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Mobile high-performance dust capturing system for bulk cargo unloading facility

Constantly rising environmental protection requirements in connection with the reduction of fine dust emissions arising during bulk cargo transshipment set new standards for operators of integrated steel mills. A worldwide unique mobile high-performance dust capturing unit for bulk cargo unloading facilities is in use on the elevated railway bunker unit at the ThyssenKrupp Steel Europe blast furnace operations in Duisburg-Hamborn, Germany. The dust capturing system is a joint development by Uhde Services and ThyssenKrupp Steel Europe.

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At its Duisburg-Hamborn site in Germany, ThyssenKrupp Steel Europe operates two large blast furnaces (No. 8 and 9). The raw material for the blast furnaces is delivered by train to an elevated bunker unit. There are three incoming tracks for the various raw materials **(figure 1)**. The raw materials are dumped into day bins **(figure 2)**. The bunker unit comprises a total of 64 day bins, which handle a daily transshipment quantity of approx. 18,000 t.

When blast furnace No. 8 was newly built, environmental protection regulations called for a high-performance dust collection system at the bunker unit. Fine dust emissions arising during wagon unloading were to be captured directly at the unloading point by means of a dust capturing system and guided to the central filter station in a controlled manner. This new system had to be integrated into the existing elevated railway bunker unit.

As the elevated bunker unit was originally built at the beginning of the 20th century, it was not designed to support a lot of additional weight. Another challenge was the request for a modular system of as few – large – components as possible in order to keep the railway track blockages necessary for pulling the parts in place as short as possible. Any interference with the running production of the other blast furnaces was to be avoided. Ultimately, the new system even made it possible to perform extensive repairs to the storage bunker unit during set-up.

3D simulation and engineering of the dust capture hoods

First, the flow conditions of emissions arising from the dumping of different materials had to be investigated in detail to ensure optimal configuration and layout of the stationary dust capture hoods, while considering the achievable energy saving potentials. ThyssenKrupp Steel Europe entrusted the company Kessler + Luch with this task. At the laboratory, the engineers simulated bunkers in different sizes and a wagon on a scale of 1:10. They determined the optimal basic data for the stationary dust capture hoods through various test series. Prior to practical implementation, final operating tests were run on the bunkers.

Then Uhde Services developed a 3D model **(figure 3)** for the existing elevated railway bunker unit including all interfering structures, e.g. skip hoists and piping routes, and clearances above the tracks. Also the main supporting structure of the unit was integrated into the model to determine the span width of the suction pipe racks and running rails

Figure 1. **Elevated railway bunker unit (without dust capturing unit)**

Figure 2. **Suction system at the side of the wagon**

for the mobile suction cars. In the basic design of the suction cars and dust collecting ducts, Uhde Services attached great importance to an optimal fluidic design of the individual components.

The basic data for the stationary dust capture hoods were derived from laboratory-scale tests and used to complete the model. With the aid of this model, Uhde Services developed a tailored solution concept for capturing fine dust emissions arising during wagon unloading.

Subsequent detail engineering for the overall plant complex was completed within three months utilizing efficient 3D engineering tools to avoid collision points, optimize fabrication sequences and reduce engineering hours. By adapting the engineering approach to the modular construction of the plant, it was possible to optimize construction and installation and erect the plant safely during running operation.

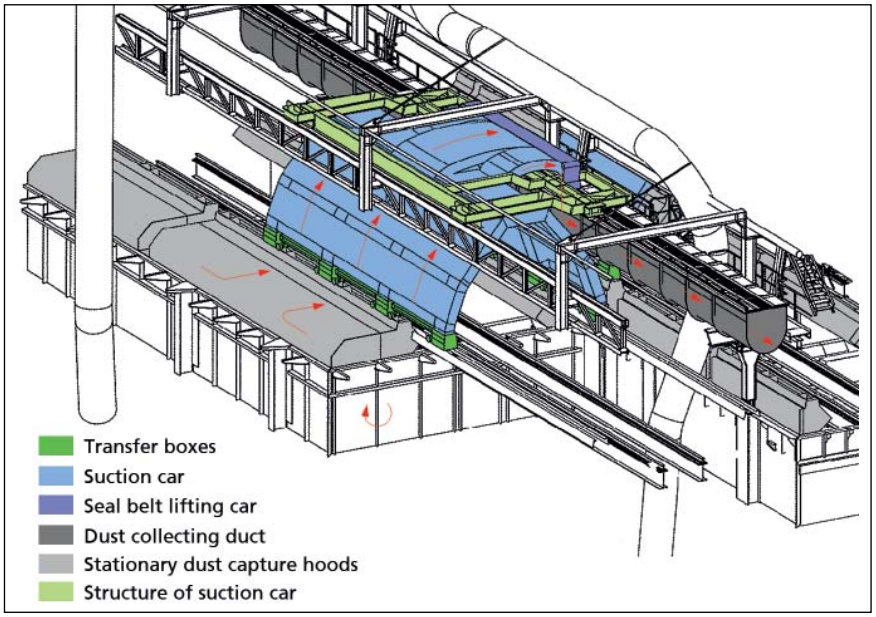

Figure 3. **Railway track with suction car and dust collecting duct**

System functionality

Applying a radio remote control, the mobile suction car of the respective track is moved over the wagon to be unloaded. The mobile suction car connects to the two stationary dust capture hoods covering the bunker along both sides of the railway tracks. Now the wagon is enclosed by the suction car. This provides additional protection against leakage of residual emissions.

The seal belt lifting car diverts the rubber seal belt of the dust collecting duct, thus establishing a permanent connection to the central filter station. This is the connecting link between the stationary hoods and the central dust collecting duct which is arranged in parallel to the railway track. Prior to unloading the wagon, the unit operator requests the necessary suction capacity from the central filter station via radio remote control. The mobile dust capture system can also be designed to work in fully automatic mode. A sophisticated monitoring system takes account of all safety aspects.

Operational results

The plant was designed with the objectives of environmental compatibility and cost efficiency in mind. As a result, an outstanding feature of the plant is the design of the dust capture hoods optimized in laboratory-scale tests. These hoods achieve a capturing efficiency ranging between 91 and 97%. They consume approx. 50% less energy than conventional systems. In addition, this mobile solution obviates the need for pipes connecting to the dust collecting ducts, including shutoff devices. This cuts capital investment costs and annual maintenance and repair costs by approx. 27%.

The successful development and implementation of the mobile high-performance dust capturing system for bulk cargo unloading operations on the existing elevated railway bunker unit at the site of ThyssenKrupp Steel Europe sets new standards in terms of dust capturing efficiency and low energy consumption. Due to the excellent dust capturing efficiency, emission values fall below statutory limits, making a substantial contribution to reducing fine dust contents in the residential areas close to the ThyssenKrupp Steel Europe facilities in Duisburg-Hamborn. ■