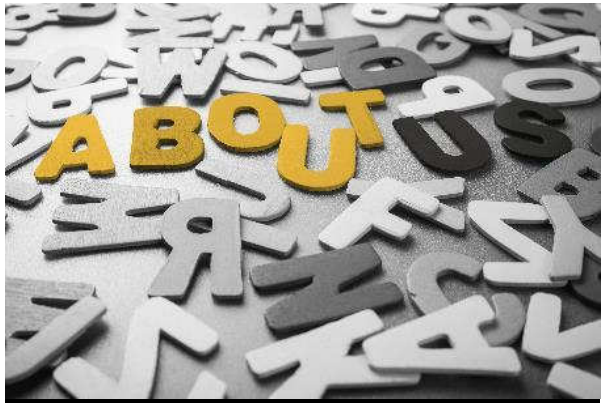
Sustainability in Refrigeration with Specialty Lubricants

KLÜBER LUBRICATION

a brand of FREUDENBERG

Agenda



1. Introduction

2. Refrigeration cycle basics

3. Refrigeration system elements

4. Refrigeration oils

5. Our solutions & benefits

KLÜBER LUBRICATION

Your expert for specialty lubricants

Founded by Theodor Klüber in 1929 in Munich, Germany

For over 90 years, we have been developing and producing innovative solutions that save energy and resources.

Industries:
Automotive | Cement | Chemical | Electrical | Food | Glass | Machines | Maritime | Metalworking | Mining | Oil and gas | Material handling | Pharmaceutical | Railways | Rubber and plastics | Steel | Paper | Power plants | Precision engineering | Textile | Wire drawing | Wind energy | Wood

Components:
Bearings | Chains | Conveyors | Compressors | Electrical switches | Gears | Linear guides | Screws | Valves and fittings | Wire
and many more ...

More than **2000 specialty lubricants** & **services**
Oils | greases | pastes | waxes | corrosion protection | drawing lubricants

Unique lab area with more than **110 test rigs.**
Extensive analytical section and customized test equipment

100 % compliance:
e.g. REACH, TSCA and many more

Thousands of **OEM recommendations**

Quality management: DIN EN ISO 9001, IATF 16949
Environmental protection and workplace safety:
ISO 14001, ISO 45001
Food industry: ISO 21469, NSF H1, Halal, Kosher

We are global and yet personal

€ 950 million sales in 2023

240 employees in research and development

Over **2,500 employees**, 1,260 of them in sales

A part of the **Freudenberg group** since **1966**.
As a **global technology company**, Freudenberg has been developing groundbreaking innovations for **170 years**.

52,241 employees in around 60 countries,
annual sales 2023: approx. € 12 billion

a brand of FREUDENBERG

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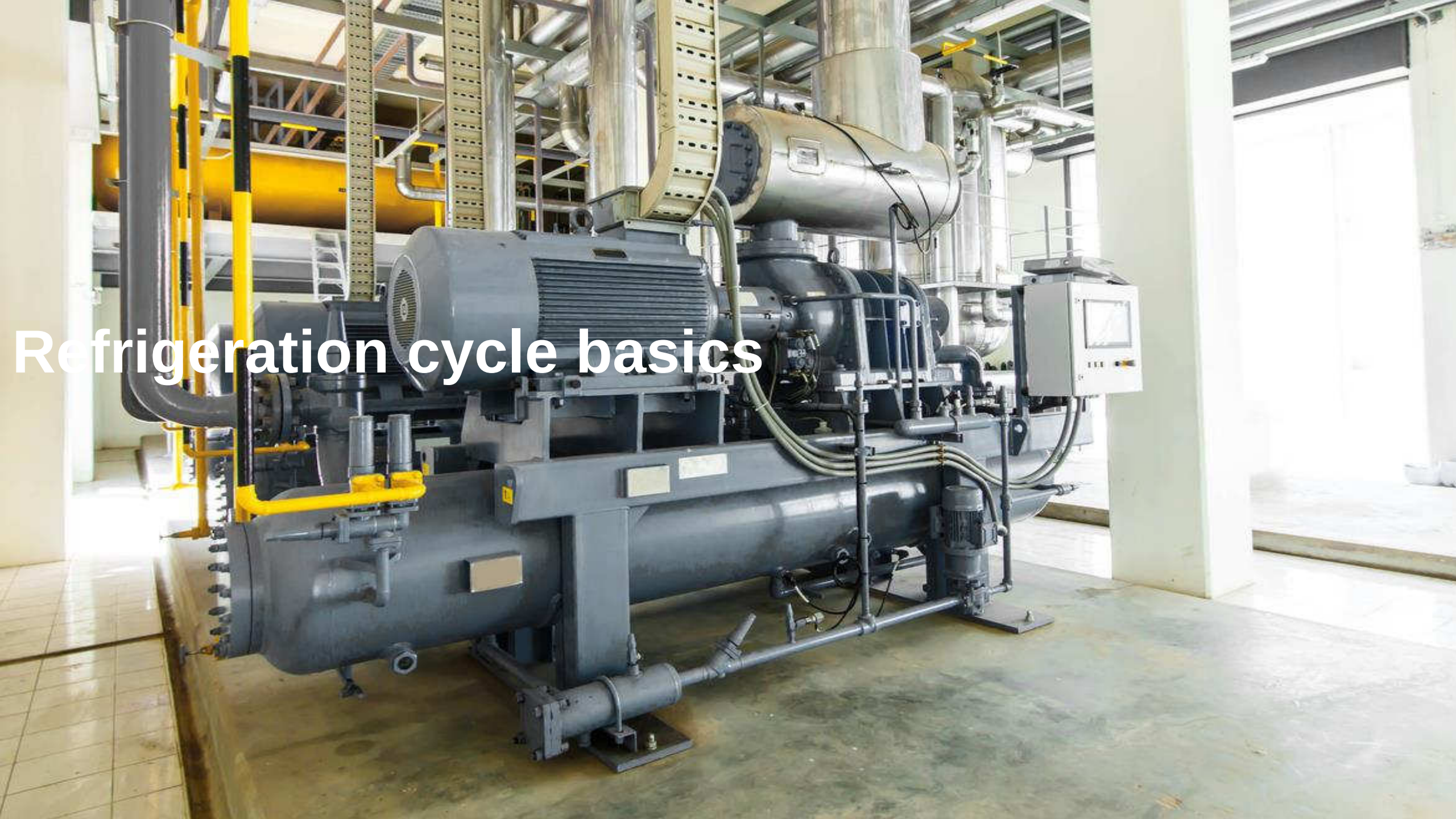
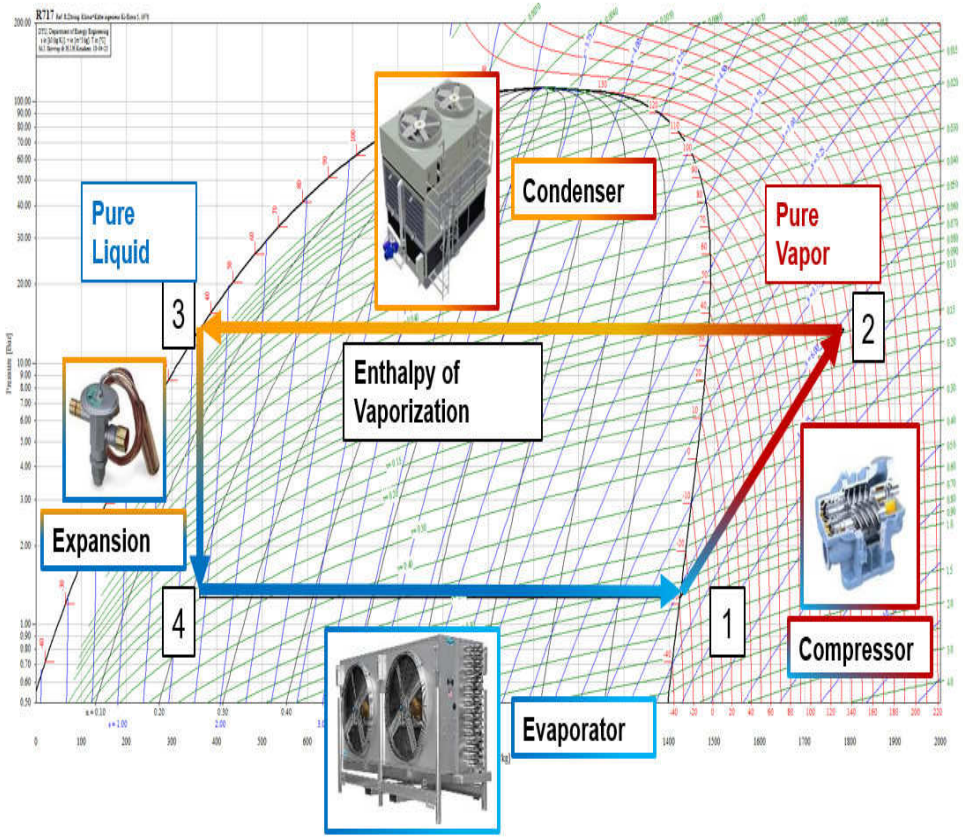


Refrigeration cycle basics

Short introduction to refrigeration cycle



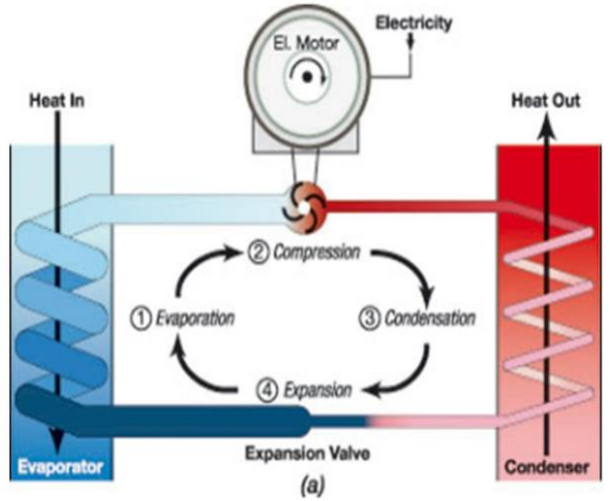
The basic mentality of the refrigeration is transferring the heat from one point (cold room, freezer tunnel,…) to other place (outdoors open space).

There are two places where heat is transferred!

1 **EVAPORATORS**: the liquid refrigerant catches heat from the point that we want to cool down. This heat is used for its evaporation.

2 **CONDERSERS**: Later, the compressed refrigerant gas leaves heat to the surrounding (atmosphere), this heat losing let the refrigerant became liquid.

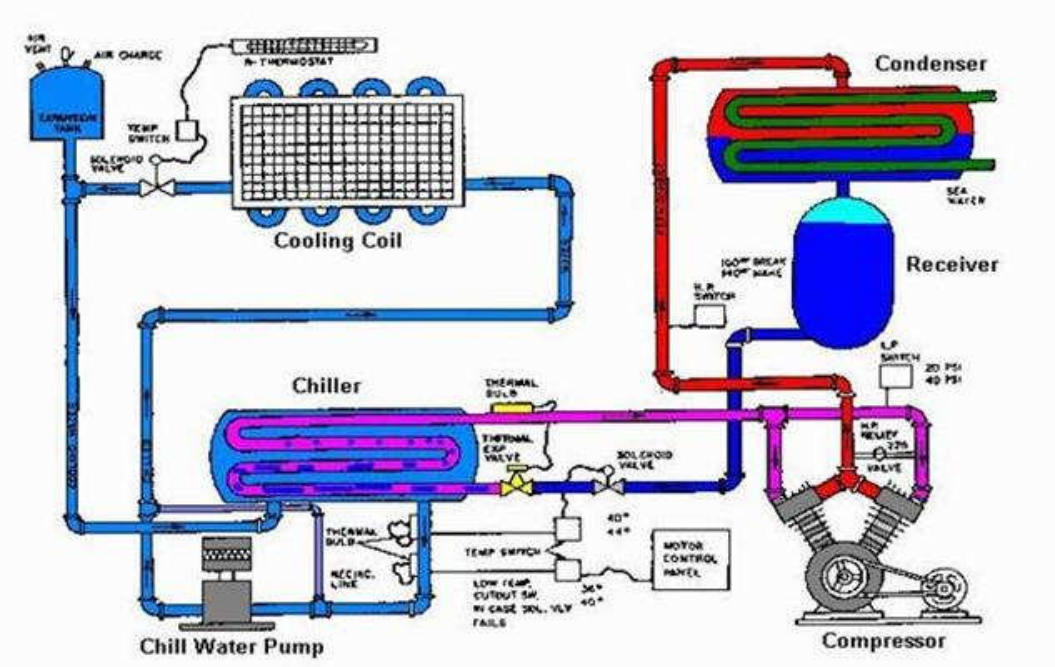
Thermodynamically pressure has direct relationship with temperature, and the combination of both would determinate if a refrigerant remains liquid or vapor.
There are other key components: Compressor and Expansion Valve to provide pressure need for required temperatures.
There will be compressors to fix pressure at high values.
There will be expansion valve devices that can fix pressure values at low pressure values.



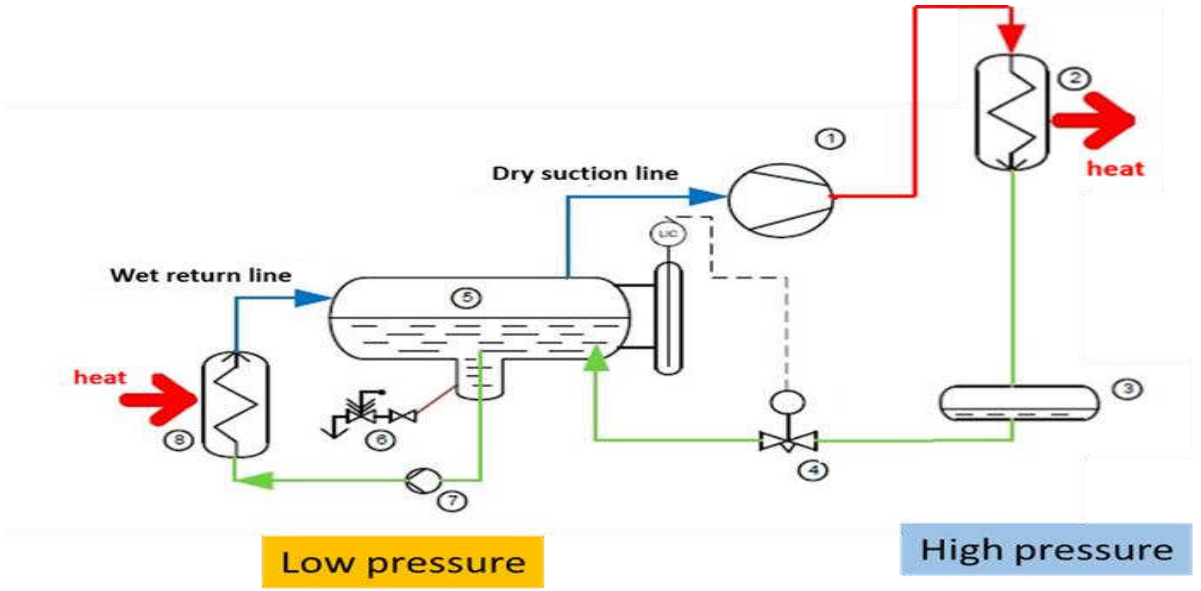
Type of refrigerating installations

– There are two main types of refrigerating installations: Dry Expansion Systems (DX) and Flooded Evaporator Systems. Each type has its own advantages and considerations, regarding oil selection and system efficiency.

Dry expansion systems (DX)



Flooded evaporator systems

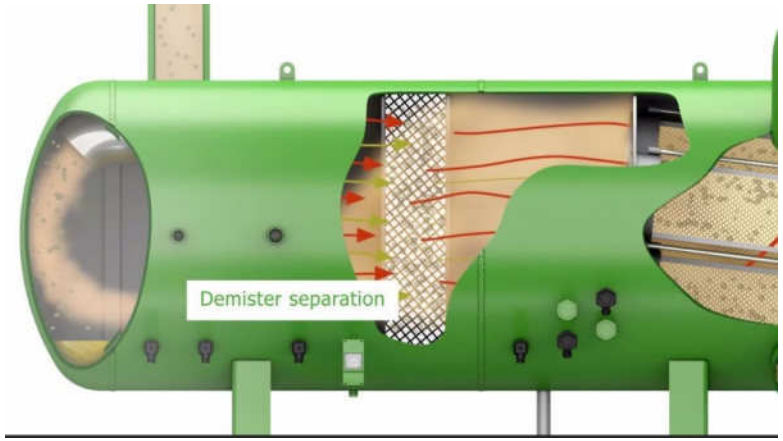


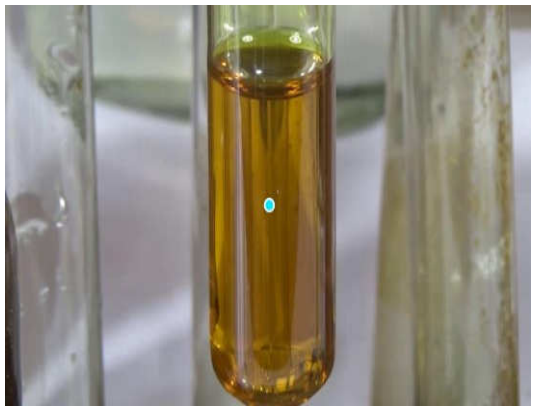
For industrial applications, and very related to
food industry. Above 95% of the installations are NH3 & CO2 FLOODED.

Refrigeration system elements

Basic refrigerating circuit elements:
1. Compressor pack: Oil separator

Oil separator tank





As cleaner is the installation, with less residues, sludge,.. It will report a higher oil retention at the compressor pack

It could be designed vertical or horizontal.

For DX systems, oil carry over is not so important. So, oil separators use to be smaller and simpler.

At FLOODED SYSTEMS they use to be bigger and more complex (with COALESCENCE filters to retain oil aerosol drops)

There are 3 parts: One dynamical separation based on speed loosing, some metal net to retain oil big drops and finally a filter coalescence catching.

Basic refrigerating circuit elements:
1. Compressor pack: Oil separator

In DX SYSTEMS; if evaporators are not reaching lowest temperature and evidenced oil accumulation.

In FLOODED SYSTEMS; if compressor is frequently asking LOW OIL LEVEL and must TOP-UP frequently.

Major reasons why OIL SEPARATOR is not retaining oil:

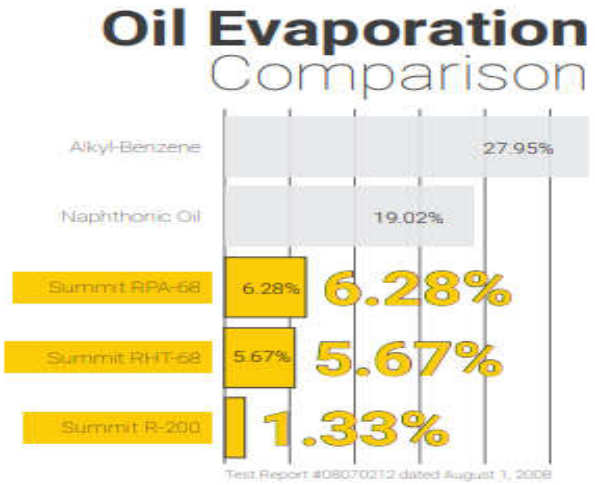
- Oil is aged and dirty. Provokes high stable foam (with refrigerant) that goes trough the separator. Also bad condition of coalescence filters.

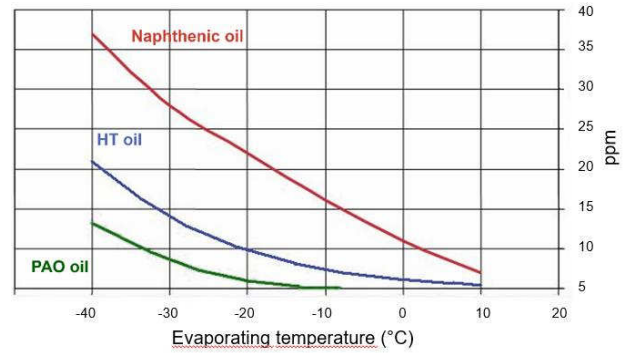
- Oil is evaporating much, especially the light fractions, and separator can not retain any vapor phase.

- High oil dilution, that decrease the density and size of the oil drops that became lighter

- Inadequate gas speed of the refrigerant inside the oil separator.

Noack volatility (*ASTM D 6375)*
Evaporation loss , 150˚ C/3h





Basic refrigerating circuit elements:
2. Condenser

Is a cooler, where the system dissipates the heat of the refrigerant to a certain temperature where its pressure is at the equilibria GAS-LIQUID

At the end of the condenser, all the gas should be liquid! And even subcooled.

Usually, those equipment are on the roof of the factories to evacuate the head to the outside air.

The final temperature is always higher tan the outside air temperature.

No need of Lubrication of internal points. Just some cross selling opportunities for Lubrication of bearings (funs and electric motors)

Basic refrigerating circuit elements:
3. Expansion valve

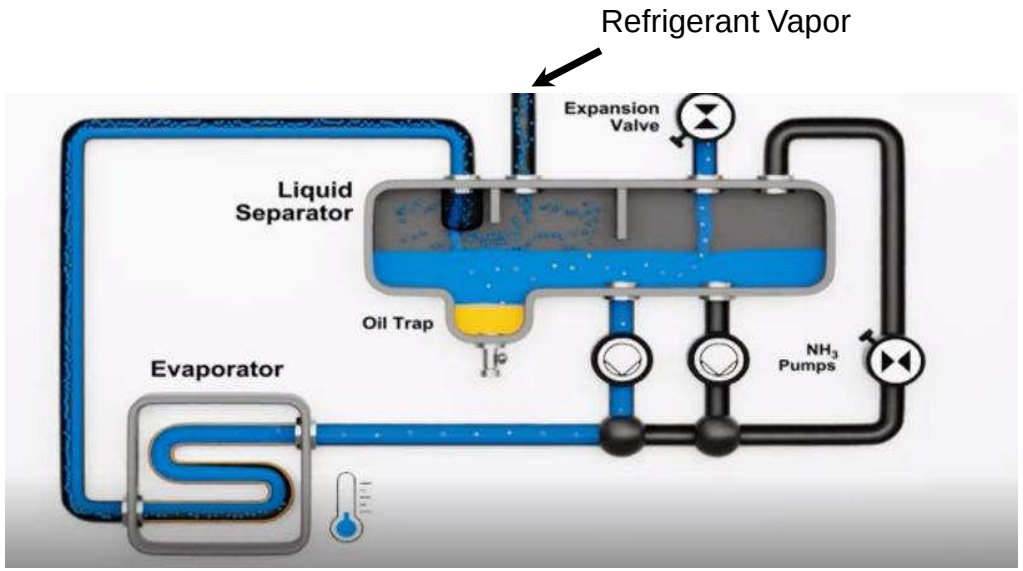
It is a design device that indirectly controls the cool temperature that we want to work!

The liquid refrigerant pipe pass form a small diameter to a higher one, so the pressure gets lower. The liquid refrigerant is not any longer in the comfort zone (G-L equilibria) and tries to evaporate to come back to stability, for evaporating needs HEAD!!

This device is always found just previous to the liquid refrigerant tank used for cooling. It will be so many expansion valves as many different tanks at different pressure/temperatures.

No need of Lubrication of internal points. Just some cross selling opportunities for Lubrication of bearings (funs and electric motors)

Basic refrigerating circuit elements:
4. Separator Tank



It is tank where refrigerant is accumulated in gas and liquid phases and stays ready for being used at the evaporators.

The liquid comes from the condenser trough the expansion valves.

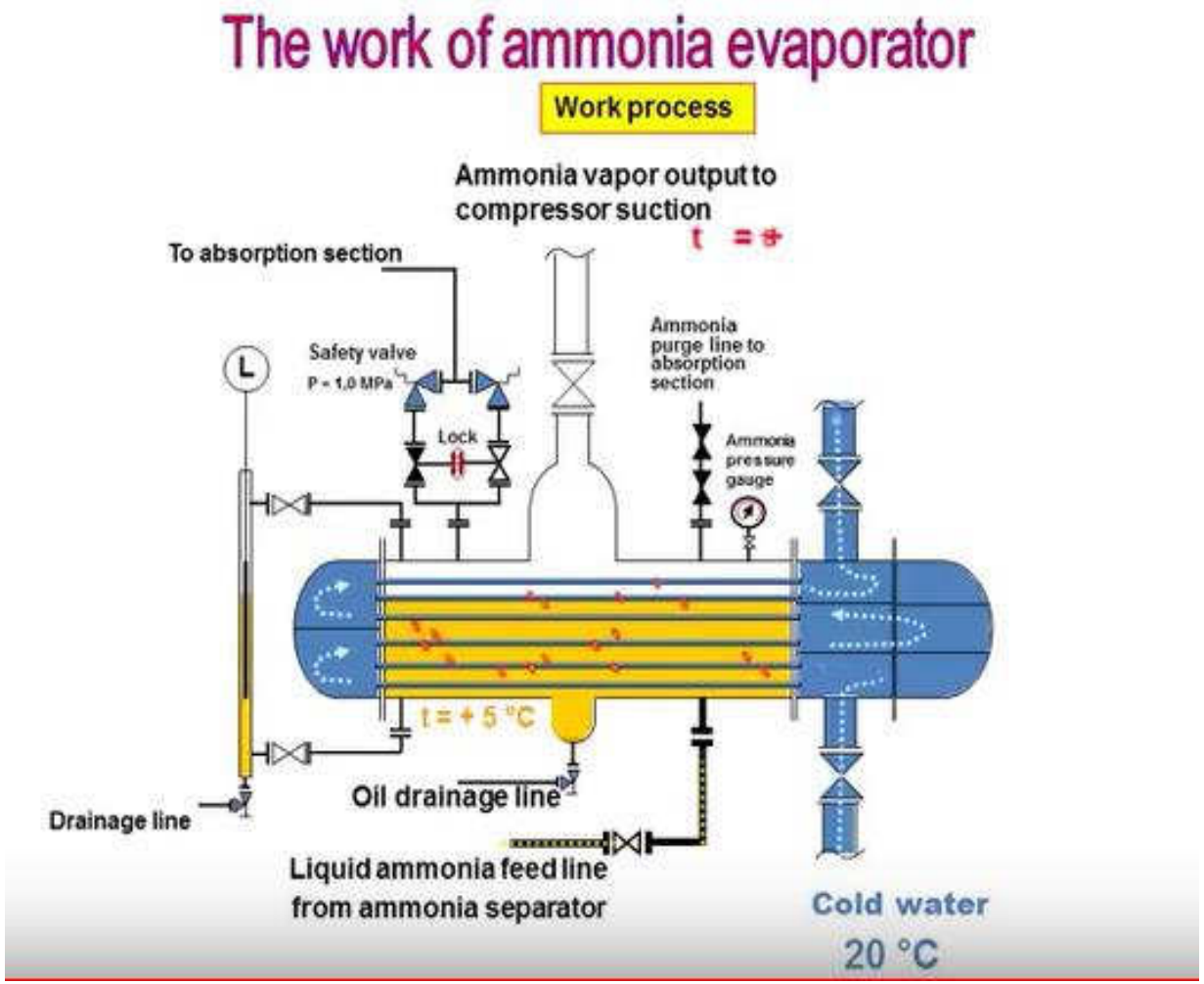
The liquid goes (by gravity or pumped) to the evaporator, where pass to a gas phase. If level of liquid go down, the compressor will run to produce more liquid by gas suction from this point.

It can arrive liquid refrigerant with some oil presence. The compressor will try to catch pure gas. So, oil will accumulate at flooded systems.

If the oil separates from the refrigerant gas and collapses to the bottom, can be recovered out of the system.

No need of Lubrication of internal points.

Basic refrigerating circuit elements
5. Evaporator



Use to be a multi-tube system, where at one side there is the refrigerant that evaporates, an at the other side other fluid that we want to cool down

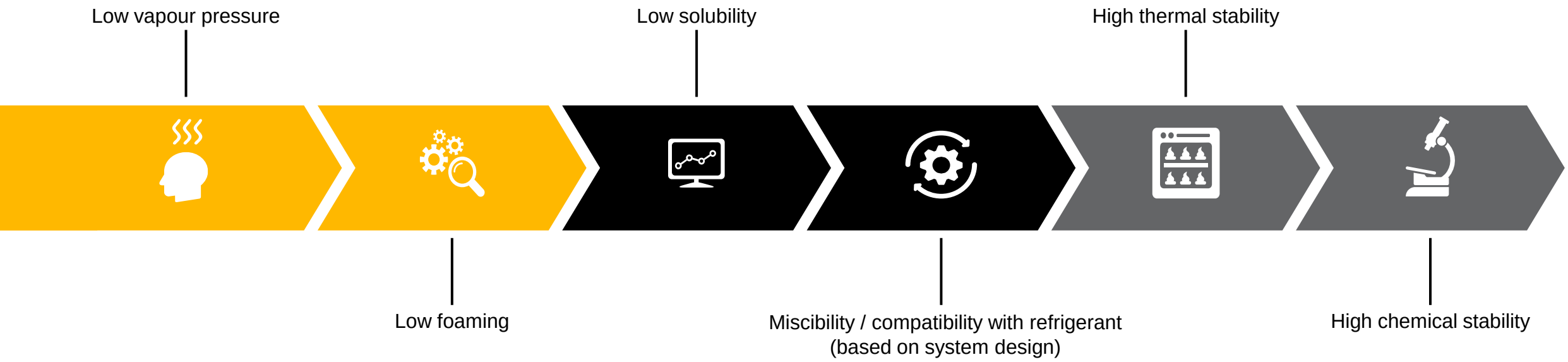
As cleaner and oil free conditions we have at the evaporators, will get higher energy efficiency (cooling)

At flooded systems, just up to 25% of the recirculated liquid refrigerant will evaporate (ratio 4 :1). As high is the presence of liquid will report higher intercooling performance.

Refrigeration oils

Refrigeration lubricant requirements

Product attributes



Solubility
Ability of a gas to dissolve into a liquid.

Miscibility
Ability of a gas or liquid to mix uniformly in another gas or liquid. Miscibility ensures better oil return to the compressor.

Refrigeration lubricant requirements

How is the efficiency of a refrigerating plant affected by the refrigeration oil?

Thermally stable oil and low vapour pressure reduces the oil vapour content in the refrigerant and oil consumption

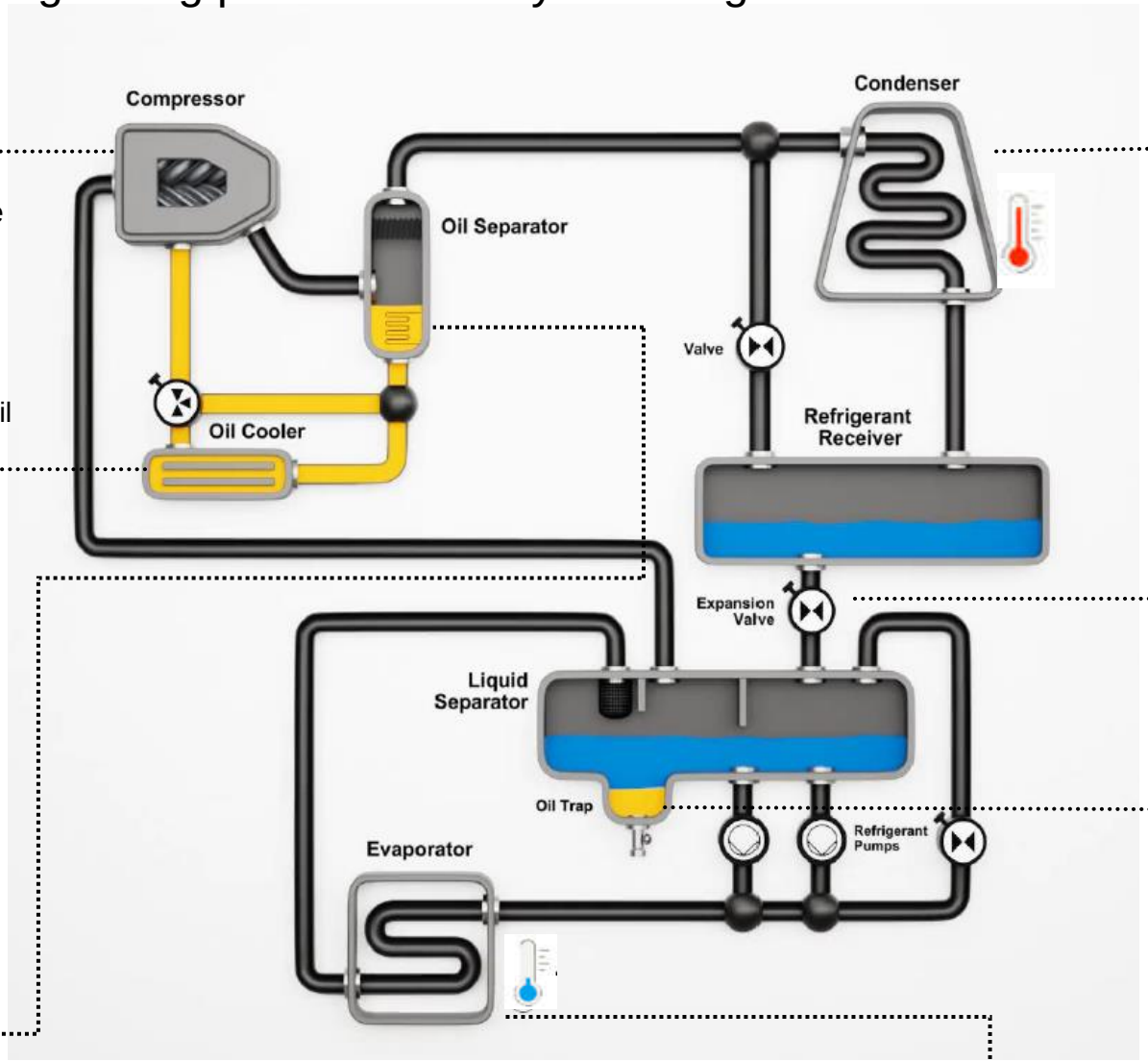
A good VI of the oil reduces the backflow effect at the rotors and increases volumetric efficiency

Reduced foaming tendency decreases the oil carryover of the compressor

Good heating capacity of the oil enables reliable plant operation

Minimal solubility and high degree of separation of oil from the refrigerant reduce the oil content of the refrigeration cycle

Reduced foaming tendency improves the degree of separation of the refrigerant/oil mixture



Chemically stable oil reduces residue formation in the refrigerating plant.

Highly refined refrigeration oils with a tailored pour point prevent paraffin deposits and functional defects

Chemically stable oil enables reliable reusability with oil traps featuring automatic oil return.

Good cold-flow behaviour facilitates oil return

A tailored pour point enables trouble-free operation of the evaporator

Oil: Aerosols, Vapour, Liquid

NH_3: Vapour, Liquid

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What can happen when you use a poor-quality lubricant?

You may incur extra operational expenses

Problems with poor-quality refrigeration compressor oils

Poor oxidation stability

Poor wear protection

Poor acid, sludge, varnish prevention

Poor foam control

High oil carry over

Poor heat-transfer capabilities

High energy consumption

Expensive

Oil replacements

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Product portfolio of refrigerant oils from Klüber Lubrication

KL product overview for possible savings potentials

Product	OEM Approval	NSF	Application	V_{40}	Oil-based	Refrigerant
Klüber Summit RHT 68 Klüber Summit RHT 100	**GEA Mycom**		Paraffin-based mineral oil especially for ammonia refrigeration compressors	68 mm²/s 100 mm²/s	MIN	R717 (Ammonia)
Klüber Summit RHT FG 68	**GEA**	**H1**	Refrigeration oil especially for ammonia refrigeration compressors in the food industry	68 mm²/s	MIN	R717 (Ammonia)
Klüber Summit RSB 68			Semi-synthetic refrigeration compressor oil for NH3 refrigeration systems and heat pumps	68 mm²/s	PAO/MIN	R717 (Ammonia)
Klüber Summit R 100 Klüber Summit R 150 Klüber Summit R 200 Klüber Summit R 300	**GEA Mycom**	**H1**	Synthetic compressor oils especially for highly stressed ammonia and CO2 refrigeration compressors	32 mm²/s 46 mm²/s 68 mm²/s 105 mm²/s	PAO	Ammonia, CO2
Klüber Summit RPS 52	**Mycom**	**H1**	PAG-based synthetic refrigeration compressor oil for dry evaporation ammonia chillers	52 mm²/s	PG	Ammonia (DX system)
Klüber Summit RPA 68			Synthetic refrigeration compressor oil especially for highly stressed ammonia refrigeration compressors	60 mm²/s	PAO/AB	Ammonia, CFCs, HCFCs
Klüber Summit RPE 32 Klüber Summit RPE 68 Klüber Summit RPE 170			Synthetic refrigeration compressor oils for refrigerants based on FKM and HFKM	32 mm²/s 68 mm²/s 163 mm²/s	POE	CFCs, HCFCs, HFCs,HFOs
Klüber Summit RAB 68			Synthetic refrigeration compressor oil with very good cleaning and dissolving effect for ammonia refrigeration compressors. Acts as a "sealing queuing agent".	54 mm²/s	AB	Ammonia, CFCs, HCFCs

Our solutions & benefits

Klüber Lubrication solutions for
refrigerating compressors

Refrigeration compressors

Overview of benefits

Refrigeration compressors

Save your money, save our planet

Less costs with lubricant

Energy saving

Klüber's oil lifetime more than 40,000 hours

Less maintenance costs with parts (filters, bearings, coalescents)

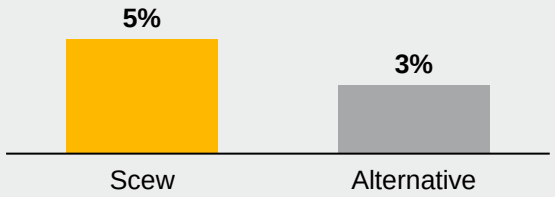
Average reduction of energy consumption of 6%

Reduction in working temperature up 10°C

Mineral oil	– High level of oil carryover/purged – High oil consumption by top-up – Frequent exchange of oil-soiled separators due to high carryover – Oil lifetime up to 5,000 hours

Switch mineral oil base to KLÜBER SUMMIT

Payback within 6 months



Energy savings achieved with Klüber Summit in different kinds of compressors

Kluber Energy provide complete transparency regarding savings and energy consumption

Energy saving helps for the reduction of emissions

Health & safety for the users, less exposure to risks

Less transport and oil discharge

Reduction of water consumption and contamination

Switch to Klüber-Summit RHT68	*2-3% energy saving*	*Lifetime up 15,000 hours*
Switch to Klüber -Summit RSB 68	*3-5% energy saving*	*Lifetime up 25,000 hours*
Switch to Klüber -Summit R 200	*3-7% energy saving*	*Lifetime up 40,000 hours*

Tangible benefits compared with mineral oil

300 litres oil sump - reference	Mineral oil	RHT	R200
Price	x	1.5x	3x
Energy saving	-	2% - 3%	4% - 6%
Oil change period	6,000 h	15,000 h	40,000 h
Filter change period	6,000 h	15,000 h	40,000 h
Coalescents change period	10,000 h	15,000 h	40,000 h
Maintenance / revision	20,000 h	45,000 h	60,000 h
Top-up / oil consumption	25 litres	6 litres	0.5 litres
Waste of purged oil	100 %	100 %	30 %

Mevlut Karakisla

Global Refrigerating Compressor Oil
Sales Develoment Manager

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