

# Energy Conservation- Refrigeration and Air Conditioning Systems

# Shipboard Applications of Refrigeration and air Conditioning

## **Refrigeration**

- Cargo Holds
- Cold Rooms
- Refrigerated Containers
- LPG and LNG
- Small Cabin Fridges

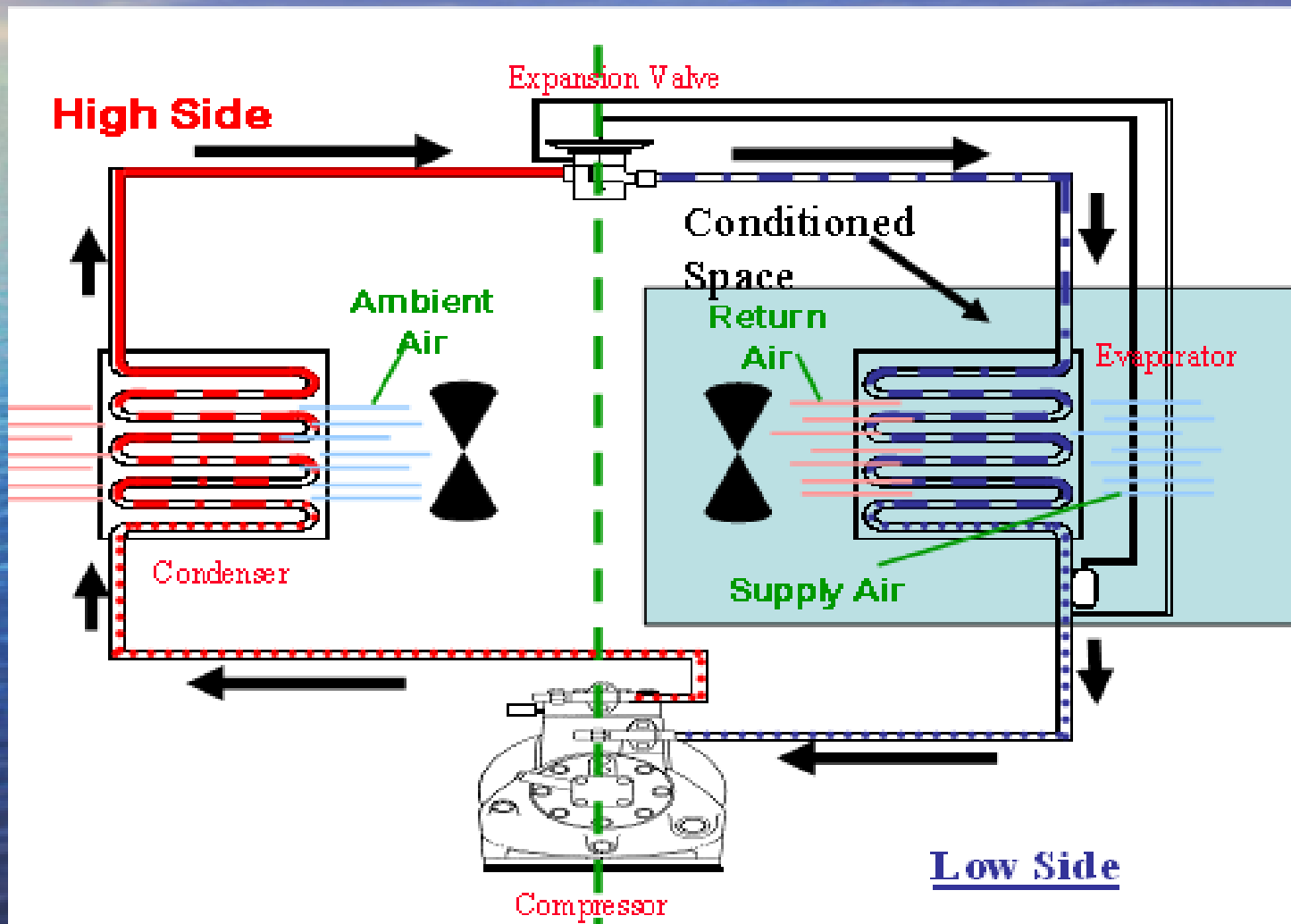
## **Air Conditioning**

- Accommodation
- Control Rooms – ECR, CCR etc.
- Bridge, Radio room etc.

# Differences between Refrigeration and Air Conditioning

- Application
- Temp
- Humidity
- Air Filtration
- Fresh Air Requirement
- Air Movement

# Basic Components of a Refrigeration System



# Energy Saving Methods in Refrigeration and Air Conditioning

- Avoid Air Conditioning to the Extent possible. It is possible to achieve reasonable comfort temperature in dry areas with relatively low ambient relative humidity by using evaporative cooling (desert coolers) instead of air Conditioning.
- The energy consumption of a Desert cooler is about 10-20% of an Air Conditioner of equivalent evaporative cooling capacity

# Energy Saving Methods in Refrigeration and Air Conditioning

- Operate Refrigeration and AC units at higher temperatures.
- The higher the evaporator temperature, higher the system capacity, lower the power input and lower the specific fuel consumption
- Every 1°C higher evaporator temperature will result in 2-3% lower specific power consumption

# Energy Saving Methods in Refrigeration and Air Conditioning

- Run Chilled Water and Brine systems at higher temperature set points wherever possible.
- Improve Air Distribution and Circulation by proper selection and strategic placing of fans
- Usage of ducts and frigid coil units (small ceiling mounted expansion coils with fans) instead of centralised coil diffuser units can lead to lower temperature settings and large energy savings



# Energy Saving Methods in Refrigeration and Air Conditioning

- Controlling the refrigerant flow through expansion valve by return air temperature in addition to evaporator superheat can give better energy savings and more precise temperature control
- Shift unnecessary heat loads out of air conditioned spaces
- Usage of false ceilings reduces power consumption in air conditioning
- Sometimes using local smaller coolers will save power compared to centralised AC



# Energy Saving Methods in Refrigeration and Air Conditioning

- Check and maintain thermal insulation
- Provide under deck insulation to the ceilings of air conditioned spaces
- Wet insulation causes energy losses
- Insulate primary and secondary refrigerant pipelines, valves and pipe fittings like valves etc. and air ducts running outside and through unoccupied spaces
- Reduce excessive window area by covering some window and skylight areas
- Use sun control films wherever possible

# Energy Saving Methods in Refrigeration and Air Conditioning

- Use of Low Conductivity window frames (PVC) reduces heat losses by conduction
- Provide insulation to sun exposed ceilings and walls
- Evaporative roof cooling (wetted mats spread on the roof) reduces air conditioning load significantly
- Landscaping of surrounding areas using fountains, trees and lawns reduces air conditioning load considerably

# Energy Saving Methods in Refrigeration and Air Conditioning

- Use self closing doors, revolving doors , air curtains, PVC strip curtains for exterior entrances
- Use buffer spaces with double doors to reduce heat losses
- Use intermediate doors in stairways and vertical passages
- Prevent exhausting of conditioned air from accommodation through toilet exhausts and kitchen exhausts

# Defrosting

- Accumulation of frost on the evaporator coils reduces heat transfer significantly
- Set Defrost interval timing (frequency) to optimal value
- Hot gas defrosting consumes less power compared to electric defrosting and is more effective
- Ensure defrosted water is drawn out of the chamber. Keep drain lines clear and unfrozen
- Minimize ingress of ambient moisture into the cold chamber

# Condensers and Evaporators

- Condensers and Evaporators are simply heat Exchangers
- Maintain condensers for proper heat exchange. A 5°C decrease in evaporator temperature increases the specific power consumption by 15%.
- Plate heat exchangers are more efficient than tube heat exchangers.
- 1°C higher temperature in the evaporator or lower temperature in the condensor can result in power savings of up to 2-3%.
- Supplying air cooled condensers with water trickle cooled air can give up to 30-40% energy saving

# Maintaining Compressor Efficiency

- Keep refrigerant side free from moisture and air
- Air and other non-condensable gases increase compressor discharge pressure
- Purge the system off air
- Excess oil is as harmful to the system as less of oil.
- Excess of refrigerant is also not recommended
- Leaky compressor valves result in reduced efficiency
- Minimise leakage through Compressor shaft seal
- Use of two smaller sized compressors instead of one compressor saves power



# Refrigeration Compressors

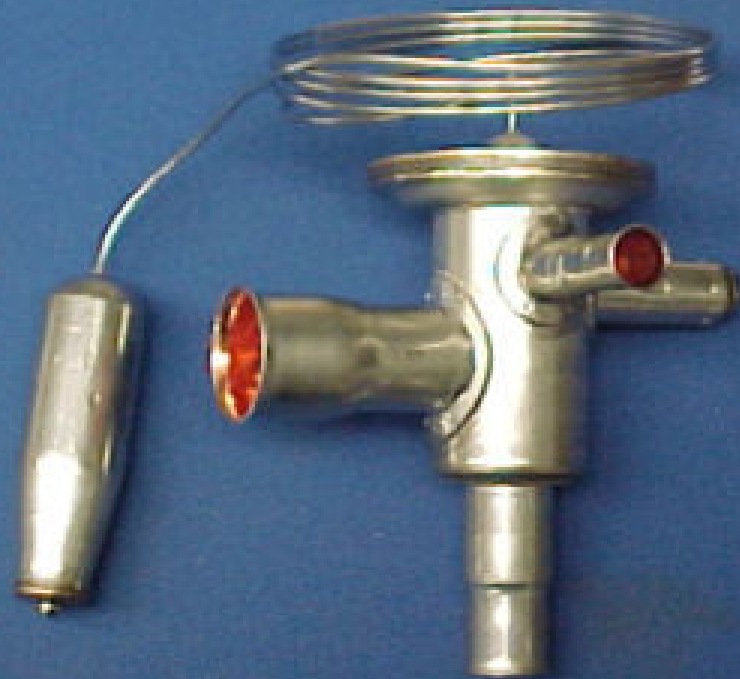




# Expansion Valves

- Balance the Expansion Valves for different cold rooms
- Back pressure valves help in maintaining refrigerant flow into various cold rooms
- Oversized Expansion valves result in hunting  
Use correctly sized Expansion valves

# Expansion Valve



# Operation of Pumping Systems

- Modify pumps to minimise throttling effect
- Use variable speed drives to control flow, not valve throttling
- Operate pumps at their maximum efficiency point
- Use small booster pumps for local higher pressure requirements

# Fan Maintenance

- Turn off fans when not required.  
Automation helps
- Clean filters, screens, fan blades regularly
- Minimise fan speed
- Dual speed Condensor fans and Evaporator fans conserve energy
- Check belt tension in belt driven systems
- Eliminate air leakage through ducts

# Reducing Power Consumption

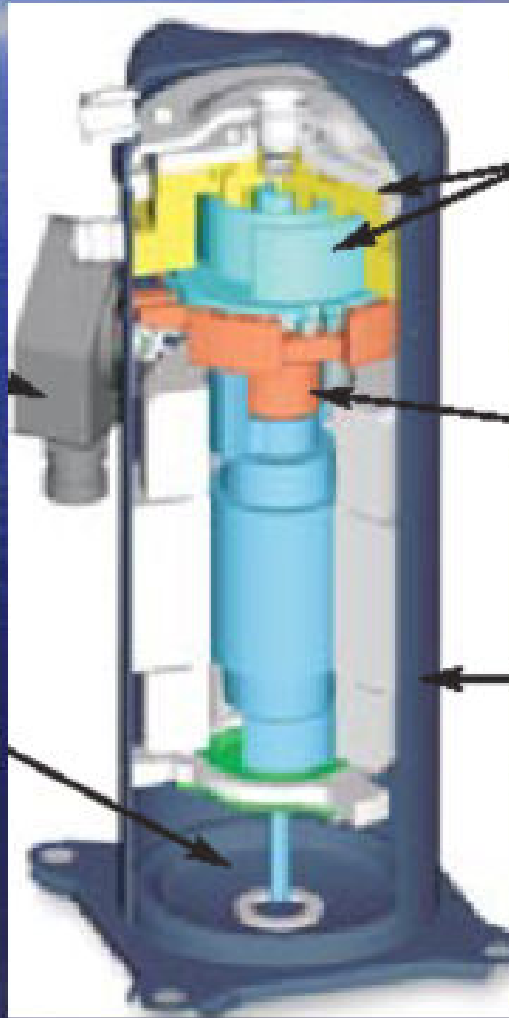
- Utilise waste heat of excess steam or flue gases to change over from gas compression systems to absorption chilling systems and save energy costs in the range of 50-70%.
- Specific power consumption of compressors should be measured at regular intervals. The most efficient compressors to be used for continuous duty and others on standby.
- Match the Refrigeration system capacity to the Actual Requirement

# Power Efficient Compressors

- Switch over to Scroll, Screw and Centrifugal Systems which are more power efficient compared to Reciprocating Compressors.
- Switch over to more environment friendly HFC refrigerants which contribute to lesser ozone depletion and lower global warming.
- Use water cooled condensers and utilize the drawn heat productively.



# Power Efficient Scroll Compressors





# Modern Instrumentation

- Use thermostats, motion sensors, and timer switches to stop air conditioning when not required.
- Use building automation systems wherever appropriate.
- Switch off unnecessary lighting to reduce heat generation in the refrigerated and air conditioned spaces. It may be done automatically by light sensors, motion sensors etc.