technology Features***

- *Production with Met. as high as 95% achieved during the first startup in less than 24 hrs.*
- *No cluster observed during first start up*
- *Very less percentage of fines observed on the product*
- *Uniform Temperature profile across reduction zone*
- *Quick start up after a lay over*
- *Improved operation cycle of scrubber packings*

# LOOKING TO THE FUTURE

JUMBO MODULE DRI

HOT CHARGING OF DRI TO STEEL MAKING

HOT DRI TRANSPORT

BRIQUETTING OF COLD DRI

# THANK YOU