

**Due to the ever growing markets for grain, also for non-food and -feed utilisation, the transport and handling of grain becomes more and more important. The minimisation of expensive demurrage and tie-up costs calls for most effective unloading equipment. The actually utilized technologies are presented and discussed here after.**

Unloading of grains from vessels is a very old operation known already since the antiquity, when grains were transported in amphora, up to the modern most sophisticated continuous ship unloaders (CSU).

Two main categories of equipment for the unloading of grains are presently manufactured: pneumatic and mechanical systems. Among the mechanical CSUs, the most common are (drag-) chain, screw type or twin belt systems. They all have their own characteristics that make them more suitable for a specific port operation, but under certain circumstances they can also be quite complimentary.

Selecting the most appropriate equipment is a real challenge for executives because many parameters have to be taken into account and the relative importance of each one is variable according to project particularities and forecast working conditions.

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#### GALLERY

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#### **CLEANING OF THE HOLD AND AVERAGE EFFICIENCY**

Pneumatic machines suck in the grains just like a vacuum cleaner and move the products to trucks, wagons and/or a storage facility by means of either gravity or a mechanical conveyor.

The most commonly accepted characteristic of pneumatic CSUs is the easy cleaning of the hold: indeed the grains can be sucked down to the bottom of the hold and with certain additional accessories it is possible to move the suction nozzle into the corners of the hold. This capability is particularly useful if different cargoes are loaded into the same hold, only separated by a simple covering liner or plywood sheets.

This quick cleaning reduces the total unloading time and, thus, costs (demurrage and tie-up) and becomes even more significant for small size vessels like barges, where the relation between regular unloading and final cleaning work is usually worse than that of, e.g., Panamax ships.

It is most frequently admitted between experts in agribulk CSUs that for this reason the average efficiency of pneumatic systems is 5 % to 10 % higher than that of mechanical equipment under similar working conditions on smaller sized vessels. With increasing vessel size, however, the cleanup percentage can significantly be offset by

the speed of unloading the bulk of the cargo in the hold due to the higher unloading rates achievable by mechanical CSUs.

For barges a pneumatic system is definitively more advantageous for that reason but also thanks together with low weight and low investment cost since barges are generally low total tonnages and are unloaded at small quays where the infrastructure does not exist to allow the use of a heavier mechanical unloader.

The mechanical systems have good performance down to the bottom of the hold but the minimum height of material of 70 - 100 cm is necessary to enable the product to be picked up which means lower clean up efficiency. In both systems, auxiliary equipment such as skid steers or small bulldozers are most useful in order to increase the hold cleaning speed.

## **ENVIRONMENT AND RESIDUES INSIDE THE MACHINES**

Both systems are quite environment friendly. More dust by the mechanical systems can be produced during the cleaning when the feeding device at the end of the vertical elevator is facing some feeding difficulties because an inadequate height of the surrounding product is not reached.

Pneumatic and mechanical systems now include latest technologies allowing them to be installed in urban areas with low noise levels. In the suction pipes of pneumatic unloaders, it is almost impossible for residues to remain due to the high volume flow of conveying air used for transportation. Adequate cleaning of the other parts is easy and there is almost no risk of contamination between cargoes.

Twin belt systems are easy machines to be cleaned; it can be more difficult for the screw and chain types, mainly at the transfer between the elevator and the horizontal conveyor supported by the boom. If the grains and its dust are wet, they can eventually stick and accumulate in those areas; the development of pathogenic micro organisms in those equipment areas can be a major concern.

## **SAFETY AND MANPOWER**

Both systems are generally safe for the operators with a few advantages in favour of the pneumatic systems because there are no rotating devices at the intake of the products such as a mechanical feeder or at the other component levels of the chains, screws or twin belts. The required manpower qualifications for operating the equipment are similar. Every manufacturer proposes many safety devices in order to minimise the risks.

## **MAINTENANCE AND REPAIRS**

If maintenance of pneumatic systems is quite frequently commented as possibly more difficult, it should be noted that the accessibility of the running components is much easier: most of them are in or nearby the main engine room on the gantry platform.

According to the model, one or two motors of several hundreds of kW at the top of the vertical arm of chain or screw type systems are of poor accessibility. Consequently this results in less maintenance visits by the workers in charge

than recommended under optimum maintenance practices.

In this respect, the twin belt machines are easier to maintain because in the vertical arm, there are no drive motors but only rollers and simple belt supports for the horizontal boom that are easily checked and replaced at minimum cost.

## **WEIGHT AND SHIP SIZE WORKABLE CAPABILITY**

The weight of the equipment can be a determining factor especially if a new quay has to be built but also if an old quay of poor resistance already exists. Pneumatic unloaders are much lighter and of course this a major factor when as it quite frequently the case, a processing industry along a river is considering to build a quay or a platform for its private use of the unloading equipment.

The range of the vessel sizes to be unloaded has to be considered: mechanical equipment is most frequently performing very well for a certain category of ships.

Thanks to their vertical and horizontal telescopic pipe characteristics, pneumatic systems can be easily designed in order to unload a large range of vessel sizes with a maximum of efficiency.

## **DELICATE CARGOES**

The discharge of delicate or fragile cargoes such as malt or cocoa beans is feasible by pneumatic and twin belt equipment thanks to reliable engineering which has been confirmed by satisfied large multi national group technicians.

The twin belts will “imprison” smoothly the products and all together they will travel at the same speed there being no relative movement between the product and the conveying belts therefore no degradation.

In the case of screw or chain type, the risk is quite higher because the speed of those conveyors in the vertical arm is about 2 - 3 times higher than what is recommended in the industry for the horizontal conveying.

## **ENERGY**

This subject is of major concern for many years and even more with the current energy price levels. Between the different technologies for both pneumatic and mechanical systems the energy consumption can vary quite a lot. Old pneumatic machines were consuming up to 2.5 to 3.0 kWh but new design equipment with latest electrical devices for optimizing the energy consumption such as the frequency inverters (also called speed control units) are allowing to lower those figures down to 0.6 to 0.8 according to the circumstances.

Also for mechanical systems, the energy consumption will vary according to the technology. Twin-belt unloaders use to have an energy consumption as low as 0.2 - 0.3 kWh meanwhile the most common figures for the screw and chain type are between 0.4 to 0.6 kWh.

When computing the energy cost for the various systems, many parameters are to be considered such as the

average efficiency or average unloading capacity (including the hold cleaning). No conclusive figures on this average efficiency between the systems can be easily established because for a single equipment, it will vary according to many factors such as the hold dimensions, the skill of the operator and the number of auxiliary equipment for hold cleaning for instance.

If some efficiency rate is considered between various alternatives of equipment, it can result in a quicker unloading time per ship which can mean important savings thanks to lower tie-up and/or demurrage costs which vary mainly according to ship size and the considered period. The daily cost of the ships rose to 40 - 60.000 USD per day during the recent years. Energy cost can vary a lot from one country to another and, of course, will be much lower in oil producing countries.

No definitive conclusion of the analysis of all those parameters is feasible based only on the energy consumption per ton of material without considering all the above mentioned factors or advantages/disadvantages of each type of equipment.

#### **TWO OTHER ASPECTS MUST BE POINTED OUT:**

Investment cost: when computing the unloading cost, the financial cost (investment + depreciation) use to amount to 50 to 60 % of the total cost: this depends mainly to the tonnage unloaded per year and the depreciation period considered. It means that as a mechanical unloader is most often more expensive than pneumatic equipment, it can be unprofitable to earn some savings on the energy cost that may be ruled out by higher investment cost.

This fact must be considered especially at low capacities such as 500-600 tph.

Combination of both mechanical and pneumatic equipment: Theoretical approach and practical experience seem to indicate that when high unloading rate is the target, the combination of both mechanical(s) + pneumatic(s) is most convenient.

In any case a professional, step by step approach of all above commented factors is necessary: each one has to be individually scrutinized in order to clarify their relative importance as much as possible before taking any decision. Such detailed analysis of the project is the only guarantee to approximate the most suitable solution for any end user.

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