



With contribution of
the LIFE programme
of the European Union

Referenties

Aanvullende informatie voor modules

De informatie in deze handleiding is gemaakt als **ondersteuning bij de modules**. Het REAL Alternatives 4 LIFE Blended Learning programma bevat verwijzingen naar de onderstaande referenties en behandelen de meest voorkomende alternatieve koelmiddelen. Bestudeer eerst de modules en bouw vervolgens voort op deze kennis door de referenties te verkennen. Deze zijn rechtstreeks toegankelijk via de online e-bibliotheek op www.realalternatives.eu/e-library of door de linken op de volgende pagina's te volgen.

www.realalternatives.eu



Module 1 – Kennismaking met alternatieve koelmiddelen

R744 (Koolstofdioxide, CO₂)

Voor gedetailleerde informatie over hoe de eigenschappen ervan de toepassing van R744 beïnvloeden.

- Danfoss Application Handbook “Food retail CO₂ refrigeration systems”
http://www.ra.danfoss.com/TechnicalInfo/Literature/Manuals/01/DKRCEPAR1A102_The%20Food%20Retail%20CO2%20application%20handbook_DILA.pdf
- Danfoss Application Handbook “CO₂ for industrial refrigeration”
<http://www.danfoss.com/BusinessAreas/RefrigerationAndAirConditioning/Refrigerants/CO2inIndustrialRefrigerationApplications.htm>
- Danfoss article “Transcritical refrigeration systems with CO₂”
<http://refrigerants.danfoss.com/co2/#/>
- Shecco Guide Natural Refrigerants 2014
<http://publication.shecco.com/publications/view/2014-guide-natural-refrigerants-europe>
- Institute of Refrigeration Safety Code for Carbon Dioxide <https://ior.org.uk/buy-documents?id=153&state=b>

R717 (Ammoniak, NH₃)

- Institute of Refrigeration Safety Code Ammonia <https://ior.org.uk/buy-documents?id=152&state=b>
- Institute of Refrigeration Ammonia Guidance notes <https://ior.org.uk/buy-documents?search=ammonia&id=48&state=b>
- International Institute of Ammonia Guide on Ammonia <https://ior.org.uk/buy-documents?search=ammonia&id=173&state=b>

R1234ze (HFO)

- Bitzer refrigerant Report 19 <https://www.bitzer.de/gb/en/downloads/>
- Honeywell leaflet: Solstice – a full range of ... refrigerant solutions
<https://www.honeywell-refrigerants.com/europe/product/solstice-yf-refrigerant/>

R290, R1270 en R600a (KWS)

- Institute of Refrigeration Safety Code for Flammable Refrigerants
<https://ior.org.uk/buy-documents?id=149&state=b>

Druk

- Danfoss Refrigerant Slider App
http://www.danfoss.com/north_america/businessareas/refrigeration+and+air+conditioning/product+selection+tools+details/koolappnew.htm
- Bitzer PT App <http://www.bitzer.de/eng/apps>
- Institute of Refrigeration Guidance note on Regulations related to Pressure Equipment and Systems <https://ior.org.uk/buy-documents?search=pressure&id=460&state=b>

Prestaties en werkomstandigheden

Informatie over de prestaties van koelmiddelen kan worden berekend met behulp van onderstaande gegevens

- Coolpack Software <http://en.ipu.dk/Indhold/refrigeration-and-energy-technology/coolpack.aspx>
- Bitzer selection software <http://www.bitzer.de/eng/Products-Service/BITZER-Software2>
- Bitzer refrigerant Report 19 <https://www.bitzer.de/gb/en/downloads/>
- Copeland Select 7 Software http://www.emersonclimate.com/europe/en-eu/resources/software_tools/Pages/product_selection_software.aspx

Impact op de omgeving

Factors used in a TEWI calculation vary significantly and are system specific. Industry guidance on calculating TEWI is available:

- British Refrigeration Association Guideline Method for Calculating TEWI <https://ior.org.uk/buy-documents?search=tewi&id=110&state=b>
- TEWI Calculation and Seasonal Efficiency tool from SKN <http://sdfab.se/downloads/program/TEWI/>

Andere relevante standaarden en regelgeving

Internationale standaarden aankopen: <http://www.iso.org/iso/store.htm>

- ISO 817:2005, Refrigerants -- Designation system, An unambiguous system for numbering refrigerants. It includes safety classifications (A1, A2, A3).

Om Europese normen in nationale talen te kopen, doorzoekt u de lijst CEN (European Committee for Standardization) ledenlijst op

<https://standards.cen.eu/dyn/www/f?p=CENWEB:5>

Om standaarden in het Engels te kopen van BSI

<http://shop.bsigroup.com/ProductDetail/?pid=00000000030249953>

- EN 378-1:2008 A2:2012, Refrigerating systems and heat pumps – Safety and environmental requirements, Basic requirements, definitions, classification and selection criteria, Practical limit and Maximum charge sizes
- EN 378-2:2008 A2:2012, Refrigerating systems and heat pumps – Safety and environmental requirements, Design, construction, testing, marking and documentation, High pressure protection Ventilated enclosures
- EN 378-3:2008, Refrigerating systems and heat pumps – Safety and environmental requirements, Installation site and personal protection, Machinery rooms, Refrigerant detectors
- EN 378-4:2008 A2:2012, Refrigerating systems and heat pumps – Safety and environmental requirements, Operation, maintenance, repair and recovery, Repairs to flammable refrigerant systems
- EN 60079-0:2009, Explosive atmospheres – Equipment – general requirements, Categorisation of flammable gases Classification of equipment and Zones
- EN 60079-10-1:2009, Explosive atmospheres – Classification of areas – explosive gas atmospheres, Zones and classification of equipment
- EN 60079-14:2008, Explosive atmospheres – Electrical installations design, selection and erection, Location of sources of ignition, Wiring
- EN 60079-15:2010, Explosive atmospheres – Equipment protection by type of protection “n”, Electrical equipment and enclosures for use in potentially flammable areas. Labelling of electrical equipment
- EN 60335-2-24:2010, Household & similar electrical appliances – Safety
- Part 2-24: Particular requirements for refrigerating appliances, ice-cream appliances & ice-makers, Systems with less than 150 g flammable refrigerant charge.

- EN 60335-2-40:2003, Household & similar electrical appliances – Particular requirements for electrical heat pumps, air conditioners and dehumidifiers, Design, application and servicing of AC systems using flammable refrigerants.
- EN 60335-2-89:2010, Household & similar electrical appliances – Safety. Part 2-89: Particular requirements for commercial refrigerating appliances with an incorporated or remote refrigerant condensing unit or compressor, Systems with less than 150 g flammable refrigerant charge, leak simulation testing for area classification.

UK Health and Safety Guidance in Engels is beschikbaar op <http://www.hse.gov.uk/>

- ADR, European Agreement concerning the International Carriage of Dangerous Goods by Road, Transport of flammable gases in systems or equipment by road
- RID, Regulations concerning the international carriage of dangerous goods by rail, Transport of flammable gases in systems or equipment by rail

Module 2, Veiligheid en risicobeheer

Module 3, Ontwerpverschillen bij gebruik van alternatieve koelmiddelen

CO₂ Transkritische werking

- Danfoss video, CO₂ phase change <http://www.danfoss.com/BusinessAreas/RefrigerationAndAirConditioning/EducationAndTraining/CO2+Phase+Changes.htm>
- NaReCO₂ manual Natural Refrigerant CO₂ http://www.khliminet.be/media/drupal/NaReCO2_manual_2009.pdf
- Danfoss, Transcritical refrigeration Systems with CO₂, how to design a small capacity system [http://files.danfoss.com/TechnicalInfo/Rapid/01/Article/TranscriticalArticle/PZ000F102_ARTICLE_Transcritical%20Refrigeration%20Systems%20with%20Carbon%20Dioxide%20\(CO2\).pdf](http://files.danfoss.com/TechnicalInfo/Rapid/01/Article/TranscriticalArticle/PZ000F102_ARTICLE_Transcritical%20Refrigeration%20Systems%20with%20Carbon%20Dioxide%20(CO2).pdf)
- Danfoss Food Retail CO₂ Refrigeration http://files.danfoss.com/TechnicalInfo/Dila/01/DKRCEPAR1A102_The%20Food%20Retail%20CO2%20application%20handbook_DILA.pdf
- Emerson Guide, Introduction to R744 Systems http://www.emersonclimate.com/en-us/Market_Solutions/By_Solutions/CO2_solutions/Documents/Commercial-CO2-Refrigeration-Systems-Guide-to-Subcritical-and-Transcritical-CO2-Applications.pdf
- Emerson Guide, R744 Commercial System Design http://www.emersonclimate.com/europe/en-eu/Resources/Software_Tools/The_Right_Balance_Calculator/systems/Pages/r744_booster_transcritical.aspx
- Emerson Guide, Introduction to Transcritical operation <https://emersonclimateconversations.com/2015/05/28/co2-as-a-refrigerant-introduction-to-transcritical-operation/>

Ontwerp van subkritische cascadesystemen

- Danfoss Cascade CO₂ Systems http://files.danfoss.com/technicalinfo/dila/01/RA8AB202_co2.pdf
- Emerson Guide, Co₂ Hybrid Cascade Systems http://www.emersonclimate.com/en-us/Market_Solutions/By_Solutions/CO2_solutions/Pages/SubcriticalCO2Cascade.aspx

Koelcapaciteit

- Refereer naar REAL Alternatives 4 LIFE Module 1 – Kennismaking met alternatieve koelmiddelen www.realalternatives.eu
- Emerson Right Balance Calculator http://www.emersonclimate.com/europe/en-eu/Resources/Software_Tools/The_Right_Balance_Calculator/Pages/Calculator.aspx

R717 (Ammoniak)

- Refereer naar REAL Alternatives 4 LIFE Module 1 – Kennismaking met alternatieve koelmiddelen
- Danfoss Refrigerant Slider App http://www.danfoss.com/north_america/businessareas/refrigeration+and+air+conditioning/product+selection+tools+details/koolappnew.htm
- Bitzer PT App <http://www.bitzer.de/eng/apps>

- IoR Safety Code of Practice for Refrigerating Systems utilizing Ammonia R717 <https://ior.org.uk/buy-documents?id=152&state=b>
- International Institute of Ammonia Refrigeration introduction <https://ior.org.uk/buy-documents?search=ammonia&id=173&state=b>
- IOR Ammonia Servicing Guidance Note 17 <https://ior.org.uk/buy-documents?id=247&state=b>

R32

- Refereer naar REAL Alternatives 4 LIFE Module 1 – Kennismaking met alternatieve koelmiddelen
- Danfoss Refrigerant Slider App http://www.danfoss.com/north_america/businessareas/refrigeration+and+air+conditioning/product+selection+tools+details/koolappnew.htm
- Bitzer PT App <http://www.bitzer.de/eng/apps>
- Institute of Refrigeration Safety Code for Flammable Refrigerants <https://ior.org.uk/buy-documents?id=149&state=b>
- Institute of Refrigeration Service Engineer Guidance on handling R32 <https://ior.org.uk/buy-documents?search=r32&id=394&state=b>

R1234ze

- Refereer naar REAL Alternatives 4 LIFE Module 1 – Kennismaking met alternatieve koelmiddelen
- Danfoss Refrigerant Slider App http://www.danfoss.com/north_america/businessareas/refrigeration+and+air+conditioning/product+selection+tools+details/koolappnew.htm
- Bitzer PT App <http://www.bitzer.de/eng/apps>
- Institute of Refrigeration Safety Code for Flammable Refrigerants <http://www.ior.org.uk/ROEW5TVYA>
- Case studies including Waitrose Trial http://www.unep.fr/ozonaction/information/mmcfiles/7686-e-Low_GWP_Alternatives_in_Commercial_Refrigeration.pdf

R600a (isobutaan)

- Refereer naar REAL Alternatives 4 LIFE Module 1 – Kennismaking met alternatieve koelmiddelen
- Danfoss Refrigerant Slider App http://www.danfoss.com/north_america/businessareas/refrigeration+and+air+conditioning/product+selection+tools+details/koolappnew.htm
- Bitzer PT App <http://www.bitzer.de/eng/apps>
- Institute of Refrigeration Safety Code for Flammable Refrigerants <https://ior.org.uk/buy-documents?id=149&state=b>
- British Refrigeration Association has published a Guide to Flammable Refrigerants <http://area-eur.be/publications/guide-flammable-refrigerants>

R290 en R1270 (Propanen en Propaan)

- Refereer naar REAL Alternatives 4 LIFE Module 1 – Kennismaking met alternatieve koelmiddelen
- Danfoss Refrigerant Slider App http://www.danfoss.com/north_america/businessareas/refrigeration+and+air+conditioning/product+selection+tools+details/koolappnew.htm
- Bitzer PT App <http://www.bitzer.de/eng/apps>

- Institute of Refrigeration Safety Code for Flammable Refrigerants
<https://ior.org.uk/buy-documents?id=149&state=b>
- British Refrigeration Association has published a Guide to Flammable Refrigerants
<http://area-eur.be/publications/guide-flammable-refrigerants>

Ontwerpproces voor toepassingen met brandbare koelmiddelen

- Institute of Refrigeration Safety Code for Flammable Refrigerants
<https://ior.org.uk/buy-documents?id=149&state=b>
- Guidelines on the safe use of hydrocarbon systems from GIZ
<http://www.giz.de/expertise/downloads/Fachexpertise/giz2010-en-guidelines-safe-use-of-hydrocarbon.pdf>
- AREA publishes a guide on equipment for flammable low GWP refrigerants (A2L and A3). <http://area-eur.be/publications/guide-equipment-low-gwp-refrigerants>

Module 4, Lekdichtheid en lekdetectie bij gebruik van alternatieve koelmiddelen

Lekdichtheid

- Refereer naar REAL Alternatives 4 LIFE Module 1 – Kennismaking met alternatieve koelmiddelen www.realalternatives.eu (Leakage Issues)

Vaak voorkomende lekken

- Real Zero Guide to 13 Common Leak Points <http://www.realalternatives.eu/real-skills-amp-real-zero-guide-to-common-leaks>

Druktesten

- Institute of Refrigeration Service Engineers' Section Guide on Pressurising installed systems with nitrogen to find leaks <http://www.realalternatives.eu/guide-to-pressurising-installed-systems-to-find-lea>
- Information on Trace-A-Gas for detection of smaller leaks <https://www.agas.co.uk/products-services/service-gases/products/trace-a-gas-tag/>

Lektestregimes

- F Gas Regulation 2014 and Leak testing requirements <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014R0517&from=EN>
- Asda Supermarket UK case study on leakage reduction through improved testing published by the Institute of Refrigeration <https://ior.org.uk/buy-documents?search=retail&id=333&state=b>

Veiligheid

- Eurammon Ammonia 06 Leakage monitoring at ammonia refrigeration plants <http://www.eurammon.com/information-materials/information-papers/leakage-monitoring-ammonia-refrigeration-plants-0>
- IOR Guidance Note 10, Working with Ammonia <http://www.realalternatives.eu/working-with-ammoni>
- IOR Guidance on Servicing Ammonia Systems <http://www.realalternatives.eu/app/images/documents/GN17-ammonia-servicing.pdf>

Vaste lekdetectiesystemen

- IOR Guidance Note on Fixed Refrigerant Detection Systems <http://www.realalternatives.eu/fixed-leak-detection-syste>

Indirect lektesten

- IOR Guidance Note on indirect leak checking <http://www.realalternatives.eu/indirect-leak-checking>

Module 5, Onderhoud en herstellingen bij systemen die gebruik maken van alternatieve koelmiddelen

Inleiding

- Refereer naar REAL Alternatives 4 LIFE Module 1 – Kennismaking met alternatieve koelmiddelen www.realalternatives.eu

Lektesten

- REAL Alternatives 4 LIFE Module 4 Leak Testing www.realalternatives.eu

Lekdetectie

- REAL Alternatives 4 LIFE Module 4 Leak Testing www.realalternatives.eu

R717 bijzonderheden

- REAL Alternatives 4 LIFE Module 4 Leak Testing www.realalternatives.eu
- IOR Guidance Note 10, Working with Ammonia
<http://www.realalternatives.eu/working-with-ammoni>
- IOR Guidance on Servicing Ammonia Systems
<http://www.realalternatives.eu/app/images/documents/GN17-ammonia-servicing.pdf>

Brandare koelmiddelen bijzonderheden

- BRA guide to servicing flammable refrigerants in a retail environment <http://area-eur.be/publications/service-hydrocarbon-refrigerant-equipment-retail-environment>

Module 6, Retrofitten met lage GWP-koelmiddelen

- Honeywell – Solstice guide: <http://www.honeywell-refrigerants.com/europe/product/solstice-1234ze/>
- Mexichem Fluor via Harp International Refrigerants: <http://www.harpintl.com/refrigerants.php>
- Chemours – Opteon Refrigerants: https://www.chemours.com/Refrigerants/en_GB/index.html
- Bitzer Refrigerant Report 19: https://www.bitzer.de/shared_media/documentation/a-501-19.pdf
- Cool Tool Software for evaluating of refrigerant options (free sample version available) : http://www.cooltool-software.com/index_english.htm

Module 7 – Wetgeving en standaarden

ISO Internationale standaarden

- ISO 817:2005, Refrigerants -- Designation system, An unambiguous system for numbering refrigerants. It includes safety classifications (A1, A2, A3). Available to purchase from the International Standards Association
<http://www.iso.org/iso/store.htm>

Europese standaarden

- EN378 Refrigerating systems and heat pumps – Safety and environmental requirements Available to purchase from European Standards Association
<http://standards.cen.eu/dyn/www/f?p=CENWEB:5:::NO:::> or in English from BSI
<http://shop.bsigroup.com/ProductDetail/?pid=00000000030249953>

Institute of Refrigeration Publicaties

- IOR Guide: References, Standards and Legislation www.ior.org.uk
- IOR Guidance Note 21 Pressure Equipment and Systems Guide to regulations
<https://ior.org.uk/buy-documents?id=460&state=b>
- IOR Refrigerant Safety Codes of Practice www.ior.org.uk

AREA Publicaties

- Covering Refrigerants and F Gas Regulations <http://area-eur.be/publications>

Europese Regelgeving en Richtlijnen

- Pressure Equipment Directive 97/23/EC
https://ec.europa.eu/growth/sectors/pressure-gas/pressure-equipment/directive_en
- The Fluorinated Greenhouse Gas Regulations (EC 842/2006) New F Gas Regulation 2014 and Leak testing requirements <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014R0517&from=EN>
- F Gas Regulation pursuant regulations on training, labelling etc
http://ec.europa.eu/enterprise/sectors/mechanical/atex/index_en.htm
- ATEX Directive http://ec.europa.eu/growth/sectors/mechanical-engineering/atex_en
- UK DSEAR <http://www.hse.gov.uk/fireandexplosion/dsear.htm> (UK checklist for ammonia systems <https://ior.org.uk/buy-documents?search=dsear&id=305&state=b>)

F Gas Regelgeving nuttige begeleiding

- F Gas Support documents (UK) <https://www.gov.uk/government/collections/eu-f-gas-regulation-guidance-for-users-producers-and-traders>
- EPEE (EU) <https://www.epeeglobal.org/refrigerants/>
- AREA Guidance
<http://area-eur.be/publications/area-app-calculator-fgas-and-en378>
<http://area-eur.be/publications/guide-new-f-gas-regulation>
<http://area-eur.be/publications/area-f-gas-logbook>
- ACRIB guidance on GWP values and leak testing
<http://www.acrib.org.uk/QO2RMV96056>

Module 8, Meten van de financiële en de ecologische impact van lekkende koelinstallaties

Impact op de omgeving

- Refereer naar REAL Alternatives 4 LIFE Module 1 – Kennismaking met alternatieve koelmiddelen
- **Real Skills Europe Guidance**
 - GN1: Guide to good leak testing
http://www.realalternatives.eu/app/images/documents/RSE_GN1_v2_110623.pdf
 - GN2: Illustrated guide to 13 common leaks
<http://www.realalternatives.eu/real-skills-amp-real-zero-guide-to-common-leaks>
 - GN3: Designing out leaks: design standards and practices
<http://www.realalternatives.eu/real-skills-amp-real-zero-guide-to-designing>
 - GN4: Leakage matters: the service and maintenance contractor's responsibility
<http://www.realalternatives.eu/real-skills-amp-real-zero-guide-to-service-and-maintenance-of-hfc-systems>
 - GN5: Leakage matters: the equipment owner's responsibility
<http://www.realalternatives.eu/real-skills-amp-real-zero-guide-for-equipment-owners-and-end-user>

Milieu-, kosten- en juridische aspecten van koudemiddellekkage

- Copeland Select 7.7 Software http://www.emersonclimate.com/europe/en-eu/resources/software_tools/Pages/product_selection_software.aspx

Efficiëntie

- Institute of Refrigeration Guides for equipment owners covering Efficiency of Refrigeration plant <https://ior.org.uk/buy-documents?search=plant&id=122&state=b>

Veiligheid

- Refereer naar REAL Alternatives 4 LIFE Module 1 – Kennismaking met alternatieve koelmiddelen www.realalternatives.eu
- Carbon Trust fact sheet CTL018, Energy and conversion factors available from http://www.carbontrust.co.uk/resource/conversion_factors/default.htm

Module 9, Hulpmiddelen en begeleiding bij een onderzoek ter plaatse

Sjabloonbrieven en -rapporten, Site Survey Opnamebladen en Excel-calculators om de kosten van lekkage van alle koelmiddelen te evalueren, kunnen worden gedownload van de projectwebsite www.realalternatives.eu/download

Gebruiksvoorwaarden

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