Technical information on the use of flexitanks in containers in multimodal transport

The flexitank principle was developed in the 1970s as a containerised transport solution for liquids. This approach contradicts the actual purpose of the standard ISO container, which was designed for dry general cargo. This is because amongst other things, liquids do not display internal friction and pressure can exert the same force in all directions. However, at the same time, incorporating the friction between container floor and dry cargo is a basic prerequisite for the stability design of the body of the container itself (e.g., the strength of the container walls).

Today, the main substances transported in flexitanks are food additives, wine, latex and vegetable oils, but also hazardous substances such as hydraulic fluids and lubricants. The HDI Risk Consulting Marine Experts Markus Ebest and Lennart Lühn provide some general information about flexitanks and recommendations about their secure storage in containers.

**Why use flexitanks?**

Manufacturers promote the idea of higher cost effectiveness with the use of flexitanks. Compared with the use of steel drums almost 50% more material can be transported with a flexitank in a 20-foot container. Additionally, there are no expensive cleaning costs as compared to tank containers. The availability and logistical flexibility attained by using flexitanks in standard containers is also considerably better than in tank containers. This increases the attractiveness of flexitanks in the market.

There are currently 40 flexitank manufacturers in the world today, some of whom provide “supply and fit” services. This means that not only do the manufacturers deliver the flexitank itself, they also fit it into the container. The simple plastic bags that were originally used had been increasingly replaced with PVC flexitanks since the 1990s. But the concept achieved its real breakthrough in 2001 with the development of multi-layered polyethylene bladders. The cost of flexitanks has decreased considerably since the 1970s and today almost exclusively single-use products are used. The flexitanks were originally dimensioned for a capacity of approximately 16,000 litres and the damage frequency was relatively low. Cost pressure in logistics pushed the limit further and further upwards and today, flexitanks with capacities of up to 28,000 litres are used (+75%). As a consequence of this, there has been a considerable increase in the number of claims with greater loss amounts for equivalent products.

The increases before the onset of the effects of the COVID-19 pandemic, indicate that the use of FTs between 2010 and 2019 has nearly tripled. We expect that these growth rates will continue in the medium term.
Disadvantages and challenges

The use of flexitanks is scarcely regulated. The CTU Code primarily contains general, practical advice. However, the use of flexitanks for hazardous goods is forbidden by the CTU Code. Containers are nearly always used multimodally, i.e., on different types of vehicles as part of a given transport. For this reason, the flexitank in the container must be able to withstand all the transport stresses or loads that are to be expected during sea, road and rail transport and any cargo transfers a given transport may entail.

What are the greatest challenges?
- The smallest production errors in the flexitank may lead to a total loss.
- The smallest process errors in installation or filling may potentially lead to a total loss.
- The use of flexitanks is significantly more complex than presented by the manufacturers.
- Root cause analysis in the event of a claim is difficult.
- In particular, it is difficult to distinguish a defect caused by transport or by an inappropriate container from a defect inherent in the product (“inherent vice”).

A further negative aspect of single-use flexitanks that should not be neglected is their poor environmental balance. On account of what is today a multilayer construction of plastic foils that are no longer single type, the materials must be disposed of at the destination in most cases (mostly more than 100 kg per flexitank).

Loss profile

The loss profile ranges from a burst plastic bladder and bent or even pierced container walls and internal spoilage to leakage from the flexitank because of defective valves or leaks in the material. Deformations of the container walls are proven to occur even in load tests conducted by the flexitank manufacturers themselves.

In addition to damage to property and goods, environmental damage caused by leaking cargo must also be considered. Furthermore, when a flexitank leaks, this can also endanger uninvolved third parties through direct contact with the product or increased risk of accident (slipping or falling).

Ultimately, analysing the cause of flexitank damage is extremely difficult in most cases. This is mainly due to the many possible sources of defects (as shown below), which can sometimes occur in combination and may be the responsibility of different process and may be caused by different parties involved in the process.

Containers as a source of error

Apart from the frequently questionable quality of the flexitanks, one distinct disadvantage of the concept lies in the fact that standard containers were not structurally designed for this kind of load (insufficient strength of the side and end walls of the container, dynamic loads due to surge effects etc.).

The use of flexitanks often permanently weakens the container structure, which increases the danger of damage to goods when the same containers are subsequently used. A structural weakening of the containers themselves is also one of the possible causes of container losses at sea currently being investigated. In this context it is noticeable that manufacturers themselves explicitly recommend that only new containers be used containers for the installation of flexitanks, which indicates that they are aware of these dangers.

Flexitanks as a source of error

Due to normal acceleration forces or impact pulses during transport there is a risk that the flexitank will burst at the seams or valves and that the product will leak out as a result.

Furthermore, there can be production-related adhesion of the film layers that may wear through even under normal transport conditions, resulting in leakage. This can lead to so-called „leakers“ or „drippers."

The aseptic filling of a flexitank with food is frequently preceded by thermal sterilisation of the supply line and the outside of the valve with steam. The high temperatures that occur during this process can also lead to the structural weakening of the valves and the flexitank material immediately surrounding the valves.

Fitting as a source of error

The proper fitting of a flexitank presupposes the suitability of the container. The container must be undamaged, clean, odour-free, free of sharp edges and the remains of previous load-securing equipment (heads of nails or similar). If this is not so, then damage to the fitted flexitank and its contents is foreseeable (puncturing, fraying, contamination). As a rule, the floor and side walls are lined with cardboard or plastic covering up to a certain height in order to provide additional protection for the outer film layers of the flexitank.

Requirement

> The successful use of flexitanks requires compliance with complex organisational, structural and technical processes and the use of flawless materials and aids.

Leaking transport good due to a damaged flexitank
(Source: GDV)
Load securing as a source of error
Freight containers are designed for form-fitting load securing by means of distributing the volume homogenously or derive securing forces into the corner posts. For this reason, the lashing points in the container are only designed for lighter loads (usually about 1 tonne) and are therefore insufficient for securing the mass of a flexitank. This applies especially to more recent models of free-standing flexitanks that are not attached to the container walls. Considering the lack of load securing in the flexitank itself and the overloading of the end and side walls caused by the flexitank (as described above), it is therefore objectively hardly possible to secure the load in a way that is suitable for the stresses (in accordance with the CTU Code). If the flexitank can move within the container as a whole, this is dangerous to both its contents and to personnel opening the container. For this reason, some flexitank models require the fitting of a safety bulkhead on the door side of the container.

HDI Risk Consulting – Recommendations when using flexitanks
The use of tank containers should basically be prioritised for the sake of transport and product safety. Should flexitanks have to be used, the following points must be taken into account:

- Only those flexitanks that are certified by the Container Owner Association (COA) (https://www.containerownersassociation.com/technical-resource/flexitanks/) should be used. This certification contains, among other points, shock tests on railway cars.
- The COA “Code of Practice for Single-use flexitank Systems” (see link) must be complied with.
- Do not use for hazardous substances!
- Do not use for very expensive products!
- Do not use for materials that pose a danger to the environment or human health!
- When conducting sterilisation processes on the flexitank, its load limits with regard to maximum temperatures must be taken into account (thermal distortion on the flexitank and/or valve).
- Test the flexitank for cleanliness and odours as well as suitability for the respective product (the product density and the total mass resulting from it must also be considered here).
- Use only undamaged or new containers, as expressly required by some flexitank manufacturers.
- Before installation of the flexitank, the container that is going to be fitted must be inspected thoroughly in the interior area for sharp edges, nails or any similar defects that could lead to the flexitank being damaged.
- Fitting must be carried out by trained personnel familiar with the model in question and the manufacturer’s fitting instructions.
- The fitting of the flexitank must be documented step by step (at least with photographs). This documentation must be retained at least until the destination is reached.
- The flexitank must not have any wrinkles in it when empty before it is fitted on the floor area.
- It is necessary to install a door bulkhead with most models.
- The flexitank must usually be between 80% and 95% full to minimise surge effects due to excessive free space on the one hand and to avoid its overloading due to overfilling on the other.
- The valves must be tested for tightness before and after the flexitank is filled and must be disinfected, if applicable for the product and sealed.
- We would recommend, based on an investigation carried out by DNV GL (commissioned by the German Insurance Association) using flexitanks for transport amounts of a maximum of 18 tonnes.
- The container must be marked accordingly on the outside (“flexitank inside”) and the carrier informed explicitly about the intended use of a flexitank.
- Do not reuse single-use flexitanks.
- Create and carry out detailed written work instructions for the fitting, filling and use of flexitanks.
- Implement a “lessons learned” system.
- Before using flexitanks with a particular product on a particular transport relation, we recommend a test filling and, if necessary, even a test transport.

Summary
The use of flexitanks is increasing worldwide because the concept offers cost benefits. From a risk perspective, the use of flexitanks is only acceptable if all the organisational, technical and structural prerequisites have been fulfilled perfectly. Because of the high complexity of the processes and the lack of overall responsibility of a single involved party, this is a very big challenge. As experience shows, this challenge can frequently not be met on account of the high probability of errors in choice of container, fitting, or the filling of flexitanks.

Flexitanks are a loss driver and even if the aforementioned preventative measures are implemented, there remains a high risk in comparison with tank containers.
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- HDI Risk Consulting GmbH supports medium-sized companies, industrial enterprises and groups of companies in loss prevention and in setting up an in-house risk management system.

- To achieve this, HDI Risk Consulting offers its customers access to around 170 engineers and specialists from the most varied disciplines. Our goal is to support companies in controlling risks and therefore to develop an individual and risk-adapted insurance cover concept.

- HDI Risk Consulting is active all over the world in the fields of fire, road traffic, technical insurance and transportation. The focus of our activities is on identifying and assessing risks and on developing suitable individual protection concepts.

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