For Big Lumps

Slide Gates in XXL Format

Jaudt Dosierotechnik, Germany

There are applications, like lignite handling or sewage sludge handling, where slide gates of extraordinary dimensions are used. Where such gates are needed, some additional information could help to get a good design and a flawless installation.

Slide gates for handling bulk goods are available on the market in a wide range of designs and variations. If they are used as emergency shut-off slide gates or servicing slide gates, manual drive units are normally adequate. However, if they are used as working or metering slide gates and if they are actuated frequently, they are generally fitted with pneumatic (Fig. 1) or motorised drive units. Hydraulic drive units are also desirable in some cases.

Conventional Designs

Slide gates for handling bulk goods are required in various applications with both round and rectangular infeed cross-sections. Slide gates with round infeeds are normally supplied with cast housings measuring up to 900 mm in diameter. Even larger diameters are used in applications which involve the handling of liquids, and these may also be used for bulk goods.

Slide gates with rectangular infeed cross-sections are normally welded constructions with design heights of 100 mm or 140 mm and have nominal sizes of up to 1000 × 1000 mm. There is only a small number of manufacturers with great experience in the design of very large slide gates for handling bulk goods with infeed cross-sections in excess of this size. Such very large slide gates are used, for example, for blocking lignite with particle sizes of 5 mm to 200 mm.

The silos used for storing these goods may easily have a volume of 3000 m³ which means that they generally have multiple discharge points. One manufacturer, for example, who can supply such very large slide gates is Jaudt Dosierotechnik with their series of slide gates called FS XXL.

Design and Sizes of Very Large Slide Gates

The starting point for the design process is to record every detail of the operating conditions. This includes, on the one hand, silo data, such as the blocking cross-section, silo geometry including fittings, construction materials with surface properties and the filling height. On the other hand, the relevant bulk material properties, such as density, particle size, corrosion characteristics, moisture content, wear properties, flow properties or caking tendencies must also be available.

Other major factors include the prevailing temperature and pressure levels (if applicable including flow promoters) and other boundary conditions for filling and discharging the silos or opening and closing the blocking device. The above mentioned topics underpin that good communication between the supplier and system manufacturer is of vital importance. Values from previous experience must be exchanged at an early stage in the process and already established operating conditions must be communicated.
If the data relating to the bulk goods are incomplete, it is essential that discussions be held with the operator or tests carried out on samples of the bulk goods, for example to establish the horizontal load conditions. When the relevant data are known, the vertical load in the discharge cross-section must be calculated since this is the main value for the strength calculation process. With regard to these calculations, help is provided by various sources including DIN 1055 Part 6 “Load capacity in buildings – loads in silo cells”.

Special attention must be paid to the difference during the filling process (active stress state) and the discharge process (passive stress state) of the silo. The vertical stresses occurring in active may differ from those occurring in passive stress state by a factor of up to 10. Using the maximum effective vertical load it is then possible to calculate the blocking element – that is, the slide gate plate – and the guides. Other design values, such as the required closing and draw-off forces, are generally more difficult to establish and are often taken from the wealth of experience of the system or component manufacturer. Mathematical methods to calculate the theoretical draw-off forces have been proposed by JANSSEN and MOTZKUS, and many others.

When the actuation forces have thus been established, the drive units and the main components can be calculated and designed. For a motorised drive unit, for example, this means the design of the spindle and its bearings. The type of drive unit generally depends on the type of system, with threaded spindles and linear drive units being the most common types. The detailed specification of the drive unit, however, is not determined solely by the required drive forces or torques. The type of controller, safety features in the event of faults and the signal system for the positioning also play a major role in this. If it is necessary to record and save intermediate positions, the appropriate systems or controllers with infinite distance sensors must be used. If the possibility of overloads or power failures cannot be totally ruled out, the appropriate safety devices must be installed and an effective method of shutting down the complete system must be provided.

Another major part of the equation is designing the strength of the frame, which must be kept low for reasons of cost. Since the design height of the slide gate plays a role in the overall height of the complete bulk materials handling system, it has a direct effect on the overall costs. Only an FE analysis provides the required reliability for checking the strength of the complex frame structure to ensure a solid, cost-effective solution (Fig. 2).

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The bearings for the slide gate plate must be selected and designed with particular care because the load is generally high and because there is the risk of product adhering on the plate.

Finally, a conceptual and structural design can only be regarded as being successful if topics such as handling, packaging, transport, installation and servicing are taken into account at an early stage of the development process. The configuration of transport and installation units, for example, is particularly important for the XXL slide gates because of their size.

Examples

The following examples are installations of Jaudt's FS XXL slide gates. So far, more than 100 units have now been supplied to customers all over the world for a wide range of projects.

Fig 3 shows one of 16 slide gates of 1800 mm × 1800 mm for partially dried sewage sludge. The adjusted frame section with integral infeed fender has a design height of 160 mm. The gate is fully built of stainless steel in 1.4404 and has an additional drip gully. In this application, the gates are driven by pneumatic cylinders with a diameter of 500 mm and linear distance sensors allow determination of the exact position of the slide gate.

The example illustrated in Fig. 4 provides a good impression of the dimensions required by some applications. These slide gates are installed at a lignite storage system. The system uses a total of 24 slide gates with opening dimensions of 2800 mm × 1600 mm. The centrally connected double slide gates are able to resist pressure surges of up to 1 bar and are driven by a spindle drive unit and motor with overload trip and emergency hand wheel.

Summary

Precise description of the operating conditions, the specific construction, safe design and detailed planning of all steps including transport and installation is particularly important for large slide gates for handling bulk goods. Only then is it possible to achieve maximum operating safety, low costs and a short lead time.

POWTECH 2008, Stand 7-436

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