EUROPE

ATMO sphere

CAPACITIVE MEASUREMENT OF VOID FRACTION HBX-SENSOR

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HB Products A/S

- **Business:** Electronical sensors
- **Competence :** Industrial Refrigeration
- **Experience:** more than 30 years world wide represented by
- **Origin:** Denmark
- **Web:** www.hbproducts.dk

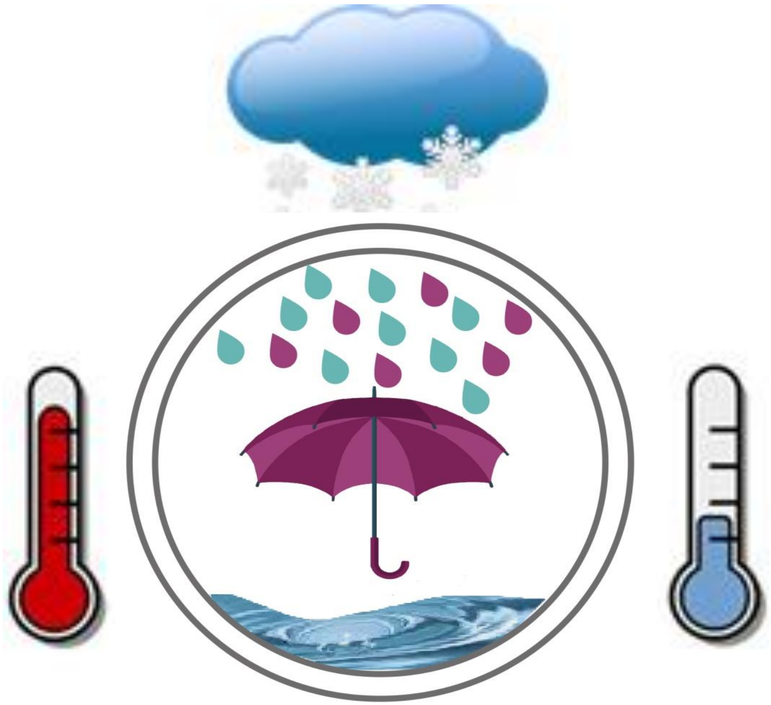
Why are we here?

Optimization with NEW SENSOR Technology

- **Increase evaporator efficiency**
- **Vapor quality based control**
- **Enable smart regulation**

Sensors Measuring and Controlling:

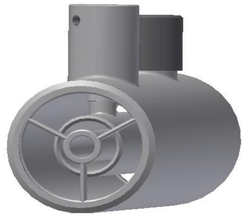
- ✓ The refrigerant phase as degree of dryness “X”
- ✓ Vapor Quality in the evaporator outlet without delay
- ✓ Reducing super heat and increasing suction pressure
- ✓ Reducing wet suction lines in pump circulation systems
- ✓ Optimizes riser function & evaporator performance especially at part load
- ✓ Low Charge design makes Ammonia more safe

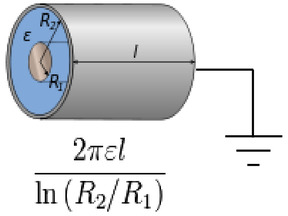


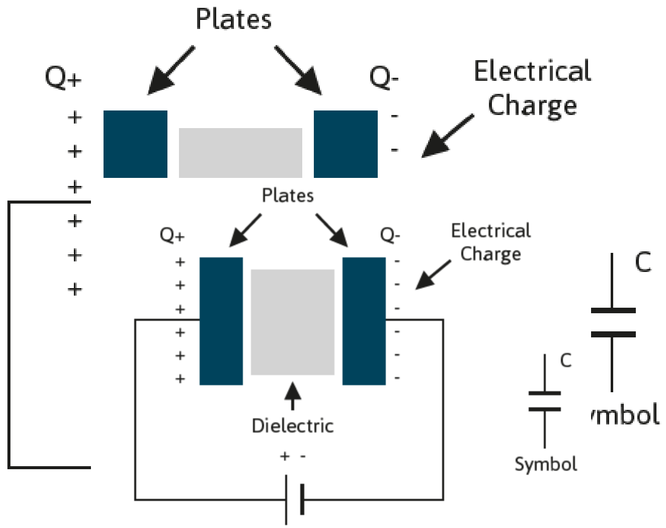
Low Carbon Technologies

How do we measure?

- **Measuring principle is capacitive. Measuring the dielectric properties of various media in pF*.**
- **Two electrodes inside the system perfo the measurement.**
- **Real time measurement.**
- **No moving parts.**







Material	Dielectric constant of 1 to 100
Water / brine	80
Ammonia	17
CO2	1.5 to 2.0
Oil type PAO, PEO Oil type PAG, POE	2.2 Mineral and synthetic types 3.5 Synthetic types
R134a	9.24
R22	6.35
R410A	7.78
R507	6.97
Ice	3.2
Air	1.0

Dielectric Constant at temperature 20°C/68°F

Two or more measuring electrodes/conductors measure the charges and change in electrical field/resistance depending on difference in the dielectric properties of various media. **Void fraction measurement** = the ratio between vapor and liquid amounts is measured instantaneously, i.e., without delay.

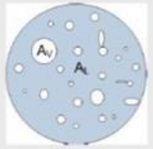
DX systems

- **Measuring the refrigerant phase as degree of dryness of the refrigerant as <u>VOID FRACTION</u>.**

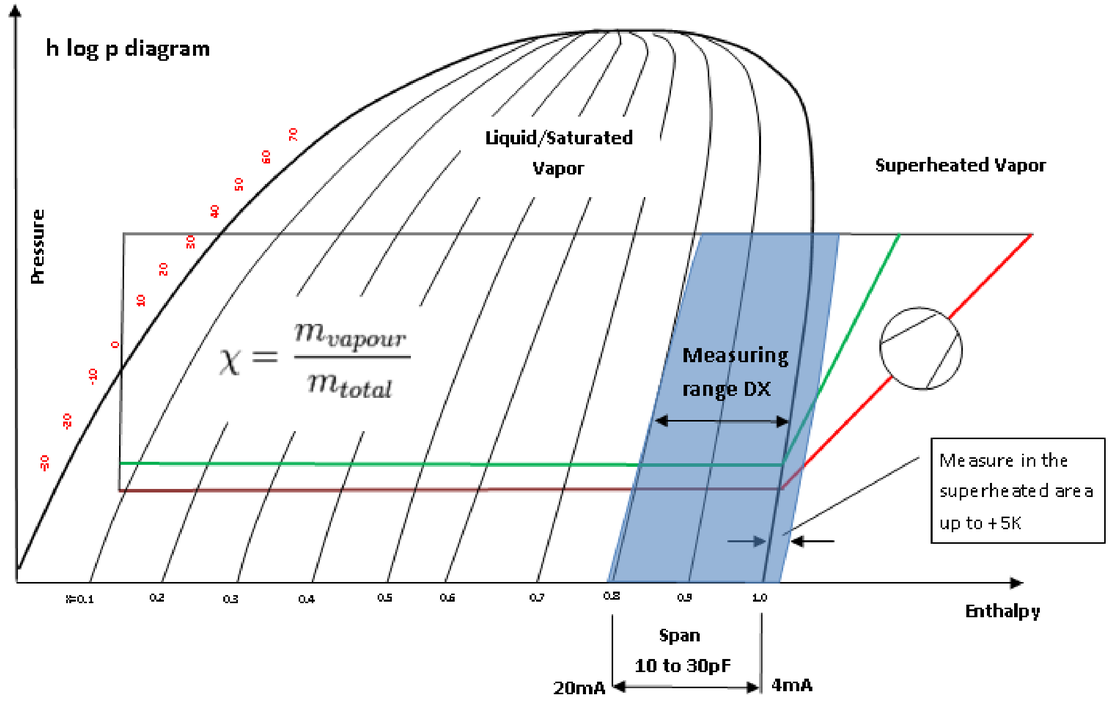
Void fraction

- Ratio of vapour cross section and total cross section

$$\varepsilon = \frac{A_V}{A_V + A_L}$$

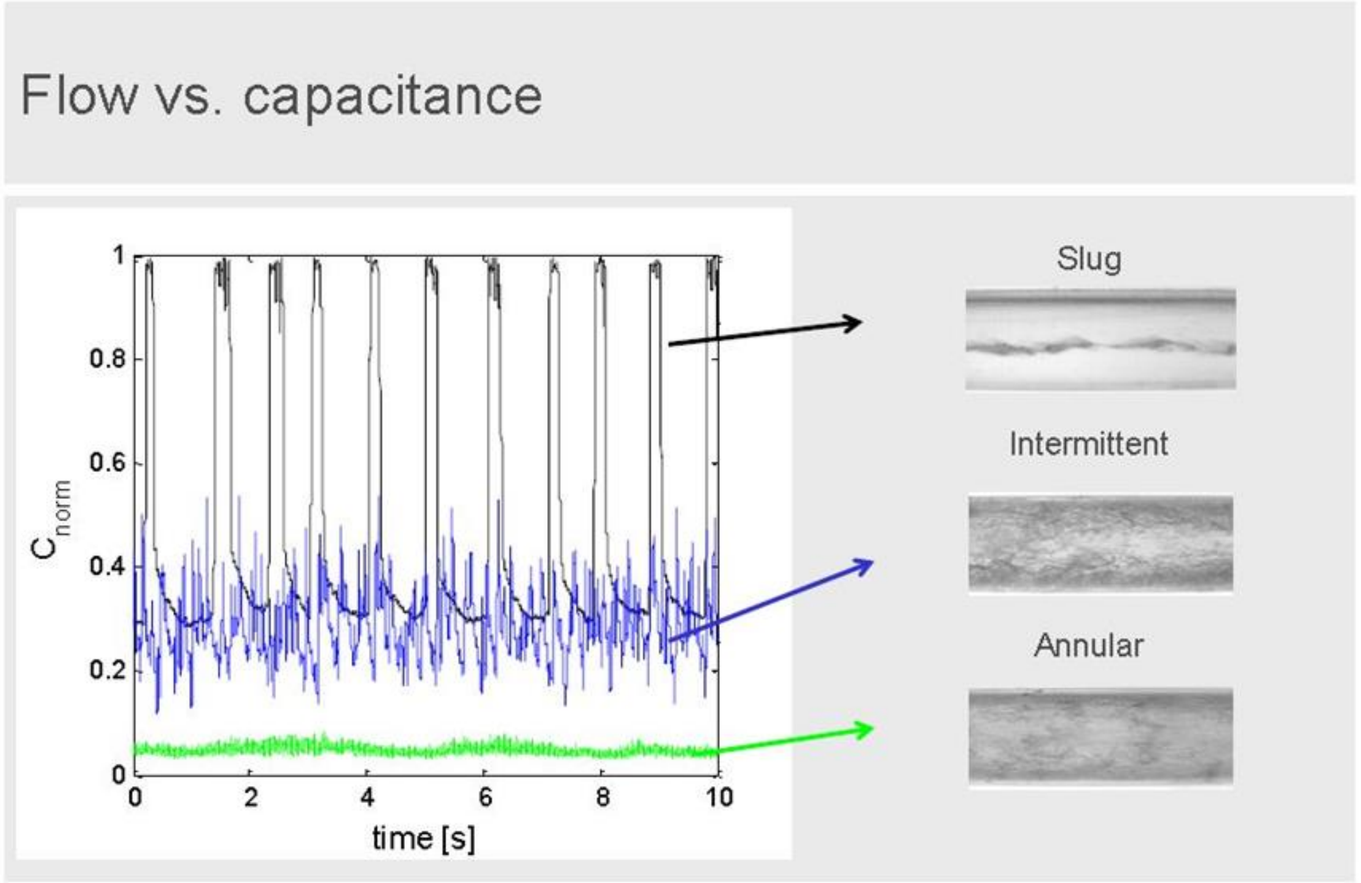


- **Safe use of ammonia DX control**
- **Water content is no barrier for the measurement (boiling point)**
- **Reduced charge of refrigerant**
- **Reduction of super heat**
- **Increased pressure**
- **Optimized system and reduce power consumption.**



Real Time Measuring

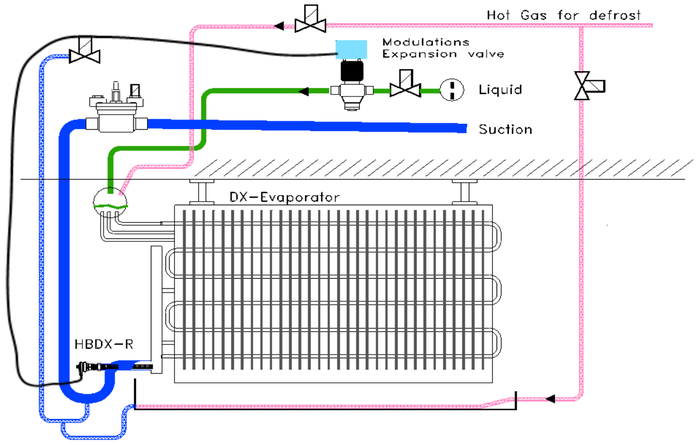
- Measuring the **VOID FRACTION**
- Reduce overfeed
- Minimize wet suction lines
- Reduce pressure drop in riser pipes
- Reduce charge of refrigerant
- Optimizing capacity
- Reduction of power consumption
- = “Optimum Vapour Control” (OVC)



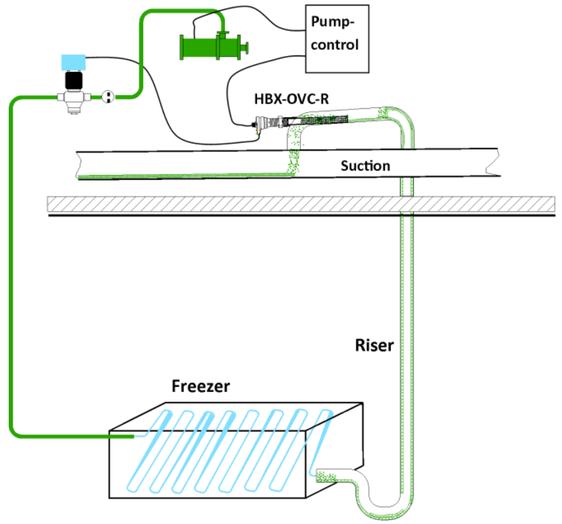
Source: Gent University

X Sensor Control

- **HBX-DX sensor replaces the superheat control and Thermostatic Expansion Valves on DX-evaporators.**



- **The HBX-OVC sensor control the circulation rate (overfeed).**
- **The sensor can regulate both a liquid-valve and the pump circulation rate.**



Saving potentials for NH3 systems

Superheat DX versus Vapour Quality based DX.

Energy conservation factor	Percentage impact [%]
Liquid injection control into the evaporators	10-15

Source: Scantec Refrigeration Technologies Pty. Ltd

Loss related to pressure drop in wet suction lines and riser pipes.

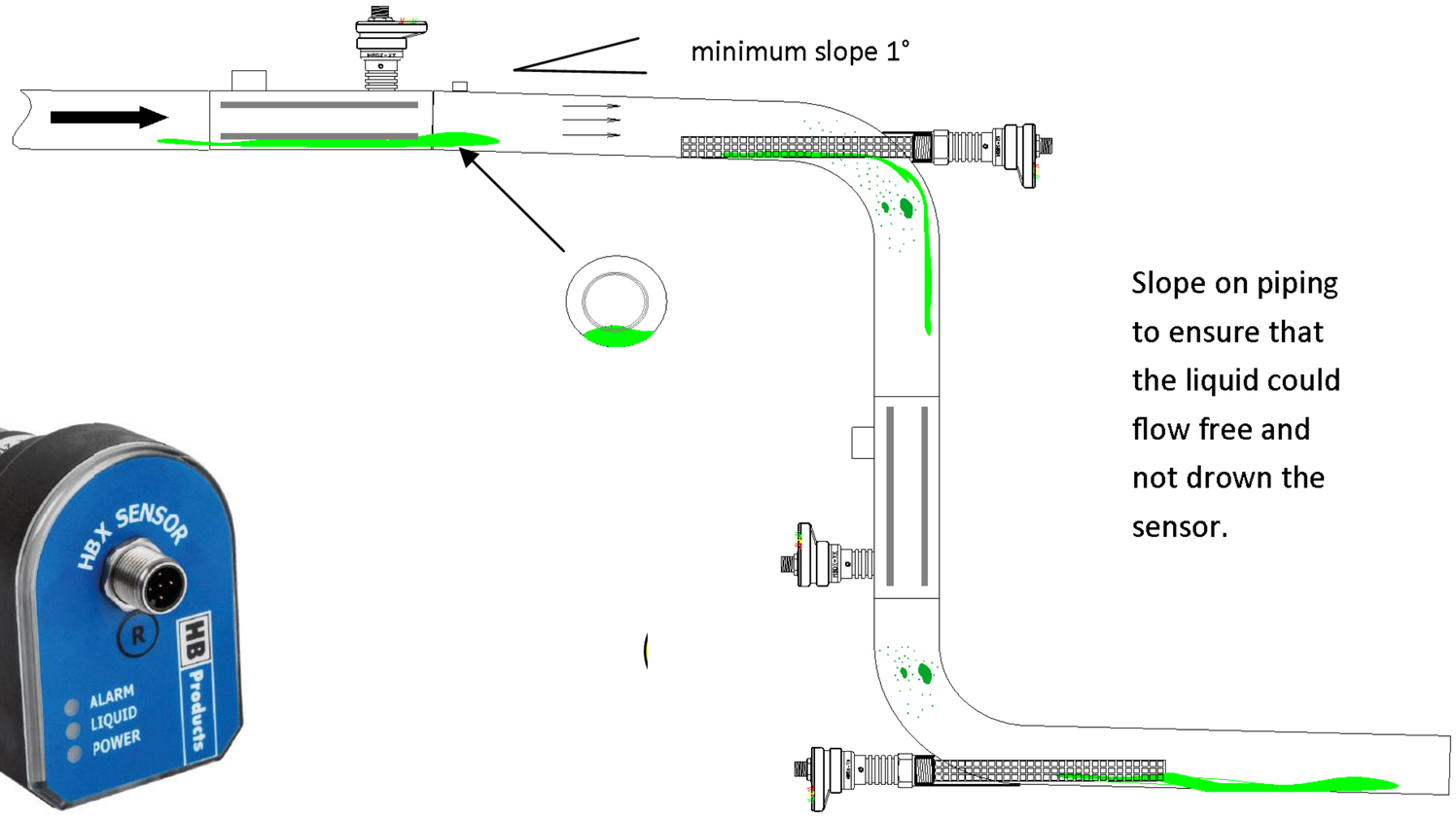
Numbers are related to a change of 1 ° K.

Temperature	Capacity	COP	Power
10°C	-3.6%	-5.0%	+5.2%
-0°C	-4.0%	-4.3%	+4.5%
-10°C	-4.4%	-3.8%	+4.0%
-20°C	-5.1%	-3.5%	+3.6%
-30°C	-5.5%	-3.9%	+4.1%
-40°C	-6.5%	-4.4%	+4.6%
-50°C	-7.3%	-5.0%	+5.2%

Source: Cool Partners

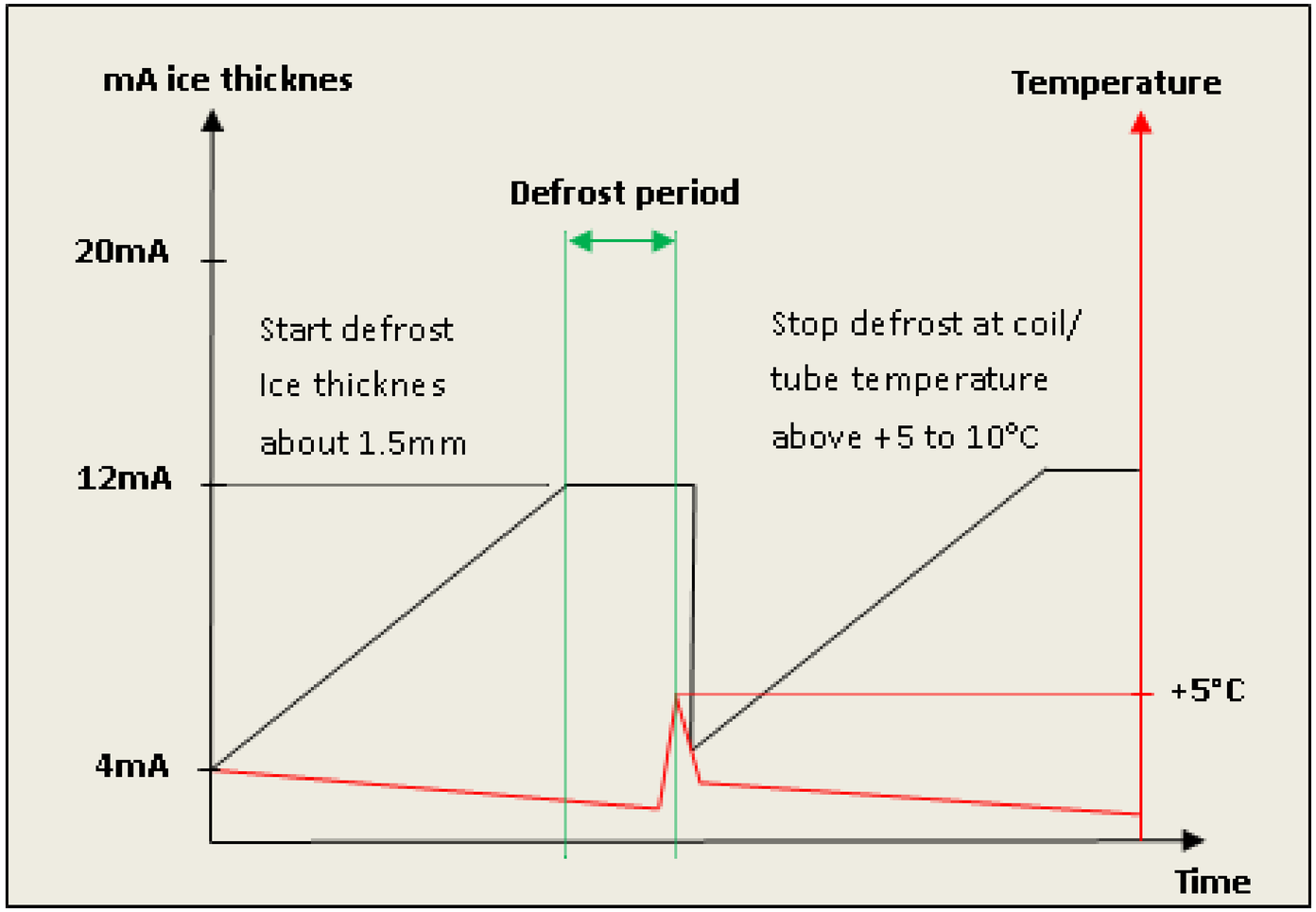
Suction pressure: 1°K decrease means approximately:

Mounting the “X” sensor



Slope on piping to ensure that the liquid could flow free and not drown the sensor.

Defrost on Demand



What now…

- Proven sensors both for DX and overfeed systems.
- Series production.
- Projects in operation globally.
- Continuing development approving the sensors for more refrigerants
  - Now also LT CO2 systems
- Evaporator manufacturers to design evaporators that can utilize this new technology (no superheat zone)
- Optimizing the liquid distribution systems for better part load operation
- Low charge system with high efficiency do benefit from using vapor quality sensors
- Huge potential with the HBX-Sensor technology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Thank you very much!