Energy Efficient And Sustainable Technology For Industrial & Commercial Cooling & Heating Applications

11th November 2021 (14:25hrs Israel Time)

Wanson Technologies Ltd.

Know Thy Speaker!

THERMAX

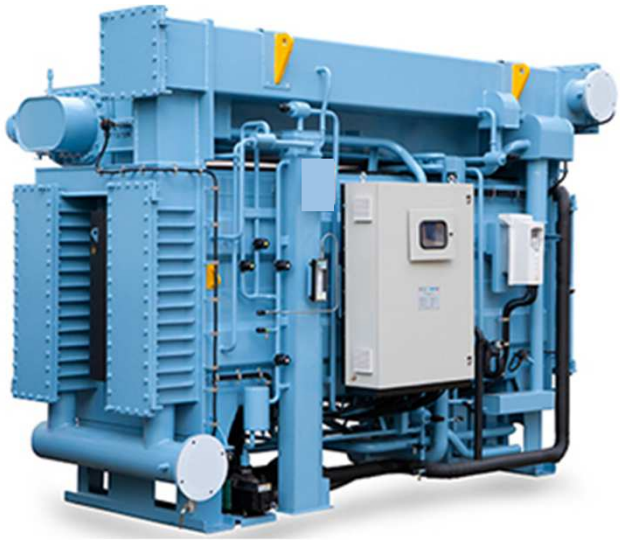
- Mule Venkataratna Reddy is the International Sales Head of Thermax's Cooling business
- He has over 25 years of experience in various functions such as Sales and Services
- He headed the business in Bangladesh as Country Manager for 10 years followed by a 3-year stint as Country Head for Turkey and CIS countries
- A mechanical engineer from the University of Goa, Reddy is an expert in Energy-efficient Cooling and Heating systems, Heat Recovery, and Absorption technology, etc.
- **Israeli Representative – Mr. Yoram Gross (CEO – Wanson Technology Group) & Mr. Oded Gross (Director – Wanson Technology Group)**

M. V. Reddy

Head - International Sales

Industrial Products Business - Cooling

Introduction to Vapour Absorption Technology



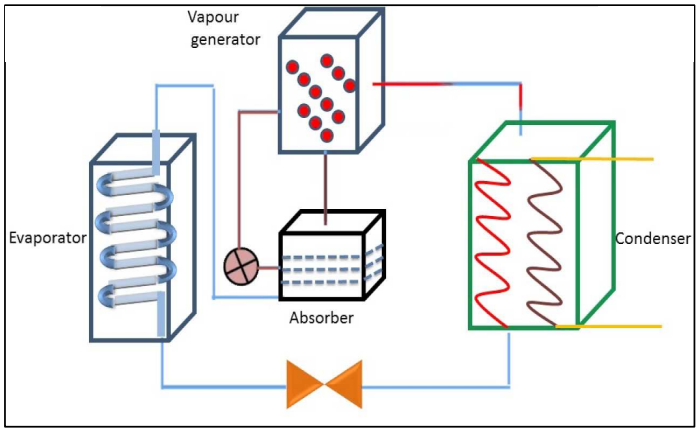
A typical LiBr-H_2O vapour absorption machine

Image Source: India Mart

- Vapour absorption is a **thermally driven technology** that **utilises heat** from **low-grade energy sources** for cooling and heating purposes
- An absorption system consists of four main components, namely the **evaporator, absorber, generator, and the condenser.** Water to be chilled is circulated through evaporator tubes maintained at vacuum
- **Liquid Refrigerant (water) sprayed on the evaporator boils and flash cools itself**
- However in large quantities, latent heat of evaporation for refrigerant is extracted from chilled water, ultimately cooling the chilled water to the required degree.

Operation of Vapour Absorption Technology

- **Highly concentrated hygroscopic LiBr solution** is sprayed on absorber tubes carrying cooling water
- Absorption of **refrigerant vapour heats up LiBr and dilutes the solution** in the process
- **Cooling water circulated** through absorber tubes removes heat of dilution
- **Dilute LiBr** now ineffective as an absorbent is **sent to generator by absorbent pump**
- The **LiBr solution boils in the generator** by removing **heat from the high-temperature heat source** (steam, hot water, or waste heat)
- The **water vapor released in the process enters the condenser**, where it condenses and re-enters the **evaporator as refrigerant**. This cycle of cooling is repeated as long as heat source and heat sink (cooling water) are available
- Customised to be driven by a variety of heat sources, vapour absorption machines can offer **simultaneous cooling and heating with 0°C chilled water and 90°C hot water,** heating alone with a **heat pump- up to 180°C hot water**, or **cooling alone which can offer up to -5°C chilled water.**



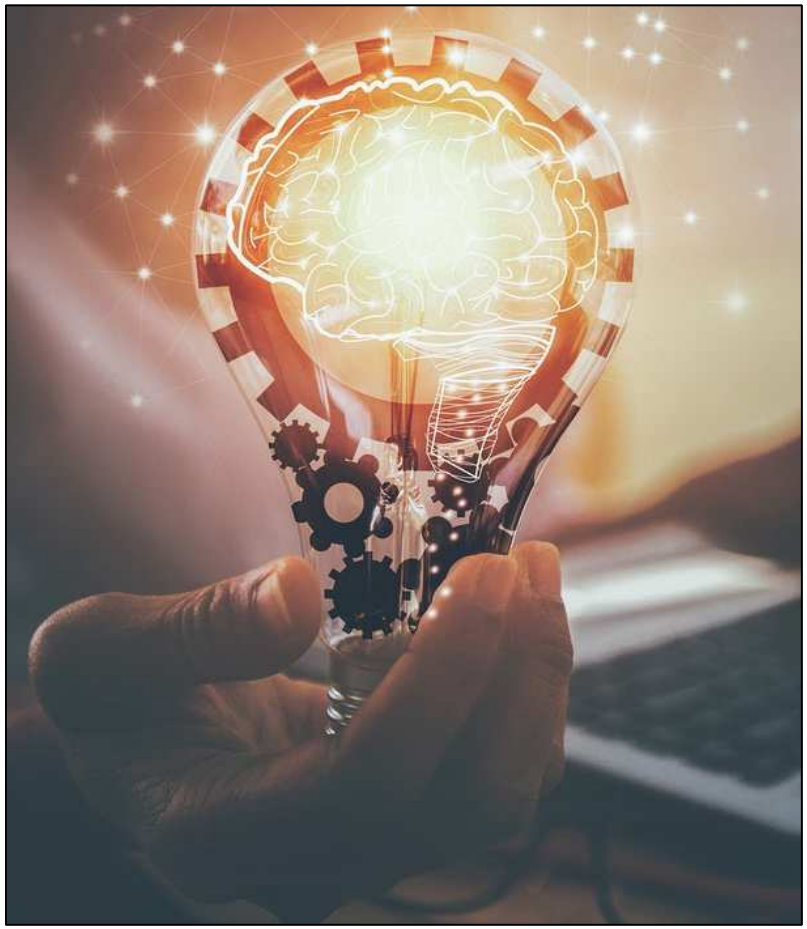
Vapour Absorption Cycle

Eco Friendly & Sustainable Technology

- **Eco-friendly fluids and reutilisation of low-grade heat** render vapour absorption machines the best comfort cooling and heating solutions in terms of **environmental sustainability**
- The heat-powered refrigeration cycles apart from **reducing fossil-fuel consumption, improve the efficiency** of the chillers and heat pumps

Efficient variations of vapour absorption chillers

1. Absorption Heat Pump
2. Absorption Heat Transformer
3. Hybrid Chiller
4. Chiller-Heater
5. Multi Energy Absorption Chiller
6. Cogeneration & Trigeneration



Absorption Heat Pump

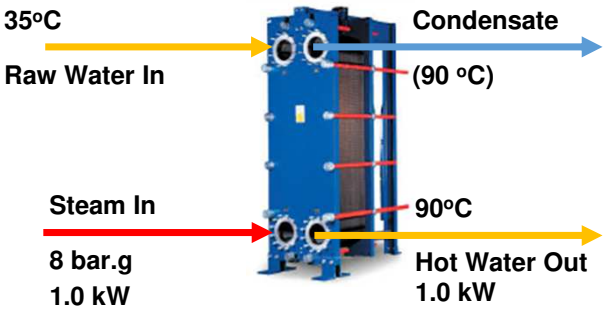
A typical Absorption Heat Pump

Image Source: Wikipedia

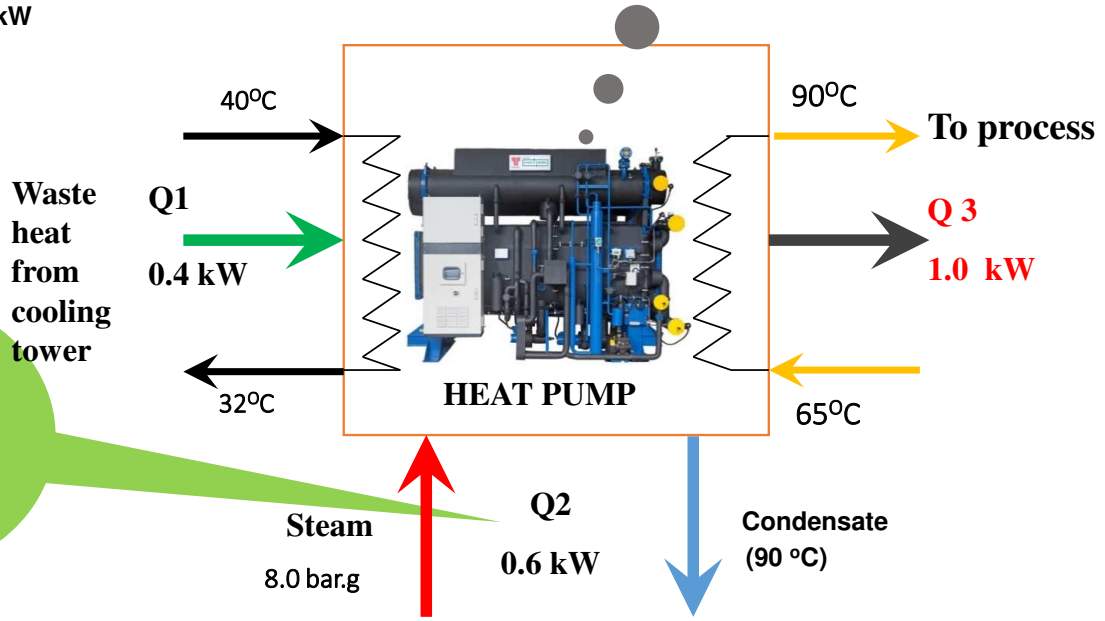
- One of the most promising vapour absorption machines is absorption heat pump which **generates hot water up to 90°C**
- Potential sources of heat pump include **dry saturated steam, high temperature hot water, exhaust / flue gases or conventional fuels**
- This machine saves **40% energy consumption** in applications such as district heating, boiler feed water heating, painting booths in automobile, pasteurisation and cleaning in dairy processing, etc.

Absorption Heat Pump

Conventional System

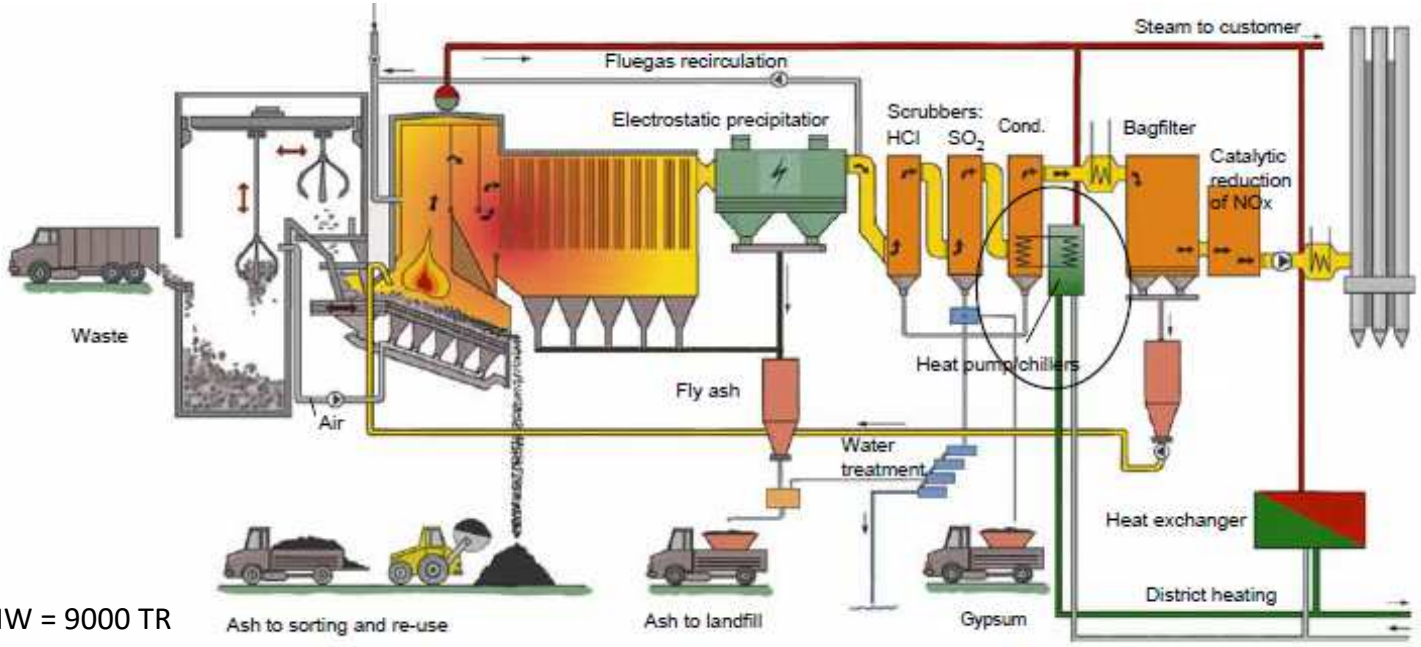


Heat Pump is a Device that Pumps heat from the Lower temperature to Medium Temperature using High Grade Energy



40% Savings in Energy

Absorption Heat Pump in District Heating



- District heating application
- 8 Heat Pumps, Total Capacity = 32 MW = 9000 TR
- One of the largest waste to energy projects in North Europe & Single largest environment initiative in Denmark
- Utilization of heat from Incineration of Municipal waste
- This waste-to-energy plant will burn waste collected from 500,000 - 700,000 inhabitants and 46,000 companies
- Hot Water Temp = 85ºC

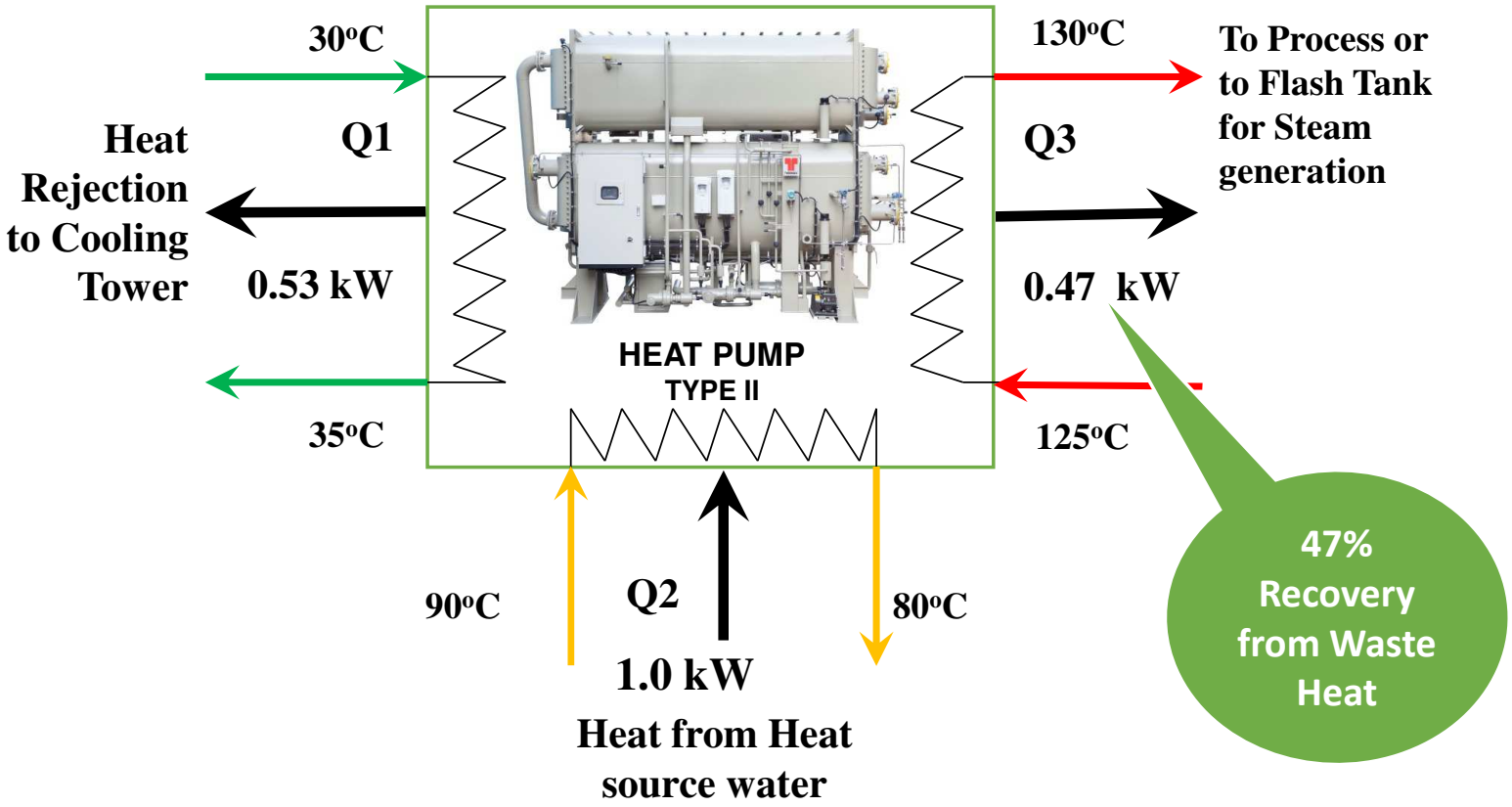
Absorption Heat Transformer

- Yet another **waste to wealth solution** using absorption technology, where the equipment can upgrade the temperature of waste heat, making its use possible
- The **efficiency of this equipment is nearly 47%,** which can lift the **temperature of waste heat by nearly 40-45 °C**
- Waste heat in the **temperature range of 75 – 110^{0}C** can be boosted to higher temperature, to be used as **superheated water or can be converted into steam**
- Such a product typically finds application in food industry, cogeneration, chemicals, refinery etc.

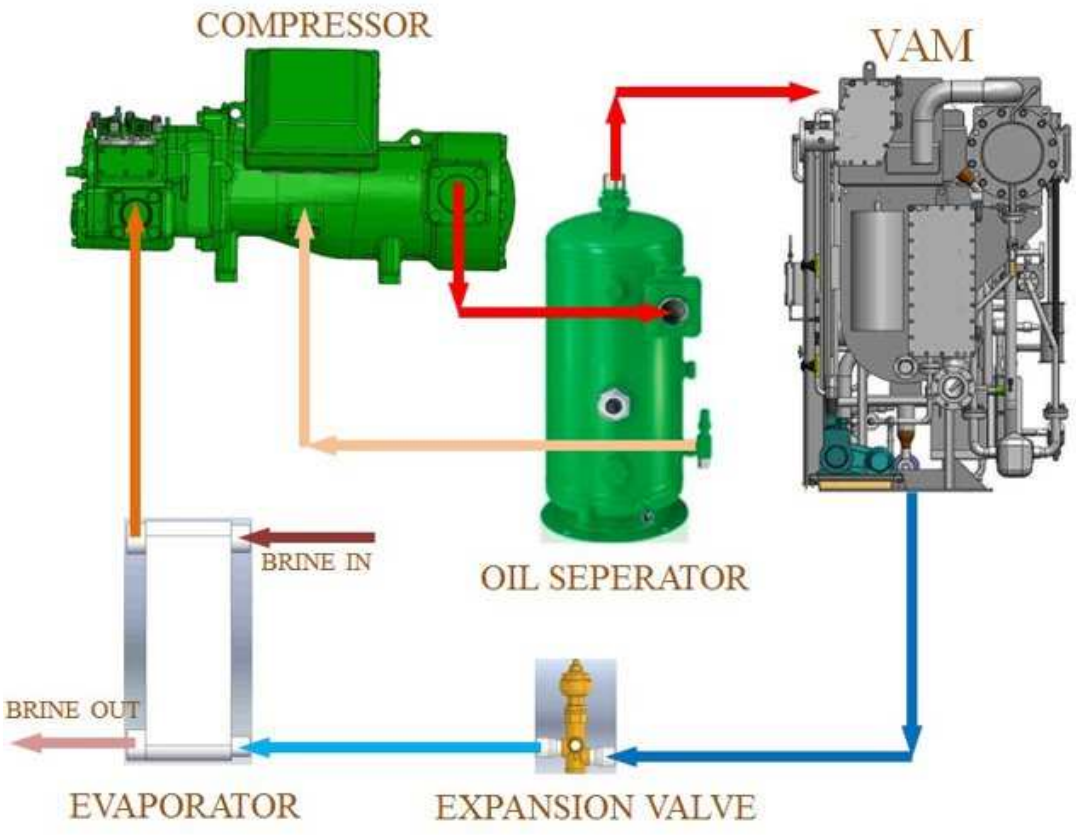
A typical Absorption Transformer

Image Source: World Energy

Absorption Heat Transformer



Hybrid Chiller



The Hybrid Cycle

- A **unique combination** of electrical chiller and absorption chiller technologies. Hybrid chiller aims at **harnessing the advantages of both for cooling**
- Capable of **generating chilled water up to -40°C**, high efficiency hybrid chiller **reduces electricity consumption by 50%**
- Integration of technologies enables hybrid chiller to **generate higher COP with the available waste heat**
- Hybrid chillers find application in comfort cooling and refrigeration especially in pharmaceuticals, chemicals, dairy processing, edible oil, food and beverage industries.

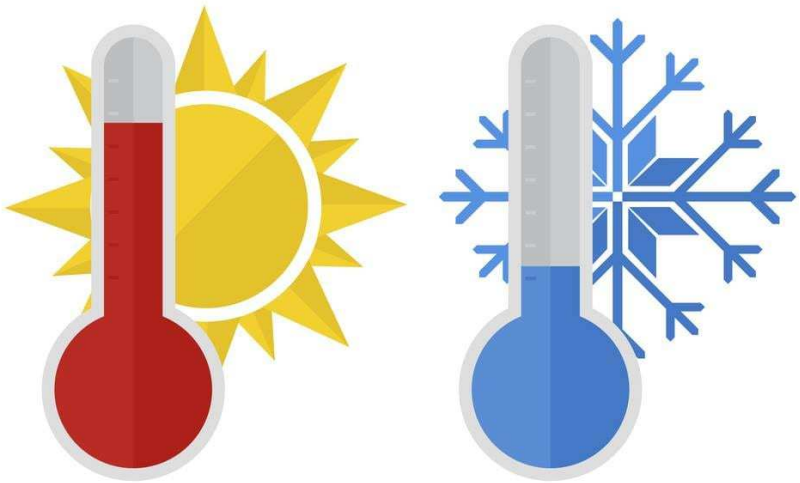
Hybrid Chiller

- Reduction of Overall Power Consumption
- Generates Higher COP with Available Waste Heat
- High Operational Savings
- Flexibility in Operation
- Fully Automatic Operation
- Reduces Dependency on Grid Power

Typical Specification					
Description	Unit	Case 1	Case 2	Case 3	Case 4
Brine temperature profile	°C	0 / -5	- 5 / -10	-10 / -15	-15 / -20
Refrigerant temperature	°C	-10	-15	-20	-25
Power consumption (Conventional)	kW / TR	1.15	1.35	1.65	2.10
Power consumption (Hybrid chiller)	kW / TR	0.55	0.65	0.8	1.03
Steam consumption (Hybrid Chiller)	kg/hr / TR	4.4	4.5	4.7	4.9
Power Savings	%	52	52	52	51

High Efficiency Simultaneous Chiller Heater

- Another interesting variation of absorption chiller is the **high-efficiency chiller-heater that generates either chilled or hot water or both simultaneously**
- Deriving **40% of heat required for generating hot water** from the low temperature chilled water, **chiller-heater reduces consumption of external heat by 40%** as compared to conventional hot water generator
- At simultaneous cooling and heating mode, the maximum heating capacity is **75-80% of the cooling load**
- Upon switching over to heating mode, the machine operates at 100% heating capacity
- Majorly applied in dairy processing, breweries, food and beverage industries, chiller-heaters double up as both cooling and heating solutions for various processes.



High Efficiency Simultaneous Chiller Heater

Conventional System

391 kg/hr
steam @
8 bar(g)

Hot water generator

260 kW
heating

350 kg/hr
steam @
8 bar(g)

Steam Driven Chiller

352 kW
(100 TR)
cooling

391 + 350 = 741 kg/hr

Cooling and Heating

High Efficiency Solution

260 kW
heating

352 kW
(100 TR)
cooling

Steam Driven Chiller-heater

585 kg/hr
steam@ 8 bar

585 kg/hr

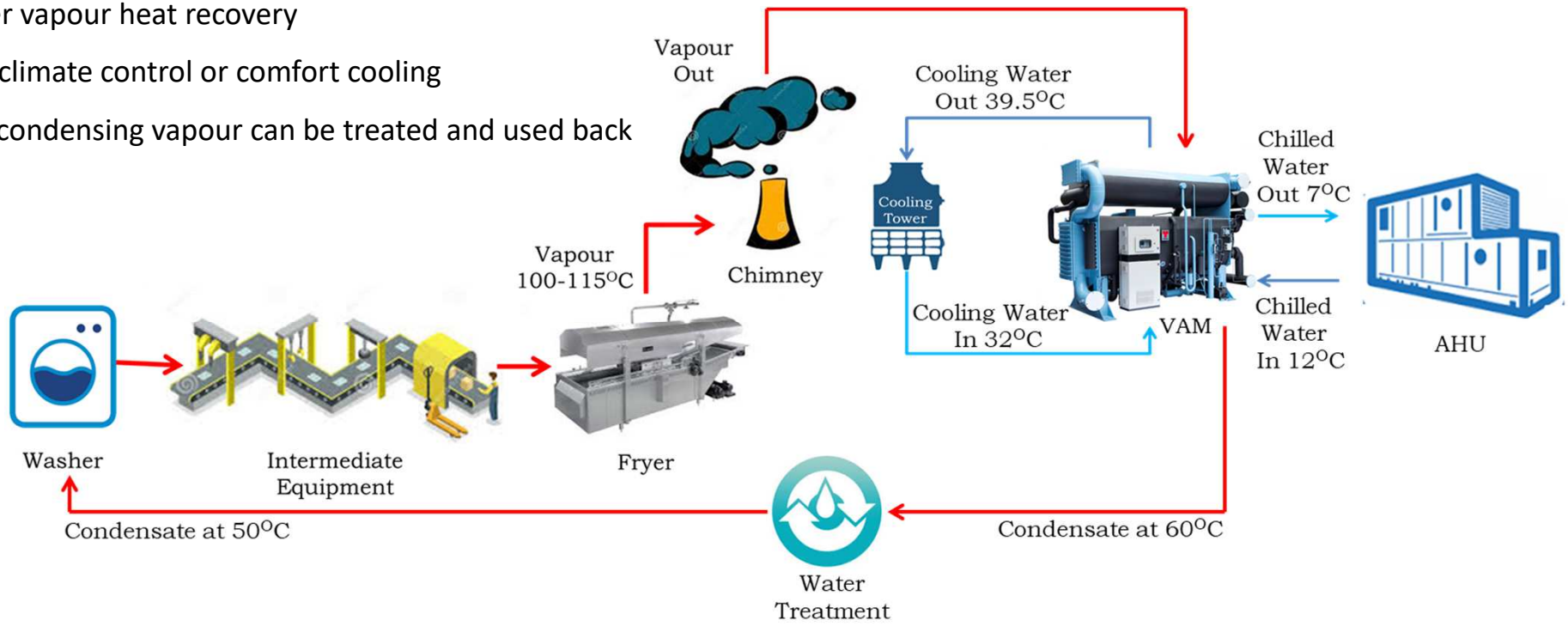
21%
less steam

Ultra Low Pressure Vapour Heat Recovery

- Many industries have flash steam or process vapour at close to atmospheric pressure (2 – 5 kPa)
- Single stage Ultra low pressure driven vapour absorption chiller
- Heat from the Vapour can be used to generate Chilled water
- Example: Potato fryer vapour heat recovery
- This can be used for climate control or comfort cooling
- Water recovered by condensing vapour can be treated and used back in process

1500 kg/hr Potato chips line can produce

500 TR Cooling + 3.5 m^3/hr water recovery

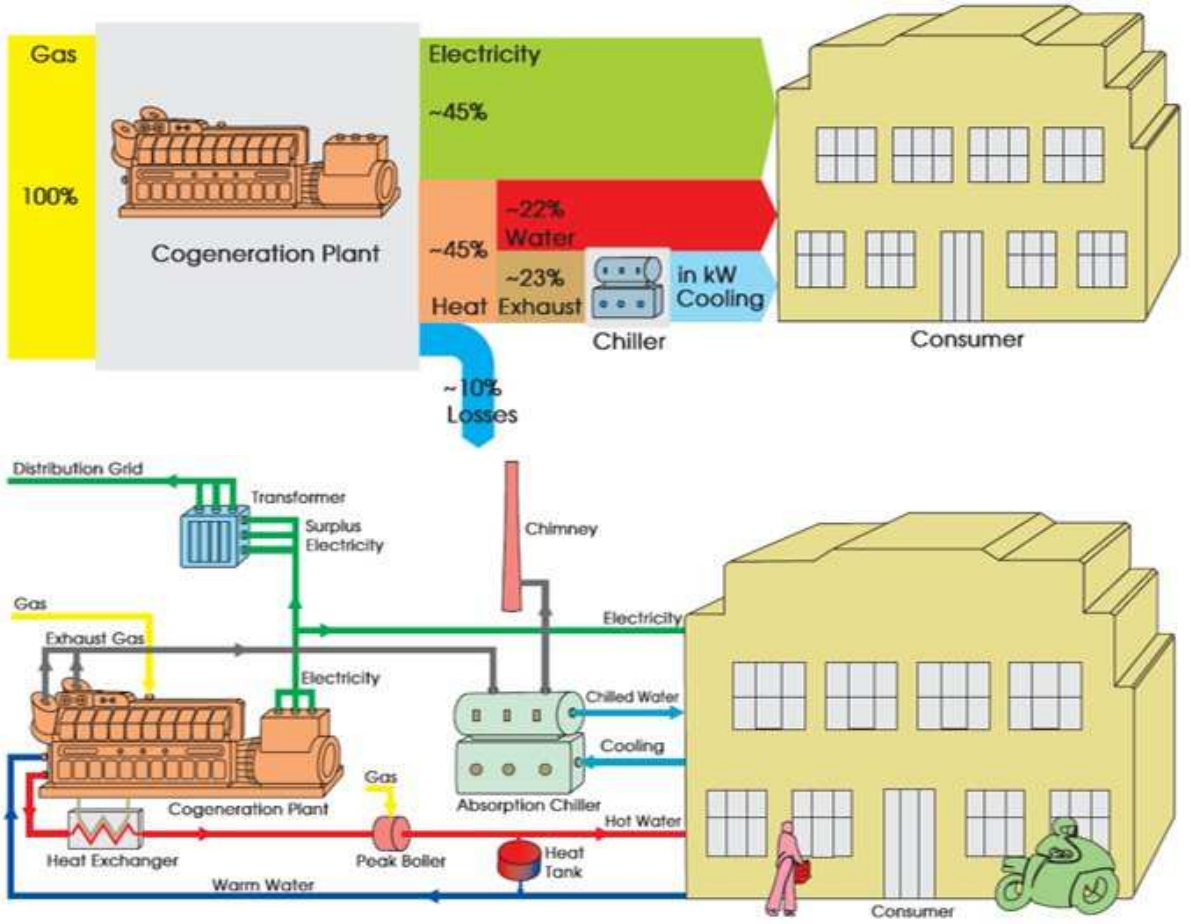


Multi Energy Absorption Chiller

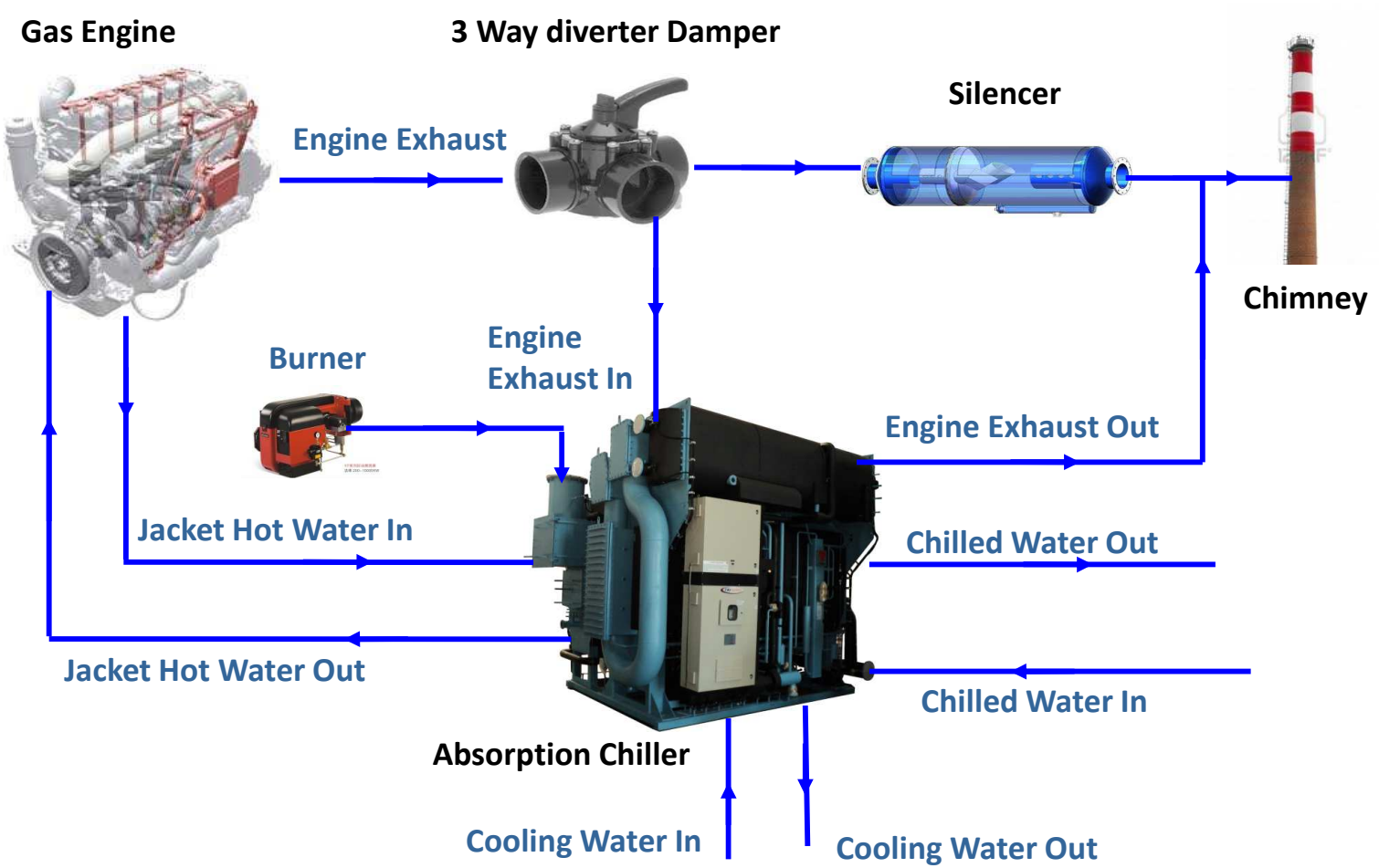
- By means of combining single and double effect cycles, multi-energy absorption chillers u**tilise heat from more than one heat source to enable maximum heat recovery**
- High- grade and low-grade heat is used in double effect cycle and single effect cycle respectively to enhance the chiller's performance
- **Combination of heat sources** such as exhaust gas, steam, hot water and liquid/gas fuels drives the chillers although the most commonly sought is Exhaust gas & Hot Water Series which runs on recovered engine exhaust and engine jacket water
- Such chillers find application in trigeneration, textiles, refineries and chemical industries.

Cogeneration – Trigeneration

- Cogeneration (CHP) and trigeneration (CHPC) systems, as **alternatives to conventional power systems**, contribute to the **reduction of primary energy consumption** and **greenhouse gas emissions** in residential and commercial sectors
- Vapour absorption technology is central to cogeneration and trigeneration by **recovering excess heat** from the premises and repurposing it for cooling and heating
- About **50-60%** of the power consumption of any commercial establishment is by **Air Conditioning** equipment
- CHPC is the most efficient way of meeting the power requirement of such installations, while addressing the cooling and heating requirements for **FREE!**
- The overall efficiency of such systems are in excess of **85%**



Cogeneration – Trigeneration



Case Study – Trigeneration in Action!

Four multi-energy chiller-heaters each of 660 tons of refrigeration installed at Hudson Yards in the USA harness waste heat from buildings cogeneration plant to deliver chilled water. With the installation of the chiller-heaters, the buildings' energy consumption for comfort cooling has been reduced significantly.

Hudson Yards, USA

(Tri-generation Plant) :

4 nos. x 660 TR Exhaust + Jacket

Water absorption chiller-heater

Heat Source: Exhaust + Hot water

generated by 4 nos of 3.3 MW gas engines.

Savings Calculation

Sr.	Description	UOM	Compression Chiller	Thermax VAM
1	Chilling Capacity	TR	**500**	**500**
2	Heating capacity	kcal/hr	**0**	**0**
3	Energy Source for Chilling		Electricity	Steam
4	Energy Source for Heating		N/A	N/A
5	Steam Consumption for chilling	kg/hr	0	3.50
6	Steam Consumption for Heating	kg/hr	0	0
8	**Electrical Power requirement**			
	Chiller power	kW	350	3.25
	Total Power	kW	350	3.25
9	Steam rate	USD/kg	0.000	
10	Electrical Power rate	USD/kWhr	0.166	
11	**Hourly Operational cost**			
	Steam Cost	USD/hr	0.00	0.00
	Electrical power cost	USD/hr	58.10	0.54
	Total hourly operational cost	USD/hr	58.10	0.54
12	Hourly Operational savings	USD/hr	57.56	
13	**Annual Savings Considering 8000 hrs of operation**	**USD**	**460484.00**	
		ISK	**1477559.62**	

THANK YOU