
Engineering guidelines

In the next pages we want to share with you some of our best knowledge and practices that will help you to build and maintain an efficient installation with a long service life.

1 Engineering your system

When you are engineering the ideal cooling system, you require a fluid that helps you. We have a whole range of products and you can select the cheapest product that is suitable for your application. However, in general important savings can be achieved in the design phase of a cooling or heating system when you pay attention to the following characteristics of the fluid that will be used in your system:

<i>low viscosity</i>	less pumping energy, less compressor power needed
<i>high thermal conductivity</i>	smaller heat exchanger required = cheaper installation
<i>compatibility</i>	some products are more compatible with elastomers and sealings than others. By choosing the right combination, you can save money. Also metal choices are important. Freezium is less compatible with Aluminum than Zitrec M or L for example.
<i>small primary circuits</i>	service costs of secondary systems are known to be cheaper up to one-third than those for primary refrigerants.
<i>secondary systems are cheaper</i>	because the secondary circuit works at low pressure, the secondary system can be build with cheaper, even pre-assembled component groups and adapted easily to the changing needs of your equipment.

In the engineering phase you can prevent with small and cheap changes those small annoyances that become a big thing in the long run. For example:

<i>pumps</i>	are best placed on stainless steel drip trays with a discharge to a floor drain
<i>water pump seals</i>	most water pumps use face seals which need minimum leakage for lubrication purposes. Those leaks do not indicate any pump failure but are necessary for its normal functioning. To make sure you have the right type of water pump seal, it is recommend to speak with your pump supplier and inform him which heat transfer fluid you will be using.
<i>air purge</i>	must be installed at the highest point of the system
<i>separators</i>	all products will perform optimal as long as the right dilution is present. One should avoid contamination or dilution by building into the system dirt and air separators.

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filter

the installation of a filter with porosity 0.6 – 0.8 mm will capture those corrosion products that might be formed at some critical parts of the installation. By removing those corrosion products, further depletion of the inhibitors is prevented.

expansion tanks

like all other fluids, Zitrec-solutions will expand as temperature rises. Expansion tanks are therefore commonly used in systems containing Zitrec-fluids. To determine the expansion volume required, one can use the following formula:

$$\Delta V = [(\rho_{low} - \rho_{high}) \times V] / [\rho_{high}]$$

Where: ρ_{low} = the density at the lowest anticipated temperature
 ρ_{high} = the density at the highest anticipated temperature

remarks: Zitrec fluid/water mixtures can dissolve Zinc when hot and should therefore not be used in galvanised pipes.

2 Determination of the corrosion behavior of heat transfer fluids

Zitrec fluids are designed to be used in closed systems and one should remember that oxygen from the air increases the oxidation/corrosion of metals. Additionally water evaporates from open systems and the resulting Zitrec/water-mixture will have different heat transfer properties and a different freeze point than the original mixture. By this concentration-effect the corrosion protection will be affected.

Numerous methods are used to determine and investigate the corrosion properties of heat transfer fluids. One example is ASTM D1384 (American Society for Testing of Materials) which correlates weight loss on metal coupons inserted in the fluid to corrosion behavior in your installation. Other methods are dynamic heat test,

electrochemical testing, knocking chamber test, etc.

Based on our long experience in the automotive sector, Arteco has a fully equipped laboratory that allows testing our products under various conditions. To avoid having to build all installations in stainless steel, we provide you with heat transfer fluids that can prevent also other metals from corroding. Zitrec fluids protect commonly used metals and alloys in cooling and heating installations, reducing maintenance costs and extending the life of the process equipment. Especially Zitrec M, L and A who use the well-known organic acid technology, patented by our parent company ChevronTexaco and is used extensively in the automotive sector. For more details we refer to the product information leaflets.

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3 Water quality

Our Zitrec heat transfer fluids have been designed to be mixed with tap water containing a maximum of 100 mg/kg chlorides. They are mixable with water in any concentration. However, for reasons of corrosion and frost protection, you should carefully check the content of concentrated heat transfer fluid versus water. We want to remind you that the water quality used to make the final mixture is extremely important. Mostly tap water can be used but you should make sure that the water used to dilute the heat transfer fluid contains not more than 100 mg/kg chlorides and water hardness should not exceed 100 ppm.

Especially when aluminium is used in part of the installation, this is extremely important.

To avoid potential mistakes when diluting the concentrate with water, we prefer to deliver the heat transfer fluid as a ready-mixed antifreeze solution. Fully deionised water is used for the pre-diluted products we supply to you.

Our Freezium product on the other hand, which is available in different ready-to-use dilutions, should not be further diluted with water.

4 Filling your system with the heat transfer solution

Before charging a system with the final solution, make sure that the system has been cleaned and that welding deposits, water from the pressure test and other 'foreign' particles have been removed. The removal of these products should be done in accordance with the instructions of the manufacturer. In general chemical cleaning must be done with great care in order not to introduce corrosion. However, before any cleaning takes place, all debris must be removed from the system.

When changing from another heat transfer fluid to Zitrec the system should be thoroughly cleaned to remove all traces of the previous fluid. Also it is important that any corrosion deposits and hard water scale will be removed. We can recommend to flush twice with a 5% solution of Zitrec AC. If the flush water still looks contaminated or dirty after the second flush, the flushing should be continued until clear flush water is obtained. If the system is severely corroded, we recommend to contact a professional cleaning company. In particular one should take care to remove calcium deposits because corrosion inhibitors tend to be

depleted by residual calcium and thus the corrosion properties of Zitrec is reduced. In any case we recommend to check the compatibility between Zitrec or Freezium and the previous heat transfer fluid to judge the necessary cleaning and rinsing.

The time between draining a system and re-filling it, should be as short as possible since the oxygen from the air will cause surface corrosion. Especially cast iron is very sensitive to this type of corrosion. If possible, it is recommended to close of the system after drainage and before refilling occurs.

Start filling the heat transfer solution from the lowest part of the system, so that the air might be pressed out from the system at its highest points, through the air purging devices. We strongly recommend to use an external pump for this purpose such that the system pumps don't need to operate while there are still micro-bubbles in the liquid. These micro-bubbles may lead to pump cavitation during the filling cycle.

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If you can warm up the heat transfer fluid until 30-40°C, less air bubbles will be entrapped in the fluid.

As stated already earlier in this text, we recommend to use demineralized water boiler condensate or distilled water. Tap water should only be used when it is very soft and when the chloride level is very low. Chlorides are known to increase corrosion rates for most metals.

In case the water is added separately from the heat transfer fluid, we recommend to first fill the installation with 2/3 of the water, than fill Zitrec and top up with the remaining 1/3 of the water.

When refilling an existing installation, we urge to take all possible measurements to make sure that no corrosion products remain in the system. These corrosion products will deposit on the metal surface and hinder the proper action of the corrosion inhibitors contained in our product and additional consumption of inhibitors might occur. Our products reduce the surface tension of the mixture water/coolant compared to plain water mixtures. Next to filling the system with a heat transfer fluid, minor leakage might become apparent at places in the system where corrosion had started before. If tightening the connections does not cure the problem in such cases, that part of the system in question should be drained.

5 Open and closed systems

Our heat transfer fluids are designed to operate in closed systems. Since oxygen in combination with metals increases the tendency of metals to oxidise or corrode we strongly recommend to avoid their usage in open systems. The nature of most corrosion inhibitors is such that inhibitor

Besides renewing the seal material, the system engineer should ensure that pipe connections are technically satisfactory.

Pressure testing can be done either with pure water or Zitrec/water-mixtures. After the test, the system should be left filled with a Zitrec/water-mixture to prevent pitting taking place. If the system needs to be drained after the pressure test and cannot be refilled within a few days, the system should be thoroughly rinsed and dried. If not, corrosion is likely to occur. The time between draining a system and re-filling it, should be as short as possible since the oxygen from the air will cause surface corrosion. Especially cast iron is very sensitive to this type of corrosion. If possible, it is recommended to close of the system after drainage and before refilling occurs.

After the filling is completed, you should check if the right concentration has been used. For checking the concentration, we recommend the usage of a hand refractometer. They typically are sufficiently reliable for this purpose. After using the system pump for a few hours, we recommend to check the concentration once more.

DO NOT start the system fluid pumps until the system has been air-purged.

DO NOT mix our products with other fluids, as this might affect the stability and/or corrosion protection of our products!

depletion will be higher when air is present in the liquid.

However, if an open system has to be used for application related reasons, we recommend to install the recycling pipes in such a way that the openings are well below the liquid surface (this is

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important in order to avoid excessive air in the solution). In an open system it is also important to minimize the risk of water evaporation. If too much water is evaporated, the solution might reach a point whereby not all inhibitors are soluble any

more and crystallization might occur. Adding more water to the solution than the evaporated quantity will decrease the frost protection level and boiling protection. This will also lead to a system whereby corrosion protection is no longer guaranteed.

6 Material compatibility

a. Materials used for piping

All the usual types of material can be used. To avoid excessive erosion, we recommend to limit the flow rate to a maximum of 1.5 m/s.

Examples are: copper, brass, steel, stainless steel, cast iron and plastic pipes (ABS, PP),

provided that they are suitable for the selected temperature level.

When plastic pipes are selected, it is important to use PE-types with reduced oxygen diffusion. Metals that are not suitable are: galvanized steel, zinc, soft solder.

b. Air purging equipment

Install air-purging equipment at the highest points of the system and drain valves at its lowest points, in order to facilitate drainage - if required - during maintenance and service. Equip the air-purger with a shut-off valve that can be closed as soon

as the system is air purged. Check air-purging valves regularly and clean them with water if necessary to ensure that nothing is blocking the valves.

c. Filters

In any closed loop system it is recommended to install filters to filter out corrosion products that will agglomerate with each others or with some of the corrosion inhibitors. Especially when you are draining an existing installation and refilling it with a new heat transfer fluid, one should flush the system until no more deposits are found in the filters.

Good practice has learned that placing filters at the pressure side of the pump is more efficient. In theory all filter types are suitable but some are more expensive and some require more maintenance as the service life is shorter.

In the industry a wide spread of types is found but mostly the filter mesh size varies from 0.6-0.8 mm.

d. Pumps

The most critical part for liquid pumps is the shaft sealing, mostly referred to as face-seals. In our co-operation with suppliers of face seals, we have learned that many types exist but in general

silicon carbide- silicon carbide pairs almost always guarantee an acceptable cost and service life. Please consult the pump supplier for advice about

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a suitable pump and inform them on the heat transfer fluid you intend to use.

It is important to inform you that a small 'leakage' is considered normal and is required to provide the necessary cooling and lubrication effect between the stationary and the rotating surfaces.

e. Valves

Valve material should be selected from the list under section 6a to ensure maximum compatibility with the other components used and the heat transfer fluid. Next to the type of valves, also the

Organic heat transfer fluids have a tendency to evaporate and crystallize at the other end of the seal. The crystals will be visible on the surface. These can be flushed away from the sealing surfaces with water.

positioning of the valves is very important. Some valves for example only function properly when placed 100% vertical.

f. Elastomers & sealing materials

Depending on the type of heat transfer fluid, you should realise that the viscosity and surface tension properties of the various products we offer are different. For example the viscosity at low temperature is higher for MPG-based products than for MEG-based products. If in your application you need an MPG-based fluid, it is important in the design phase to realise that the pump- and seal-choice should be adapted.

Compression set is one important parameter for seal material. With compression set we mean the degree of permanent shrinkage after a defined time of being pressed together. One important aspect of elastomers is that their properties are widely influenced by the type and the amount of filler material. The list below is a recommendation only and indicates families of elastomers, not commercially available products. Given the enormous potential variations, we have not been able to test all possible variations.

- EPDM
- butyl rubber
- synthetic rubber
- nitrile rubber
- natural rubber
- PE (LD and HD)
- FEP (for instance Teflon)
- NBR rubber
- chloroprene rubber

Individual testing of specific seals we recommend to request specific information from the supplier of the seal (and not the supplier of the base elastomer that was used to make the seal).

For more details on elastomers, we refer to the specific document.

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g. Mechanical assemblies

Pipes and other parts of the installation should be assembled using one of the techniques below. If the operating temperature is lower than the assembly temperature it is important to tighten all connections again some time after the assembly.

- welding
- soldering (brazing, silver soldering – not soft soldering)
- flange joints
- screw unions
- glue-ing (plastic pipes)

Trying to connect a plastic flange to a metal flange, often leads to leakage after a short time period unless the supplier of the plastic pipes can provide special flanges for this purpose.

When using special glues it is extremely important to follow the guidelines of the manufacturer when selecting and applying the glue.

When using threaded connection pieces, we recommend to use thread tape type Teflon to avoid leakage.