



VAPOR QUALITY



Evaporator control based on Vapor Quality

- Energy saving
- For all refrigerants
- Enables low charge systems



HB Products



What is a Vapor Quality Sensor

The Vapor Quality Sensor is a unique sensor able to measure the liquid content in the evaporator output. The sensor is used both in liquid overfeed systems as well as in direct expansion systems.

In liquid overfeed systems the sensor can be used for controlling the circulation ratio and hence reduce the energy consumption. Other benefits are increased cooling capacity and risers working during part load.

In DX systems the sensor replaces the superheat control and due to a faster control loop the superheat can be reduced to less than 1K. For large ammonia systems the sensor enables low charge systems with the same efficiency as in liquid overfeed systems.

The sensor is capacitive and detects liquid in the gas liquid mix leaving the evaporator. The measurement is instant and provides a much better feedback for the control than a temperature sensor used for superheat control. This allows for a lower superheat and smaller variation.

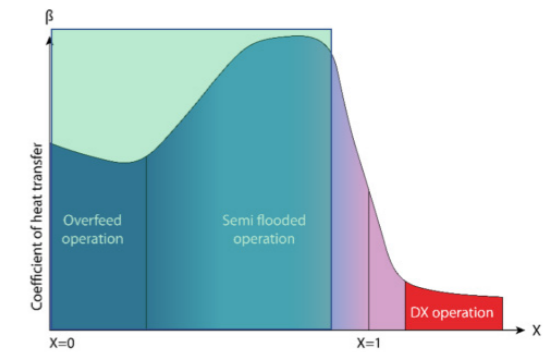
Liquid overfeed systems

Liquid overfeed systems can be both simple and efficient, but during part load the efficiency decrease and the capacity drop if the circulation is not controlled. Circulation of liquid increase the power consumption on the compressors and reduces the cooling capacity because the low heat transfer in evaporator.

To improve the energy efficiency of an liquid overfeed system the circulation ratio must be a low as possible while maintaining a good liquid distribution in the evaporator.

The Vapor Quality Sensor is installed just after the evaporator, and it can measure the circulation ratio. Then the pump capacity control or liquid valves can be used to reduce the liquid flow is based on the measurement - this maintains a constant circulation ratio.

The low circulation ratio secures the refrigerant is boiling which leads to maximum heat transfer and efficiency. The optimal heat transfer is obtained when the gas content is high, and boiling is intensive.

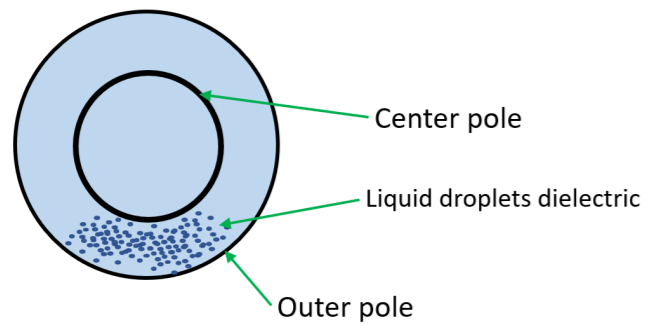


Optimal liquid overfeed system

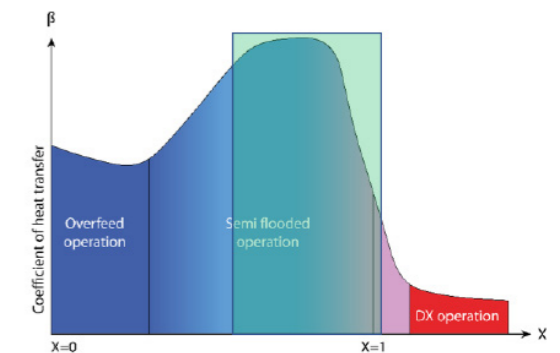
The circulation ratio must be low even during part load. The evaporator operates where it is most efficient

How does it work

The sensor consists of an inner and an outer pole. The gas with liquid flows through the sensor between the two poles and the liquid content is detected.



Vapor Quality installed on Air-cooled evaporator with distributor, Scantec Refrigeration



Uncontrolled liquid overfeed system

When the circulation ratio increases during part load the cooling capacity is reduced and the energy efficiency is reduced. The evaporator operates where it is inefficient.

Low Charge DX systems

Large low and ultra low charge DX systems are possible to control when using Vapor Quality control – even for ammonia plants.

Large DX systems based on superheat control are normally rather inefficient due to a superheat of more than 5K. By controlling based on Vapor Quality measurement the superheat can be reduced to less than 1K. This means large systems can be constructed as low charge DX systems with an efficiency better than conventional liquid overfeed systems.

Since 2015 more than 25 cold stores has been built in Australia alone using low charge ammonia systems. These cold stores have energy consumption below 20 kWh/m³/year and this number can not be reached by common liquid overfeed systems.

DX operation

In a DX system it is important to control the expansion valve optimally. If the gas is super heated the pressure loss grows rapidly and the cooling capacity drops. If the liquid is not evaporated completely the compressor can be damaged.

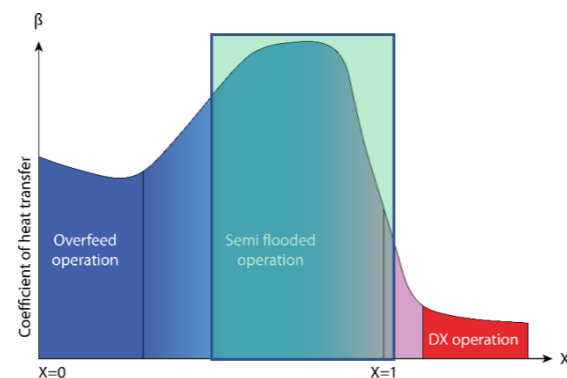
The Vapor Quality Sensor measures the liquid content in the gas and this signal is used for valve control. The measurement has no delay and makes it significantly better than the temperature measurement used for calculating the superheat. The instant measurement is reason for the faster and more accurate control which allows for a superheat less than 1K.

Optimal evaporator efficiency

When the liquid is boiling and evaporating rapidly the evaporator is most efficient. When the superheating is minimized the heat transfer is high and the capacity is highest.

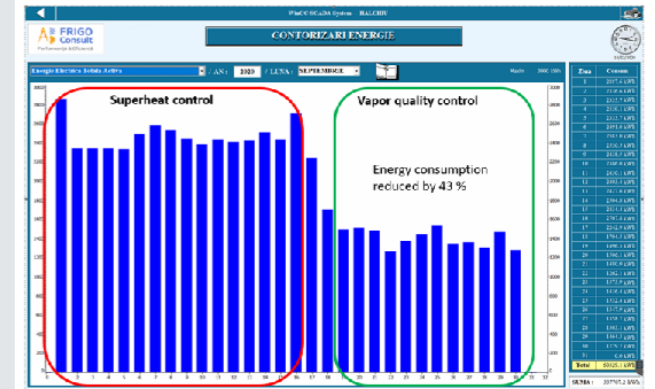
DX control

Vapor Quality control with less than 1K superheat means the evaporator operates where it is most efficient.



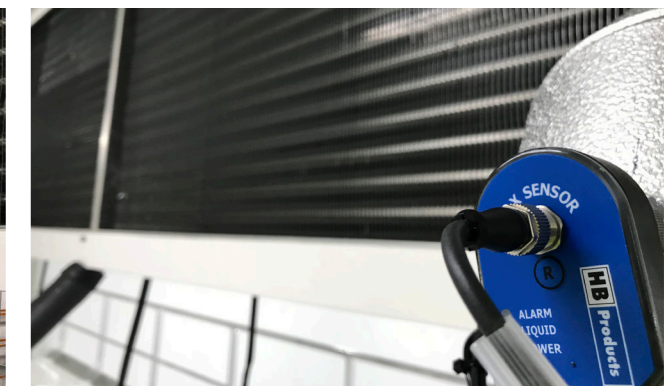
Case Stories

In Romania, a cold store was installed in the Summer of 2020 using DX ammonia. The system was started using superheat control and later the entire cold store changed to Vapor Quality control. The energy saving was 43% for the entire cold store with the same load.



On a small 100kW industrial chiller both superheat and Vapor Quality control was implemented. The chiller has a charge of 4 kg ammonia. The SEPR value (an EU seasonal COP) was reduced by 46% when operated with Vapor Quality control

In Australia several cold stores has replaced their HFC systems with new low charge DX ammonia systems. Results shown the energy reduction was up to 70%.



Vapor Quality installation, Australia.

Product range

The Vapor Quality Sensor is useable for all refrigerants, but some refrigerants require a more sensitive sensor compared to others.

We have different versions of the sensors suited for different systems and suction pipe sizes.



The Angle Rod Sensor is designed for smaller systems. The sensor has a high sensitivity and is suited for CO₂, HFC/O and HC's.







The Inline Sensor is the only version to be installed in a straight line. It is suited for all refrigerants.



The Strainer Housing Sensor can be used for both small and very large suction lines. The sensor is not suited for CO₂, propane and butane used in DX applications.



The Rod Style Sensor can be used for all refrigerants but must be installed in an elbow and be sitting at the bottom of a horizontal pipe.

Products	Installation location	Pipe size								
		Inch	1/4"	1/2"	1"	2"	4"	8"		12"
 Angle	Elbow			6-25 mm						CO ₂ HFC/HFO
 Inline	Straight, horizontal or vertical					25-100 mm				CO ₂ HFC/HFO Ammonia HC
 Strainer Housing	Elbow					20-300 mm				Ammonia HFC/HFO
 Rod Style	In an elbow after a horizontal pipe						50-200 mm			CO ₂ HFC/HFO Ammonia HC

Sensor output

All the sensors provide an analog 4-20 mA output linear to the liquid content of the gas. The measuring range is adjusted for the application and is as standard set for either DX or liquid overfeed application.

The sensor can be configured with a built-in controller for direct valve control. This means the valve is controlled from the sensor based on parameters in the sensor. The modification of the parameters must be done directly on the sensor by use of the HB Tool installed on a laptop.

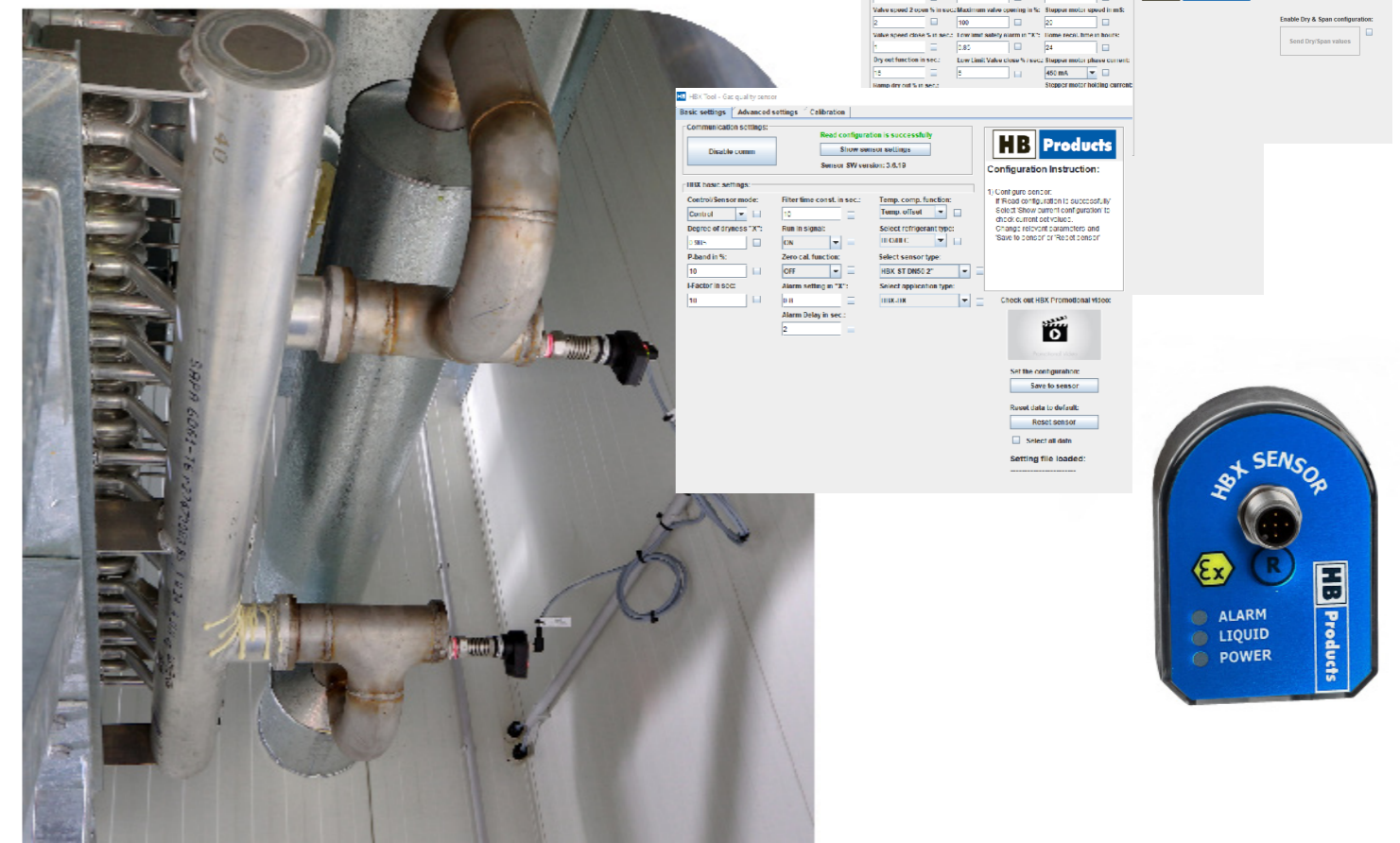
This feature can reduce the cabling work and save programming cost but requires easy access to the sensor.

Installation Sensor output

The sensor must be installed just after the evaporator. If the sensor is installed above the evaporator there will be a delay and a risk of liquid accumulation between the sensor and the evaporator.

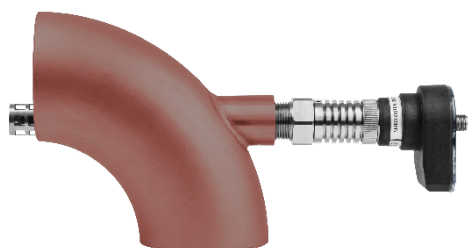
Sensor setup

The sensor is configured and calibrated using the HB Tool which can be downloaded for free. Find it on www.hbproducts.dk/en/hb-tool





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Other applications

Compressor protection

A simple version of the sensor is used for compressor protection. The sensor is used in larger systems to protect the compressor against liquid and for optimizing

Proven by the Industry

HB Products has made reliable and efficient sensors and switches for the refrigeration industry for over 25 years. We understand the importance of operational reliability and make our products with that requirement in mind. Which is why we consequently and thoroughly test new products on refrigeration systems or industrial applications before we add them to our product line. That way we can guarantee that your installation will run safely and efficiently. All our products are developed and made in Denmark to ensure the highest standards of quality. We use local components widely in the production and have our own in-house Q&A to ensure that every item comply to the highest industry standards.

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We are dedicated to supplying switches and sensors for industrial applications. We focus on refrigeration, but our sensors can be used in other industrial applications where robust and reliable sensors are called for.

Our sensors are developed and manufactured in Denmark. We mainly use local sourced parts to increase flexibility and reduce lead times. All sensors and switches comply with EU directives and have earned the CE marking.