National Dangerous Goods Training Consortium

Tanker Guidance Notes

May 2012

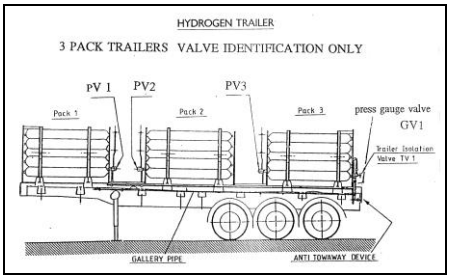
Content

GAS TANKS:

Four types of gas tankers used,

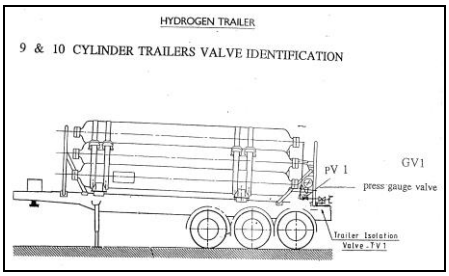
Cylinder Trailers

Banks of gas cylinders mounted horizontal and permanently attached to the trailer, small gas cylinders fastened together in banks and all interconnected by a piped manifold with a single outlet connection. Safety features built in each bank, one or two cylinder per bank containing no gas designed for excess pressure relief should a problem arises with the other cylinders in the bank.



Tube Trailers

Gas tube's the length of the trailers and permanently attached to the, mounted horizontal three or four high. The tubes are connected together with a piped manifold. Tube trailer are used as it would be impracticable to build and transport the gases in a tank. The tubes are used for transporting unstable gase's.



Liquefied Pressure Tanks

Liquefied gas tanks transported at normal atmospheric temperature, these liquefied gases are usually flammable or toxic gases. The gases are converted into a liquid by pressure alone and retained as a liquid by the gas pressure, Butane at a pressure of 1.75 Bar and Propane at a pressure of 6-7 Bar. The tank have safety valves to relive excess pressure, toxic tanks have high pressure venting valves.

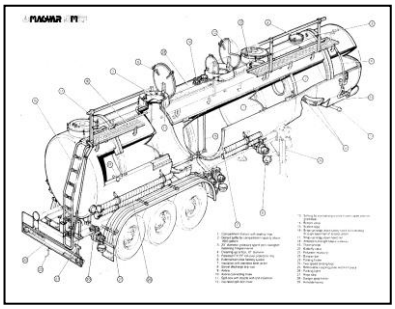
Cryogenic Gas Tanks

Cryogenic gas tanks built similar to a thermos flask, the tank build design like a GP tank with a thickness 3-5mm for the internal tank. These tanks are very expensive to buy £200,000 upwards. They are designed with an inner stainless steel tank for the cold temperature with an outer tank usually aluminium, between the tanks will be a vacuum and insulation materials such as purlite granules or silver foil. Gas tanks are usually painted white to reflect the heat and stop heat penetrating the outer vessel. The products transported in the tanks are very cold temperatures of minus -196^{o}C and Helium transported at minus -269^{o}C. Helium tanks are designed with an inner stainless steel tank with another stainless steel tank and an outer tank (a tank within a tank within a tank). Between the inner tank and the middle tank the vessel is filled with nitrogen -196 ^{o}C this helps keep the liquid Helium cold at -269 ^{o}C. The holding time for transport of a Helium tank is 48 days. The cost of 1kg of liquid helium is over £1,000 per kg (payload per tank 4560kg added this to the build cost of the tank £250,000 the value of each tank would be in excess of £4,500,000).

CO2 gas tanks work at very high pressures 18 Bar and these tanks are made of thicker materials 15mm to withstand the pressures.

GENERAL PURPOSE TANKERS:

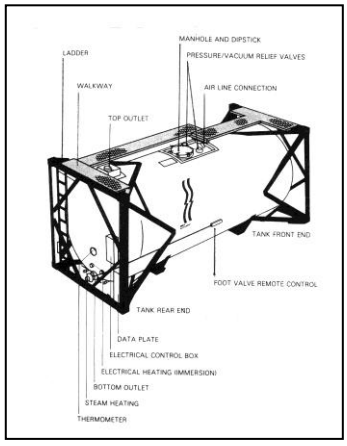
Petrol & Sprit or Solvent Multi Compartment Tanks



Petrol tanks made of aluminium for lightness and designed for petrol companies to transport more litres of petrol and diesel per transport journey. Some ridged petrol tankers are made from GRP. Generally petrol tankers in the UK are elliptical in shape designed for a lower centre of gravity and for access to petrol station forecourts. These are slowly being phased out and changed to cylindrical tanks as petrol tanks are loaded at ground level and the tankers have separate unloading areas at petrol stations having no restriction on vehicle height. As all tankers have to be built to ADR standards this save the tank manufacture having to build different styles of tanks. Top loading (splash loading) is being phased out at most petrol loading terminals which reduces the risk of working at height. Petrol tankers load and unload either by the use of pump gravity or vapour recovery discharge.

Sprit or solvent tanks are made from stainless steel or mild steel usually transporting class 3, 6, 8 or 9 types of products. Various shapes of tanks are used but most new build tanks are cylindrical. Sprit tanks load and unload using pump, gravity or vapour recovery systems.

General Purposes Tanker & ISO Tank Containers



Cylindrical tanks designed for pressure discharge. These tanks are made of different materials and with different capacity for various products. Acid tankers build size 16,000ltrs or slightly larger depending on amount and type of product loaded. Some tanks have internal linings such as rubber or glass etc as a resistance against product loaded Hypochlorite Solution UN1791 (Hypo (Bleach)) Class 8 which would attack mild or stainless steel tanks.

Larger GP tank with greater capacities are made so the tanks can transport a variety of different products, these may have different density and need less volume or more volume (i.e. 16.000lts of Caustic = 23tons / 30,000ltrs of White Sprit = 22tons). Tanks are either single compartment fitted with baffles or multi compartment tanks with no baffles. Usually made of stainless steel and designed for pressure, pump, gravity and vapour recovery systems.

ISO tanks are basically a receptacle fitted within a frame used for lifting off and on vehicles, trains and ships (inter-modal). ISO tanks are usually (not all) single compartment tanks and do not have baffles. Usually 20-foot in length, because of the size of the ISO tank frame there is a maximum capacity for the tank (28.000ltrs approx). Newer built ISO tank containers are designed at with a 20 foot frame, the tank itself extends outside the inner frame at each end allowing more products to be transported. With the extended tank in the 20 foot frame it will allow a greater tank capacity (30,000ltrs or more) and the lightness of the tanker will allow a greater pay load.

IMDG

<u>Tank Codes for ISO tanks.</u>

IMO Type 1 – Hazardous Tank
IMO Type 2 – Low Hazardous Tank
IMO Type 5 – Non-refrigerated Tank
IMO Type 7 – Refrigerated Tank

Non-hazardous tanks are commonly referred to as Type 0.

Powder Tanks

Two types used Tipping and non-tipping (hopper tanks). Tipping tanks used for various types of powders and granules that cannot be loaded non-tipping hopper tanks and visa-versa. Tipping tanks are fitted with stabilisers to reduce the dangers of strong wind's that can blow them over or stabilise the tank on uneven ground surface. Modern day tipping tank stabilisers are fitted with pressure pads so the driver can ensure that forces working on each of the stabilisers are even.

Hopper tanks have two or more bottom conical outlets connected to one discharge pipe which is under-slung travelling the length of the vehicle this is the disadvantage of uneven ground that could damage the pipe (example humpback bridges, sleeping policeman etc). Usually made of aluminium for lightness.

Unloading System of both types of powder tanks: The tanker usually unloads using air pressure the tank will require volume of air as well as pressure, when powders are pressurised off they have to unload thought a 4" outlet pipe this may block so the tank is fitted with an aeration outlet and air injection system on the pipe connection. The aeration system on the outlet will make the powder fluid so it runs like a liquid, the injector will carry the powder on a custom of air to receiving vessel.

These tanks require volume of air rather than high pressure air for discharge fitted with aeration connection's to make the powder fluid at the discharge outlet.

Dangers of unloading powder tanks: Powder tanks will create large amounts of static so for this reason it is more than important that the tank is earthed before and during the loading and unloading of the tank 30,000 volts or more can be generated.

The powder may compact in the tank at each end when travelling on the road due to braking and acceleration forces, the driver must never hit the tank with metal objects (metal poles, Hammers etc.) this could damage the tanker with disastrous consequence. Hitting the tank with a metal object will thin the tank wall.

Waste Tanks & Specialist Type Tanks

Used for a wide variety of waste chemicals. These tankers are built of stronger materials than a standard GP tanker. The tanks are used for self-loading under vacuum and unloading through pressure. The tank has to be made of thicker metals than a standard GP tank 8-10 mm because of the vacuum loading system. Other features of these tanks, the materials use for the construction of tank will have to resist the types of chemicals loaded, so the operator has to ensure that prior to loading that the chemicals are tested for suitability for the type of tank used. Waste tanks can be made of various metals aluminium, mild steel, stainless steel and some cases maybe lined with rubber or PVC. Most will have a large rear opening door to assist with tank cleaning for sludgy products. Any waste movements will be subject to the waste regulations.

Other specialist tanks:

To name just a few of these Bitumen and Sulphur tanks are made of mild steel and are built to the same standard as a GP tankers. the main difference for this type of tank is that they only have one manlid for loading at the front of the tank and will have an emergency manlid or blanking plate at the rear of the tank for siphon pipe unloading should the outlet footvalve fail and the product has to be off loaded before it solidifies in the tank. The Sulphur tanks are smaller than the Bitumen tank because of the specific gravity

of the two products. Both tanks will have surge plates or baffles for ADR vehicle stability. Because of the high temperature for these substances additional safety features are fitted and used the footvalve operation is fitted at ground level to the (UK tanks) nearside and has a large turn wheel footvalve and outlet valve lever is located in the same area, this enables the driver access to valves should the discharge pipe fails and gives the driver protection from the outlet connection points the product.

Hydrogen Peroxide tanks are used for transport of this product only, the product can be affected by organic substances such as wood, leaf matter or could have a reaction with metal objects. When hydrogen peroxide is loaded into the tank for the first time a reaction between the product and stainless steel tank.

Tanker Designs

Basically two design shapes cylindrical and elliptical.

Elliptical tanks have some advantages because of there shape they have a lower centre of gravity and a reduction in vehicle height for access to petrol station forecourts and loading gantry's, most not all usually transport petrol, kerosene, diesel and gas oil. These are discharged using gravity or pump method and are generally loaded and unloaded using an in built vapour recovery system. If this type of tank were subject to pressure it would seriously damage the tank with a risk of bursting and escape of the product.

Cylindrical tanks (not all) are designed for pressure discharge. The advantage of pressure vessels are that they can discharge by air or nitrogen pressure, pump, gravity and can be used for vapour recovery. The design of a cylindrical tank will allow it to be discharged using pressure, the tank pressures forces must be equal on the tank or the tank may implode or burst. Usually maximum working pressure 2 Bar is used of the vessel.

Additional note: Cylindrical tanks are being phased into the petrol industry, modern day petrol tanker loading and unloading systems used by companies have done working at height risk assessments and has reduced the need for drivers working on top of the tanker (most petrol tankers don't have access ladders). Newer general purpose tanks also have built in features to reduce the need for working on top of the tankers but because for the variety of chemicals transported there is still a need to access the top of the tanker for loading through the manlid hatches and cleaning of the tanker. most modern tanks are fitted with handrails and in some cases sliding lanyard / harness rail for working at height safety, when these systems are used they are usually interconnected to the trailer parking brake which would prevent accidental drive off should some one be working on top of the tank.

Tanker Valves & Fittings

Air Connections

The force supplied from the vehicle's power take compressor or the customer own air or nitrogen supply.

The vehicle may have a filter, gauge and non-return valve fitted if not this equipment will be fitted to a domestic road tanker.

These connections are fitted usually at ground level on pressure vessels on GP tanks, and are fitted with a filter to prevent carbon and other particles that could create an explosion risk within the tank. Pressure gauge for the driver to observe the pressure during discharge and a non-return valve to prevent the pressurised air or vapours blown back through the pipework back into the compressor from the tank, also it stops the pressure reversing the compressor and damaging the carbon blades.

Air Compressors

The air compressor is fitted to the vehicle and driven via the PTO from the vehicle engine. The compressor is fitted with a safety relief valve to prevent over pressurisation of the vessel or system with a risk of bursting. The compressor works by sucking in air from the atmosphere as

the compressor rotates trapping the air within the compressor system. Inside the compressor it has an offset eccentric drum which has carbon blades so as the cylinder rotates the air is squeezed/compressed which increases the pressure within the system and build the pressure up in the vessel to a maximum of 2 Bar or less if required by the tank or product.

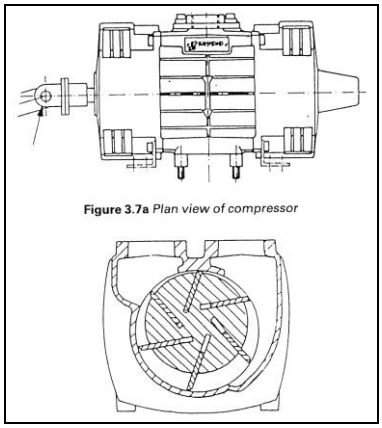
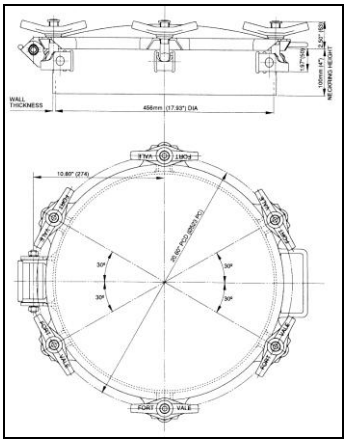


Figure 3.7a *Plan view of compressor*

Petrol & GP Manlids

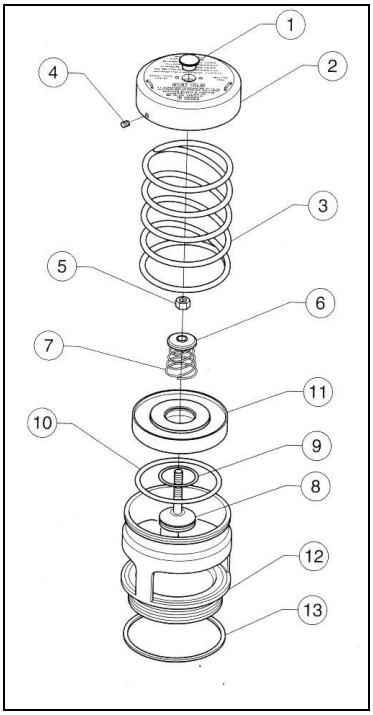
Tankers are fitted with manlids and hatches to access the tank as a means of filling and cleaning. Petrol tanks have filling hatches, modern day petrol tankers do not have filling hatches or ladders to access the tanker top and therefore the hatches have been replaced by bolted blank plates.



General purpose tanks have manlids for access for filling, dipstick loading and splash loading. The opening will allow monitoring of the load. The manlid is also used when the tanker needs cleaning this allows easy access for cleaning and inspection after tank cleaning. The manlid can also be used to gain entry to the tank for service work and repairs. The manlids have other safety features explained later in different sections.

Pre Vac Valves

Pressure vacuum valves are fitted to tankers for safety reasons, they are fitted to prevent the tank from bursting and imploding. The valve are generally called pre-vac (pressure vacuum valve) which allow the tank to breath. The vacuum side of the valve works if the product cool's and creates a vacuum within the tank, this will open the internal valve (vacuum side) which will allow air vapour into the tank preventing the tank from implosion. When a balance has been obtained in the tank the inter relief valve (vacuum side) will close this is done with assistance from the light spring on the valve sealing the tank (hermetically). If the tank exceeds (maximum allowable working pressure) MAWP will be at risk of bursting. The pre-vac valve has a set working pressure, if the tank is subjected to excessive pressure the valve will operate opening the valve allowing the excess pressure to escape from the tank, once a safe pressure has been obtained the valve will close re-sealing the tank and preventing any escape of product or vapour from the tank. The tank must have the correct type of pre-vac valve fitted to the tank preventing the tank from imploding or bursting.



Bursting Disc

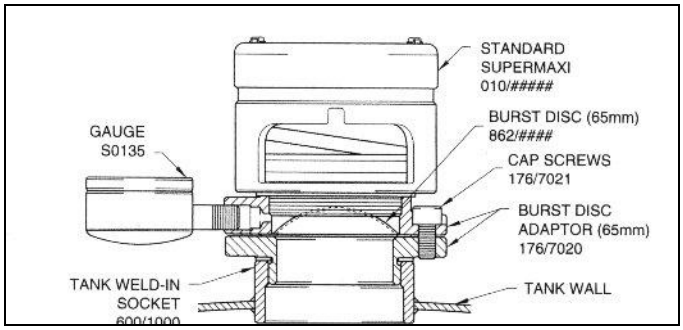
Some tanks not all are fitted with bursting disc, there are two requirements for the disc to be fitted.

1. Discs are fitted for certain types of products and are fitted to prevent external air or moisture damaging the load. This provides the tank with a hermetic seal and escape of vapours from the tank. Some types of products that have bursting disc are (TDI) Toluene Di-isocyanate UN2078 6.1. Olefins, Highly Flammable UN3292 3.

2. Bursting discs are also fitted to tanks in for emergency pressure relief for certain products such as Hydrogen Peroxide UN1415 Class 5.1, the disc will break at the pre-determined pressure setting.

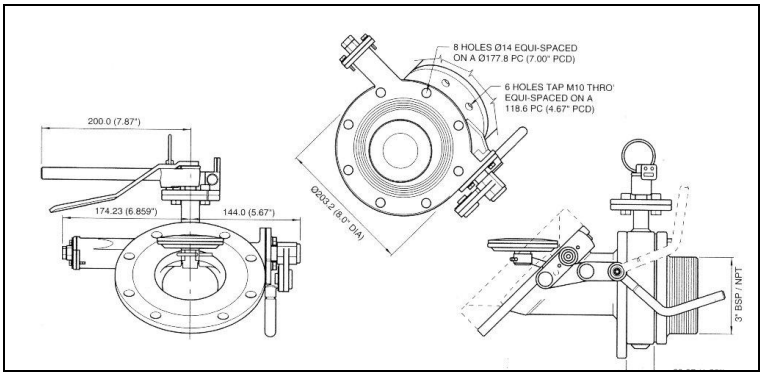
The bursting discs are mounted between the safety valve and the tank. The only way of telling if the tank is fitted with a bursting disc is by the data tag protrudes between the safety valve and the tank. A tank fitted with a bursting disc will only allow excessive pressure from within the tank this will cause the disc to rupture. A bursting disc will not allow external pressure into the tank, the designed of this type of disc is to protect the load against damage form air or moisture which could contaminate the load. The cost of the disc is about £200 each the reason is that the manufacture of disc will make ten, test eight, selling two this is to ensure they work correctly when in use?

Extra note: some bursting disc will allow a 10% air flow into the tank if it a vacuum were caused these are usually to comply with IMDG requirements for sea transport.



Footvalve

Tanks have many different type of footvalve fitted, and they are all operated in different ways according to the type of products and tanks that are used. This is a picture of a typical foot valve used on an ISO tank it is called a clean flow valve. The type of valve is used as it will allow an easy flow of liquid from the tank. The clean flow of liquid from the tank also reduces the static build up that can be created by the conventional spring operated footvalve. This footvalve is operated at ground level and usually by hand, it can be fitted with a remote cord which can be used in an emergency situation to stop the unloading process.



Some GP tankers have a rod and wheel operated foot valve which are opened by hand from the top of the tanker using the hand turn wheel. The driver may be at risk from falling as he is working on top of the tank and valve is usually located at the rear of the vehicle.

Modern day GP tanks are fitted with air operated foot valves and are operated at ground level reducing the falling risk.

ISO tanks aren't generally fitted with air operated valves as they are use on multi-modal journeys and are a de-mountable system that would require an air supply to operate the tank.

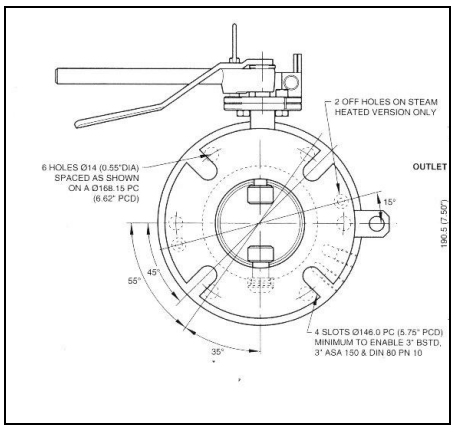
All foot valve work internally a bit like the plug in your bath! The valve has to open into the tank to let the product out. Designed into most foot valve housings is an engineered grove this is in case the tank was involved in an accident, if the outlet pipe was damaged the housing would break off at on the engineered grove rather than breaking the complete housing from the tank bottom, the foot valve would then retain the load within the tank preventing an environmental hazard.

Outlet Valves

Tanker outlet valves are fitted as a secondary valve should the footvalve fail it will retain the chemical within the tank system. The outlet valve should always be fitted with a blank cap during transit, this is last line of defence against accidental product loss.

There are varying design types of valves gate, butterfly clean flow & ball valves. They all have advantages and disadvantages some are slower to operate (gate valves) because of operation

design, some valves have only one seal when closed but are easier to cleaned (butter fly & clean flow), the ball valve has two seals but has a risk of contamination when changing loads as product can be trapped in the ball valve.



API Connections

American Petroleum Institute Connectors: these valves and connectors are generally used in the petroleum industry and are easy on and easy off 6" male outlet connectors, the outlet valves are fitted with a two stage valve and a sight glass called a viz-wink. The viz-wink is used by the driver to check if the compartment either contains product or the compartment has been completely drained. UK petroleum companies use API valves and connect the 4" discharge hoses using a fitting called (by petrol tanker drivers) an elephant's foot this is a 6" female with 4" outlet male connector. The two stage valve allows the driver to control the flow from the tank to the customers receiving tank it will help prevent an air lock in the system.

Standard GP Tanker Connectors

The standard type of fitting or connectors used in the chemical industry are BSP threaded. The fittings used are usually reducers as most not all GP tankers are fitted with 3" standard BSP threaded outlets.

Some European tanks have French or Crown and Curve fittings these are easy on and off type fittings they can be removed from the connection outlets as they will have a BSP thread.

The hazard of using the easy on/off type fittings, any pressurised chemicals in the discharge system would be released and may cover or splash chemicals over you. Unlike using the standard BSP screw thread type fitting, undoing the screw threaded pipe the chemical would leak thought the threads warning of pressure still within the system?

Some fitting are called table D, this is a four bolt flange fitting this is used for substances such as Acid and some Toxics. When using this type of connector a good seal and four bolts must be used.

Camlock are sometime used for gases, sulphur dioxide, alkalis and non hazardous substances such as Lub Oils.

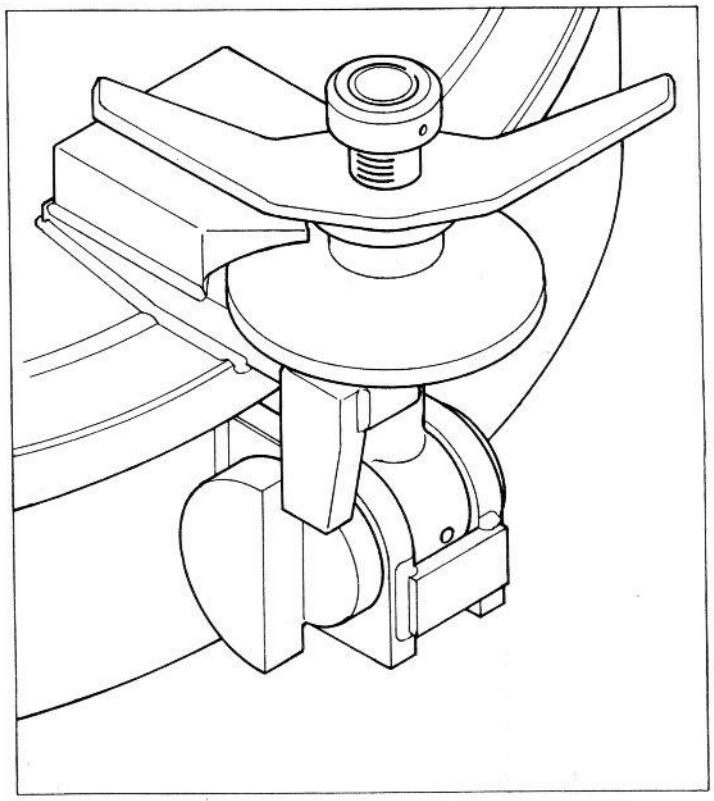
These fitting must be made of materials that will resist the action of the chemicals loading or unloading, when using the connectors they must be fitted with a good seal.

Excess Flow Valves

Excess flow valves are fitting as an additional safety feature to gas tanks and highly volatile substances. An excess flow valve prevents a large escape of product form within the system should there be a break in the connection. It also slows or stops the discharge if the flow rate were too fast. when unloading flammable gases from a tank friction is created, if there were sufficient air and flammable vapours in the system then all you require would be a spark for an explosion, the excess flow valve would slow the rate of discharge or in some cases even stop unloading procedure to prevent the explosion risk.

Safe Bolts and Lid Key

To close the manlid securely they have lid keys/bolts as additional safety features the modern tanker has safety bolts fitted to the manlid. usually tank manlids are fitted with six securing bolts, modern day tanks are fitted with To close the manlid securely they have lid keys/bolts as additional safety features the modern tanker has safety bolts fitted to the manlid. usually tank manlids are fitted with six securing bolts, modern day tanks are fitted with safe bolts these are fitted to prevent the manlid being accidentally opening a tank under pressure, it will also prevent the tank manlid from being closed without locating the safety bolt first. The sequence for the safe bolt is last bolt off first bolt on.

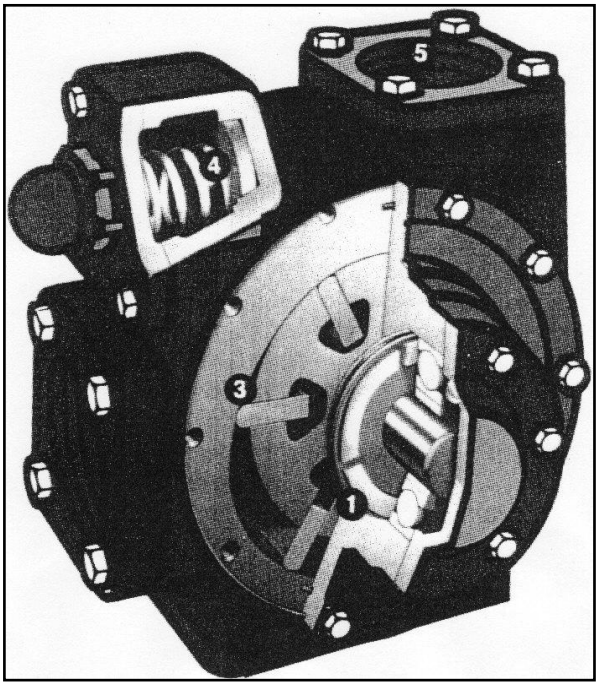


Hydraulic Flow Valves

Hydraulic flow control valves fitted to tanker hydraulic off loading system enables the driver to stop and start the pump without having to stop or start the vehicles engine, this valve allows the driver to start the pump off loading the chemicals or if required can reverse the liquid flow without have changing discharge hose connections on the cargo pump. The driver can control the speed of the cargo pump through the flow control pressure valve for different products.

Cargo Pumps

There all many types of discharge pumps use for loading and unloading chemicals, they all basically work the same, the only difference is that some work by gravity and some will self prime (i.e. suck).



This is Blackmore self priming pump, the direction of rotation for this pump is anti-clockwise liquid is sucked or feed to the inlet connection side of the pump (lower left-hand side) the spring operated blades the transfers the liquid round thorough the pump to the outlet connection. It is important that all pump connections are made correctly as the discharge hoses and the pump would have no protection from the in built safety valve (the pump will still work in reverse). When the chemical in the pump is at the outlet point the cavity of the pump is reduced this will now squeeze the liquid into the discharge pipe and force the liquid into the customers receiving vessel. As the pump continues to rotate the inner cavity becomes larger creating suction within the system, which will suck more product into the pump. If the inlet valve or the customer's pipe has a blockage to the receiving vessel the hose would be over pressured with a risk of bursting, for this reason the pump is built with an internal safety valve which would allow liquids to circulate within the pump and would reduce the pressure within the system. It is important that the pump rotates the correct way for this reason

Tanker Linings

Tanks are made from lots of different materials, the strength of the tank has be able to carry the load but may react with the construction of the tank so for this reason they may have to be lined with a resistant coating. This coating maybe rubber, PVC, poly-propylene, teflon or glass etc.

Tanker Baffles

Fitted to for tanker stability and liquid surge, some tankers aren't fitted with baffles (ISO tank containers & some types of GP tankers). Some tanks such as milk tankers don't have baffles as you don't want to change the milk into cheese!!! Surge plates are fitted to some tanks that usually transport one type of chemical. Some baffles are ribbed to help reduce side-ways movement and added strength to the baffle but only used for single type products when tanker cleaning is not critical. The chassis of the vehicle is the tank and baffles, in other words the tank is the chassis rails and the baffles the cross members.

Tanks over 7.500ltrs single compartment that are not fitted with baffles are required to have a minimum 80% filling ratio, most general purpose tanks are fitted with baffles and have a capacity of 30,000ltrs. ADR design of older tanks was three manlids with two baffles, which meant that each cross section of the tank between the baffles was 10,000ltrs. Based on this if the tank were loaded with an acid solution of 22tonnes (16,000ltrs) the fill ratio would only be slightly over 50%, technical breaking ADR rules on filling ratios. So ADR changed the design of new build tanks to four manlids and three baffles thus making each cross section between baffles 7,500ltrs, newer tanks now have capacities of 36,000ltrs and have five manlids with four baffles reducing the cross section between the baffles to 7,200ltrs.

Effects of a Moving Load

Moving loads are dangerous to both drivers & other road users, so the driver has to drive with consideration for the load and stability of the vehicle, also consider the weight transfer and movement of differing viscosity of chemicals as applies for 20% - 80% filling ratios for ADR and IMDG for sea vessels.

Tanker Filling Ratio

Tanks greater than 7500 ltrs with no baffles or compartments must either be filled:
More than 80% or less than 20%

Ullage –
Tanks containing liquids must leave space for liquid expansion due to an increase temperature

Tanker Testing & Plating

Tankers have to under go testing at set periods. A road tanker must have a full test and inspection every 6 years and a leak and pressure test every 3 years.

A tank container must under go a full inspection test every 5 years and intermediate test for leaks and pressure at 2 ½ years. The reason for the differing test periods is that basically the tank container is regarded as a receptacle and doesn't require an ADR approval certificate, but will have an inspection data plate attached to the frame.

Tanker Cleaning

Tanker cleaning should be carried out by professional tank cleaning depots, such as the cleaning stations operated by TDG. The drivers are responsible for opening the tank and booking the tank in at the cleaning station. The driver must state the chemicals that need cleaning giving the class hazard and the UN number and if known the next product to be loaded next. This is important because the tank may retain the heat from cleaning for sometime and may damage the next product to be loaded (i.e. form a skin (like boiled milk) or have a reaction with the product).

Vapour Recovery System

Used for petrol and environmentally damaging substances. What is vapour recovery, it is basically vapour replacement from the discharging vessel (liquid from one vessel / vapour return from the other vessel) this is connected via inter connecting vapour recovery line. When used correctly it will prevent any vapour loss from the system and protect the environment also in some cases save money.

Petrol companies use this system because it saves thousands of pounds per year in lost profit and in most cases using this system increases their profits at petrol filling stations. When you fill your car up with fuel vapours from the cars fuel tank are recovered via the filling nozzle, the vapours are returned under ground which are cooled in the underground tank, the recovered vapours are warm so the warm vapours in the cool underground tank condensate back into a liquid, this amount is very small but over a year it can be measured in litres. The same happens with the 40,000ltr petrol tanker but he will be taking the vapours back to the petrol terminal this amount of fuel can be measured in litres per tanker load. Most modern day petrol stations now have their own site vapour recovery system which prevents vapours from the underground tanks recovering into the petrol tanker, the system will allow only air into the tanker thus making it safer for the return road journey, the petrol station keeps all its own vapour in the system will convert the vapours back into sellable fuel.