Chapter 14:

Solutions for challenging environment: Part 1: Cold, Warm, Moisture / Dust

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In the following two chapters we will have a look at the challenges we face in different environments and the solutions we have available. Chapter 14 and 15 cover the following challenges:

1. Cold environment
2. Warm environment
3. Wet and polluted environment: the IP protection
4. Chemical influences or corrosive environments like seawater (chapter 15)

1. Cold Environment

In chapter 2 we already discussed air preparation and drying. At temperatures below 0 °C, properly prepared and **dried air** is essential. It is important to consider the **dew point.**

The dew point is the temperature to which a given parcel of air must be cooled, at constant barometric pressure, for water vapor to condense into water. The relative humidity at the dew point is 100%. In the area below 0° C the dew point is also called **frost point**.

As soon as air becomes compressed, the relative amount of particles in the air increases, also the water particles, this means water falls out. Therefore the air-pressure has a big influence.

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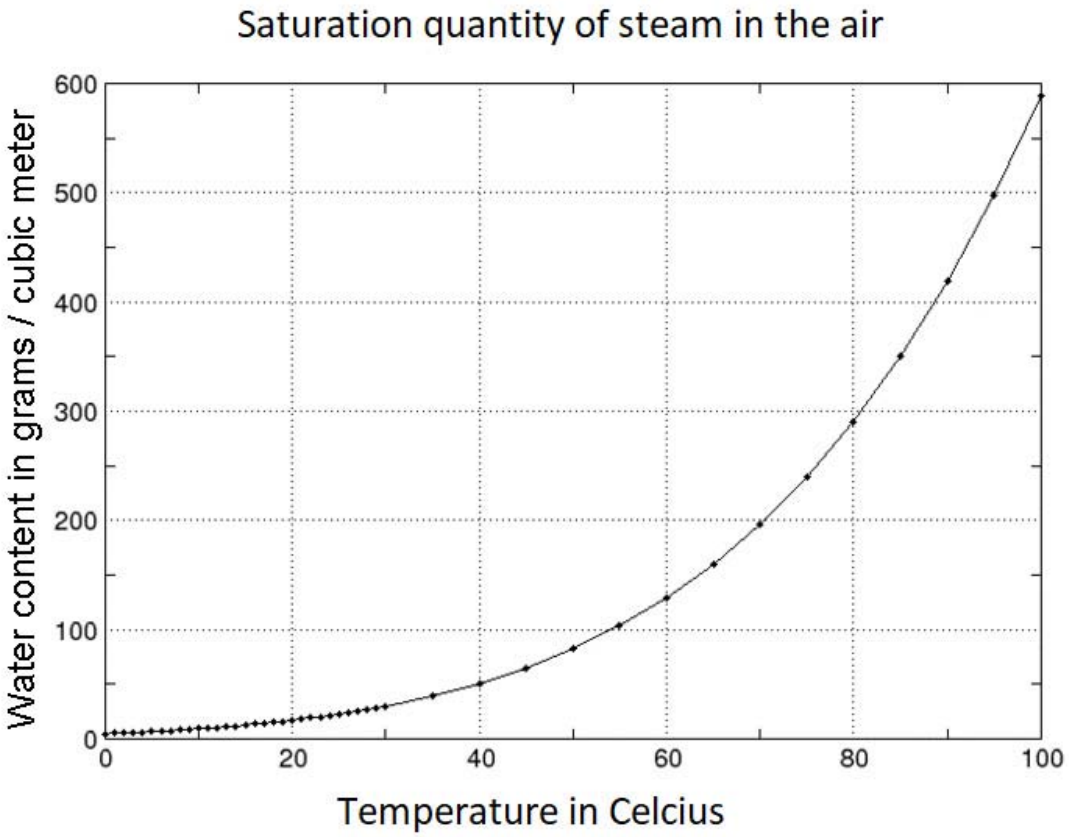

Keep in mind: The dew point has to be 15°C under the environmental temperature, otherwise the air will lose its ability to keep the water when being compressed. Water in the valve / actuator would then freeze and lead to leakage or malfunction.

In order to reach the dew point it is important to use an appropriate dryer. We recommend the use of an adsorption dryer. Check the dew point of the dryer which must be at least 15°C under the ambient temperature.

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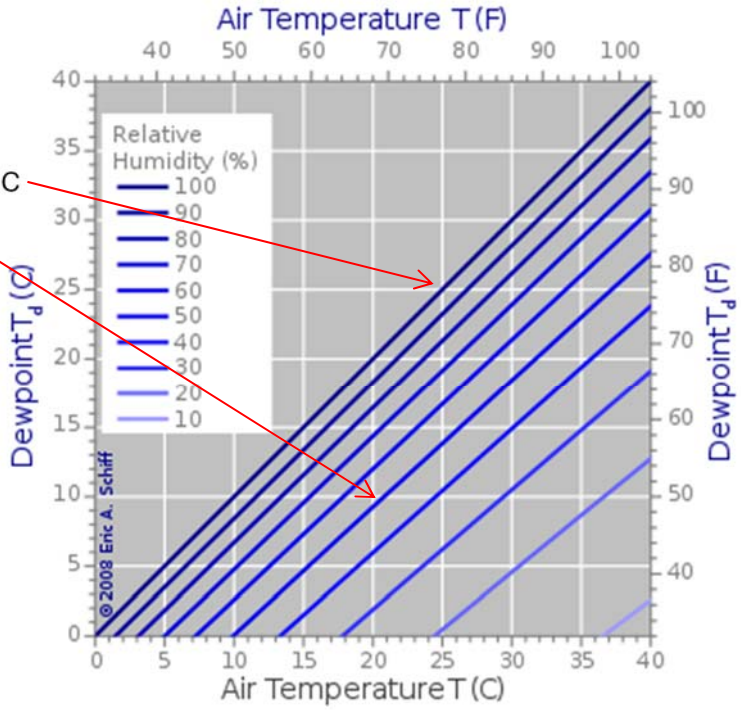
Example:

If we are declaring in our manual / catalogue that the dew point has to be 15° C below the current environment temperature signifies, that the relative humidity of the air-pressure has to be distinctly lower than 100%. As a result freezing as well as spread of condensate is avoided.

- Environment temperature = 25° C
- Dew point at 100% humidity = 25° C
- Required dew point = 25° C - 15° C = 10° C
- this means a relative humidity of ~ 50%



Don't lubricate yourself! As a special lubrication is being used inside the HAFNER low temperature valves, the usage of other lubricants or oils might lead to malfunction.

Please note that in most of our low temperature valves we use lip seal rings made from PUR (Polyurethane). Due to the geometry of these seals, the pressure connection is only possible at port 1. We can optionally use a different type of sealing system where pressure can be connected to other ports as well. For further information, please ask the manufacturer.

Please note that below -40 °C, the valve leakage may increase to 10 cm^3/minute.

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The Hafner low temperature valves carry the suffix "**TT**" or "**AIR TT**" (optional sealing system):

- BR 311 701 **TT**
- HV 511 701 **TT**
- MH 510 701 G **TT**
- MNH 510 701 **TT**

In particular, the choice of material for the sealing elements is crucial in low-temperature applications. PUR, silicones and low-temperature NBR are particularly suitable. But not only the material, but also the geometry of the seals plays a crucial role.

The components of **cold-resistant cylinders** are usually stainless steel, anodized aluminium, sintered bronze or brass. Seals are made from polyurethane and NBR.
Below -20 °C the NBR gasket hardens and loses its sealing ability, so the cylinder starts to leak. Cylinders used at high temperature are usually made with FKM seals, which however cannot be used below 0 °C.

Our **air preparation** units are generally usable till -10 °C, so it is important to place them in a location that keeps them from getting any colder than this. It is important not to let the moisture collected in the filter cup freeze as the ice may crack the cup. It is therefore beneficial to use the automatic version. Some selected FRL-units are available for -40° C on request.

It is important that not only our main components such as valves and cylinders withstand extreme weather, but the 'transmission elements' too. A type of **pneumatic tube** must be used which due to its material, can withstand minus degrees. The table below illustrates the temperature range for some **tubes** and **fittings**.

Product	Material	Temperature range
Tube	Teflon	-200 °C to +260 °C
	Polyamide	-60 °C to +100 °C
	Polyurethane	-35 °C to +60 °C
	Polyethylene	-10 °C to +40 °C

Product	Version	Temperature range
Fittings	Cutting ring	-60 °C to +300 °C
	Thread without O-ring	-40 °C to +80 °C
	Thread with O-ring	-20 °C to +80 °C
	Push-in	-20 °C to +80 °C

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2. Warm environment

We face the challenge of a warm environment not only in high temperature production processes, but also in hot areas such as the Gulf region or applications with direct sun exposure. Especially the selection of the right rubber and plastic parts is essential for products in hot areas.

Pneumatic valves are available with a wide variety of sealing materials such as NBR, PUR, FKM / FPM, EPDM and many more. Seals that perform well in hot environments and are most commonly used are FKM and FPM. These seals are identical in their raw material (fluorine-rubber / fluoroelastomer), the different designations are coming from different standards. While the FPM designation conforms to the DIN-ISO standard, the FKM seal conforms to the American ASTM standard.

Remark: Many people use Viton® as a synonym for FKM / FPM, but it is a trademark by DuPont.

Solenoid valves for high temperature applications cause major challenges to manufacturers

Generally it is easier to find pure pneumatic components (no electric components on them) for hot environment than solenoid valves. Most of the solenoid system manufacturers limit their systems to 50°C/+60°C as the electrical actuating of the solenoid is causing additional heat. Hafner however offers their solenoid valves for up to +80°C (DC-versions only) due to a special material selection. Non-electrical valves are available for up to +120°C.

In case a solenoid valve is required and the environment exceeds +80°C, an option might be to take the solenoid out of the hot area and only leave a pneumatic valve or actuator in the hot environment.

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When building control cabinets, be careful with putting too many solenoid valves into a small cabinet. Solenoids also warm-up the cabinet as most of the power consumption is transformed into heat. Electronic components that are also put into the control cabinet tend to suffer substantially. Adding a ventilation system can help to reduce the heat.

When making the specifications for the solenoid valves, the **voltage** and **duty cycle** is an important aspect. You can consider as a general rule that AC magnets tend to heat up more than DC magnets.

A duty cycle or power cycle is the fraction of one period in which a signal or system is active.

For solenoid valves the duty cycle specifies the maximum time of energizing the coil. The duty cycle is indicated as “ED” on the solenoids. Most of the Hafner solenoids are 100%ED what means that they can be energized continuously. For applications with 100%ED we recommend the usage of FKM plunger seals. NBR is hardening through and therefore not recommended. Hafner solenoid valves have FKM plunger seals as a standard.

The Hafner high temperature valves carry the suffix “HT” (solenoid valves) or “VIT” (non-electrical valves):

- MH 311 015 **HT**
- MNH 520 121 **HT**
- P 510 701 **VIT**
- HVR 520 701 **VIT**

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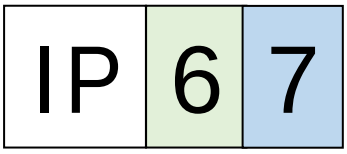
3. Wet and polluted environment: the IP protection

When making the specifications for solenoid valves, special attention must be paid to dust and water infiltration. Different electrical components are available based on the requirements. Electrical equipment is therefore categorized in IP-classes. IP stands for International Protection Mark. With this, the protection against environmental influences has been indicated on a protective case (housing) that protects circuits of a technical equipment. The IP classification is described in the IEC 60529:1989 standard.

Example:



The protection is indicated by the 2 characters after the IP code.

- The first character ranges from 0 to 6. It denotes mechanical protection against the penetration of solid particles.
- The second character ranges from 0 to 9K. It means protection against liquid ingress.

IP

First Character

IP	Particle size	Protection against solid particles
X	-	X means there is no data available to specify a protection rating with regard to this criterion.
0	-	No protection against contact and ingress of objects
1	>50 mm	Any large surface of the body, such as the back of a hand, but no protection against deliberate contact with a body part
2	>12.5 mm	Fingers or similar objects
3	>2.5 mm	Tools, thick wires, etc.
4	>1 mm	Most wires, slender screws, large ants etc.
5	Dust protected	Ingress of dust is not entirely prevented, but it must not enter in sufficient quantity to interfere with the satisfactory operation of the equipment.
6	Dust tight	No ingress of dust; complete protection against contact (dust tight). A vacuum must be applied. Test duration of up to 8 hours based on air flow.

Second Character

IP	Protection against liquid ingress
X	X means there is no data available to specify a protection rating with regard to this criterion
0	None
1	Dripping water
2	Dripping water when tilted at 15°
3	Spraying water
4	Splashing of water
5	Water jets
6	Powerful water jets
6K	Powerful water jets with increased pressure
7	Immersion, up to 1 m depth
8	Immersion, up to 1 m or more depth
9K	Powerful high temperature water jets

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Some examples based on the IP-list:

IP65: *Fully protected against dust AND protected against low pressure water jets from all directions*

IP66: *Fully protected against dust AND strong water jet and immersion in water*

IP67: *Fully protected against dust AND immersion in water for a limited time*

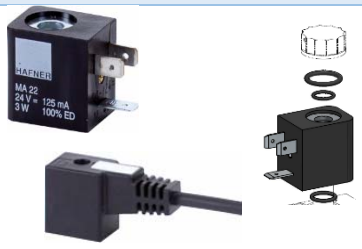
IP68: *Fully protected against dust AND can be used continuously 1-3 meters under water for 30 minutes (but individually specified by the manufacturer)*

IP69: *Fully protected against dust AND can be used continuously for up to 1 hour under water up to 3 meters*

Please note: A higher IP-class does not automatically that the "lower" IP-class is covered as well. Example: a valve which is rated for IP67 is not automatically rated for IP66.

IP-protection for Hafner solenoid valves:

Hafner solenoid valves usually offer IP65 protection. Other protections can be offered as per the following table and on request.

Standard Industrieform B coil and connector	Epoxy coil, additional seals and connector with moulded cable	Epoxy coil with M12 connection
IP65	**IP67**	**IP67**
		

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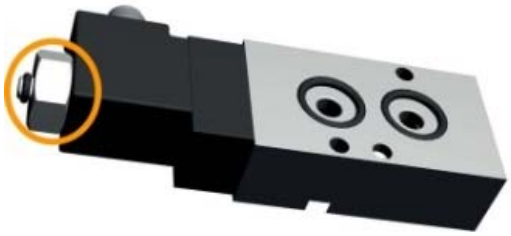
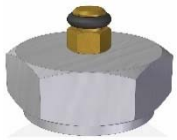
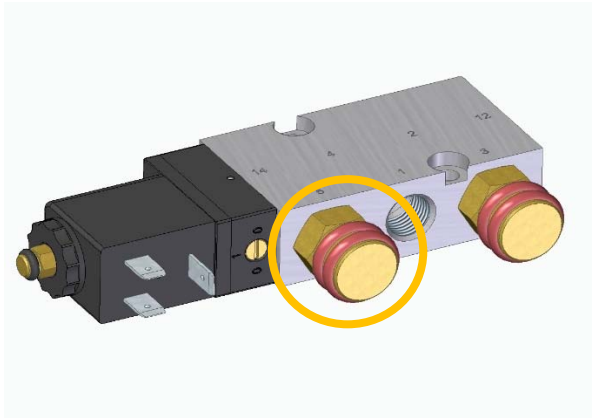
For superior protection in very wet and dirty environments, we recommend the use of non-return valves in all exhaust ports. We offer exhaust protection fittings for the operator tube as well as for the valve exhaust ports:

Protection for the operator tube, type MSR:





Protection for the valve exhaust ports, type ESR:



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