Comparison pneumatic- versus mechanical unloading and transport

Pneumatic transport for unloading cement uses suction systems
and is always in dilute phase.

For pneumatic transport of cement by pressure systems,
dense phase and dilute phase are both possible.
For long distances and high capacities the dilute phase
system is preferred, while plugging can be avoided easily.

Mechanical unloading is done in various ways, of which
the grab-unloader and the screw-unloader are commonly used.
The grab-unloader is considered non-continuously,
while pneumatic- and screw-unloaders are considered continuously.

The main properties of grab-unloaders are:
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- high flexibility
- acceptable reach in holds
- acceptable energy consumption per ton
- clean-up capabilities under normal conditions sufficient.
- dust emission caused by leaking grab shell
- dust emission when opening grab shell by air displacement.
- receiving hopper with dust extraction filters around the circumference.
- receiving hopper with rain cover when not operating.
- the hopper can also be filled through a pneumatic conveying pipeline, using the filters for dedusting the convey-air and with closed rain cover.
- risk of damage to the ship
- wearing by cement on rope wires and grabs
- subsequent transport also mechanical by means of belt conveyors, screw conveyors, trucks, screw feeders, etc.

The main properties of screw-unloaders are:
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- low flexibility.
  different types of commodities do mix with
  remaining products in dead spaces in the system.
- insufficient reach in holds due to rigid construction
- lower energy consumption.
- clean-up capabilities are poor due to the principle
  of the vertical screw, whereby the screw section must
  be completely filled to transport (use of additional devices)
- system is sensible for blocking in case of overfeeding
  (use of additional control system)
- dust emissions in the holds by avalanches and during
  clean-up because of product falling back from the
  screw in case of insufficient filling.
  risk of damage to the screw by foreign matter in the cement.
  (In such an event the screw can even get stuck)
- wearing by cement on screws, screw pipes and shaft seals
- subsequent transport also mechanical by means of
  belt conveyors, screw conveyors, trucks, etc.
- a pneumatic subsequent pressure-transport is also an option with the related
  properties.

The main properties of dilute phase pneumatic transport are:
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- High flexibility
  Easy reduction of dead spaces in the system internally makes the system suitable for handling different types of commodities because of simple and minimum cleaning procedures
- reach in holds improved by maneuverable nozzle into two perpendicular directions
- Because of the principle of pneumatic dilute transport (higher velocities) a higher energy consumption.
- clean-up capabilities are good, due to the feeding independent function and movability of the suction nozzle into two perpendicular directions
- vacuum system is not sensible for blocking (or plugging) because of operating principle with application of positive displacement pumps.
- pressure system is almost insensible for blocking due to regulating system for continuous maximum performance.
- dust emission in the holds is reduced to a minimum by "skimming off" movement of nozzle and downwards flowing covey-air. This also applies for the clean-up situation.
  Proper operation of shovels is then required.
- limited risk of damage to the system by foreign matter in the cement. Too big lumps are left behind in the hold. Smaller lumps can pass the system freely.
  Butterfly valves can be affected by foreign matters in the cement.(mainly ropes).
- little wearing by cement (only on butterfly valves)
- Subsequent transport is generally also pneumatic, especially where long distances and difficult routings are involved.

Combination of mechanical- and pneumatic convey system
using a screw feeder.
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A screw-feeder consists of a screw with a reducing
pitch along the screw in the transport direction whereby the
screw fits exactly into a tube.
The feeding of the screw is then higher than the output.
This causes the material to be compacted and forming a plug in the tube. This plug can be stable and strong enough to withstand and seal against the high pressure in the pipeline.
As the screw feeder in a pneumatic pressure convey system has to
push the compacted bulk volume against the pressure under
considerable friction between the tube wall and the
screw flights, this type of feeder consumes a high energy per
conveyed ton, depending on backpressure.
(f.e. 110 kW for 150 tons/hr at 1.7 bar(o) # 0.73 kWh/ton)
Higher pressure requires higher power, also due to increased friction.
A to high pressure will cause the drive motor of a screw feeder
to stall and choke the screw tube.

The screw feeder/pneumatic convey system is continuous.

Systems using a screw unloading, with the inherit properties,
that dump the product into a screw feeder for subsequent
pneumatic pressure conveying, will therefore consume this
extra amount of energy compared to a double pressure vessel system.

This additional energy consumption is a considerable
disadvantage.