TEXTE
131/2023

Final report

Environmentally friendly handling techniques of fertilisers in ports

by
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publisher:
German Environment Agency

German Environment Agency

TEXTE 131/2023

Project number 168062

FB001221/ENG

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On behalf of the Federal Environment Agency

Imprint

Publisher
Federal Environment Agency
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Completion date:
October 2022

Editorial:
Subject area II 2.3 Protection of the Seas and Polar Regions
Julian Mönnich

Publications as pdf:
http://www.umweltbundesamt.de/publikationen

ISSN 1862-4804

Dessau-Roßlau, September 2023

Brief description:Environmentally friendly handling techniques of fertilisers in ports

The study examines fertiliser loading in German ports and its potential impact on the environment. In doing so, the best practices for loss-reducing handling of unpackaged fertiliser are identified. Fertilisers are mainly exported via the ports in Hamburg, Mecklenburg-Western Pomerania and Schleswig-Holstein. Specialised terminals use closed handling systems to minimise the loss of fertiliser. A trial showed a loss rate of 85 g per 100 t, which is many times lower than previously assumed. Practicable approaches to handling fertilisers in the port include covering the space between the ship and the quay wall and regular cleaning of the handling areas. In addition, processes such as unloading the fertiliser from the ship and storing it in the port are also described and possible hazards for the environment are explained.

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AdBlue	Trade name for a water-urea mixture/brand for products related to exhaust gas aftertreatment for diesel engines by means of SCR,
AG	Public limited company
AHL	Ammonium nitrate-urea solution
Air1	YARA trade name for an AdBlue urea solution
CAS	Calcium ammonium nitrate
DAP	Diammonium phosphate
DESTATIS	Federal Statistical Office
EPOXY	Epoxy resin, plastic of high strength and chemical resistance
g	Gram
if necessary.	if necessary
gg.	vis-à-vis
GmbH	Limited liability company
h	Hour
HELCOM	Helsinki Commission, Baltic Marine Environment Protection Commission
as a rule	as a rule
IBC	Intermediate Bulk Container, English for bulk packaging for liquids.
incl.	including
K+S	K+S AG, German mining company, formerly Kali und Salz AG
kg	Kilogram
Truck	Truck
m	Metre
MARPOL	International Convention for the Prevention of Pollution from Ships
NOx	Nitrogen oxides
NoX Care	Trade name for a high-purity urea-water solution that reacts with NOx over the SCR catalytic converter to form harmless nitrogen and water.
p.a.	per annum (per year)
RFH	Rostock Cargo and Fishing Port
SCR	Selective Catalytic Reduction (technology for the treatment of exhaust gases)
SSA	Sewage sludge ash
t	Tonne, 1,000 kg
a.o.	among other things
v.v.	vice versa (vice versa)
YARA	Yara International, chemical company

Summary

The aim of this study is to examine the loading of fertiliser in Germany's ports with regard to a possible environmentally hazardous discharge of fertiliser into water bodies, to identify the best available technology or the best available environmental practice, and subsequently to develop practicable improvement measures for the proper, loss-reducing handling of unpackaged fertiliser in the port.

Fertiliser from Northern Germany´s potash district and from fertiliser factories located near ports is exported mainly via German seaports, located in the federal states of Hamburg, Mecklenburg-Western Pomerania and Schleswig-Holstein. For the inland fertiliser is imported by ship for local distribution.

Fertiliser handling largely takes place in terminals specialised in this type of cargo (Hamburg, Rostock, Wismar), or alternatively in universal terminals (Rostock, Lübeck, Brake and inland ports). While there are storage facilities in the seaports for combined traffic1, direct loading into further means of transport usually takes place inland. Cargo handling terminals specialising in fertilisers have wind- and weather-protected port-internal means of transport (e.g. enclosed conveyor belts) and use specialised technology (enclosed grabs on mobile, predominantly hydraulic port handling equipment; use of good flow brakes, etc.) for this good only. The handling from quay to ship is unprotected; in the event of rain or wind, the loading or unloading process has to be interrupted to ensure the quality of the cargo.

In literature, the loss of cargo is assumed to be 0.05 %; at the same time, this amount lost was equated with the amount entering the water. The terminal operators interviewed estimated the cargo loss to be 2 to 5,000 times lower. A test showed that the amount potentially spilled into the water was significantly lower, at about 85 g per 100 t of cargo moved; at 0.00000085 %, it is about a factor of 60,000 lower than the amounts lost so far.

Closed, regularly maintained, single-variety handling systems, defined as enclosed grabs, enclosed conveyors and covered berths with short distances to the storage location, combined with experienced personnel, optimise cargo handling and spillage. Covering the space between the vessel and the quay wall to catch possible dribble has been identified as a viable approach. All ports then carry out cleaning without water of the quay wall using machine and hand-operated brooms, with the swept material being collected and disposed of or recycled. Where possible, cleaning water is collected and disposed of or treated by local wastewater treatment plants.

The unloading of the fertiliser from seagoing or inland vessel as well as the delivery of the transhipment goods by rail or truck to the port's own warehouse could be identified as processes to be analysed for the incoming cargo traffic into warehouses at the port. Direct loading of the cargo discharged from the ship onto rail or truck is also possible. Fertiliser stored in the port is further loaded by sea or inland vessel, by truck or by rail. The ports offer filling into big bags, loading into containers and processing of the fertiliser.

In the context of processes carried out close to water, there is a risk of nutrients entering the water. Common methods used in the port industry, such as wetting the cargo, are not possible with fertilisers to avoid dust, so gentle and low-dust techniques and aids (closed systems, cascade chutes, etc.) are used. In addition to avoiding crossing open water areas, preparation (covering water inlets, etc.) and regular cleaning of the handling areas is an important element in reducing nutrient entry. However, it is also important to train employees not only in technical

[1] Broken traffic refers to transports in which the goods themselves are reloaded on the transport route (e.g. from ship to train).

matters, but also in the overall context. An employee who is educated in environmental protection uses his skills and technical equipment differently than staff who are not informed about the long-term consequences.

1 Inducement and introduction

The entry of fertilisers harmful to the marine environment during transport and cargo handling and related activities can trigger severe impairment (oxygen depletion of the water) of living organisms, especially in coastal waters.

> *Excursus on types of fertilisers:*
>
> *A distinction must be made between nitrogen compounds and natural or chemical/artificially produced fertilisers.*
>
> *Mineral solid fertilisers (also inorganic fertilisers) are mostly in the form of salts. For example, nitrates (the salts and esters of nitric acid) are used in particular as oxygen-releasing fertilisers such as potash salts and lime after industrial processing in agriculture, but also for the production of explosives, plastics and dyes.*
>
> *Nitrogen fertilisers are industrial fertilisers, mostly ammonium nitrate, ammonium sulphate and potassium nitrate. They are produced from ammonia and nitric acid. Ammonia synthesis according to the HABER-BOSCH process is one of the most important chemical processes. In application, it is only a matter of ensuring that a maximum of the fertiliser reaches the plant roots. This does not produce any carbohydrates, which in turn could serve as food for microorganisms in the soil. As a result, the soil loses quality and is dependent on the supply of further fertiliser. Unused nitrogen also ends up in the groundwater.*
>
> *Natural fertilisers are usually of animal or plant (=organic) origin and come from agriculture and the food industry. The elements to be fertilised are bound to carbon. They are also referred to as farm manures, the components of which contain nutrients important for microorganisms and thus ensure an increase in the organic content of the soil (better rooting, better utilisation of nutrients). Farm fertilisers include, for example, liquid manure, slurry, manure, guano, composted plant residues, sewage manure, blood, bone and fish meal as well as horn shavings and urea. The latter can also be synthesised and is then considered a chemical fertiliser.*

According to literature, the loss of goods calculated for the entire transport chain is estimated at 50 kg per transported tonne of cargo.

In the context of this study, it will be examined whether this input can be reduced through both technical measures and procedural changes in ports. This could be a relevant contribution to meeting the reduction requirements of the HELCOM Baltic Sea Action Plan. In the Baltic Sea Action Plan, the corresponding action has been defined as "Develop and introduce best technologies, techniques and practices (BAT/BEP) to minimize nutrient losses from dry bulk fertiliser storage and handling in ports in the Baltic Sea region by 2024". Practical recommendations for the optimisation of processes in the port for the proper, loss-reducing handling of unpackaged fertiliser cargoes are being developed.

For this purpose, the best available technology or best available environmental practice is determined with regard to the handling process, storage and downstream cleaning of the handling area including disposal (incl. drainage). Innovative practical measures are also included.

Within the framework of the study, a questionnaire was drawn up to obtain a comprehensive and reliable picture not only of fertiliser handling volumes in German seaports and inland ports, but also of cargo handling processes and applied cargo handling techniques. A questionnaire (s.a. Annex 1) was sent by mail to 18 German seaports (North Sea and Baltic Sea) and to 106 of the largest German inland ports, asking about the quantity of fertiliser handled, broken down by physical state (solid/liquid), by sea/land loading and import/export or transhipment. Furthermore, questions were asked about empirical values on the amount lost during the transport process as well as the further use/intermediate storage. Questions were also asked about the current handling procedure of bulk fertiliser, this relates to the handling technology used (if applicable for each type) (grab, conveyor belt etc.), the efficiency and possible weather-related restrictions. Furthermore, cleaning methods of the handling area, the handling of lost cargo as well as the possibility to collect cleaning water were asked for. The feedback is summarised and included in the study; it is not broken down by port.

Interviews were conducted with those responsible for cargo handling at Rostocker Fracht- und Fischereihafen GmbH, Seehafen Wismar GmbH and J. Müller AG for their terminal in Brake and, where possible, the terminal processes were inspected. We would like to thank the staff of ports and terminals involved for the extensive information they provided.

2 Statistics and techniques and procedures used

2.1 Statistics

The Federal Statistical Office DESTATIS provides statistics on the handling of fertilisers in German ports (2021), but only subdivides these into nitrogen compounds and fertilisers (excluding natural fertilisers) and chemical and (natural) fertilisers2 .

A subdivision into solid and liquid fertilisers was not made. An estimate from country- and district-specific trade balances was not possible, as these are not available. Including incomplete country-specific statistics and our own surveys, the result is an unrepresentative picture.

The ports of Hamburg and Mecklenburg-Western Pomerania mainly export fertilisers from the North German potash district in Lower Saxony and from fertiliser factories near the port (Rostock). Schleswig-Holstein also exports mainly nitrogen compounds from a chemical plant located in the port area (Brunsbüttel). All other federal states import fertilisers by inland waterway or sea, mostly for distribution to local farmers or fertiliser dealers.

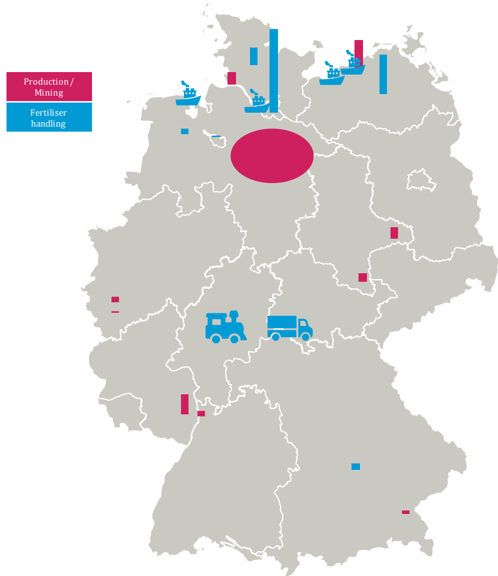


Figure 1 Fertiliser production and turnover in Germany

The distribution by federal state is shown in Figure 1 *Fertiliser production and turnover in Germany*. This is substantiated by Table 1 *Port handling of fertilisers by federal state*.

[2] Nitrogen compounds are of particular technical importance. Nitrates are mainly used as fertilisers in agriculture, but also for the production of explosives, plastics and dyes. The starting material for most industrially used nitrogen compounds is ammonia. Thus, ammonia synthesis according to the HABER-BOSCH process is one of the most important chemical processes. Natural/organic fertilisers include manure, slurry, green manure, straw, but also commercial fertilisers such as sewage sludge or compost from composting operations.

Table 1 Port handling of fertilisers by federal state (2021)

State	in 1,000t
Hamburg	4.282
Mecklenburg-Western Pomerania	2.002
Schleswig-Holstein	878
Bavaria	321
Lower Saxony	255
Baden-Württemberg	76
Bremen/Bremerhaven	51
Rhineland-Palatinate	27
Brandenburg	18

Source: federal and state statistics and own surveys

The northern German ports of Hamburg, Rostock as well as Brunsbüttel and Wismar are leading in the handling of fertilisers, followed by the ports of Lübeck and Brake. This is shown in Table 2 Fertiliser handling in German ports by type (2021, in t).

Table 2 Fertiliser handling in German ports by type (2021, in t)

Port	Nitrogen compounds and fertilisers	Chemical and (natural) fertilisers	Total
Hamburg	4,139,825	142,851	4,282,676
Rostock	1,711,276	16,111	1,727,387
Brunsbüttel	594,442	0	594,442
Wismar	25,395	223,718	249,113
Lübeck	244,067	0	244,067
Brake	143,226	8,813	152,039
Bremen/Bremerhaven	14,570	36,900	51,470
Kiel, Husum etc.	27,354	10,339	37,693
Saßnitz	25,824	0	25,824
Cuxhaven	4,876	0	4,876
Puttgarden	2,053	0	2,053
Papenburg	2,001	0	2,001
Total	**6,934,909**	**438,732**	**7,373,641**

Source: DESTATIS

No statistically relevant handling of fertiliser was recorded for the ports of Wilhelmshaven, Bützfleth, Nordenham, Leer, Husum and Kiel. No nationwide statistics are kept by the Federal Statistical Office DESTATIS for inland ports.

In any case, liquid fertiliser was loaded by pipeline. This study will not deal with this in more detail as neither dust formation nor trickle losses occur for technological reasons. The solid fertilisers relevant for this study are loaded in bulk.

2.2 Techniques used

A distinction must be made between terminals specialised in the handling of fertilisers and universal terminals.

In the specialised terminal, there is a break in the transport chain (intermediate storage). Due to the homogeneity of the transported bulk materials, continuous and largely automated handling is possible. Decisive here is the stowage behaviour due to the technological good properties such as angle of repose, grain size and bulk density. They are loaded falling using grippers and continuous conveyors (belt systems).

Excursus on the typology of (bulk) ports:

Bulk cargo ports and seaports in general are characterised by a basic structure divided into three parts. They have a waterside area with (protected) berths for the handling of seagoing vessels, an internal port area that accommodates the areas and technology for the handling of incoming and outgoing goods, and a landside area with the connection and handling points for inland means of transport. In terms of their technical equipment, bulk goods ports are oriented towards the requirements that bulk goods place on handling and storage procedures due to their characteristic and technological properties (homogeneity). They have a range of handling and conveying technologies specially developed for bulk goods. These are responsible for moving the goods over short distances in both horizontal and vertical directions. These include facilities for loading and unloading seagoing vessels and inland means of transport, for the storage and retrieval of goods and for the intermediate transports required in the port area.

The handling equipment intended for the handling of seagoing vessels, which is naturally grouped around a berth, is usually either import- or export-oriented. However, in the context of increasing ship sizes and the associated growing handling capacities, the handling equipment has been distributed more widely and handling processes have been divided up functionally. On the one hand, this increases the conveying effort; on the other hand, this can be compensated for by increasing capacity, flexibility and reliability of the facilities.

A distinction is made between continuously and discontinuously operating conveyors. Continuous conveyors generate a continuous flow of transport material, which makes it possible to transport large quantities of material. Various methods based on mechanical, pneumatic or hydraulic operation have been developed for handling bulk materials in horizontal, inclined and vertical directions. The choice of the appropriate means of transport is again based on the transport-technological properties of the goods (grain size, flowability). Discontinuous conveyors transport bulk materials discontinuously from the pick-up point to the delivery point. Their operating sequence is characterised by alternating load and empty runs, downtimes *for loading and unloading, and connecting runs. A distinction must be made between floor-bound or floor-free, rail-bound or rail-free means of transport.*

Bulk handling is not always a direct transfer process from inland means of transport to bulk carrier or vice versa. Often there is indirect handling with intermediate storage within the port area. Open-air storage areas for bulk goods that are not sensitive to weather conditions, covered warehouses or bulk goods halls and special warehouses for bulk goods that are sensitive to weather conditions (silos for grain) are available for stockpiling.

In inland universal terminals, there are often no or few storage facilities and the goods to be transported are loaded directly, usually by truck (direct loading).

Those terminals specialising in the export of fertilisers (from about 200,000 t cargo handling p.a.) almost exclusively use wagon unloading by means of deep bunkers, subsequent transfer to warehouses by means of enclosed conveyor belt systems equipped with dedusting technology as well as special ship loaders connected to the conveyor belt systems, some of which are also equipped with goods flow limiters. The cargo handling facilities form a closed system, loss of fertiliser is hardly possible, if at all.

Terminals specialising in the import of fertilisers mainly use enclosed grabs on (mobile, mainly hydraulic) harbour cranes, which store the cargo in warehouses via hoppers and enclosed conveyor belt systems. Removal from storage is regularly carried out with wheel loaders or telescopic handlers either directly onto the truck (in an enclosed hall) or by means of hoppers and conveyor belt systems onto the truck or train.

Smaller terminals (mostly import) tend to use direct loading, where the goods to be transported are loaded directly from the ship onto the truck or train using closed and open grabs.

The less fertiliser is handled, the less specialised the terminal is, the more likely it is that the equipment used is also used for other types of goods. The easier the equipment is to clean, the more likely it is to be used for other types of goods (a bucket grab is easier to clean than a conveyor belt system, the grabs are usually also used for other types of goods, the conveyor belts are kept clean if possible).

Only a few, even of the specialised terminals can handle bulk cargo independently of the weather conditions, almost all loading and unloading sites are unprotected (handling cargo open air) and all interrupt the process of fertiliser handling in the event of rain, mostly also during storms. Special exceptions (and only present in the inland port) are covered berths, where rain- and partly wind-protected cargo handling is possible.

The handling speed depends on the specialisation of the terminals. Specialised terminals can unload at up to 600 t/h using ship loaders and store at 250 t/h using crane handling. Universal terminals handle between 120 and 300 t/h by crane or excavator.

2.3 Cleaning and cargo losses

Most terminals train their staff in the use of techniques to make the handling of fertilisers as gentle as possible and to avoid cargo losses (for example, through low drop heights and timely closing of grabs when loading by crane). This is facilitated by regular maintenance (complete closure of the grabs).

The following applies primarily to universal terminals: trickle losses or spilled goods are already swept up during loading (depending on the volume, manually with a broom or sweeper), picked up, partially cleaned or uncleaned depending on the condition, returned separately to the supplier, added to the cargo or disposed of. Special protective measures include laying a tarpaulin between the quay wall and the ship and, if necessary, also on the quay surface (covering rainwater floor drains for the period of cargo handling) to catch possible losses. Some ports have coated the quay surface with epoxy to protect it from decomposition and to facilitate the collection of possible trickle losses. The use of silo outlets with a small cross-section also leads to positive effects, which, however, causes losses in handling capacity.In all ports, the accumulation of cleaning water is avoided as far as possible. Only if the port areas to be cleaned are connected to a separate catch basin may these areas be cleaned with water. This cleaning water is mostly taken away by means of IBC containers for professional disposal; in rare cases, disposal (after prior consultation and in limited quantities) is possible via the local sewage treatment plant. Cleaning water from the ship is disposed of by specialised companies.

Only minor cargo losses occur in the interviewed terminals, as shown in Table 3 *Ports with fertiliser loss*.

Table 3 Ports with fertiliser loss (2022)

Loss quantity in %	Loss quantity in kg per t of cargo handled	Number of ports
Not specified		9
0,000000 %	0,000 kg	6
0,000005 %	0.005 kg	1
0,000010 %	0.010 kg	2
0,000020 %	0.020 kg	1
0,000100 %	0.100 kg	1
0,000500 %	0.500 kg	1
0,001000 %	1,000 kg	2
0,010000 %	10,000 kg	1
0,025000 %	25,000 kg	1

Source: own survey, Ramboll

One port stated that it had determined the trickle loss to be 0.0007 % through its own study, whereby the sea-land transhipment (v.v.) in conjunction with a silo and housed conveyor belts is almost loss-free. These figures are also only partially valid, as many ports add that the loss quantities mentioned are trickle losses, which are then picked up as sweepings by sweepers/wheel loader brooms/hand brooms and either disposed of, returned to the production plant or fed to agricultural entrepreneurs for further use.

On average, the reported handling loss is 2.35 kg per t handled, which corresponds to 0.23 %. The median is 0.01 kg per t handled, which corresponds to 0.001 %.

Based on a reference/calculation in the call for tenders for this study to an article by Matthias Grote et al. "Dry bulk cargo shipping - An overlooked threat to the marine environment?" from 2016, a fertiliser spillage to the water of 0.05 % of the bulk cargo is assumed. The original source states:

"Dry bulk cargoes carried on bulkers can enter the marine environment at different phases during transport: loading, transhipment, unloading and washing of cargo holds. We tried to estimate the amounts of cargo losses in two ways:

People involved in cargo handling operations report about cargo residues remaining on hold and deck surfaces and in structural elements of the ship. Experts assume that about 0.05% of the cargo is lost (e.g. unloading with grabber, washing cargo contaminated surfaces and holds), although this value may depend on the physical properties and on the commercial value of the good. Based on the total bulk quantities shipped of estimated 4.3 billion tonnes, it is likely that at least 2.15 million tonnes per year are discharged into the oceans, mainly the coastal sea." [2016)

This vague ("Experts assume") assumption refers, on the one hand, to (in the opinion of the study authors) the entire transport chain of global transports (and not the Baltic internal and external fertiliser transports, which are given priority in this study) and, on the other hand, is only fed by unspecified statements of an unspecified number of port experts ("People involved in cargo handling operations..." as well as "Experts assume...").

The subsequent calculation of the worldwide (port- and ship-induced) fertiliser input does not take into account the special features of the transports. For example, ships and wagons are often used in (partly factory- or group-owned) shuttle traffic, i.e. the outward journey is loaded, the return journey empty. Although this may be an improvement from a transport economics point of view, in this case there is no need for (thorough, water-based) cleaning of the means of transport and thus no cleaning water that would otherwise be produced.

It is also assumed that (all) cleaning water is discharged into the sea/harbour basin, which is not the case. In fact, the opposite is the case; cleaning water produced in the port or during the crossing is to be collected and handed over to local treatment plants for purification. This is done on the basis of an amendment to MARPOL Annex V that came into force in 2013, which does not permit the discharge of wastewater into the Baltic Sea. The amendment to MARPOL Annex V affects all Baltic Sea ports in this study, but not the North Sea ports.

It should not be concluded directly from fertiliser losses to inputs into the sea.

Within the framework of this study, cargo handling companies and employees involved in the handling of fertilisers on a daily basis were asked about a possible loss in the entire transport process. On average, the reported handling loss is 2.35 kg per t handled, which corresponds to 0.23 %. The median is 0.01 kg per t handled, which corresponds to 0.001 %.

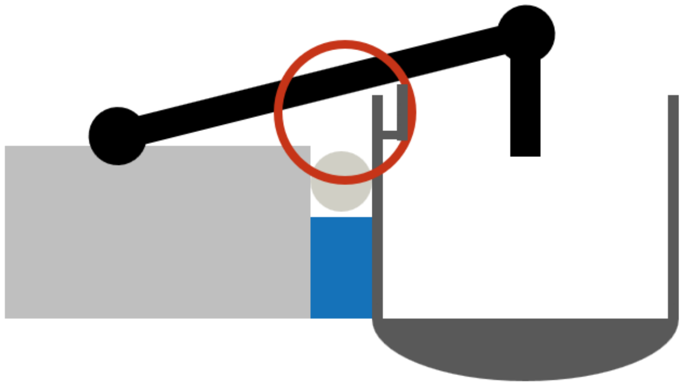
In comparison now stand

Grote et al.	0,05000 %		and the
Statements according to port survey	0,00235 %	mean	
	0.00001 %	median	

opposite. This corresponds to a factor of 2 (mean value) or a factor of 5000 (median). This discrepancy prompted the study initiator to specifically commission the physical examination of possible residues in the ship's hold as well as any losses incurred during cargo handling.

For this purpose, the fertiliser loading of a ship was accompanied. The goods were delivered in wagons and loaded directly into the hold of the ocean-going vessel by means of two conveyor belts. One of the conveyor belts was enclosed, one was open. Especially in the area between the quay side and the ship - the ship is kept away from the quay side with fenders - there is a possibility of cargo entering the aquatorium, this is shown in *Figure 2 Schematic depiction of the critical area between quay side and ship*

Figure 2 Schematic depiction of the critical area between quay side and ship



Source: own graphic, Ramboll

The area below the conveyor belts between the ship's rail and the beginning of the continuous conveyor was closed with dark green fabric tarpaulin (6 m x 10 m). The colour dark green was chosen to contrast as much as possible with the white fertiliser loaded in the form of pellets. The fabric tarpaulin was placed parallel to the ship and fastened with flexible tarpaulin tensioners, see Figure 3 *Photo of the experimental setup*.

Figure 3 Photo of the experimental setup

Source: own source, Ramboll

Figure 4 Photo of the experimental setup

Source: own source, Ramboll

For safety reasons, the corridor running around the cargo hold must not be covered, see white arrow in Figure 4 *Photo of the experimental setup*.

During the test, two 60 t wagons are unloaded via the test structure, after two wagons the tarpaulin is cleaned and the cargo loss on the tarpaulin in the area between quay and ship is collected. The weighing is done with an uncalibrated but plausible kitchen scale.

A total of 15 trials were carried out, with quantities between 45 g and 97 g per 120 t of fertiliser handled.

For the further calculation of the percentage loss quantity, rounded 100 g per 120 t of cargo is used, which corresponds to 83.33 g per 100 t or 0.0000008333 %. This means that the loss quantity of a handling fertiliser in a German port determined in the test is 60,000 times lower than the 0.05 % loss quantity named by Grote, but it is also lower than the loss quantities estimated or determined by the ports and terminals (factor 2,820 compared to the mean value, or factor 120 compared to the median). These values differ significantly from each other. They show that this continues to be an issue that needs to be looked at closely, as the handling of cargo can vary from terminal to terminal, port to port and country to country.

For Germany, however, this has demonstrated a clearly environmentally friendly way of handling fertiliser as a cargo.

2.4 Summary

The information obtained on cargo handling volumes and techniques mostly describes the individual port very well, but cannot be transferred to other ports, or only with difficulty. A statistical evaluation does not appear to make sense due to many inconsistencies; in particular, no valid descriptions can be drawn from this. However, the following summarised qualitative statements can be drawn from the survey:

Individual seaports (due to their location in relation to the production sites) operate primarily in land-sea cargo handling, while inland ports forward incoming cargo from the seaports in particular to fertiliser traders for further distribution.

Fertiliser plants located inland do not use inland vessels for transport.

Almost all ports use harbour cranes or dredgers with bulk material grabs, sometimes in combination with conveyor belts, to handle solid fertiliser.

Closed, regularly maintained, single variety systems (closed grab, enclosed conveyors as well as covered berths with short distances to the storage location) in combination with experienced personnel optimise cargo handling and loss.

The installation of tarpaulins or other covers between the ship and the quay wall to catch possible dribble was identified as a practicable and efficient approach.

After finishing the cargo handling process, all ports carry out dry cleaning of the quay wall using machine and hand-operated brooms, whereby the swept material is collected and disposed of or recycled. Where possible, cleaning water is collected and disposed of or purified by local sewage treatment plants.

From the data mentioned in the scientific discourse with regard to the percentage of loss, it can be concluded that German ports handle the cargo of fertiliser in a comparatively exemplary manner. At the same time, depending on the source, these figures are only valid to a limited extent and differ significantly from one another.

3 Fertiliser terminals and techniques used

The main types of goods relevant to this study are explained on a port-specific basis. The explanations are limited to seaports with an annual fertiliser turnover of more than 150,000 t. At the same time, port-relevant production sites are also included, if relevant and known.

Hamburg

Kalikai cargo handling facility of K+S Minerals and Agriculture GmbH

K+S Minerals und Agriculture GmbH specialises in the handling, storage and shipping of moisture-sensitive bulk goods extracted by the parent company, in particular salts, potash and other fertilisers. The terminal is the largest and most specialised. Goods with a total volume of about four million t per year are exported via the 500 m long potash quay in Hamburg-Wilhelmsburg. The terminal has twelve warehouses and six silo cells (single-variety, 8 - 45,000 t per storage location) with a storage volume of 405,000 t. 95 % of the goods are transported by rail (16 goods trains daily, 70,000 wagons p.a., 66 t per wagon) from German mines to Hamburg and unloaded via two deep bunkers (600 t/h and 1200 t/h respectively). Sea-going and inland vessels are unloaded by means of a grab system, the discharge takes place via an (enclosed) conveyor belt system (12 km total length with 600 t/h/belt) with the help of wheel loaders (capacity of each wheel loader bucket 6 t). The ships are loaded with loose loaders (1x 20 m boom 2,000 t/h, 2x 25 m boom 3,000 t/h). To avoid dust formation, the loaders are equipped with cascade chutes. In addition to ship loading, containers with loose and bagged goods are also loaded (50,000 20-foot containers á 20 t p.a.). Big bags and pallets can also be loaded.[3]

Umschlagbetrieb Louis Hagel GmbH & Co. KG

By means of a loose loader, ships can be loaded with free-flowing (dry) bulk goods (fertiliser, road salt) in direct handling (from rail or truck) or in indirect handling from silos via a closed pipe system with integrated conveyor belts with a capacity of up to 750 t/h. The bulk goods can be loaded from the silos via a closed pipe system with integrated conveyor belts. Transhipment from inland waterway vessel to seagoing vessel or v.v. is carried out by means of a 12 t grab crane (max. 500 t/h). Incoming goods can also be stored in silos or weighed and loaded onto trucks, wagons or into containers. For this purpose, the goods are dropped from a low drop height via a hopper at the height of the crane bridge. The hopper can be closed electrically when it starts to rain. The goods are brought ashore via a closed conveyor belt system, weighed there with a container scale and further loaded or stored. The goods can also be crushed and screened.

The goods can be stored in four silos according to type. The roof of silo 1 (17,000 t storage capacity) has a 28° slope, which corresponds to the cone of repose of fertiliser. The goods are usually delivered by rail or ship. They are brought into the silo via enclosed conveyor belts. Both storage and removal from storage are carried out with a specially developed scraper. During storage (500 t/h), the goods are transported from the bottom to the top by means of the scraper blades and thus "pushed" upwards. This eliminates a free fall of the goods and reduces possible dust formation to a minimum. In addition, this also prevents the formation of dust cones or segregation of the valuable goods. During retrieval, the scraper knives scrape the goods back onto the conveyor system from top to bottom. The goods can be discharged via the bulk loader onto the ship (800 t/h) or via a hopper at a truck loading station (250 - 450 t/h).

[3] Images at https://south-central.de/digital-selection/kalikai-hamburg/

Silo 2 complements silo 1 with a storage capacity of 5,000 t. Silos 3A and 3B consist of two identical silo cells with a storage capacity of 8,000 t each. Storage takes place from the ship by grab crane and conveyor belt system or from the truck into a deep bunker. The goods are removed from this silo by wheel loader. Onward transport is by truck or rail. The weight of the goods to be loaded is determined automatically and protected from the wind by a calibrated automatic weighbridge. Rainproof loading of 20-foot containers with bulk goods is possible (85 t/h).

Figure 5 shows the ship loader together with the closed conveyor belt system. Figure 6 shows the unloading of a sea-going vessel using a closed grab bucket. The load is discharged into a hopper, which serves an enclosed conveyor belt for storing the load.

Figure 5 Ship loader and closed conveyor belt system during loading of an ocean-going vessel

Quelle: Louis Hagel, Webseite

Figure 6 Unloading of a seagoing vessel by means of a closed grab bucket, discharge into hopper and storage by means of an enclosed conveyor belt

Quelle: Louis Hagel, Webseite

Rostock

Fertilisers are handled in the Port of Rostock at four different terminals by three different companies. Solid fertilisers are handled by Euroports and RFH, liquid fertilisers by YARA.

Euroports

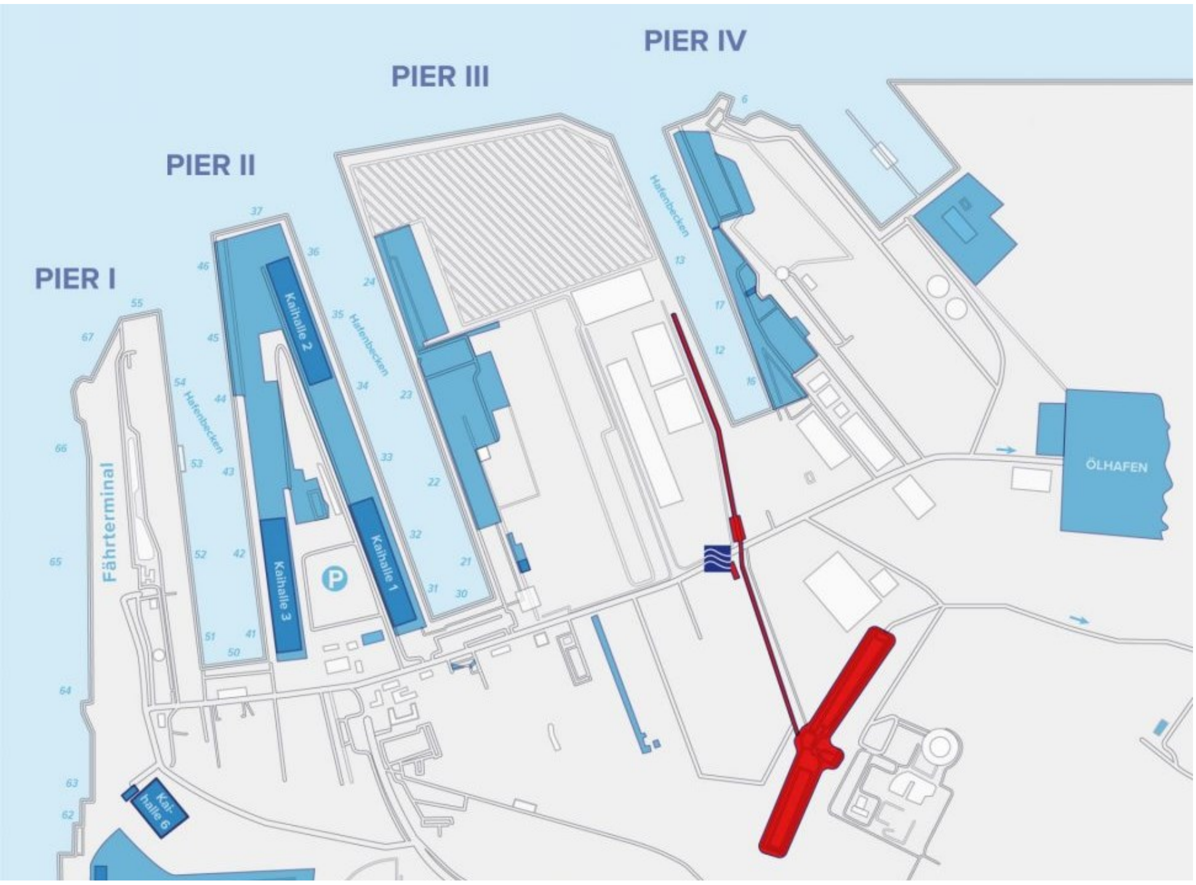
Euroports handles fertiliser in the overseas port at Pier III (berths 12 and 21)mainly nitrate fertiliser and calcium ammonium nitrate. The company operates a ship loader (with a capacity of 1,000 t/h) specially built for fertilisers and equipped with a dust removal system and good flow brake in the export area and a wagon unloading station (deep bunker). There are covered warehouses with a capacity of 60,000 t. The warehouses are firmly connected to the quay via a 700 m long covered conveyor belt system, as shown in Figure 7 and in Figure 8.

Figure 7 Storage halls for fertiliser with conveyor belt connection to terminal in the port of Rostock

Quelle: Euroports, Webseite

Calcium ammonium nitrate (CAS), axane, sulphates (of 24 % nitrate), potash, diammonium phosphate (DAP) and sewage sludge ash (SSA) are handled. Dolomite, a lime fertiliser, is imported to supply the Yara production plant.

Figure 8 Location of the fertiliser warehouses (red) in the port of Rostock



Quelle: Euroports, Webseite

Rostock Freight and Fishery Port (RFH)

The Rostock Freight and Fishery Port (RFH) handles next to axane and urea nitrate other typs of fertilisers. Handling is carried out by means of grabs, enclosed (single-variety) conveyor belts and hoppers. In a separate bagging facility, fertilisers can be packed into big bags (Figure 9).

Cloddy and lumpy fertiliser can be gently processed with RFH's own fertiliser crusher, leaving the free-flowing fertiliser untouched, see Figure 10.

Figure 9 Bagging system for fertiliser

Source: RFH, website

Figure 10 Crusher for fertiliser

Source: RFH, website

Yara (Berth 7/"Chemical Harbour")

The jetty is used exclusively for the handling of liquid products for or fertilisers produced by the YARA fertiliser plant Rostock-Poppendorf. Pipelines connect the tankers with the storage facilities. The loading/unloading capacity is 1,200 t/h. Ammonium and AHL from the Brunsbüttel plant are unloaded as incoming intermediate products for production in Poppendorf. For export liquid fertiliser is handled. The jetty is operated by YARA itself.

YARA production plant Rostock-Poppendorf

In Rostock, YARA operates two nitric acid plants and two plants for the production of nitrate fertiliser, an AHL plant and two plants for the production of technical ammonium nitrate. About 1.5 million t of nitrate fertiliser, 200,000 to 300,000 t of ammonium nitrate urea solution (AHL) and around 150,000 t of industrial chemicals are produced here annually by about 250 employees.

For the nitrate fertiliser, liquid ammonia produced at the sister plant in Brunsbüttel is landed as a precursor via the plant's own port ("chemical port") and pumped into the Poppendorf plant via a 13 km long pipeline.

YARA has had a fully automated big bag bagging plant since 2017 (capacity 200 big bags per hour and 300 t of loose fertiliser per hour). YARA is participating in a consortium to build an electrolysis and ammonia synthesis plant in the port of Rostock, which is scheduled for completion by 2025.

Brunsbüttel

The products handled at the Port of Brunsbüttel are nitrogen compounds and fertilisers in liquid form. Cargo is pumped from tanks by pipeline into product tankers. About 60 % of the materials produced in Brunsbüttel are shipped by ship to Europe and overseas. Solid fertilisers are neither produced nor handled at Brunsbüttel.

YARA production plant Brunsbüttel

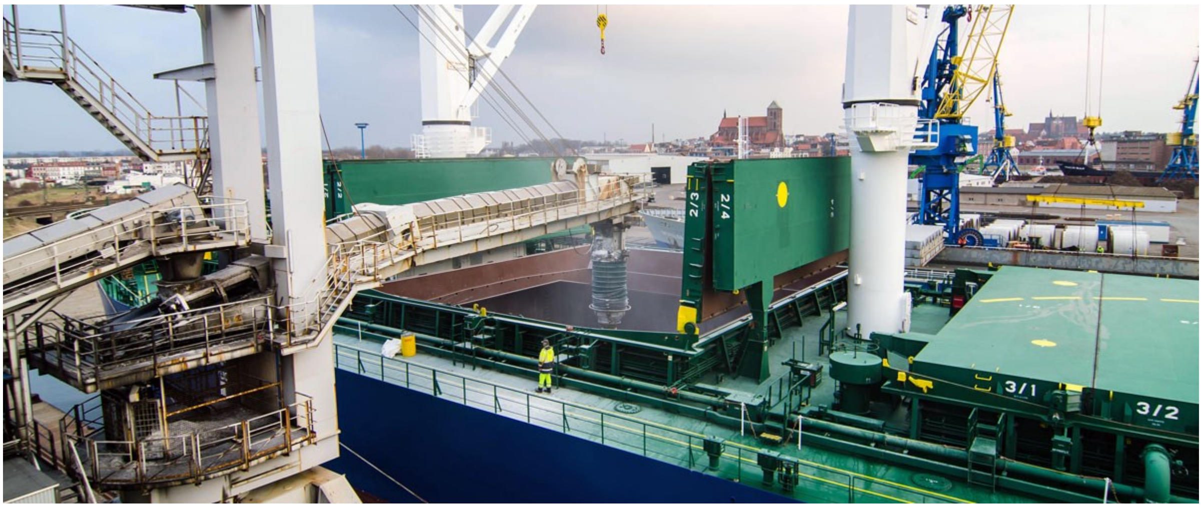
The Brunsbüttel YARA site is an industry-focused site. The production plant has two units, the ammonia plant and the urea plant. An existing air separation unit operates according to the Linde process. An ammonia synthesis plant uses the Haber-Bosch process to produce the air gases nitrogen, oxygen and argon, which are needed for various technical and industrial applications. Various grades of ammonia and urea are produced at the Brunsbüttel plant, as are AdBlue/Air 1 and NOx Care products for NOx reduction in trucks and power plants.

Wismar

Seehafen Wismar GmbH

Seehafen Wismar GmbH handles fertilisers for the K+S Group, among others, and has storage capacity for 120,000 t. Delivery takes place by rail, wagon unloading takes place via deep bunkers, further handling takes place by means of enclosed conveyor belts. Removal from storage is carried out by means of a mobile ship loader (600 t/h) onto ships, which transport the cargo mainly to the Scandinavian and Baltic markets.

Figure 11 Ship loader for fertiliser in the seaport of Wismar



Source: LHMV, website

Even though the facility (built in 1960) was also designed for other goods, today only fertilisers are handled. Due to continuous modernisation, it corresponds to the current state of the art.

Lübeck

Fertilisers are handled in the Port of Lübeck by Hans Lehmann KG, Umschlag & Handel GmbH (Lagerhaus Lübeck), ATR Landhandel GmbH & Co. KG and Burrmann Hafenlogistik GmbH.

Hans Lehmann KG

Fertilisers are loaded openly and exclusively in direct handling processes at the 550 m long Lehmannkai 3, which specialises in bulk goods. Two cranes (8 t, 16 t) and a rail connection are available. Packaged fertilisers are also handled.

Lagerhaus Lübeck Dr. Pleines GmbH & Co. KG

Umschlag & Handel GmbH operates the handling and storage facilities owned by Lagerhaus Lübeck Dr. Pleines GmbH & Co KG. The total storage capacity of approx. 150,000 t for heavy grain, animal feed and fertiliser is distributed over seven cantilevered, former shipyard halls, which are equipped with 8 m high concrete walls that can be filled in. Mineral fertiliser is handled by hydraulic grab dredgers on a covered conveyor belt system and transported to warehouses located directly at the quay. In addition, a liquid fertiliser terminal with a storage capacity of 30,000 t was built in 2004, which is managed by AgroBaltic GmbH.

ATR Landhandel GmbH & Co KG

At the silo quay in Vorwerker Hafen, ATR handles fertiliser, among other things. Fertilisers are handled by a fixed, covered installation. In the silo, the goods are transported by means of bucket lifts and temporarily stored there in silo cells.

Burmann Port Logistics GmbH

At Burmannkai I, fertilisers, among other things, are handled in grab handling with two hydraulic mobile excavators (250 t/h discharge capacity) in halls located directly on the quay. In some cases, an internal terminal transfer (300 m) by truck is necessary. With dredger-based handling, attention is paid to low discharge heights and ongoing maintenance; the grabs are equipped with double cutting edges to prevent possible scattering losses. Open grabs are deliberately used, as the fill level can be better controlled this way. This prevents additional lifting operations and enables more precise loading of the trucks.

As standard, a tarpaulin is hung between the ship and the quay to catch possible trickle losses. The surface drainage of the handling area is equipped with a sediment separator and is connected to the wastewater sewer; the entry of fertiliser is prevented by covering the inlets in the direct handling area. Trickle losses on the quay are regularly collected by a street sweeper and recycled in different ways depending on their condition.

The ship is loaded by means of conveyor belts. The terminal has a rail connection.

Brake

J. Müller AG

J. Müller operates an agricultural terminal in Brake, which is connected by rail, sea and road and also handles fertilisers. Fertilisers are imported in their entirety by ship and loaded in their entirety by truck both into the on-site warehouse and directly to customers in north-western Lower Saxony. Handling is crane-based with open grabs (250 - 300 t/h) by specially trained staff. Trickle losses are regularly cleaned and picked up by brooms during the handling process; at the end of the activities, final cleaning is carried out by broom trucks. The reloading takes place in the storage halls on trucks; outside the halls this is not permitted for reasons of immission control.

4 Handling processes and possible optimisations

4.1 Processes and their components

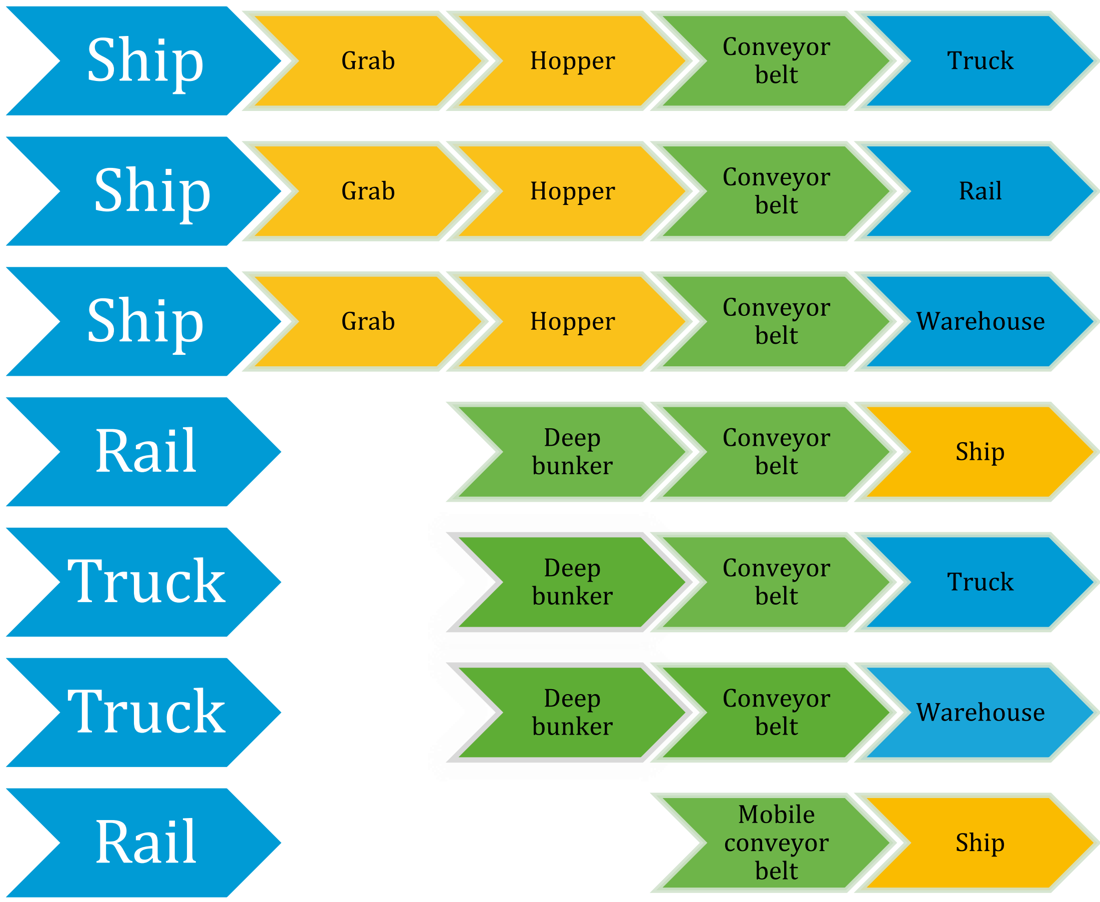
The processes can be roughly divided into "inbound handling/direct loading", "outbound handling" and "preparation and packaging", whereby individual components are repeated in each case.

Incoming cargo (or qualified as direct handling with the onward loading component, see bottom line in Figure 12 Incoming cargo handling and direct loading) is delivered by sea, rail or truck.

The ship is unloaded into a hopper by means of a grab crane or dredger on the port side. The hopper transfers the cargo to the conveyor belt. Goods delivered by rail or truck are unloaded via a deep bunker and fed to the conveyor belt; the truck can also unload onto a bulk device. Via a continuous conveyor, the load is either stored in the warehouse or transferred to the appropriate loading facility for further loading onto trucks or trains.

Of these processes, only the unloading by means of a gripper and feeding via a hopper to the conveyor belt or the loading of the ship usually takes place unprotected (yellow). The conveyor belt is enclosed in most cases or when relevant handling quantities occur. A special situation to be considered is the direct loading of a ship by means of a mobile conveyor belt with wagons as the cargo source. All other activities take place protected within the warehouse or are protected accordingly by structural measures (green).

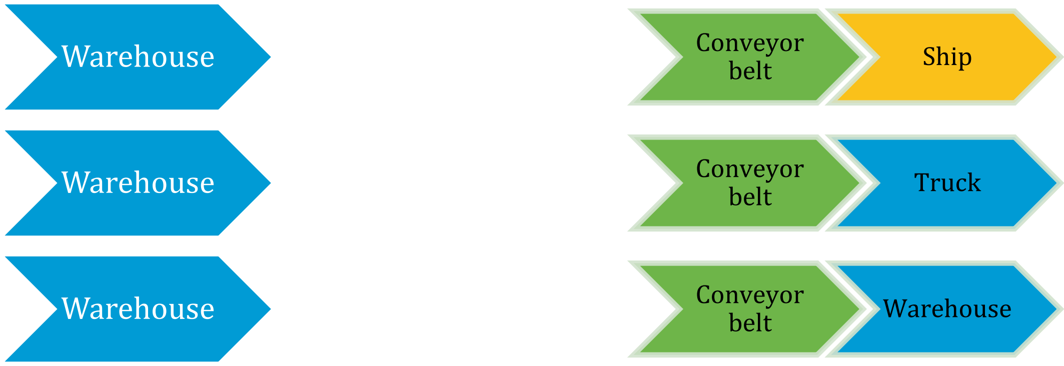
Figure 12 Incoming cargo handling and direct loading



Source: own graphic, Ramboll

During outgoing cargo handling (Figure 13), the fertiliser is usually delivered from the warehouse to the ship via an enclosed conveyor belt or loaded onto trucks or wagons via the respective enclosed loading station.

Figure 13 Outgoing cargo handling process

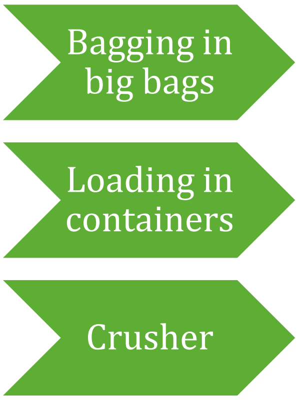


Source: own graphic, Ramboll

In addition, the process components "bagging in big bags", "loading in containers" or the preparation of the fertiliser by means of a crushing plant can be identified, these are shown in Figure 14. These processes usually take place in an enclosed and thus protected environment.

Most of the process elements, such as the unloading of rail wagons and trucks into the deep bunker, internal transport by conveyor belt, the loading of trucks and wagons, and packaging and processing services, take place in a protected environment, there is hardly any loss that could affect the environment here.

Figure 14 Other process elements



Source: own graphic, Ramboll

Process elements such as unloading ships by means of grabs and then dropping them into the hopper, unloading trucks into a hopper, unloading wagons onto a mobile conveyor belt and loading ships are carried out close to the water and therefore involve the risk of cargo loss.

4.2 Water-related processes

The application of best available technology is intended to avoid possible nutrient loading during near-water handling of fertilisers. With the techniques and working practices currently used, there is a loss of cargo, albeit minimal.

In particular, the usual methods used in ports to reduce dust, such as spraying with water, cannot be used because of the possible consequences for the quality of the goods, since the water-soluble fertiliser is to be protected from moisture. Also, bulk fertiliser is a very price-sensitive commodity and must be handled with care. Every additional handling operation has a negative impact on the quality of the goods, every change - such as the transport in big bags or containers - in the transport chain has a negative cost impact.

While specialised handling equipment, such as ship loaders with transport goods supply by means of tubular conveyor belts for special bulk goods operations, is acquired and used at a few main handling locations, fertiliser is a rather insignificant handling good in the majority of ports, which is additionally handled by crane or grab-based alongside other bulk goods.

In smaller ports, the handling of fertilisers increases the utilisation of existing handling equipment and is only supplemented by mobile conveyor belt systems characterised by low investment costs. At the same time, the smaller handling terminals are more flexible in the use of their mobile handling equipment (purchase, sale, use at different handling terminals, exchange/replacement in case of maintenance/repair). A ship loader, on the other hand, can usually only be replaced by a second ship loader, and repairs can only be carried out on site.

4.2.1 Ship unloading by means of crane/dredger grab and discharge into hopper

Ships are unloaded by means of open or closed bucket grabs, which are mounted as attachments to cable-operated, hydraulic or electro-hydraulic cranes or dredgers.

Rope hoist cranes (see Figure 15) have been installed in ports for a long time, are available cheaply on the second-hand market and are robust in terms of technology. Compared to more modern crane types, they are somewhat slower and cannot be controlled as precisely, but in combination with an experienced and trained crane operator they are a suitable handling device for fertiliser.

Figure 15 Rope hoist crane with closed bucket grab drops fertiliser into hopper

Source: Louis Hagel, website

Hydraulic cranes (as an example, the Mantsinen 120 R in Figure 16) require less maintenance and can be operated more precisely and sensitively by the crane operator. The electro-hydraulically equipped crane offers a higher level of operating comfort.

Figure 16 Port handling equipment Mantsinen 120R with articulated arm

Source: RFH, website

Both variants, as well as rope hoist cranes of more recent construction, enable low-jerk movements and precise positioning of the load; they are identified as the preferred handling equipment for fertilisers.

Highly productive pneumatic ship unloaders or screw conveyors are not used for unloading due to their negative impact on the transported goods.

Clamshell buckets in open or closed versions are used in crane- or dredger-based cargo handling for loading, but primarily for unloading the vessel. Conventional grabs have an open top, which encourages spillage and dust drift.

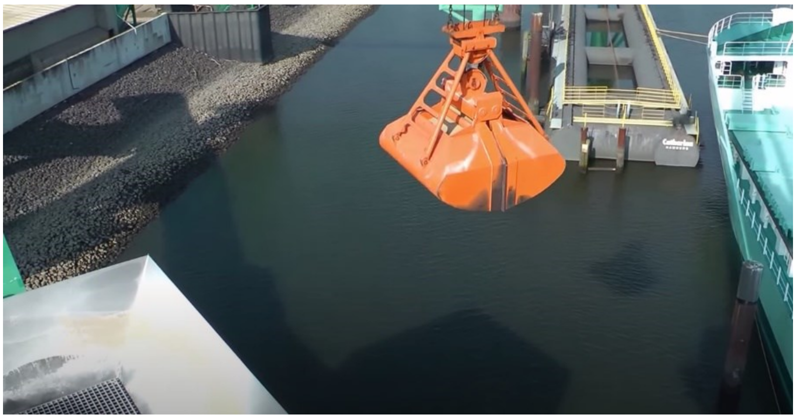
The attachment for crane or port handling equipment should be a closed, hydraulically operated clamshell bucket (example see Figure 19) with the largest possible capacity should be selected; these ensure less dust formation in windy conditions. Regular checks to ensure that the grabs close completely and regular maintenance, combined with careful operation by the crane operator, will result in minimal or no drizzle loss. The operator should also ensure that no residue remains on the closed clamshell bucket. The correct application of the technique by the operator is of great importance. The grab load should be optimised, the grab properly closed, a smooth movement between the vessel and the quay should be made and an appropriate opening height to the hopper or hold should be chosen by the operator. Opening the grab too high leads to dust formation. Special software automates and optimises these movements.

Figure 17 Kinshofer handling and industrial grab C40-VHD-C especially for fertilisers

Source: Kinshofer, website

The fertiliser is to be fed to the conveyor belt for internal transport; for this purpose, it is discharged into a **hopper,** which serves as a loading point for the continuous conveyor. The distance to be covered by the handling equipment should be as short as possible. This location is naturally close to the water, Figure 17 shows such a hopper. To protect the fertiliser from the weather, the hopper has an electric roof lock that can be operated from the crane bridge.

Figure 18 Potential nutrient input due to long distance between vessel and hopper



Source: Louis Hagel, website/YouTube channel

In the example case, the hopper lies on a platform above the water. The bucket grab is guided over the open water due to the dolphin berth (Figure 18) and not, as in the case of a quay berth, only over the (small) distance between quay and ship caused by the fender constructions. Stowage of cargo in the hopper, which leads to a cone of debris beyond the hopper intake, should also be avoided. Again, proper application and training of crane operators play a major role. Opening height can promote losses due to blowing, overfilling the hopper reduces dust filtration and can interrupt the supply of material to the conveyor. Air curtains and wind fences can be used to avoid the effects of strong winds.

Catching possible trickle losses by means of a roofing/covering of the water, i.e. below the crane movement from the hold to the hopper, would prevent possible entry analogous to covering the space between the quay and the ship with a tarpaulin.

4.2.2 Ship loading

The ship is usually loaded by means of **loose loaders**, to which the bulk material to be loaded is fed on conveyor belts. The loose loader is placed above the hold and the cargo is dropped into the hold through a trim chute. The loading head is moved in the ship for better trimming of the cargo; it is usually adjustable in height as well as in the direction of discharge. The advantage of these telescopic trim chutes is the low drop height, which leads to less dust formation. It can also be equipped with a dust removal system or a good flow brake for gentle discharge of the load. **Cascade chutes allow** the load to flow through a series of buckets, thus reducing the flow rate, and a cover serves to limit dust. A closing cone seals the outlet of the loading head after completion of the loading process, this prevents any products that may still be adhering from falling out.

A method of loading ships that is for safety reasons not used in Germany is the inflow of fertiliser through openings in the closed cargo hatches. Although this allows for weather-independent and dust-free loading, it has not become established in practice.

The transport of fertilisers in sea containers has not become established in Germany and is only used for small quantities. The loading of big bags (1 - 2 t each) or palletised bags by ship also only takes place in individual cases due to the lack of economies of scale (usually slower loading and possibly inadequate use of the ship's space).

4.2.3 Direct handling Wagon - Ship

A variant of outgoing ship loading is the direct transfer of fertiliser delivered by wagon to a ship by means of a conveyor belt. The fertiliser is unloaded by gravity on the quay tracks (in the immediate vicinity of the ship) through the unloading hatches of the wagon onto a wagon unloading belt placed underneath the wagon. A second conveyor belt (in an enclosed or unenclosed version) now transports the goods over the hold, from where a discharge protected by a trunk takes place into the hold of the ship.

Due to the proximity to water, a possible entry of the fertiliser into the water is possible through various pathways. Measures are taken against this:

- Where possible, enclosed crop conveyors are used, under which a tarpaulin is placed, especially in the handling area between quay and ship, to catch jumping (rare) fertiliser or fertiliser sticking to the conveyor belt (tarpaulin as in Figure 19). The collected material is collected on the quay wall and finds suitable further use or is disposed of.
- Regular cleaning of the quay surface prevents the spreading of fertiliser and possible flight into the water or the environment.
- Rain drainage channels or rainwater inlets embedded in the surface are closed before loading begins by collection boxes, magnetic foil or jute bags. Any material collected during the loading process will be used for other purposes or disposed of, and the openings will be reopened after the end of the loading process.

Figure 19 To prevent nutrients from entering the water, the space between the quay side and the ship is covered with a tarpaulin

Source: Burmann Hafenlogistik, website. Photo: André Leisner

Under these conditions, the direct transfer of fertiliser from the wagon to the ship prevents nutrient input as far as possible.

4.3 Summary of possible optimisations

The core element in the handling processes is the human being. Employees should be aware of what their actions trigger. If they are aware that fertilisers introduced into the water or the environment due to poor handling capacity put a strain on the ecosystem and that this also has serious economic effects, the employees will pay more attention to their actions in the future and of their own accord and improve them. Such intrinsic motivation not only has a positive effect on the environment, but also improves the quality of the handling process.

Regular technical training in the gently handling of cargo handling equipment should be supplemented by training in sustainability/environmental protection. Motivated employees are forward-looking, they recognise interrelationships better. The use of machine operators who are familiar/experienced with the equipment and the type of goods also ensures positive environmental effects.

The further away or the less close any handling operations are from the water, the less chance there is of fertilisers being introduced into the water.

The unloading of a ship should preferably be carried out with closed bucket grabs as an attachment to an electro-hydraulically controlled crane. It is important to ensure that both halves of the bucket grab interlock well. The bucket grab is completely closed during the handling process and no trickle material can fall out. Regular inspection and maintenance support this process.

Crossing open water should be avoided as far as possible. Depending on the berth and unloading situation, the distance between the ship and the quay determined by the impact protection has to be crossed. Covering this area with tarpaulins or mobile, foldable and/or permanently installed containment devices prevents fertiliser from entering the water.

Due to the shallow water depth, the ship to be unloaded can also be at a greater distance from the shore-side receiving device. Due to the construction, the crane is located between the ship and the berth, so that a crane reach of open water has to be crossed in each case. This is to be avoided as a matter of principle; a cover would prevent entry here.

Continuous conveyors used should be enclosed and, if necessary, equipped with dust extraction systems. Regular maintenance and the use of conveyors for only one type of material (in this case fertiliser) is advantageous.

For seaward, outgoing fertiliser handling, telecopic, weather-protected ship loaders with low drop heights and cross-sections, integrated cascade chutes and crop flow limiters optimise dust-reduced discharge.

The quay should be prepared for fertiliser handling, e.g. by covering the inlets for surface water disposal in the direct handling area. Cleaning the quay side at short intervals and, if necessary, installing collecting devices prevents the cargo from being carried further by wind or other influences. Collected cargo cannot be discharged into the water. Additional protection and improved properties for cleaning the quay surface and collecting the collected cargo are provided by coating the quay surface with EPOXY.

Table 4 summarizes possible improvements in fertiliser handling.

Table 4 Possible improvements in fertiliser handling

Possible improvements in fertiliser handling
Trained/experienced, intrinsically motivated employees
Avoid maximum distance from water/transhipment over open water (tarpaulin cover)
Enclosed, modern/regularly maintained handling equipment
Quay preparation (close surface water disposal) and regular quay cleaning

Last but not least, the weather conditions should also be taken into account; cargo handling at higher wind speeds naturally also ensures the displacement of dust particles of the handled goods.

5 List of sources

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Annex 1: Questionnaire with cover letter

This questionnaire was sent out to the terminals in German language only.

Für Mensch & Umwelt

Umwelt Bundesamt

Umweltbundesamt I Postfach 1406 I 06813 Dessau-Roßlau

FRAGEBOGEN ZUM UMSCHLAG VON DÜNGEMITTEL

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Anlage
Fragebogen zum Umschlag von Düngemittel

Sehr geehrte Damen und Herren,

das Umweltbundesamt führt aktuell eine Pilotstudie zu umweltfreundlichen Umschlagtechniken von Düngemittel in Häfen durch. Wir bitten Sie, uns bzw. unseren Auftragnehmer, die Ramboll Deutschland GmbH aus Rostock, mit der Beantwortung des beigefügten Fragebogens sowie der Übersendung von ggf. unterstützenden Unterlagen zu unterstützen. Dafür möchten wir uns bei Ihnen im Voraus bedanken.

Der Eintrag von für die Meeresumwelt schädlichen Düngemitteln bei Transport und Umschlag sowie damit verbundenen Tätigkeiten kann eine starke Beeinträchtigung (Sauerstoffverarmung des Wassers) der Lebewesen, insbesondere in den Küstengewässern, auslösen. Der auf die gesamte Transportkette gerechnete Warenverlust beträgt schätzungsweise mehrere Kilogramm je transportierter Tonne.
Im Rahmen dieser Studie wird geprüft ob sowohl durch technische Maßnahmen als auch durch prozessuale Änderungen in Häfen dieser Eintrag reduziert werden kann. Dies könnte ein relevanter Beitrag zur Erfüllung der Reduktionsanforderungen des HELCOM-Ostseeaktionsplans sein. Praktikable Empfehlungen für die Optimierung von Abläufen im Hafen zur sachgemäßen, Verlust reduzierenden Handhabung von unverpackten Düngemittelladungen werden erarbeitet.

Wir bitten um Beantwortung der Fragen bis zum 20.04.2022.

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Die Ergebnisse des Fragebogens werden im Rahmen eines Berichts anonym veröffentlicht. Gerne übersenden wir Ihnen nach Fertigstellung die Studie.

Für Fragen und Anregungen steht Ihnen Herr Nils Heine von der Ramboll Deutschland GmbH unter der Telefonnummer 0179-7417112 oder per E-Mail unter nils.heine@ramboll.com zur Verfügung.

Vielen Dank!

Mit freundlichen Grüßen

Im Auftrag

Julian Mönnich

2

Bitte zurück per Briefpost an
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Fragebogen zum Umschlag von Düngemitteln

Neben der Erhebung ggf. bei Ihnen umgeschlagener Düngemittelmengen ermitteln wir die beste verfügbare Technik bzw. beste verfügbare Umweltpraxis in Bezug auf den Umschlagprozess, die Lagerung und die nachgelagerte Reinigung der Manipulationsfläche einschließlich Entsorgung (inkl. Entwässerung).

Fügen Sie gern weitere in Ihrem Haus verfügbare Unterlagen bei (Statistik, Bilder oder Videos des Umschlaggeräts etc.).

Vielen Dank für Ihre Teilnahme!

Hafen: ________________________________

Ansprechpartner: ________________________________

Email: ________________________________

Frage 1: Düngemittelumschlag

Wie viel Düngemittel wurde im Jahr 2021, 2020 und 2019 umgeschlagen?
(Bitte alle Mengen in Tonnen eintragen, gern zusätzlich nach Düngemittelarten aufteilen und ggf. Beiblatt beifügen.)

2021 Fest-/Trockendüngemittel: Flüssigdüngemittel:

2020 Fest-/Trockendüngemittel: Flüssigdüngemittel:

2019 Fest-/Trockendüngemittel: Flüssigdüngemittel:

Frage 1.1: Düngemittelumschlag

Wie teilt sich der Anteil zwischen See- und Landverladung im Jahr 2021 auf?
(Bitte alle Mengen in Tonnen eintragen)

Seeverladung: Landverladung:

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Frage 1.2: Düngemittelumschlag

Wie sind die Import, Export sowie die Transshipment Umschlagszahlen?

(Bitte alle Mengen in Tonnen eintragen)

Seeverladung

Import: Export: Transshipment:

Landverladung

Import: Export: Transshipment:

Frage 1.3: Düngemittelumschlag

Wie viel kg pro transportierte Tonnen geht schätzungsweise im gesamten Transportvorgang verloren?

______________kg je transportierte Tonne

Frage 2: Verwendung

Wo wird das Düngemittel verwendet? (Agrarhändler in Umgebung, Weiterverladung durch LKW/Bahn)

Freitext-Antwort

Frage 3: Zwischenlagerung

Wo wird (zwischen-) gelagert und wie weit ist die Entfernung zur Be-/Entladungsstelle?

Freitext-Antwort

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Frage 4: Umschlagsmethoden – Geräte

Welche Umschlagtechniken/Geräte werden verwendet? Wie viele Tonnen wurden mit dem Gerät im Jahr 2021 umgeschlagen?

- ☐ offener Greifer (Hafenkran) Menge in Tonnen:
- ☐ geschlossener Greifer (Hafenkran) Menge in Tonnen:
- ☐ offenes Förderband Menge in Tonnen:
- ☐ geschlossenes Förderband Menge in Tonnen:
- ☐ anderes:

Frage 4.1: Umschlagsmethoden – Geräte

Werden diese bei Regen und Wind unterbrochen? Wie viele Tonnen pro Stunde können mit dem Gerät umgeschlagen werden?
Falls Sie diesbezüglich Arbeitsanweisungen für Ihre Mitarbeiter haben, bitten wir um Übersendung

Hinweis: Wenn vorhanden, können gern Bilder der Geräte angefügt werden.

Frage 4.2: Umschlagsmethoden - Geräte

Setzen Sie die Geräte auch für den Umschlag anderer Güter ein? Wenn ja, welche?
Freitext-Antwort

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Frage 5: Umschlagsplatz

Ist der Umschlagsplatz Wetter- und Windgeschützt? Welche Maßnahmen werden zum Auffangen vom verschütteten oder staubenden Düngemittel verwendet?
Freitext-Antwort

Frage 6: Reinigung des Umschlagplatzes

Wie wird der Umschlagsplatz gereinigt? Was passiert mit verlorener Ladung?
Freitext-Antwort

Frage 7: Reinigungswasser

Besitz der Hafen Kapazitäten um Reinigungswasser aufzufangen bzw. können kommunale Kapazitäten benutzt werden? Wenn möglich, spezifizieren Sie die genutzten Kapazitäten.
Freitext-Antwort

Für alle weitere Unterlagen und Information bezüglich des Düngemittelumschlags, die sie der Rücksendung dieses Fragebogens beilegen, sind wir Ihnen sehr dankbar.

Rückfragen? Nils Heine, Telefon 0179-7417112

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