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Learning Unit 4

Heat pumps system installation



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1 INTRODUCTION

Heat pumps may take their energy from the air, the ground, or a source of water. This energy is then delivered as coolness via cooling system or heat via a heating or hot water system.

Learning unit includes different types heat pumps and main hints of installation:

1.1 Air-water and air-air heat pumps installation

Air-water and air-air heat pumps installation. Air-water and air-air heat pumps are common in all European countries; they are used for heating and cooling.

1.2 Ground-water heat pumps installation

Ground-water heat pumps installation. Ground-water heat pumps are common in European countries with colder climate. They have higher heating efficiency and are used mainly for heating. Heat pumps installation contains different types of problems, what the installer must provide - the following learning units deal with them.

2 LECTURE NOTES

2.1 Air-water and air-air heat pumps installation

Installing the outdoor unit

Transport

Impacts, compression and tensile loads can cause damage to the outside panels of the appliance. Never apply loads/weight to the top, front or side panels of the appliance.

If the compressor in the outdoor unit is tilted too far, lubricant will enter the refrigerant circuit and damage the appliance.

Max. tilting angle: 45° for approx. 4 min, otherwise 30°.

Types of installation:

- Floor standing installation with line entry above ground level
- Floor standing installation with line entry below ground level
- Wall mounting
- Roof installation (flat or pitched roof)

Floor standing installation

Particularly in more temperate and colder climate zones (minus temperatures, snow and humidity), a distance to the substrate of at least 300 mm is required. Where such a support cannot be used, install the outdoor unit freestanding on a solid base (provided on site) with a height of at least 150 mm. Secure the outdoor unit with supports for floor standing installation (accessories) to a concrete foundation. Use ground anchors with a tensile force of at least 2.5 kN to secure the support to the foundation.

Wall mounting

Use the wall mounting bracket set, the wall must meet the structural requirements. Use suitable fixing materials, depending on the wall structure. If there is no level access to the outdoor unit, ensure it is easily accessible all year round for service and maintenance. Provide sufficient maintenance areas. Install suitable protection equipment, e.g. fall protection.

Roof installation

Flat roof installation

Due to the higher static loads (roof/wind load) and the higher acoustic requirements for roof installation, the structural calculations and sound concept require input from specialist design engineers.

If the outdoor unit is to be installed on a flat roof, in addition to the requirements for floor standing and wall installation, the planning measures to be taken into account include the following:

- As the outdoor unit is located higher up when installed on a flat roof, the propagation of operating noise is more intense than with floor standing installation. Roof surfaces are normally more reverberant than floor areas. To prevent noise nuisance, install the outdoor unit at a sufficient distance from neighboring buildings. If required, provide suitable noise reduction measures. Take into account sound reflection from the surfaces of buildings when analysing sound propagation.
- Provide on-site wind protection measures where necessary, e.g. screens, walls, etc.
- Check to ensure that the installed height of the outdoor unit does not exceed the permissible building height, e.g. as specified in outline planning restrictions.
- Provide easy, year-round access to the outdoor unit for service and maintenance. Provide sufficient maintenance areas which comply with the safety regulations. Install suitable protection equipment which complies with the safety regulations, e.g. anchorage points.
- Recommendation: Install the heat pump on a steelreinforced concrete roof
- Incorporate the outdoor unit into the lightning protection system.
- Installation on flat roofs with a low weight per unit area (e.g. roofs made from timber rafters or trapezoidal sheet metal) is not permissible.
- With flat roof installation, considerable wind loads may occur, depending on the relevant wind zone and the height of the building.
- The higher roof and wind loads must be taken into account in the structural calculations and the fixture system of the outdoor unit. It is essential to comply with the specifications provided by the design engineer with regard to structural calculations, distances from building edges and the sound concept.

Pitched roof installation

If the outdoor unit is nevertheless installed on a pitched roof, the same requirements apply as for flat roof installation.

Siting:

- In accordance with EN 378-3, the outdoor unit may only be installed in the open air.
- Observe the information regarding noise levels. Sound emission regulations must be observed.
- When siting the heat pump on the property, always take into account the distances to neighboring properties in accordance with local building regulations.
- Do not install with the discharge side facing towards the house wall or against the main wind direction.
- During defrosting, cool vapour escapes from the air discharge vents of the outdoor unit. This vapour discharge must be taken into consideration during installation (choosing the installation location, orientation of the outdoor unit).
- Provide wall outlets and protective conduits for refrigerant lines and electrical connecting cables without moulded parts or changes of direction.
- Provide equipment to protect the outdoor unit from mechanical damage.
- Take environmental and weather influences into account when selecting the installation location, e.g. flooding, wind, snow, ice damage, etc. Install suitable protection equipment if required.

Special recommendations:

Siting in garages, multi-storey car parks and car parking areas:

- Prior to installation, it is essential to establish for the case in question whether the installation is permissible under local garage and parking area regulations.
- If required, provide impact protection to protect the outdoor unit from damage. This impact protection must be designed such that a strike by a vehicle at the applicable maximum speed does not result in damage to the refrigerant circuit.
- Siting in underground car parks is not permissible.

Installation in coastal areas:

Distance < 1000 m In coastal areas salt and sand particles in the air increase the likelihood of corrosion:

- Site the heat pump where it is protected from direct onshore wind.
- If necessary provide a wind break on site. Observe the minimum clearances to the heat pump.

Weather influences

- Observe wind loads when installing the unit on sites exposed to the wind.
- Incorporate the outdoor unit into the lightning protection system.
- Consider the heat absorbed (heating mode) and heat emitted (cooling mode) by the appliance when designing weatherproofing measures or an enclosure.

Condensate

In regions where the outside temperature is often below 0 °C, we recommend installing an electric ribbon heater for the condensate pan of the outdoor unit.

Floorstanding and wall installation:

- Ensure that condensate can drain freely.
- Allow condensate to soak away into a permanent gravel bed under the outdoor unit.

Roof installation:

- Allowing the condensate to drain freely onto the roof surface is not permissible, as this may result in the formation of layers of ice. Layers of ice on the roof may prevent further condensate from draining freely, resulting in increased roof loads.
- Use an electric ribbon heater for the condensate pipe.
- To drain the condensate, connect the condensate hose on the outdoor unit to an insulated condensate pipe. The condensate pipe is part of the standard delivery of the electric ribbon heater for the condensate pipe. If necessary, insert the condensate hose via a trap insert.

Structure-borne noise insulation and vibration isolation between the building and outdoor unit

- Where the line entry is above ground level, fit pipe bends in the refrigerant lines for vibration compensation.
- Route cables/leads between the indoor and outdoor units so they are not stressed.
- Installation only on walls with a high weight per unit area (> 250 kg/m²); not on lightweight walls, roof structures, etc.
- Vibration isolation components are included in the standard delivery of the wall mounting bracket. For floor standing installation, only use the rubber mounts

supplied. Do not use additional anti-vibration mounts, springs, rubber mounts, etc.

- When installing the outdoor unit on roof surfaces, there is a risk that structure-borne noise and vibrations will be transmitted into the building. If the outdoor unit is installed on freestanding garages, insufficient structure-borne noise insulation and vibration isolation can cause excessive noise due to resonance amplification.

Installation location

- Normal geodetic height of the installation location: 1500 m above sea level, otherwise contact with manufacturer.
- Select a site with good air circulation, so that the cooled air can dissipate and be replaced by warm air.
- Do not install in corners, in recesses or between walls. This could result in an "air short circuit" between the air being discharged and the air being drawn in. An "air short circuit" during heating mode will result in the cooled, discharged air re-entering the unit. This can result in reduced heat pump efficiency and defrosting problems. An air short circuit during cooling mode will result in the heated, discharged air re-entering the unit. This can lead to high pressure faults. Avoid "air short circuits".
- If siting the appliance in a location that is exposed to wind, ensure that the wind cannot influence the fan area. Strong wind can have a negative influence on the air flow through the evaporator. Provide on-site wind protection measures where necessary, e.g. screens, walls, etc.
- Take the lengths of the refrigerant lines into account.
- Select an installation location where the evaporator cannot be blocked by leaves, snow, etc.
- Select the installation location giving due consideration to the physical laws concerning the propagation and reflection of sound.
- Do not install above cellar shafts or in a floor trough.
- Do not install near bedroom windows.
- To avoid increased wind loads, maintain 1 m distance from building edges and corners.
- Maintain a clearance of at least 3 m to cellar shafts and windows. Maintain a clearance of at least 3 m to pathways, downpipes or sealed surfaces. The cooled air in the discharge area creates a risk of ice forming when outside temperatures are below 10 °C.

[Heat pumps system installation]

- Avoid "air short circuits" with ventilation systems. Maintain a clearance of at least 3 m to the intake area of ventilation systems.
- The installation location must be easily accessible, for example for maintenance work.
- Never install the outdoor unit on a flat roof immediately next to or above living rooms or bedrooms.
- Do not locate in front of windows, or keep a distance of 1 m from them.
- Due to the higher static loads (roof/wind load) and the higher acoustic requirements for roof installation, input from a specialist design engineer is required.

Connecting the refrigerant lines

- The outdoor unit is precharged with refrigerant.
- The diaphragm grommets for sealing the opening for the refrigerant lines are included in the standard delivery of the indoor unit.
- Refrigerant lines with flammable refrigerant (R32) must be laid between the indoor and outdoor units without interruption (EN 60335).

Oil lift bends and charging

Oil lift bends guarantee that the refrigerant oil is reliably conveyed back to the compressor. Errors in the design and installation of oil lift bends can result in appliance damage.

- The outdoor unit is installed more than 5 m above the indoor unit: install oil lift bends in the vertical hot gas line.
- Indoor unit is installed above the outdoor unit: do not install oil lift bends.
- Max. height differential, indoor unit – outdoor unit: 15 m.
- Min. line length: 5 m.
- Max. line length: from 25 m up to 30 m (see in manufacturer instructions).
- No additional charging is required for line lengths up to 10 m (see in manufacturer instructions).

Wall outlet

- No wall outlet where load bearing sections, lintels, damp proofing elements (e.g. vapour barriers), etc. are located.

[Heat pumps system installation]

- No structure-borne noise transmission, i.e. Avoid contact between metal (refrigerant line) and the building structure.
- Route cables free of strain and separated from the refrigerant lines.
- Route the hot gas line with pipe bends. This reduces the transmission of vibrations to the pipe wall.
- Use a tighter pipe bend for vibration compensation on a shorter hot gas line than on a longer hot gas line.
- Insulate all refrigerant lines.
- Secure refrigerant lines using only pipe clips with soft elastic insulating lining (EPDM).
- Secure the pipe bend for vibration compensation at the end of the bend with a pipe clip (towards the external wall).
- Secure refrigerant lines with pipe clips at intervals of max. 2.0 m. We recommend securing the refrigerant lines with pipe clips at intervals of 1.5 m.
- Recommendation: Mount pipe clips only on components with a mass per unit area $\geq 250 \text{ kg/m}^2$.
- Do not install refrigerant lines on partition walls or ceilings to rooms that require a low noise level (e.g. Bedrooms).

Torque for refrigerant lines

Cable Connection Torque in Nm

| Cable | Connection | Torque in Nm |
|----------------------|------------|--------------|
| Liquid line Ø 6 mm | 5/8 UNF | 33 to 42 |
| | 7/16 UNF | 14 to 18 |
| | 1/4 UNF | 15 to 20 |
| Hot gas line Ø 12 mm | 7/8 UNF | 63 to 77 |
| | 1/2 UNF | 50 to 54 |
| Liquid line Ø 10 mm | 5/8 UNF | 33 to 42 |
| Hot gas line Ø 16 mm | 7/8 UNF | 63 to 77 |

Installing the air-water heatpump indoor unit

Dust, gases and vapours can be damaging to health and trigger explosions. Prevent dust, gases and vapours in the installation room. The leakage of flammable refrigerant (R32) presents a fire hazard in rooms with insufficient air supply.

- Observe minimum room area.
- Ensure adequate ventilation.
- Do not operate any ignition sources in the installation room, e.g. open flue heat generator, naked flames, switched-on gas appliance, electric heater, etc. Do not smoke in the installation room.
- Electrical equipment located at a distance of 1 m around refrigerant-carrying parts of the system must meet the requirements for areas at risk of explosion, zone 2. An unfavourable room climate can lead to malfunctions and appliance damage.
- The installation room must be dry and free from the risk of frost.
- Max. 70 % relative humidity (corresponds to an absolute humidity of approx. 25 g water vapour/kg dry air).
- Ambient temperatures Wall mounted indoor unit: 5 to 35 °C. Indoor unit with integral DHW cylinder: 0 to 35 °C.
- The minimum room area can be calculated as part of a room network.
- If refrigerant is topped up due to a longer refrigerant line, it is not necessary to adjust the minimum room area.
- According to EN 378, the minimum volume of the installation room depends on the refrigerant charge and composition.

$$V_{\min} = m_{\max}/G$$

V_{\min} - Minimum room volume in m³

m_{\max} - Maximum refrigerant charge in kg

G - Practical limit to EN 378, subject to the composition of the refrigerant

For R410A: 0.44 kg/m³

Steps - commissioning, inspection and maintenance

Opening the heat pump

Contact with live components can lead to serious injury from electric current. Some components on PCBs remain live even after the power supply has been switched off.

- Never touch the wiring chambers.
- When working on the appliances (indoor/outdoor units), isolate the system from the power supply, e.g. at the separate MCB/fuse or a mains isolator. Check that it is no longer live. Safeguard against unauthorised reconnection.
- Prior to working on the appliance, wait at least 4 min until the voltage has completely dropped out. The absence of system component earthing can lead to serious injury from electrical current and component damage in the event of an electrical fault. All earth conductor connections must be reconnected. The appliance and pipework must be connected to the equipotential bonding of the building.
- Commissioning immediately after installation can lead to appliance damage. Wait at least 30 min between installing and commissioning the appliance. Refrigerant can escape when working on the refrigerant circuit.
- Work on the refrigerant circuit may only be carried out by qualified personnel.
- Ventilate the installation room during installation, maintenance and service, e.g. through windows or doors.
- Do not operate an ignition source in the installation room.

Checking the refrigerant lines for leaks

Perform a tightness and pressure test with dry nitrogen at min. 20 bar (max. 43 bar).

Evacuating the refrigerant lines and indoor unit

Commissioning is weather-dependent. At outside temperatures below 0 °C, moisture can condense and sublimate in the refrigerant lines. If water droplets and/or ice particles enter the compressor, they may cause damage to the appliance.

In the case of high relative humidity or outside temperatures below 0 °C, please observe the following:

- Use nitrogen for the pressure test.
- During evacuation, take suitable steps to keep the surface temperature of the refrigerant lines above 0 °C.
- Direct contact with refrigerant can be harmful to skin. Wear safety goggles and protective gloves when working on the refrigerant circuit. Escaping refrigerant will cause environmental pollution.

- Before evacuating the refrigerant lines and the internal unit, check all connections for tightness with leak detection spray.
- Keep the valves on the outdoor unit closed and fill the system with nitrogen through the service valve. The test pressure is the max. permissible operating pressure.

Vacuuming:

1. Close all valves at the pressure gauge set.
2. Make all connections as shown above.
3. Start the vacuum pump. At the pressure gauge set, open the valve to the vacuum pump and the valve to the hot gas connection.
4. After approx. 5 min, open the valve to the vacuum gauge. Leave the vacuum pump running until the indication on the vacuum gauge is almost at "0" (at least 30 min).
5. On the pressure gauge set, close the valve to the vacuum pump. Switch off vacuum pump. Wait approx. 5 min. If the indication on the vacuum gauge rises, there is a leak. Fix leak. Repeat process.
6. Close all valves at the pressure gauge set.
7. Remove the vacuum pump and vacuum gauge.

Charging the refrigerant lines and indoor unit:

- The outdoor unit is precharged with refrigerant.
- No additional charging is required for line lengths from 5 to 10 m.
- The system may only be recharged with refrigerant in a liquid state.

Recharging the system with refrigerant or evacuating the refrigerant can cause the condenser to freeze up. Flush the secondary side of the condenser with water or drain it completely. Mechanical stress will damage the connections. When tightening the nuts on any connections, hold with a second open-ended spanner.

Line lengths up to 10 m:

1. Remove the caps from the shut-off valves of the outdoor unit.
2. Open both shut-off valves. Refit caps.
3. Promptly undo the fill hose from the service valve (Schrader valve) of the outdoor unit: The pressure in the pipework must be greater than the ambient pressure.

4. Screw the union nut with copper cap onto the service valve (Schrader valve) of the outdoor unit: Torque 15 to 20 Nm.

Line lengths greater than 10 m:

1. Connect the hose between the pressure gauge set and refrigerant bottle. Evacuate the hose and pressure gauge set.
2. Recharge with the required amount of refrigerant: 54 g/m line length.
3. Close the valves at the pressure gauge set.
4. Unscrew the caps from the shut-off valves of the outdoor unit.
5. Open both shut-off valves. Refit caps.
6. Promptly undo the fill hose from the service valve (Schrader valve) of the outdoor unit: The pressure in the pipework must be greater than the ambient pressure.
7. Fit the union nut with copper cap to the service valve (Schrader valve) of the outdoor unit: Torque 15 to 20 Nm.
8. Enter the amount of refrigerant added on the type plate.

Checking the refrigerant circuit for leaks

Check the connections for refrigerant leaks using a leak detector:

- All flared connections of the refrigerant lines between the indoor and the outdoor unit.
- All brazed joints and threaded fittings of the refrigerant lines in the internal and external units.
- Repair any detected refrigerant leaks before commissioning the system. After commissioning the system, repeat leak test with the compressor running.

Leak detector information:

- The leak detector must be suitable for the refrigerant.
- Required sensitivity: At least 5 g/year

The leak detector must be calibrated in accordance with the device manufacturer's instructions.

2.2 Ground-water heat pumps installation

Installation room requirements

Dust, gases and vapours can be damaging to health and trigger explosions. Prevent dust, gases and vapours in the installation room. An unfavourable room climate can lead to malfunctions and appliance damage.

The installation room must be dry and free from the risk of frost:

- Ensure ambient temperatures between 0 and 35 °C.
- Max. 70 % relative humidity (corresponds to an absolute humidity of approx. 25 g water vapour/kg dry air).
- Overloading the floor can result in damage to the building structure. Observe the permissible floor load.
- Never install the appliance in living spaces or directly next to, below or above quiet rooms/bedrooms.
- The installation location must be easily accessible, for example for maintenance work.
- Observe the minimum room volume.
- To prevent the transmission of structure-borne noise, never site the heat pump above ceilings with wooden joists, e.g. in the attic.
- Recommendations for sound protection measures:
 - Reduce reverberant surfaces, particularly on walls and ceilings. Rough structural renders absorb more sound than tiles.
 - If quietness is a particularly important consideration, apply sound-absorbing material (commercially available) to the walls and ceilings.
 - The doors of the installation room should correspond to at least emission class E1. This is usually achieved by fitting tubular chipboard doors.

Minimum room volume (to EN 378):

| Refrigerant charge in kg | Minimum room volume in m3 |
|--------------------------|---------------------------|
| 1,2 | 3,2 |
| 1,7 | 4,5 |
| 1,8 | 5,5 |
| 1,95 | 4,9 |
| 2,35 | 5,9 |

Hydraulic connections

Connecting the primary circuit

The heat transfer medium can cause corrosion damage to on-site lines and components.

The components and lines used must be resistant to the heat transfer medium. Never use zinc plated/galvanised pipes.

Equip the primary circuit with an expansion vessel and safety valve. Ensure adequate thermal and anti-vibration insulation where pipes penetrate walls. Mechanically loaded hydraulic connections lead to leaks, vibrations and appliance damage. Connect on-site lines so that they are free of load and torque stress. Insulate pipes inside the building to prevent heat and vapour diffusion.

Fill the primary circuit with manufacturer recommended heat transfer medium and vent.

Connecting the secondary circuit

Equip the secondary circuit on site with an expansion vessel and safety assembly.

Ensure adequate thermal and anti-vibration insulation where pipes penetrate walls. Mechanically loaded hydraulic connections lead to leaks, vibrations and appliance damage. Connect on-site lines so that they are free of load and torque stress. Thermally insulate lines inside the building.

3 QUESTIONS & ANSWERS

3.1 Question & Answer 1

Question: For what must be observe minimum room volume by installation of heat pumps?

Answer: For the safety if the refrigerant leaks.

3.2 Question & Answer 2

Question: For what must be ensured adequate ventilation in installation room of heat pumps?

Answer: For the safety if the refrigerant leaks.

3.3 Question & Answer 3

Question: What are the possibilities for sound protection measures?

Answer:

- Reduce reverberant surfaces, particularly on walls and ceilings. Rough structural renders absorb more sound than tiles.
- If quietness is a particularly important consideration, apply sound-absorbing material to the walls and ceilings.
- The doors of the installation room should correspond to at least emission class E1.

3.4 Question & Answer 4

Question: What is "air short circuit"?

Answer: Installing air source heat pumps outdoor units in corners or between walls could result in an "air short circuit" between the air being discharged and the air being drawn in. An "air short circuit" during heating mode will result in the cooled, discharged air re-entering the unit. This can result in reduced heat pump efficiency and defrosting problems. An air short circuit during cooling mode will result in the heated, discharged air re-entering the unit. This can lead to high pressure faults.

3.5 Question & Answer 5

Question: How can the Installer after installation check the refrigerant lines for leaks?

Answer: Perform a tightness and pressure test with dry nitrogen.

3.6 Question & Answer 6

Question: What can cause the heat transfer medium to on-site lines and components?

Answer: The heat transfer medium can cause corrosion damage to on-site lines and components.

3.7 Question & Answer 7

Question: What must equip the secondary circuit on site?

Answer: The secondary circuit must equip on site with an expansion vessel and safety assembly.

3.8 Question & Answer 8

Question: Have the mechanically loaded hydraulic connections with any risks?

Answer: Mechanically loaded hydraulic connections lead to leaks, vibrations and appliance damage.

3.9 Question & Answer 9

Question: May cause dust, gases and vapours in installation room any risks?

Answer: Dust, gases and vapours can be damaging to health and trigger explosions.

3.10 Question & Answer 10

Question: What ambient temperatures must be in installation room?

Answer: Ambient temperatures in installation room must be between 0 and 35 °C.

3.11 Question & Answer 11

Question: What may cause the floor overloading in installation room?

Answer: Overloading the floor can result in damage to the building structure. Observe the permissible floor load.

3.12 Question & Answer 12

Question: How can check the refrigerant lines for leaks?

Answer: Perform a tightness and pressure test with dry nitrogen at min. 20 bar (max. 43 bar).

3.13 Question & Answer 13

Question: Can work on the refrigerant circuit anyone?

Answer: Work on the refrigerant circuit may only be carried out by qualified personnel.

3.14 Question & Answer 14

Question: Is the outdoor unit is precharged with refrigerant?

Answer: Yes. The outdoor unit is precharged with refrigerant.

3.15 Question & Answer 15

Question: What kind of pipe clips may used in secure refrigerant lines?

Answer: Secure refrigerant lines using only pipe clips with soft elastic insulating lining (EPDM).

4 PRACTICAL EXERCISES

4.1 Exercise 1

Find according to EN 378, the minimum volume of the installation room, if the refrigerant in air-water heat pump is R410A and the refrigerant maximum charge is 2,3 kg.

Answer:

$$V_{\min} = m_{\max}/G$$

V_{\min} - Minimum room volume in m³

m_{\max} - Maximum refrigerant charge in kg

G - Practical limit to EN 378, subject to the composition of the refrigerant, for R410A: 0.44 kg/m³

$$V_{\min} = 2,3 \text{ kg} : 0,44 \text{ kg/m}^3 = \underline{5,23 \text{ m}^3}$$

4.2 Exercise 2

Installed refrigerant line lengths is 22 m. Find recharging amount of refrigerant.

Answer:

Recharge with the required amount of refrigerant: 54 g/m line length (line lengths greater than 10 m).

$$22 \text{ m} - 10 \text{ m} = 12 \text{ m}$$

$$12 \text{ m} \times 54 \text{ g/m} = \underline{648 \text{ g}}$$

5 MULTIPLE CHOICE QUESTIONS

5.1 Multiple choice question 1

Refrigerant leak detector required sensitivity:

- **At least 5 g/year**
- At least 5 g/hour
- At least 5 g/day
- At least 5 kg/year

5.2 Multiple choice question 2

Recharge amount of refrigerant:

- **54 g/m line length**
- 24 g/m line length
- 44 g/m line length
- 54 kg/m line length

5.3 Multiple choice question 3

Torque for refrigerant lines connection in Nm for the connection 7/8 UNF:

- **63 to 77 Nm**
- 50 to 54 Nm
- 33 to 42 Nm
- 15 to 20 Nm

5.4 Multiple choice question 4

Torque for refrigerant lines connection in Nm for the connection 5/8 UNF:

- 63 to 77 Nm
- 50 to 54 Nm
- **33 to 42 Nm**
- 15 to 20 Nm

5.5 Multiple choice question 5

Torque for refrigerant lines connection in Nm for the connection 1/2 UNF:

- 63 to 77 Nm
- **50 to 54 Nm**
- 33 to 42 Nm
- 15 to 20 Nm

5.6 Multiple choice question 6

Torque for refrigerant lines connection in Nm for the connection 1/4 UNF:

- 63 to 77 Nm
- 50 to 54 Nm
- 33 to 42 Nm
- **15 to 20 Nm**

5.7 Multiple choice question 7

Normal geodetic height of the installation air source heat pump above sea level:

- 500 m
- 1000 m
- **1500 m**
- 2000 m

5.8 Multiple choice question 8

Torque for refrigerant lines connection in Nm for the connection 7/16 UNF:

- 63 to 77 Nm
- 50 to 54 Nm
- 33 to 42 Nm
- **14 to 18 Nm**

5.9 Multiple choice question 9

Distance to the sea which in coastal areas salt and sand particles in the air increase the likelihood of corrosion

- < 100 m
- < 500 m
- **< 1000 m**
- < 1500 m

5.10 Multiple choice question 10

Where is recommend installing an electric ribbon heater for the condensate pan of the outdoor unit.

- **In regions where the outside temperature is often below 0 °C**
- In regions where the outside temperature is often below +10 °C
- In regions where the outside temperature is often below -10 °C
- Everywhere

5.11 Multiple choice question 11

Max. % relative humidity in installation room:

- 100%
- **70%**
- 50%
- 30%

5.12 Multiple choice question 12

Installation room ambient temperatures may be:

- between -20 and 0 °C
- between -10 and 15 °C
- **between 0 and 35 °C**
- between 40 and 75 °C

5.13 Multiple choice question 13

For the pressure test of the refrigerant lines can be used:

- **Nitrogen**
- Oxygen
- Air
- Water

5.14 Multiple choice question 14

Because of resistant to the heat transfer medium in ground-water heat pumps never use:

- **zincplated/galvanised pipes**
- PE pipes
- steel pipes
- Al-Pex pipes

5.15 Multiple choice question 15

During evacuation must be the surface temperature of the refrigerant lines:

- above -10 °C
- **above 0 °C**
- above 10 °C
- above 30 °C

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