Transport of Bulk Materials in Containers

Next Generation Open Top Container Tipplers

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Today approximately 90 percent of non-bulk cargo worldwide is transported in containers. Low cost and easy access to handling equipment has helped to extend the use of containers to enter new fields. Amongst these new applications is the transport, storage and handling of bulk materials.

During the 1980s, the South African company Rocon introduced the concept of loading ships using a standard GP container with a tipping device. Unfortunately information with regards to this pioneering development is scarce and it is unknown if any Rocon devices are still in operation at present.

20 years later the concept re-emerged when Bulk Connections, a bulk materials terminal in Durban South Africa, sought ways to optimize their port operations. After a developmental phase the first container tippler was commissioned in 2003. Based on this earlier installation, ThyssenKrupp Materials Handling has further developed the concept culminating in a second generation container tippler.

Operation Basics

The uniqueness of this handling solution may necessitate some explanation concerning the operation of such a system.

The tippler is a device suspended on ropes which may use diverse types of lifting equipment as platform. Bulk Connections employed a standard container crane for this purpose. The parent machine serves to manoeuvre the tippler and attached container from the quayside to a position above the ship's hold.

A container, filled with material, is transported to the quayside where the tippler is lowered onto it and attached by engaging the standard twistlocks. Once attached, the container is lifted and manoeuvred towards the ship. At this stage the clamping beams are activated and clamping is completed by the time the tippler reaches its position above the cargo hold. Tipping commences with the inner frame rotating through 180 degree and discharging the cargo into the ship's hold.

Once the material is discharged the inner frame, together with the container, returns to its original orientation and the whole unit travels back to the quay. The unit is lowered to the rail platform where the twistlocks are disengaged and the system is ready for the next cycle. The operating cycle is therefore similar to the handling of standard containers.

First Generation Tipplers

Bulk Connections Terminal in Durban was the user of the first unit which was delivered in 2003. As it was a novel concept, the entire system was closely monitored for the duration of the first year of operation. During this period the system handled 580 000 tonnes of sized coal. The average load per cycle was 25 tonnes and a loading rate of 18 to 20 tips per hour was maintained. A daily output of 10 000 tonnes of sized coal was achieved.

The introduction of the system proceeded without any major technical problems. Some minor modifications were required to resolve teething issues, mainly the introduction of guards to protect the electrical and hydraulic equipment that was liable to be damaged during the operation of the unit. When the first unit was recently overhauled, no trace of fatigue cracking was recorded. Some impact damage was found on the clamping beams which probably stems from rough operational practices.

Latest Developments

Experience gained from monitoring the operation of the first unit was employed to improve the design of the second generation device. The main objective of the design review was a mass reduction. Originally the mass of the tipping unit was approximately 21 tonnes. As a result of this, the combined weight of the tippler, container and payload in some cases exceeded the loads normally encountered in container terminals. This limited the use of the device, as standard cranes required structural modifications.

A Finite Element Analysis (FEA) based optimization process, combined with the benefits of an improved control system, has helped to lower the mass of the design to 12 tonnes. This is close to the mass of a standard single–lift telescopic spreader, which is the basis on which most of the container handling equipment is rated.

Further attention was given to reducing power consumption. Torque requirements for various payloads throughout the tipping range were simulated to find the optimal geometry of rotation. Installed power and the size of the tilting cylinders could thereby be optimized.

Due to the impact damage which was observed on the clamping beams, the clamping procedure has come under the spotlight. The entire clamping philosophy was reviewed and an improved clamping concept was developed. This necessitated changes to the shape and guiding installation of the clamping beam, which have subsequently been introduced. The new clamping method will reduce the chances of impact when lowering the tipping device onto the container.

The empty container is rotated back and returned to the platform.

A full container on its way to the hatch.

Suitable Container Types

Containers are used as the primary medium for storage, transport and handling of bulk materials within a handling system of this type. The selection and design of these units is therefore an important aspect from a systems perspective. It should be noted that such containers are only used on land within the confines of the handling terminal and are therefore not subject to marine standards in terms of strength and rigidity. When the original unit was commissioned, Bulk Connections decided to opt for modified second hand containers to minimize the cost. The modifications included the removal of the roof of the containers and welding the doors closed. It was found that these second-hand containers had a service life of approximately 5000 cycles.

Four new containers were also built and operated in parallel with the older units. These units exhibited no trace of fatigue damage after 12 months of operation. Data collected during this period gives an indication of the most economical container selection for specific operational philosophies, cycle times and duration of operation and storage. The capital invested for different container types can be weighed against each other considering the number of units in circulation and the life span of each.

Conclusions

The use of an open-top container system for materials handling provides the terminal operator with great flexibility. It allows the cost effective handling of a large variety of materials, from small batch quantities to moderate volumes. Container terminals are no longer restricted to the handling of containerized cargo but are also able to deal with bulk materials. The process of stacking containers for bulk materials is not significantly different to stacking general purpose dry containers. Handling of containers carrying bulk materials can therefore be done using by standard container infrastructure. The material can also be stored in the containers, depending on the requirements of the port operator. The need for capital outlay associated with conventional stockyards, stockyard equipment and rail tipplers is therefore eliminated.

Due to the universality of the system components and operation, it lends itself for use in diverse fields of application. For example, ThyssenKrupp is investigating the use of a derivative system for supplying coal to power stations during emergencies. A complete handling system can be set up in a few months based on standard container handling equipment such as reach stackers, straddle carriers, container cranes and overhead cranes. Such machines are also readily available on the second hand market. Because the entire system is based largely on 'off the shelf' equipment, it can be financed for long or short term operation on an equipment lease basis. ■

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