The Efficiency of Continuous Ship Unloaders

T. Kisslinger, Germany

Nowadays, CSUs a widely accepted as a good alternative to grab type unloaders. But there's more than one type of CSU available on the market, and choosing the right type for your application can make the difference.

This paper compares the use of pneumatic and mechanical unloaders mainly for grain. Therefore, it gives a brief overview of what options are available in the market, but also goes into more detail with a comparison between chain type mechanical vs. pneumatic unloaders.

$$\text{Efficiency} = \frac{\text{Average Capacity}}{\text{Maximum Capacity}}$$

The goal is to develop an unloader that achieves higher performance by increasing the average capacity, therefore making better use of the complete installation.

The ideal case would be Average = Maximum, but this is impossible to achieve due to a series of variables, including some of which that are not even equipment related, including rain delays or the amount of visits to each hatch for ship stability.

Developments in Pneumatic CSUs

The development of software which uses frequency inverters to control turbo blower rotation speed has resulted in a more constant capacity during operations. It has also increased the ability to control the unloaded capacity. This helps, when materials with different specific weights are unloaded or capacity needs to be adjusted to match receiving conveyors.

By traditional design the boom should reach the centre of the hatch to achieve ship stability. However, a longer boom would allow one to reach the hatch corners resulting in the need to move less material with payloaders, while bigger payloaders for the clean up work would also help. With these measurements, it is possible to achieve 75 per cent capacity with pneumatic unloaders.

As you can see, it is not only the unloader itself but all of the receiving conveyors which determine the maximum capacity of the system; i.e. the system is only as strong as the weakest link in the chain.

CSU principles
The principle of CSU is to avoid peak unloading by distributing materials in time at the receiving conveyors.

CSU types
The main CSU groups are mechanical and pneumatic. The mechanical group can be divided into belt, screw, chain and bucket conveying types.

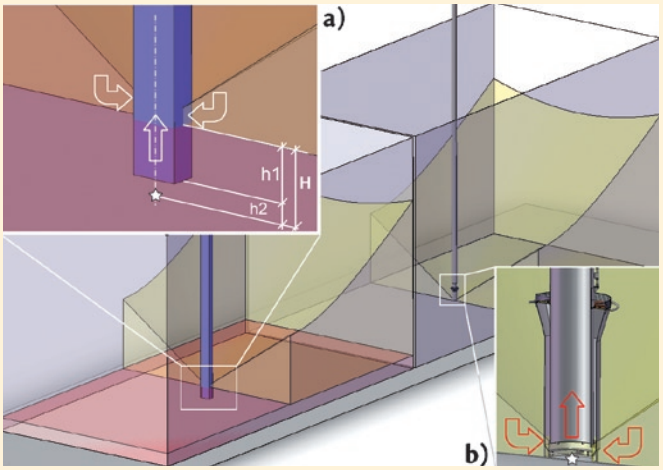
Comparison of Continuous and Discontinuous Unloading

CSUs are normally compared with a traditional grab batch unloading system. The grab capacity is calculated on the basis of the movement cycle. A buffer is needed to distribute the material load along the cycle, avoiding extreme peaks. A CSU does not need a buffer because the peak is not distributed in time cycles, but instead it is continuously transporting the material. The consequence of this is normally a lower weight and the fact that operations are environmentally friendly enclosed.

The Difference Between Chain and Pneumatic Unloaders

A regular chain unloader is used in the same application as a pneumatic unloader because they do not have a feeder, but use a free flowing characteristic to feed the unloader instead.

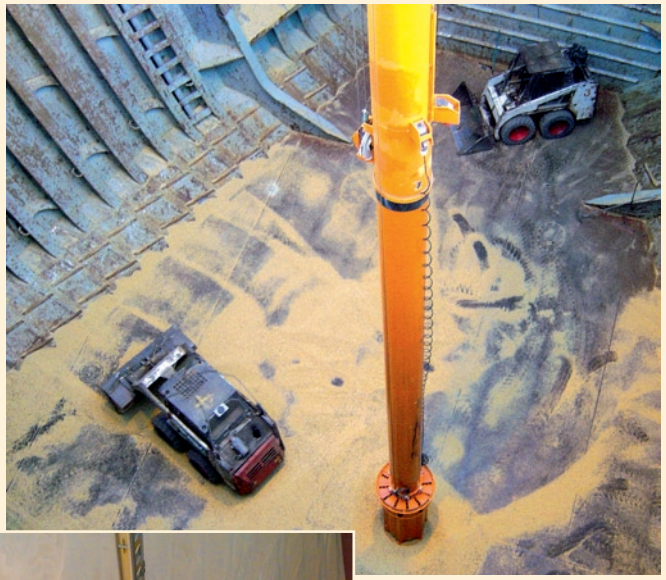
However, this is where the similarities end. The pneumatic unloader is the only CSU that picks up material from the bottom of the hatch. Fig. 1a) and Fig. 3 show that it is able to act like a vacuum cleaner, and remove all products from the hatch.



▲ **Fig. 1: Part a) of this figure shows the nozzle reaching the bottom of the hatch and picking the material. Part b) shows that the chain needs a column of product around it to be filled and that a safety distance to the hatch bottom is necessary to avoid collision.**

The chain, however, relies on product pressure to introduce the material into the chain through. The product pressure depends on the product column around the entry point. As depicted in Fig. 1b), the material height is shown as h_1 while the remaining height which does not to hit the bottom of the hatch is shown as h_2. This can also be seen in Fig. 4. The distance of the chain unloader from the bottom is dependent on the chain size (2 m to 3 m).

▼ **Fig. 2: Normal clean up work after pneumatic ship unloading. The nozzle makes free space for the payloader to be lowered into the hatch.**



◀ **Fig. 3: Although it is dangerous to work this close to the rotating part of the unloader chain, clean space must be available for the payloader.**

The design characteristic of the chain system makes it difficult to achieve better average capacities, especially when only one unloader is available and no pneumatic system is available. In many cases portable pneumatic units are used to get better results, although they increase the operating cost.

Which Capacity?

There are numerous types of capacity, including, for example, nominal, project, peak and average.

Nominal
Nominal capacity is defined by the equipment, normally the maximum capacity it can reach.

Project
Project capacity is normally higher than the nominal and includes some safety.

Peak
Peak capacity is the maximum capacity achievable by the system in short time.

Average
This is the most significant capacity for the customer because in the end it will identify the ship unloading cost. Average capacity measured from the arrival of the bulk carrier until its departure.

The average capacity depends on many factors. Some are influenced directly, while others indirectly i.e. by the unloading system, by local circumstances, available tools and accessories and manpower.

Some factors are also not changeable by the system used, therefore, they are easier to compare due to physical characteristics. Depending on the type of system, more or less material is left in the hatch and the unloading system needs more or less help to take this material out of the hatch.

Inside the hatch, the unloader is normally positioned five times (once in the centre and in the four corners) or nine times. This method of unloading means that the total number of times each hatch must be visited influences the average capacity and also the geometry of the equipment. It is important that the equipment can reach the bottom of the hatch in any situation. For example, one hatch may need to be unloaded and cleaned, leaving only material in the other hatches.

Also the method of unloading, (moving five or, respectively, nine times into the same hatch), means that the total number of times each hatch must be visited influences the average capacity and also the geometry of the equipment.

Some ship designs now allow for this, while in the past each hatch had to be partially unloaded three times so that the ship would rise (due to less weight in the hull) and thus the equipment could reach the bottom of the hatches. All these points are important, but they apply to all unloaders as general rules. If we consider that the same is true for all CSU types, then the real difference remaining in the end is that the unloading system influences the average capacity. This is shown through the ability of the system to pick up materials right to the hatch bottom, and not only two thirds of the ship.

Conclusion

Average capacity is defined by many variables. When doing a direct comparison between a mechanical system and a pneumatic system, it is easier to calculate. For a pneumatic system we calculated the average capacity to in the range between 70 % to 75 %, and these values are even achieved if unloading barges. For grab unloaders, the average capacity is normally about 50 %, while chain unloaders deliver an average capacity of less than 60 %. For example, a mechanical system with a nominal capacity of 750 t/h and an efficiency or, respectively, average capacity of 60 % should be compared with a 600 t/h pneumatic unloader that has a 75 % efficiency.

This means that by opting for pneumatic ship unloader results in a reduced total unloading time, not to mention that the investment for the receiving conveyors could be reduced accordingly if average capacity gets closer to nominal capacity. ■

About

NEUERO Industrietechnik für Förderanlagen GmbH

NEUERO is manufacturer of mobile pneumatic conveyors, grain vacs and ship unloader/loader for transport of bulk grain, plastics and other free flowing materials. The installations are suitable for agriculture, railcar unloading, milling and port handling with a range from 10 mtph to 2000 mtph capacity. The comany started in pneumatic grain conveying over 80 years ago with the manufacture of small agricultural machines. Since then the company has delivered equipment in the 20 t/h to 2000 t/h range to many installations around the world. NEUERO has two companies with sales, engineering, manufacturing and service facilities in Germany and in the US.

Contact:
Mr. Tomas Kisslinger
Neuerostr. 1, 49324 Melle, Germany
Tel.: ++49 (0) 5422 9503 0
Fax: ++49 (0) 5422 9503 50
E-Mail: tk@neuero.de