



Myths and realities of unloading grains

What is the best technology to unload grain? This important question merits an analysis of the various technological solutions and still existing myths concerning the capabilities of each one.

It is important to understand that the vessel unloading equipment, as in other sectors, is continuously improving its characteristics in comparison with old-fashioned unloaders still in operation in many ports.

Globally speaking, all techniques for unloading a vessel are valuable alternatives. It can be difficult to select with truly objective criteria the best choice according to each existing port requirements or new project targets. Nevertheless, when making such an exercise of comparing alternatives, two aspects are of the utmost importance: unloading average rate and the energy cost among the operational expenditures (OPEX).

AVERAGE EFFICIENCY AND HOLD CLEANING

The most challenging operational task for any ship unloader is its reliable capability to quickly clean the holds.

In general, the nominal capacity (also called design capacity) in tonnes per hour is considered as a quite similar figure as the maximum capacity, which is usually measured somewhere in the center and at the top of the hold.

(Above) A VIGAN pneumatic ship unloader at the Port of Alexandria in Egypt. The unloader is rated at 600-tph unloading capacity. Photo courtesy of VIGAN.

by Alain de Visscher

Weighing the pros and cons of mechanical and pneumatic continuous ship unloaders

The average capacity includes the whole unloading process including the final cleaning of the holds. The average efficiency is the ratio in percentage between average and maximum capacities.

Because the mechanical and pneumatic Continuous Ship Unloaders (CSU) have different technologies for handling the products, the results are mainly the following:

- The pneumatic unloaders are capable of efficiently sucking the products down to the hold floor surface and its corners. In practice, it means that pneumatic unloaders are a first choice not only for unloading barges but also for any size vessels.
- A lifting hoist with a capacity of between 3 to 12 tonnes can be installed on the suction boom for auxiliary equipment in order to speed up the cleaning.
- The mechanical unloaders (mainly screw, belt or chain type for agri-bulks) will maintain a handling rate along 80% to 85%

Table 1: Power consumption of VIGAN pneumatic continuous ship unloaders

Country	Unloading rate tons per hour	Power consumption kW	kWh/ton	Comments
South Korea	480	368	0.767	Corn - Hold cleaning Density : 0.72
Pakistan	610	372	0.610	Rapeseed - Top of the hold Density: 0.72
Egypt	470	315	0.670	Wheat - Hold cleaning Density: 0,75
Colombia	615	400	0.65	Corn - Top of the hold Density : 0.73
Average			0.682	

of the hold volume, but the remaining bottom layer of product (about 50 to 70 centimeters high) is much more time consuming to clean out of the ships. This bottom layer is the height necessary for the intake booth of any type of mechanical unloader to be able to pick up the products.

For both types of equipment, the aver-

age efficiency also will be influenced in a similar way by many factors such as the size of the ship, the skills of workers operating the unloaders, potential restrictions by the ship captain, and weather conditions.

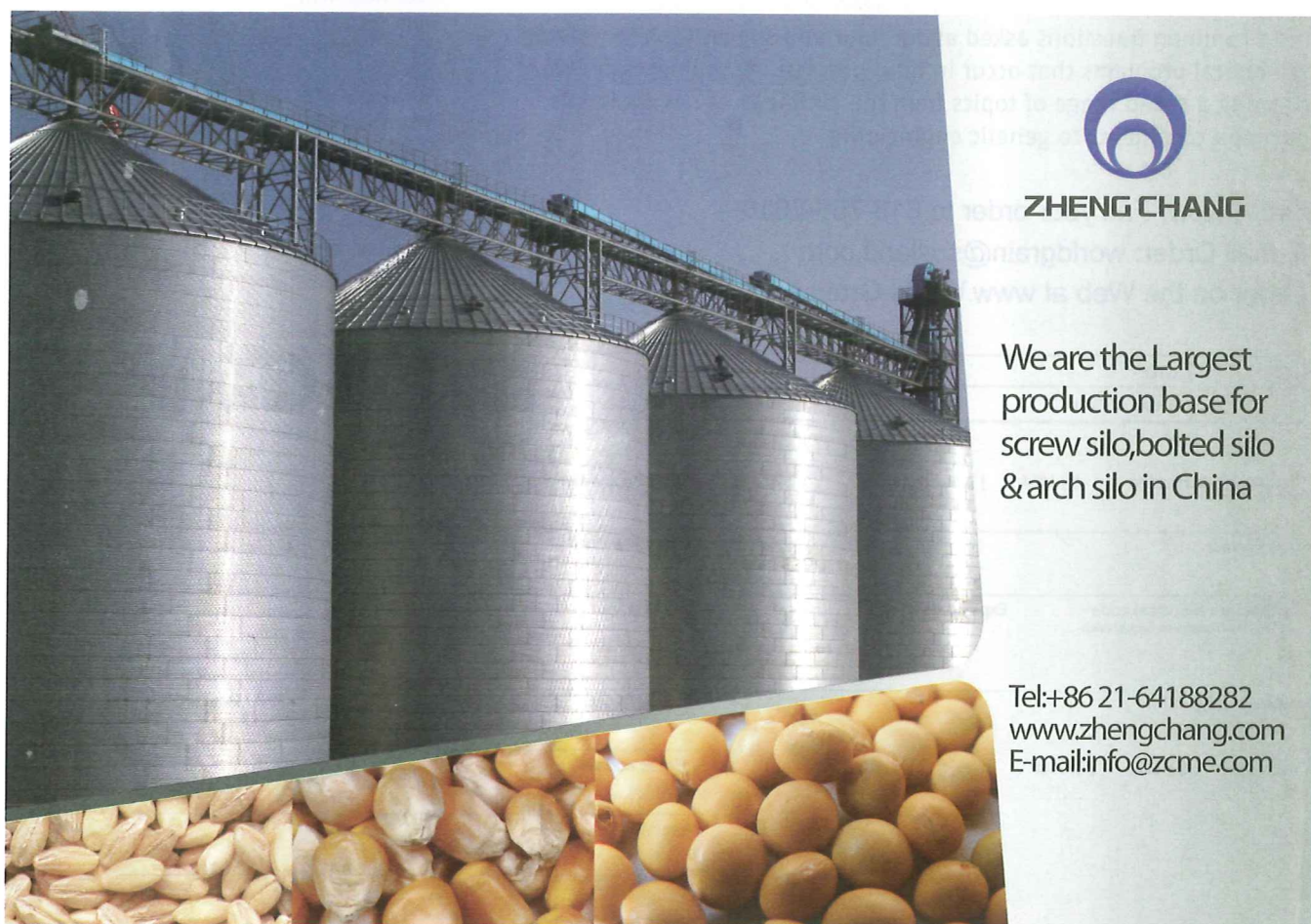
Spreadsheet or unloading simulation programs can be used to compare the

full cost between equipment alternatives. However, more trusted data can be obtained from “field reports.” With more than 200 customers around the world, VIGAN has collected reliable data from customers recording individual and precise data from their equipment from ships to the storage facilities.

A detailed report in 2001 pointed out 75% to 80% average efficiency for a 12-year-old machine. In 2012, another VIGAN customer compiled data concerning 82 ships: a 78.43% average unloading rate for a 10-year-old machine. Similar results are numerous.

Mechanical unloader average efficiency is lower for the reasons commented above. The graphic on page 88 illustrates the unloading sequence of a large vessel using one mechanical and two pneumatic unloaders. It confirms VIGAN’s own experience,

The graphic on page 96 (top of page)



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indicates that although the two pneumatic unloaders were helping the mechanical unloader for the cleaning, the average efficiency was only 65% to 70%.

ENERGY CONSUMPTION

As in many other sectors, very important improvements have been implemented to reduce power consumption.

Concerning the CSU, the most significant breakthrough is the speed variator technology (also called frequency inverters) with all the energy monitoring devices for the fine tuning of the motors and the other mechanical components in general.

It means that in comparison with 12 to 15 years ago, power consumption for pneumatic equipment has decreased from 0.9 to 1.0 kWh/t down to 0.6 to 0.8 kWh/t; and power consumption for mechanical equipment has decreased from 0.5 – 0.7 kWh/t down to 0.35 to 0.45 kWh/t.

Table 1 (page 94) shows some relevant figures with the most recent pneumatic equipment technology.

ANNUAL COST COMPARISON

Both average efficiency and energy consumption of the CSU have a significant impact on annual cost comparisons.

Using quite commonly admitted assumptions (input data) for a European port, table 2 (page 96, bottom of page) reveals that pneumatic CSU is the most interesting alternative.

This spreadsheet also shows that the energy costs have far less influence on the financial bottom line.

OTHER ASPECTS

The relative importance of the following aspects will primarily depend on each project's circumstances and port conditions:

- Total weight of the equipment: Old quays not designed for heavy equipment or with debilitated structure will require lower weight equipment. For a similar unloading capacity, a pneumatic equipment weight will be around 40% to 60% less than the mechanical one. Indeed, in

most cases, the pneumatic machine will not require any counter weight for balancing the heavy weight of the vertical and horizontal steel structures as it is the case for the mechanical CSU.

- Ship size workable capability: CSU pneumatic vertical suction line is always telescopic type which allows easy lifting out of the ship holds, whichever its

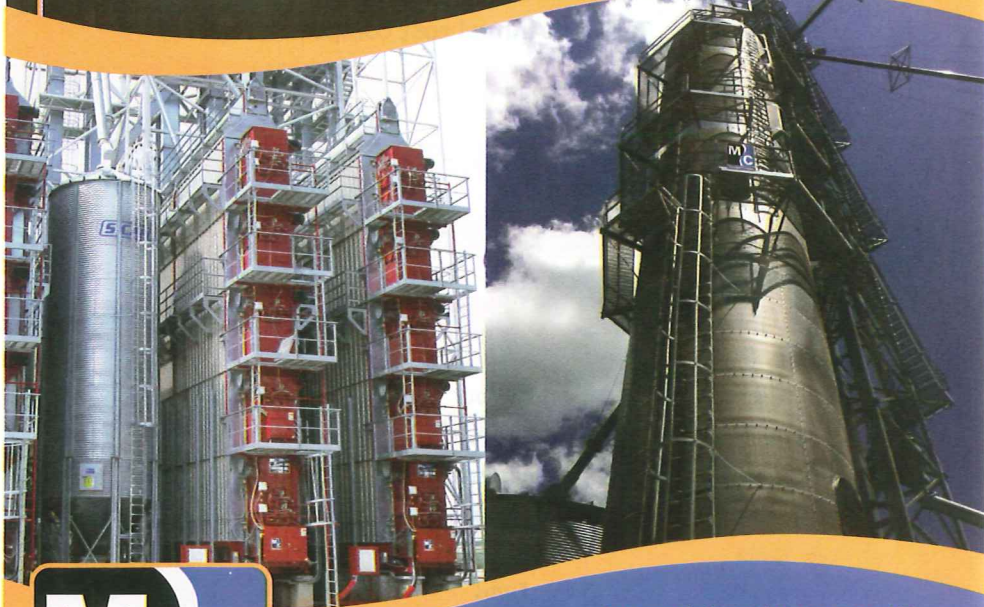
size in most circumstances, at the end of the unloading. The fixed single height of the mechanical CSU vertical leg can be a serious constraint when, for instance, larger-size vessels are becoming empty, as there is no way to lift out this vertical arm. Also, thanks to the telescopic characteristic of their horizontal suction lines, pneumatic CSU are more flexible

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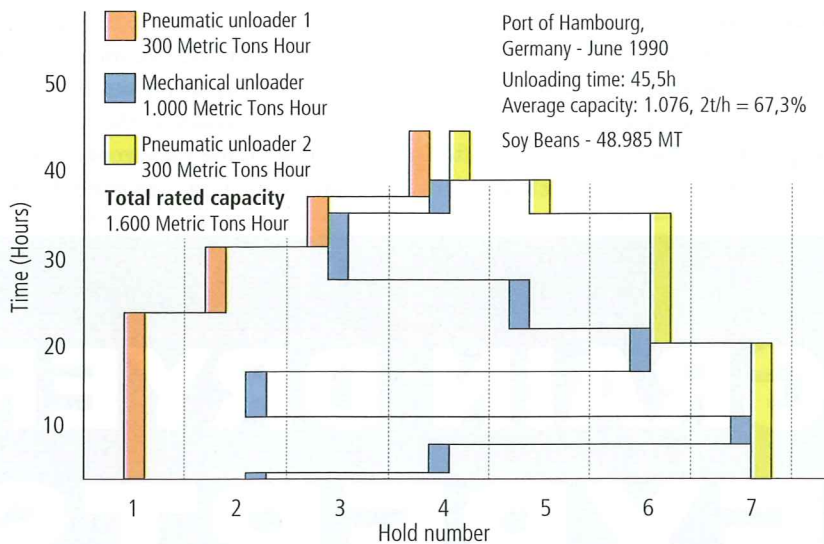


For more information, see Page 106.

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**Unloading procedure:
1 mechanical and 2 pneumatic unloaders**



to accommodate almost any vessel size.

- **Damage to the products:** Worldwide, most prestigious companies are operating pneumatic CSU for fragile grains, which causes no significant damage under their statistical analysis when unloading with state-of-the-art machines. The twin belt technology in comparison with chain or screw mechanical type CSU has the advantage that the products do not suffer

any friction during their handling by the belts as the particles are static and caught between those belts.

- **Safety:** This is a major concern and quite frequently the companies are proudly advertising their score at their plant entrance. Pneumatic suction nozzles do not have any running components along vertical and horizontal handling lines and therefore the

accident risk is non-existent.

- **Maintenance and repairs:** Suction pipes of pneumatic CSU do not require maintenance (no running parts) and can be easily repaired, so there is no need to dismantle a complex mechanical system. Almost all the maintenance can be carried in the main engine room, which is easily accessible and therefore has a greater likelihood that it will be properly carried out by the personnel in charge. Risk of cargo residues, eventually fermented due to high humidity content, and cross-contamination is avoided in pneumatic machines because the large volume of air is continuously cleaning the pipes and the other components such as the filter bags, for instance.

CONCLUSION

A capital expenditure on pneumatic equipment for a same handling capacity in comparison with mechanical unloaders is lower. In the case of mechanical CSU, the energy cost savings will be negligible compared to efficiency savings and lower capital expenditure (CAPEX) figures achieved with a pneumatic CSU.

Reliability in handling performances (duly confirmed by field reports from well-established and renowned customers) and up-to-date technology with last generation components means low operational expenditure (OPEX) figures.

Both CAPEX and OPEX figures are almost always in favor of pneumatic CSU.

Nevertheless, in the case of high annual volume unloading operations, mechanical CSU can also offer under particular circumstances an interesting alternative.

For such large-size projects, the combination of both systems, a mix of pneumatic and mechanical unloaders, is the best way to get the benefits of both technologies. **WG**

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Table 2: Annual cost comparison

Annual unloading volume		900,000 tons	
Energy costs		0.10 Euro/kWh	
Nominal capacity		600 t/h	
Tie-up cost per day		39,500 Euros	
per hour		1,646 Euros	
Labor cost per day		250 euros	
		Mechanical	Pneumatic
Average efficiency	%	70	75
Average unloading	tons/hour	420	450
Power consumption per ton	kWh/t	0.40	0.70
Unloading time	Hours/year	2,143	2,000
Unloading time	Days/year	89.29	83.33
Rounded figures		89	83
Annual energy costs	Euros	36,000	63,000
Annual Tie-up costs	Euros	3,527,143	3,292,000
Labor costs	Euros	22,250	20,750
TOTAL	Euros	3,585,393	3,375,750
			minus 6 %

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