Possibilities for the configuration of the EnviBAT pressure regulation system at coke plants

Möglichkeiten zur Konfiguration des EnviBAT-Einzelkammerdruckregelungssystems an Kokereien

An advanced solution to reduce fugitive emissions from coke oven batteries is the application of an individual chamber pressure regulation system as the PROven technology, which — after several technical enhancements — is now being marketed by ThyssenKrupp Industrial Solutions under the new brand name EnviBAT pressure regulation system. Dependent on the clients’ demands either an integrated or a modular solution is available for the configuration of the EnviBAT system in a coking plant.

Several technical developments have been performed in the past to reduce fugitive emissions from coke oven closures [1]. However, a reduction of the battery emissions from doors, charging-hole lids, etc. has reached process technical constraints. One fundamental limit is the inseparable relationship between the pressure in the collecting main and the pressure in all chambers connected with the main: The amount of developing raw gas varies from a quite high level at the beginning to a very low level at the end of the coking time. To avoid ambient air penetration into the oven, which would damage the refractory material, it is necessary to keep the pressure in the oven on a positive level over the whole coking time — even at the end. In the conventional way this is done by keeping the collecting main backpressure on an appropriate positive level (~ 1 – 1.5 mbar). However, resulting from the intense gas development at the beginning of the coking time a higher pressure level may cause emissions from the oven doors.

An advanced solution to completely overcome this problem is an individual chamber pressure regulation system. The basics of such a system were developed by DMT [2]. In the years from 1999 till 2003, the system (brand name PROven; PROven is a registered trademark of TÜV Nord AG and it is still used by DMT)
GmbH & Co. KG) was tested for the first time in industrial scale jointly by DMT and ThyssenKrupp Industrial Solutions AG (TKIS AG, formerly Uhde GmbH) at the old coke oven battery no. 6b (52 ovens, 6 m high) of the former August Thyssen coke plant in Duisburg [3].

To evaluate the environmental advantages of the system already in those earlier stages of development, measurements of the content of poly-aromatic hydrocarbons (PAH) in the air were taken at the battery 6b of the coke plant August Thyssen. Even at this old plant these emissions were reduced by 70 % [4].

Because of these promising results TKIS took an exclusive licence from DMT in 1998 to improve the marketability of this system. One main step into this direction — among several others — was the development of a so-called overflow regulation device instead of the formerly used drain control element. This was done to guarantee not only a more reliable operation and a better control accuracy, but in particular a higher safety of the system. In the course of the time, the system had been further optimized. Thereafter in 2003 it was installed on both batteries of the new coke plant Schwelgern in 2003 where it sets the officially recognized environmental standard for new plants [4; 5].

As the essential patents for the system ran out in March 2014 the licence contract between DMT and TKIS ended at that time. TKIS decided to continue the successful marketing of the improved PROven technology under the new brand name EnviBAT pressure regulation system for the reduction of fugitive emissions at coke plants. Since 2010 it has been accepted as a Best Available Technique (BAT) [6].

Further marketing of the system – now under a new brand name

Until today a coke production of 30 million t/a was realized worldwide using this EnviBAT pressure regulation system:
- 13 coke oven batteries in China
- 11 coke oven batteries in South Korea
- 6 coke oven batteries in Brazil
- 1 coke oven battery in the USA
- 4 coke oven batteries in Germany
- 1 coke oven battery in Canada.

Figure 1 shows the EnviBAT pressure regulation system installed at Posco in Gwangyang, South Korea.

Functional principle of the EnviBAT system

The EnviBAT pressure regulation system consists mainly of the FixCup, crown tube and the overflow regulation devices installed inside of the gas collecting main (GCM), figure 2.

It is able to manage all necessary actions during a complete coking cycle. In the following, the three most important control positions of the system during the coal carbonization cycle are illustrated in figure 3.
- It starts in the charging position with closing the standpipe lid and connecting the coke oven to the GCM for charging the coke oven, figure 3a. During charging the overflow regulation including the plug is lifted to its uppermost position. Hereby the FixCup is drained completely and the raw gas can flow undisturbed into the GCM.
- After completion of charging the carbonizing of the coal follows; in this phase the oven pressure is controlled depending on the actual amount of coke oven raw gas generated during the coking period, figure 3b. The crown slots can more or less be shut by varying the water level in the FixCup. Thereby, a differently strong flow resistance

![EnviBAT pressure regulation system at Posco in Gwangyang, South Korea](image1.jpg)

EnviBAT-Einzelkammerdruckregelung bei Posco in Gwangyang, Südkorea
is opposed to the crude gas as it passes through the crown slots, and thus it makes it possible to regulate the oven pressure.

Finally at the end of the coking time the coke oven is disconnected from the GCM. The slots in the crown tube are flooded completely and the fast-filling pipe is opened for filling the FixCup. If the pressure exceeds a certain threshold value, the standpipe lid is automatically opened and the oven can be pushed, figure 3c.

In addition to the aforementioned overflow regulation device TKIS has implemented several additional enhancements into the original system for example [7; 8]:

- Improving the pressure control quality by applying low-pass filters, with significant decreasing of the scattering range of the pressure control and thus the occurrence of emissions.
- Optimizing the control cabinets for a safe pneumatic regulation. The cabinets manage all the automatic and manual pneumatic operation and control action. The risk of any leaking lines or connection between the positioner and cabinets is minimized.
Most important control positions of the EnviBAT system | Die wichtigsten Regelungsstellen der EnviBAT-Einzelkammerdruckregelung

Modular solution of the EnviBAT system

Modulare Lösung der EnviBAT-Einzelkammerdruckregelung
In particular a safe interlocking of the operation cycles is guaranteed.

Development and downsizing the structural elements of the EnviBAT system to smaller ovens down to a height of only 4 m.

Figure 4 shows the plexiglas model for testing and optimizing the system for small-sized coke ovens which has laid the basis for the first implementation of the EnviBAT system in 2011 at the 5-m battery of Essar Algoma plant, Canada.

Latest possibilities for the configuration of the EnviBAT system

Meanwhile there are basically two technical possibilities for the configuration of the system:

▷ an integrated solution consisting — as mentioned before — mainly of the FixCup, crown tube and the overflow regulation devices installed inside of the collecting main, which can be implemented either by the erection of a complete new coke oven plant or combined with the exchange of an existing GCM at an existing coke plant,

▷ a newly developed modular solution consisting of a modular housing in addition to the FixCup, crown tube and overflow regulation devices, figure 5, which allows an installation of EnviBAT system outside of the GCM — on the top of the GCM without removal of the existing conventional GCM valve during a retrofit-installation. The modular solution fulfills the process with the same components and functions as the integrated solution.

Figure 6 shows the important technical equipment of the integrated and modular EnviBAT pressure regulation systems.

From these possibilities for the configuration of this system three different applicable options for implementation in a coke plant are available — dependent on the clients’ demands, figure 7:

▷ For new coke plants: For the erection of a new coke plant the EnviBAT system is integrated from the beginning of the planning until the final realization as one (of the many) technical features/components in the new plant.

▷ For existing coke plants: Many customers have used the possibility to improve the environmental compatibility of their existing plant by installation of the EnviBAT system. There are two sub-options for retrofitting existing batteries with the EnviBAT system:

▷ Combined installation of the EnviBAT system and a new GCM: Most of the EnviBAT system retrofit-installations have been combined with the exchange of an existing more or less damaged GCM, a combination which is also cost saving for the customer. In this case the complete GCM is prefabricated, mounted and the EnviBAT system components are integrated; thereafter the complete GCM +

EnviBAT system was taken into operation as a whole.

▷ EnviBAT system installation without exchange of the GCM: However, in some cases the existing GCM was in a quite good condition such that an exchange for technical and economic reasons would be not reasonable. The biggest example of this type of installation is the August Thyssen battery no. 6b that consisted of 52 ovens, 6 m tall and was operated successfully from 1999 to 2003.

▷ Also for this type of installation care was taken that the connection between the oven and the
GCM (via standpipe and gooseneck) can be realized by the operating staff without interrupting the battery operation. The mounting procedure needs a certain logistics (organization of crane etc.), but is an inherent part of conventional maintenance, which is described in TKIS’s maintenance manual for each plant. A similar case is the exchange of only a single gooseneck which sometimes has to be performed because of damage or other reasons.

However, an improved and more service-friendly option for the customer is the new modular solution developed by TKIS, figure 5. This arrangement has the advantage of a simplified mounting procedure during which the conventional GCM valve flap can be held closed. Therefore all mounting steps for the EnviBAT system components can be handled much easier. After completion of the mounting the old GCM valve flap is opened and the respective oven can be taken into operation again. An additional advantage is that the modular EnviBAT system construction is insensible to any movement or expansions of the Battery due to the concentric arrangement of all control devices.

**Summary**

By application of the EnviBAT pressure regulation system fugitive emissions from the closures of traditional coke oven batteries can be minimized. Therefore even the most stringent environmental requirements can be met.

ThyssenKrupp Industrial Solutions (TKIS) is in the position to supply the EnviBAT system in all relevant configurations for a customer:

- the integrated solution in combination with a complete new battery or,
- the integrated solution for existing coke plants – preferably in combination with an exchange of the GCM,
- the new modular solution for existing batteries without a need for changing the existing GCM.

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Dr.-Ing. Joanna Kühn-Gajdzik, Senior Process Eng.; Dipl.-Ing. Frank Krebber, Senior Process Eng.; Kerstin Überschär, Senior Design Eng.; Dr. rer. nat. Friedrich Huhn, Head of Process Group, CP-CO, ThyssenKrupp Industrial Solutions AG, Dortmund, Germany. friedrich.huhn@thyssenkrupp.com

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**Important components**

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<tr>
<th>EnviBAT pressure regulation systems</th>
<th>Integrated solution</th>
<th>Modular solution</th>
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<tbody>
<tr>
<td>GCM</td>
<td>New collecting main</td>
<td>Existing collecting main</td>
</tr>
<tr>
<td>Old GCM valve</td>
<td>Not available</td>
<td>Available</td>
</tr>
<tr>
<td>Fix-Cup</td>
<td>Inside the GCM, replacing the conventional flap in the goose neck</td>
<td>Outside the GCM</td>
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<tr>
<td>Crown tube the downstream end of overflow regulation device</td>
<td>A pipe with calibrated slots cut into its end, fitted to the standpipe elbow</td>
<td></td>
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<tr>
<td>Pressure controller</td>
<td>Controlling the position of the pneumatic cylinder for the actuation of the overflow regulation device</td>
<td></td>
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<tr>
<td>The fast flooding pipe</td>
<td>Supplies ammonia liquor to quickly fill the FixCup in case the oven is to be disconnected from the gas collecting main</td>
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**Comparison of the integrated and modular solution of the EnviBAT system**

<table>
<thead>
<tr>
<th>Gegenüberstellung der integrierten und modularen Lösung des EnviBAT-Systems</th>
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<tr>
<td>GCM (via standpipe and gooseneck) can be realized by the operating staff without interrupting the battery operation. The mounting procedure needs a certain logistics (organization of crane etc.), but is an inherent part of conventional maintenance, which is described in TKIS’s maintenance manual for each plant. A similar case is the exchange of only a single gooseneck which sometimes has to be performed because of damage or other reasons. However, an improved and more service-friendly option for the customer is the new modular solution developed by TKIS, figure 5. This arrangement has the advantage of a simplified mounting procedure during which the conventional GCM valve flap can be held closed. Therefore all mounting steps for the EnviBAT system components can be handled much easier. After completion of the mounting the old GCM valve flap is opened and the respective oven can be taken into operation again. An additional advantage is that the modular EnviBAT system construction is insensible to any movement or expansions of the Battery due to the concentric arrangement of all control devices.</td>
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**REFERENCES**


**Options for the configuration of the EnviBAT system**

<table>
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<tr>
<th>Konfigurationsmöglichkeiten für das EnviBAT-System</th>
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<tr>
<td>28 coke oven batteries: at Schwelgern, HKM – Germany; POSCO - Pohang, POSCO Gwangyang, HYUNDAI – South Korea; TISCO, Shougang, Shagang, Magang, Wugang – China; USS Clarion – USA</td>
</tr>
<tr>
<td>8 coke oven batteries: CST and CSN – Brazil, Esser Algoma – Canada</td>
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<td>August Thyssen – Germany (in cooperation with DMT)</td>
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