dunze GmbH

Cuxhavener Str. 36-42
21149 Hamburg
Germany

Tel.: 0049 (0) 40 500 533 81
Fax.: 0049 (0) 40 500 533 82
EMail: **info@dunze.de**

Recommendations for the operation with high pressure systems

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1. Potential of danger

To work with high pressure systems has not be dangerous.
Fundamental for the potential of danger of a high pressure system, is the product out of the total volume and the pressure, therefore not the high pressure alone.
Frequently the problems rather appear in the low-pressure-area, since not sufficient attention is dedicated to this section. A bursting standard hydraulic hose might become much more dangerous as a high pressure tube. A high pressure fitting is much safer designed as a normal hydraulic connection.
The estimation of the dangers of a high pressure-installation is sometimes wrong. Safety precautions are inappropriate. They are to weak or on the other hand installed with an exaggerated effort.

2. Consultations

Persons working with a high pressure-system have to be aware which dangers can appear. In a case of doubt, request the written opinion of an expert.
The operators of a high pressure-installation should discuss in regular meetings, for example every 12 months, safety precautions and dangerous incidents of the system.

3. Production of high pressure systems

High pressure-systems should be designed and produced by competent personnel only.
If you have no experience with high pressure systems and components, purchase a system complete with the necessary documentation that is manufactured according to regulations
As it is not permitted to drive without a divers license, it is allowed not to permitted to work with a high pressure system not manufactured according to regulations.

4. Energies under pressure

Never underestimate the energies of a fluids under pressure. The compressibility of water under 1000 bars pressure is approximately 5%, at 4000 bar approximately 20%. The compressibility of oil under 1000 bars pressure is approximately 10%. If this energy becomes suddenly free, it might accelerate a part considerably, like a bullet.
A liquid jet hitting a person can lead to considerable injuries, up to the removal of body-parts. A liquid jet penetrating into the body usually leads to poisonings and must immediately be treated.

5. Lifespan

Mechanical engineered parts can become unsafe by unforeseen chemical and mechanical influences in the course of the time. The operators usually become careless after a certain accident-free period.
High pressure-parts are designed and manufactured occasionally in a way, that they have no infinite lifespan.
A short pressure test, even with overpressure, is no assurance that a high pressure component is save for its lifetime.
Operate your pressure-system in a way, that the failure of a part can not injure anybody!

If it cannot be avoided to work directly on high pressure parts, always carry a goggles, a protection-helmet, security-shoes and protection-clothing.

Whoever works on installations under high pressure unprotected, doesn't deal courageously but irresponsible!

6. Components

a) Pressure gauges

Pressure gauges should be used only up to 2/3 of they scale pressure. The scale and the measuring part should be separated by a so called “solid front”. The case must be protected by a rear wall that can in case of a failure be blown out. The gauges should be filled with liquid.

b) Valves

Hand-valves are a most critical, due to the close contact with the operator. The design of many hand-valves is unsafe. The gland nut can tear off or can unscrew by itself. Valves with an additional protection-cap or a yoke covering the gland nut are safer as valves with an

unprotected gland nut. Remote operated valves are often safer, more reliably and sometimes, under consideration of the cost of the installation, less expensive.

c) Connections

Every high pressure connections must be equipped with one or two venting holes. The high pressure tube seals on the smallest point of the cone. The area of the collar and gland nut is up to 30 times lager as the area of the cone, therefore the gland might blow out in the case of leakage, if the gland nut has to carry the full pressure. To prevent this, the fluid must be able to escape over the venting holes without an pressure increase.

d) High pressure-tubes

The stability of high pressure-tubes should be calculated according to the regulations for pressure vessels. Every 500 to 1000 mm the tube should be hold with a bracket. The bending radius of the tube shall not be smaller as the sextuple tube-diameter (For a 9/16” or 14,3 mm tube i.e. 86 mm radius). Most high pressure tubes obtainable are cold drawn. It is not permitted to warm them up exceeding 700℃, because they loose up to 80% of their yield strength.

e) High pressure-hoses

High pressure hoses are one of the most dangerous parts of a high pressure system. It is strongly recommended to use a protection hose over the high pressure hose. Wires that hold the swaged connection to prevent the hose from hitting an operator in case of a failure should always be used.

Linear-transmissions joints are sometimes a safe alternative to high pressure-hoses. It has the advantage, that it can work with a larger diameter as a hose, lasts longer and is much safer.

f) Rupture disc assemblies

The burst pressure of the rupture discs has to be at least 30% over the operating-pressure.
The entire system must be designed for the burst pressure of the rupture disc!
Rupture discs are subject to a fatigue. In such cases premature bursting happens, also below the burst pressure. Rupture discs should be used with systems only, in which a sudden pressure-increase could happen, otherwise overpressure-valves are recommended.

g) Overpressure-valves

Overpressure-valves are also called relief valves. They open at a set pressure and close at a pressure below the opening pressure. The opening-pressure of relief valve lies 5% to 10% over the operating pressure.
A entire system must be designed for the opening-pressure of the relief valve.
Under consideration of all facts, it is in most cases more economical to use a safety valve instead of a rupture disc.

7. Pressure-systems

There are no special rules, restrictions or permissions for high pressure systems or components. Like any other machine, high pressure systems have to carry a CE sign, to confirm, that the manufacturer followed all concerning regulations.

8. Liquids

Working with liquids under high pressure, attention has been paid to the freezing point.
At room temperature hydraulic oil gets solid at approximately 3000 bars, water at 7000 bars. In a tube the freezing point depends on the orifice to a great extend. I.e. a special high pressure oil gets solid at room temperature in tubing with 1 mm orifice at 7.000 bars, in a 1,6 mm tubing at 11000 bars.

9. Service and repairs

Never service or repair a system under pressure.
Check that all pressure gauges or indicators show no pressure.
The release valve must be open.
If the system works with an elevated temperature, wait until it cools down.
Disconnect electricity and compressed air.
Do not release a high pressure connection under pressure.
Don't try, to tighten a leaking high pressure connection under pressure.
You might destroy the part that you are trying to turn, as it has to carry the load of the torque and in addition the load of the pressure. 2/3 of your torque gets lost into friction and adds the load on the part under pressure.
Use only components, that are designed for the pressure you like to work with. If your components work in a heave duty application, like in some hydro-forming applications, buy components for the next higher pressure level and test them with the increased pressure. If not all components are designed for the elevated pressure, test the concerned components only.
Use a suitable lubricant on all high pressure fittings.

10. Leakages

All leakages have to be repaired with no delay. A permanent leak will cause additional damages.