Title of lecture: Ventilation Systems for Carbon Dioxide and Ammonia

Name of speaker: Dr Dermot Cotter – Star Technical Solutions

eurammon Symposium, DATE: 7th July 2022

ADEAREST The World Below Zero | ALFA LAVAL | evapco for LIFE | Güntner | Johnson Controls | STAR REFRIGERATION | WITT

eurammon
refrigerants delivered by mother nature

Areas Covered

- Machinery Rooms & Non Occupied Spaces
- Normal Ventilation
- Occupancy Ventilation
- Emergency Ventilation
- Zone 2NE Concept
- Non Occupied Area Extract Hoods

Standards Accross Europe

EN 378-2:2016 (E)

European foreword

This document (EN 378-2:2016) has been prepared by Technical Committee CEN/TC 182 "Refrigerating systems, safety and environmental requirements", the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by May 2017, and conflicting national standards shall be withdrawn at the latest by May 2017.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 378-2:2008+A2:2012.

Purpose of Ventilation for Refrigeration Systems

Carbon Dioxide

- Toxic effects

Ammonia

- Toxic effects
- Flammability

Type of Ventilation - Occupancy Ventilation

EN 378-3:2016 (E)

Openings for outside air shall be positioned to avoid re-circulation into the room.

5.13.2 Ventilation for normal operating conditions or when machinery room is occupied

Ventilation shall be in accordance with national regulations with a minimum of 4 air changes per hour when the machinery room is occupied. ~~In the event that the necessary ventilation rate cannot be~~ achieved an audible and/or visual alarm shall be initiated and, where relevant, electrical supplies shall be terminated.

Type of Ventilation - Occupancy Ventilation

EN 378-3:2016 (E)

Openings for outside air shall be positioned to avoid re-circulation into the room.

5.13.2 Ventilation for normal operating conditions or when machinery room is occupied

Ventilation shall be in accordance with national regulations with a minimum of 4 air changes per hour ~~when the machinery room is occupied~~. In the event that the necessary ventilation rate cannot be achieved an audible and/or visual alarm shall be initiated and, where relevant, electrical supplies shall be terminated.

Type of Ventilation - Emergency Ventilation

5.13.4 Required airflow for emergency mechanical ventilation

Machinery rooms

Airflow of the mechanical ventilation shall be at least the quantity obtained by Formula (1):

$$\dot{V} = 0{,}014 \times m^{2/3} \qquad (1)$$

where

$\dot{V}$ is the air flow rate in m^3/s;

m is the mass of refrigerant charge, in kg, in the refrigerating system with the largest charge, any part of which is located in the machinery room;

0,014 is a conversion factor with units of $m^3/s\ kg^{2/3}$.

An emergency ventilation system with 15 air changes per hour is sufficient.

Ammonia is Flammable

Ammonia is B2L refrigerant – Highly toxic and lower flammability

Lower Flammability = Flammable

If Still any doubts look at the

www.youtube.com › watch

Elk Grove Village, IL Yogurt Plant Ammonia ... - YouTube

An **explosion** caused by an **ammonia** leak at a food manufacturing plant Friday morning in Elk Grove Village cause…

YouTube · Bryan Haywood · 23 Oct 2019

Type of Ventilation – Normal Ventilation – Classification of Area

All areas where a refrigerant is present must have a classification of area

Area classified as Zone 2:	All equipment ATEX rated
Area classified as Zone 2NE:	Standard equipment can be used

Type of Ventilation – Normal Ventilation – Classification of Area

Zone 2NE

Zone 2 of Negligible Extent

Zone of negligible extent such that if ignition did occur it would have negligible consequences

Volume is <0.1m³ with the average gas concentration of ≤50% Lower Flammability Level (LFL)

Type of Ventilation – Normal Ventilation

6.2.14 Protection against fire and explosion hazards

EN378-2

For systems using flammable refrigerants, refrigerating systems shall be constructed so that any leaked refrigerant will not flow or stagnate so as to cause a fire or explosion hazard in areas within the equipment where components and apparatus which could be a source of ignition and which could function under normal conditions or in the event of a leak, are fitted.

Refrigerating systems in the scope of and complying with EN 60335 series are deemed to comply with this clause.

NOTE 1 Sources of ignition include hot surfaces that exceed specified temperature limits, flames and hot gases that are not suitably enclosed and electrical apparatus that could arc or spark. For other types of potential sources of ignition refer to EN 1127–1. Annex K gives guidance on the potential ignition sources.

To determine whether a source of ignition is in a position where leaked refrigerant could flow or stagnate, EN 60079-10-1:2009 shall be used to estimate the size and extent of a potentially flammable zone.

Type of Ventilation – Normal Ventilation

6.2.14 Protection against fire and explosion hazards

EN378-2

For systems using flammable refrigerants, refrigerating systems shall be constructed so that any leaked refrigerant will not flow or stagnate so as to cause a fire or explosion hazard in areas within the equipment where components and apparatus which could be a source of ignition and which could function under normal conditions or in the event of a leak, are fitted.

Refrigerating systems in the scope of and complying with EN 60335 series are deemed to comply with this clause.

NOTE 1 Sources of ignition include hot surfaces that exceed specified temperature limits, flames and hot gases that are not suitably enclosed and electrical apparatus that could arc or spark. For other types of potential sources of ignition refer to EN 1127–1. Annex K gives guidance on the potential ignition sources.

To determine whether a source of ignition is in a position where leaked refrigerant could flow or stagnate, EN 60079-10-1:2009 shall be used to estimate the size and extent of a potentially flammable zone.

Type of Ventilation – Source of Release – EN60079-10-1:2021 - Section 6.2

Each item of process equipment (for example, tank, pump, pipeline, vessel, etc.) should be considered as a potential source of release of a flammable substance. If the item cannot foreseeably contain a flammable substance, it will clearly not give rise to a hazardous area around it. The same will apply if the item contains a flammable substance but cannot release it into the atmosphere (for example, a fully welded pipeline is not considered to be a source of release).

If it is established that the item may release a flammable substance into the atmosphere, it is necessary, first of all, to determine the grade or grades of release in accordance with the definitions, by establishing the likely frequency and duration of the release. It should be recognized that the opening-up of parts of enclosed process systems (for example, during filter changing or batch filling) should also be considered as sources of release when developing the hazardous area classification. By means of this procedure, each release will be graded either 'continuous', 'primary' or 'secondary'.

Type of Ventilation – Source of Release – EN60079-10-1:2021 - Section 6.2

Each item of process equipment (for example, tank, pump, pipeline, vessel, etc.) should be considered as a potential source of release of a flammable substance. If the item cannot foreseeably contain a flammable substance, it will clearly not give rise to a hazardous area around it. The same will apply if the item contains a flammable substance but cannot release it into the atmosphere (for example, a fully welded pipeline is not considered to be a source of release).

If it is established that the item may release a flammable substance into the atmosphere, it is necessary, first of all, to determine the grade or grades of release in accordance with the definitions, by establishing the likely frequency and duration of the release. It should be recognized that the opening-up of parts of enclosed process systems (for example, during filter changing or batch filling) should also be considered as sources of release when developing the hazardous area classification. By means of this procedure, each release will be graded either 'continuous', 'primary' or 'secondary'.

Type of Ventilation - Source of Release – EN60079-10-1:2021

Table B.1 – Suggested hole cross sections for secondary grade of releases

Type of item	Item	Leak Considerations		
		Typical values for the conditions at which the release opening will not expand	Typical values for the conditions at which the release opening may expand, e.g. erosion	Typical values for the conditions at which the release opening may expand up to a severe failure, e.g. blow out
		S (mm^2)	S (mm^2)	S (mm^2)
Sealing elements on fixed parts	Flanges with compressed fibre gasket or similar	≥ 0,025 up to 0,25	> 0,25 up to 2,5	(sector between two bolts) × (gasket thickness) usually ≥ 1 mm
	Flanges with spiral wound gasket or similar	0,025	0,25	(sector between two bolts) × (gasket thickness) usually ≥ 0,5 mm
	Ring type joint connections	0,1	0,25	0,5
	Small bore connections up to 50 mm[a]	≥ 0,025 up to 0,1	> 0,1 up to 0,25	1,0
Sealing elements on moving parts at low speed	Valve stem packings	0,25	2,5	To be defined according to Equipment Manufacturer's Data but not less than 2,5 mm^2 [d]
	Pressure relief valves[b]	0,1 × (orifice section)	NA	NA
Sealing elements on moving parts at high speed	Pumps and compressors[c]	NA	≥ 1 up to 5	To be defined according to Equipment Manufacturer's Data and/or Process Unit Configuration but not less than 5 mm^2 [d and e]

Type of Ventilation – Normal Ventilation – Steps in Classification of Area

1. Determine hole size for ammonia release – Use EN60079-10-1 as basis
2. With the max operating pressure and hole size – determine refrigerant release rate
3. Measure the air velocity that is continuously available across the source of release
4. Calculate the volume with the average gas concentration of ≤50% Lower Flammability Level (LFL)

Type of Ventilation – Normal Ventilation – Steps in Classification of Area

1. Determine hole size for ammonia release – Use EN60079-10-1 as basis
2. With the max operating pressure and hole size – determine refrigerant release rate
3. Measure the air velocity that is continuously available across source of release source
4. Calculate the volume with the average gas concentration of ≤50% Lower Flammability Level (LFL)

If volume is $<0.1m^3$ ➔ Zone 2 NE (Non hazardous area)

If volume is $>0.1m^3$ ➔ Zone 2 area – ATEX equipment required or improve ventilation

If at any time the air velocity is reduce below the minimum to allow the area to be classified Zone 2NE, the power supply to the area must be removed.

Machinery Room Ventilation – For Safety

Carbon Dioxide

- Occupancy – 4 ACH
- Emergency – Based on refrigerant quantity and up to 15 ACH

Ammonia

- Normal – Continuous to allow area to classified as Zone 2NE (Non-hazardous)
- Occupancy – 4 ACH
- Emergency – Based on refrigerant quantity and up to 15 ACH

Non Occupied Spaces – Not Designated a Machinery Room (EN378- 3)

4.5 Refrigerating equipment located in an unoccupied space not designated a machinery room

Where compressors or pressure vessels are located in an unoccupied space which is sealed from any occupied space the location shall be treated as a machinery room in accordance with Clause 5.

Where equipment (not including compressors and pressure vessels) containing non-permanent joints is located in an unoccupied space which is sealed from any occupied space the requirements of Clause 5 shall be applied, but if mechanical ventilation is required according to 5.13, ventilation shall be from an extractor hood positioned adjacent to the equipment and the ventilation rate shall be more than 0,05 m^3/s per ventilator. In the case of equipment subject to adverse conditions, for example severe vibration or a corrosive atmosphere, the ventilation rate shall be more than 0,5 m^3/s per extractor hood. If mechanical ventilation is required, refrigerant detectors shall activate the ventilation at 50 % of the ATEL, except for refrigerants with a characteristic odour at concentrations below ATEL/ODL (such as R-717), or 25 % of the LFL, whichever is lower.

Non Occupied Spaces – Not Designated a Machinery Room (EN378- 3)

4.5 Refrigerating equipment located in an unoccupied space not designated a machinery room

Where compressors or pressure vessels are located in an unoccupied space which is sealed from any occupied space the location shall be treated as a machinery room in accordance with Clause 5.

Where equipment (not including compressors and pressure vessels) containing non-permanent joints is located in an unoccupied space which is sealed from any occupied space the requirements of Clause 5 shall be applied, but if mechanical ventilation is required according to 5.13, ventilation shall be from an extractor hood positioned adjacent to the equipment and the ventilation rate shall be more than 0,05 m^3/s per ventilator. In the case of equipment subject to adverse conditions, for example severe vibration or a corrosive atmosphere, the ventilation rate shall be more than 0,5 m^3/s per extractor hood. If mechanical ventilation is required, refrigerant detectors shall activate the ventilation at 50 % of the ATEL, except for refrigerants with a characteristic odour at concentrations below ATEL/ODL (such as R-717), or 25 % of the LFL, whichever is lower.

Non Occupied Spaces – Not Designated a Machinery Room (EN378- 3)

4.5 Refrigerating equipment located in an unoccupied space not designated a machinery room

Where compressors or pressure vessels are located in an unoccupied space which is sealed from any occupied space the location shall be treated as a machinery room in accordance with Clause 5.

Where equipment (not including compressors and pressure vessels) containing non-permanent joints is located in an unoccupied space which is sealed from any occupied space the requirements of Clause 5 shall be applied, but if mechanical ventilation is required according to 5.13, ventilation shall be from an extractor hood positioned adjacent to the equipment and the ventilation rate shall be more than 0,05 m^3/s per ventilator. In the case of equipment subject to adverse conditions, for example severe vibration or a corrosive atmosphere, the ventilation rate shall be more than 0,5 m^3/s per extractor hood. If mechanical ventilation is required, refrigerant detectors shall activate the ventilation at 50 % of the ATEL, except for refrigerants with a characteristic odour at concentrations below ATEL/ODL (such as R-717), or 25 % of the LFL, whichever is lower.

Non Occupied Spaces – Not Designated a Machinery Room (EN378- 3)

4.5 Refrigerating equipment located in an unoccupied space not designated a machinery room

Where compressors or pressure vessels are located in an unoccupied space which is sealed from any occupied space the location shall be treated as a machinery room in accordance with Clause 5.

Where equipment (not including compressors and pressure vessels) containing non-permanent joints is located in an unoccupied space which is sealed from any occupied space the requirements of Clause 5 shall be applied, but if mechanical ventilation is required according to 5.13, ventilation shall be from an extractor hood positioned adjacent to the equipment and the ventilation rate shall be more than 0,05 m^3/s per ventilator. In the case of equipment subject to adverse conditions, for example severe vibration or a corrosive atmosphere, the ventilation rate shall be more than 0,5 m^3/s per extractor hood. If mechanical ventilation is required, refrigerant detectors shall activate the ventilation at 50 % of the ATEL, except for refrigerants with a characteristic odour at concentrations below ATEL/ODL (such as R-717), or 25 % of the LFL, whichever is lower.

Non Occupied Spaces – Not Designated a Machinery Room (EN378- 3)

4.5 Refrigerating equipment located in an unoccupied space not designated a machinery room

Where compressors or pressure vessels are located in an unoccupied space which is sealed from any occupied space the location shall be treated as a machinery room in accordance with Clause 5.

Where equipment (not including compressors and pressure vessels) containing non-permanent joints is located in an unoccupied space which is sealed from any occupied space the requirements of Clause 5 shall be applied, but if mechanical ventilation is required according to 5.13, ventilation shall be from an extractor hood positioned adjacent to the equipment and the ventilation rate shall be more than 0,05 m^3/s per ventilator. In the case of equipment subject to adverse conditions, for example severe vibration or a corrosive atmosphere, the ventilation rate shall be more than 0,5 m^3/s per extractor hood. If mechanical ventilation is required, refrigerant detectors shall activate the ventilation at 50 % of the ATEL, except for refrigerants with a characteristic odour at concentrations below ATEL/ODL (such as R-717), or 25 % of the LFL, whichever is lower.

Non Occupied Spaces – Not Designated a Machinery Room (EN378- 2)

A remainder from earlier

6.2.14 Protection against fire and explosion hazards

For systems using flammable refrigerants, refrigerating systems shall be constructed so that any leaked refrigerant will not flow or stagnate so as to cause a fire or explosion hazard in areas within the equipment where components and apparatus which could be a source of ignition and which could function under normal conditions or in the event of a leak, are fitted.

Refrigerating systems in the scope of and complying with EN 60335 series are deemed to comply with this clause.

NOTE 1 Sources of ignition include hot surfaces that exceed specified temperature limits, flames and hot gases that are not suitably enclosed and electrical apparatus that could arc or spark. For other types of potential sources of ignition refer to EN 1127–1. Annex K gives guidance on the potential ignition sources.

To determine whether a source of ignition is in a position where leaked refrigerant could flow or stagnate, EN 60079-10-1:2009 shall be used to estimate the size and extent of a potentially flammable zone.

Non Occupied Area – Extract Hoods

Carbon Dioxide

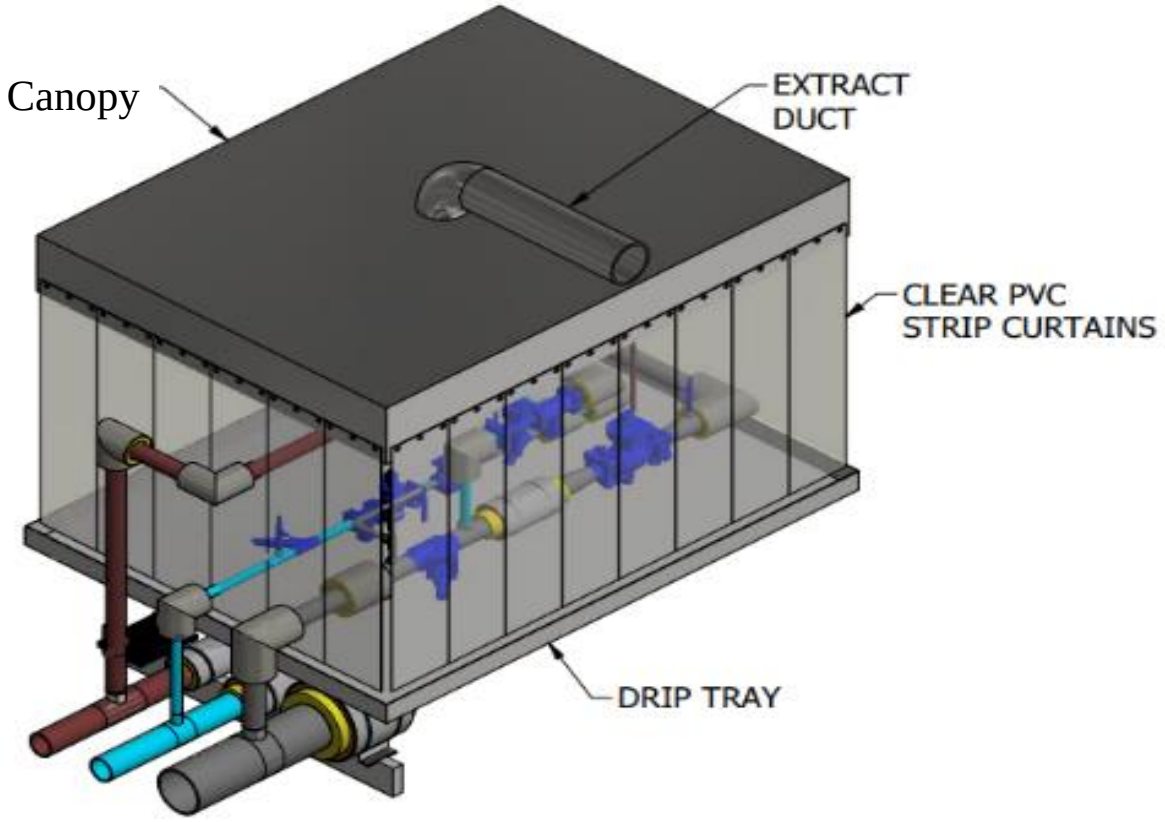
- Toxic

Ammonia

- For Normal Ventilation – Continuous to allow area to classified as Non-hazardous
- Toxic
- Skin Burns – Prevent liquid falling on insulated ceiling and onto persons

Extract Hoods for Ammonia

1. Canopy
2. Drip tray for liquid catchment.
3. Curtains to draw air across the valves and prevent air short circuiting.
4. ATEX fan to extract the ammonia
5. Gas sensor – Inline of air flow (as your share gas sensors between hoods, sensor level reduce by the quantity.)



Ammonia Extract Ventilation Discharge Points

IIAR-2 Recommend ventilation discharge upwards with a velocity of > 12.7m/s

Q&A

eurammon e. V. is always available as a sparring partner for questions on refrigeration with natural refrigerants.

Contact:

Dr. Alexander Schmeink| Lyoner Straße 18 | 60528 Frankfurt | Germany

Phone: +49 (0)69 6603-1277 | E-Mail: alexander.schmeink@eurammon.com

eurammon

refrigerants delivered by mother nature