Coke Oven Pressure Regulation – The next generation PROven® system

“PROven® NG”

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Pressure development during coking time at coke oven doors

![Graph showing pressure development over coking time with different emission levels and ideal pressure levels.]

- High Emissions
- Low Emissions
- Current practice adjustment
- Ideal pressure
- Low emission adjustment
- Air ingress
Conventional operation: „on the main“ and „off the main“

Oven is „on the main“ ready for charging / coking process

- Goose neck
- Collecting main
- Flushing liquor
- Collecting main valve (opened)
- Standpipe lid is closed

\[ P_{\text{oven}} = P_{\text{collecting main}} \]

Oven is „off the main“ ready for pushing

- Collecting main valve (closed)
- Standpipe lid is opened

\[ P_{\text{oven}} = 0 \text{ mbar} \]

No oven pressure control during coking process.
Some basics of PROven® - Pressure Regulated Oven

The most important technological improvements of PROven®:

- The oven pressure is decoupled from the collecting main pressure.
- The collecting main operates with negative pressure.
- The pressure inside each oven is controlled individually.
- Charging gases are sucked off by negative collecting main pressure.
- The conventional valve is replaced by a so called „FixCup“.
The PROven® system
PROven®: Operation of the FixCup

Oven is “on the main” ready for charging

\[ P_{\text{oven}} = P_{\text{collecting main}} \]

Oven pressure regulation during coking process

\[ P_{\text{oven}} \neq P_{\text{collecting main}} \]

Oven is “off the main” ready for pushing

\[ P_{\text{oven}} = P_{\text{atmosphere}} \]
A closer look into the PROven® system
References – PROven® (Pressure Regulated Oven)

PROven®
a registered Trademark of
DMT GmbH & Co. KG

Installed by Uhde GmbH, Germany for
- KBS Schwelgern, Germany
- Taiyuan Iron and Steel, China
- POSCO, Korea
- Ma Anshan, China
- CST, Brazil
- Hyundai Steel Company, Korea
- Shougang, China
- CSN, Brazil
- Shagang, China
- HKM, Germany
- Clairton, USA
- Algoma, Canada

PROven®
is installed in more than 2100 ovens worldwide
The next generation of PROven®:

PROven® NG

- The special drain valve is no longer necessary.
- A new rotatable cup is introduced replacing the FixCup.
- The water level inside the new rotatable cup is fixed (always in overflow mode).
- The crown pipe itself is moved to directly control the oven pressure!
- The new rotatable cup can be rotated like a „conventional valve“. 
PROven® and PROven® NG:
Both systems in comparison (1/2)

PROven®
- Water sealing
- "crown pipe*
- FixCup
- Water level adjustable
- Drain valve

PROven® NG
- Upper part of the "crown pipe"
- Lower part of the "crown pipe" movable (red)
- Continuous overflow at same water level
- New: rotatable cup
PROven® and PROven® NG:
Both systems in comparison (2/2)

**PROven®**
(drain valve not shown here)

- strong deflection of the crude gas
- turbulences of crude gas
- pressure control by variable water levels

**PROven® NG**
(no drain valve necessary)

- small deflection of the crude gas
- no turbulences of the crude gas
- pressure control by moving the crown pipe up and down
PROven® NG:
Operation of the rotatable cup

Oven is „on the main“ ready for charging

\[ P_{\text{oven}} = P_{\text{collecting main}} \]

Crown pipe open; standpipe lid is closed

Oven pressure regulation during coking process

\[ P_{\text{oven}} \neq P_{\text{collecting main}} \]

Crown pipe moves in water; standpipe lid is closed

Oven is „off the main“ ready for pushing

\[ P_{\text{oven}} = P_{\text{atmosphere}} \]

Crown pipe dipped in water; standpipe lid is open
Experimental validation:
Testing of PROven® NG in a 1:1 scale model for small coke ovens in the labs of DMT

Coke Oven Pressure Control Simulation
- Variation of gas flow
- Variation of oven pressure and characteristics of pressure control
- Influence of different types of slots in the crown tube
- Behavior of water surface in the rotating valve
- Modelling of PROven® NG behaviour

Optimization of spray nozzles
- Moistening of all components

Influence of typical operation conditions
- Tilting of standpipes
- Behavior of control device
Experimental validation –
Photos of PROven® NG

Oven is „on the main“ ready for charging

Oven pressure regulation during coking process

Oven is „off the main“ ready for pushing
PROven® NG in pressure control mode
Emptying of the rotatable cup

Oven is „on the main“ ready for charging
PROven® and PROven® NG: Comparison of oven pressure control

Set Point: Oven pressure = 0.2 mbar (20 mmWC)

Collecting main pressure: real data; gas flow = 1.100 m³/h
Conclusions (1/3)

- The PROven® NG design is much simpler and more rugged.
  - The new crown pipe and rotatable cup are less prone to blockages than the previous drain valve in the FixCup.
  - The PROven® system has narrow clearance in some parts of the drain valve that can be blocked by deposits and reduces watertightness of the drain valve.
  - Permanent discharge of buoyant particles by continuous water overflow over the rim of the rotatable cup into the gas collecting main.
  - Bigger particles are swept out by rotating the new rotatable cup during pushing of the oven.

- No relative movement of the PROven® NG components, if the collecting main and the goose neck misalign.
Conclusions (2/3)

- The pressure control speed with PROven® NG is enhanced.
  - By moving the crown pipe up and down in the water of the rotatable cup the oven pressure control is fast and direct.

- The pressure control is decoupled from the previous water level rise or fall (which is different in speed).
Conclusions (3/3)

- The dimension of the PROven® NG system is significantly smaller.
  - Retrofitting with PROven® NG can be done without modification of the gas collecting main.
  - Arrangement of the complete PROven® NG system outside the gas collecting main is possible.
  - The water seal of the actuation rod is located outside the goose neck with PROven® NG, therefore less heat impact and direct accessibility for maintenance & visual control.
The **PROven® NG** system has been tested in the DMT test stand as 1:1 scale model for a 4 m coke oven.

The **PROven® NG** system is actually under flow modelling and simulation for scaling.

The **PROven® NG** system will be tested at a coke plant in 2014.

The **PROven® NG** system will be available in the market soon.
THANK YOU FOR YOUR ATTENTION!