PACKAGED AMMONIA CHILLERS (PAC) – COMFORT COOLING

PAC RECIP
UP TO 1,400kW (400TR)

PAC SCREWS
UP TO 8,000kW (2,275TR)
Where are PAC chillers installed?

- Siemens (USA)
  *PAC chiller after painting at M&M Refrigeration (MD)*

- Heathrow Airport T5 (UK)
  *NS DUAL PAC chillers, four units, each 6.6MW (1,877TR)*

- LEGO (Mexico)
  *PAC recip chillers, Rotatune*
90% of the permanent cooling of the London Olympic site will be HFC-free, including:

The Energy Centre will feature ammonia chillers: The new Energy Centre and network being built on the site will provide efficient and low-carbon power by using new technology including biomass boilers and a Combined Cooling Heat & Power plant to capture the heat generated as a by-product of electricity production. The Energy Centre will feature ammonia chillers. According to the “Sustainable design and construction update”, 2,250 tonnes in carbon will be saved per year due to the Combined Cooling Heat and Power (CCHP) plant.

The Aquatics Centre will also feature an ammonia chiller: Being located too far from the energy centre to be catered for by it, the Aquatics Centre will make use of a separate ammonia chiller. The ODA had previously announced its decision to use natural refrigerants to cool the Aquatic Centre building, after receiving criticism last summer from the Commission for a Sustainable London 2012 among others for its original plans to use HFCs for the purpose.
The ammonia-based system at Homerton University Hospital in Hackney, London, UK replaced an existing one running on R22.

The system features:

Two ammonia chiller units of 0.5 MW cooling capacity each that cool water from 12°C to 6°C.

U-tube suction separators fitted to the chillers: Supplied by Alfa Laval the suction separators allow for a refrigerant charge reduction by a third. Applied to a plate evaporator, the advantages of a thermosyphon system are retained, while keeping the refrigerant charge volume in the chiller similar to that of a DX unit.

A safety shutdown programme ensuring that any leaks are contained within the system: an ammonia scrubber has been installed behind the system, as well as extract fans to remove the motor heat and an ammonia detection system near the exhaust fan. As a result, in the occasion of the smallest amount of ammonia release, the extract fans will shut down and the air scrubber will start. A water pump producing water spray is then activated allowing the ammonia passing through it to be absorbed into the water. Even in the unlikely event that the entire ammonia charge leaks, the air scrubber can absorb it all in the water.
Why choose PAC chillers?
Ammonia is chosen as the primary refrigerant because of its superior thermodynamic and transport properties. It offers many desirable qualities:

- A natural occurring, bio-degradable chemical.
- Part of the Earth’s natural nitrogen cycle.
- Short atmospheric lifetime.
- Ammonia has zero Ozone Depletion and Global Warming potential.
- Very efficient refrigerant, high specific cooling capacity, heat transfer, high COP, low TEWI.
- Easily detected.
- Low refrigerant cost (about 3 USD per kg, comes in 60kg cylinders or bulk).
- Has been safely used for over a century.

Moreover, ammonia is a “future proof” refrigerant from environmental and cost view point.

It is of course a toxic alkaline and, if not contained in a properly constructed plant, potentially lethal to humans, as are most other refrigerants if severely exposed for long period.
However, ammonia can be safely contained and has been widely used in thousands of refrigeration plants for over a century.

Recent technological developments have resulted in very low refrigerant charges for the latest generations of PAC chillers by reputable international brands.

The application is widely understood by refrigeration engineers and requires no special engineering beyond the well established thermodynamic, mechanical and material engineering technologies.
The PAC chiller Function
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The Heat Exchangers

The condenser and evaporators are Alfa Laval plate heat exchangers (PHE); laser welded cassette exchangers especially developed for ammonia chiller applications. The cassettes are mounted in support frame to provide the required heat exchange surface area. The secondary cooling medium is circulated through the gasketed section of the heat exchanger and the ammonia through the enclosed section of the welded cassettes. If the porthole gasket at the ammonia connection were to fail, there is a clear leakage path to the atmosphere to avoid contamination of the secondary fluid. Various grades of stainless steel or titanium plates are available. Standard PAC chillers come with stainless steel grade AISI316. The use or high grade stainless steel cassettes leads to long life-expectancy compared to conventional HFC chillers with copper tubing in shell. Moreover, the cassettes are self-cleaning, hence less maintenance is required. The evaporator is mounted together with a suction/liquid separator to provide a natural circulation, flooded operation.

Excellent Part Load Performance

The use of a thermosyphon system (gravity feed) allows close approach temperatures to be utilized for the evaporator. Importantly, this means the total heat exchanger may be utilized at part load and the LMTD will reduce with reducing load. As for the evaporator, the LMTD in the condenser will reduce as the thermal load decreases. The combined effect is to improve the part load performance of the PAC chiller.

The superior part load performance of the PAC chillers means that payback time often is calculated in months, not years, when the PAC chiller is compared to DX-chillers and other kinds of conventional chillers.
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PAC chiller control

Each PAC chiller comes with user friendly control system; large screen, full text, etc. and multiple options for customized control solutions and data logging, for instance extended chiller plant control including cooling towers with sequencer control, with or without wet bulb control, and pumps.

The standard PAC chiller control system includes all necessary operating and safety controls.
Some of the additional features are:

- **Operational Log**
  Displays a list of the system’s operating conditions for the past two hours, at 30 second intervals.

- **Trend Log**
  The same as above, but with user defined recording intervals (default is 15 minutes).
  - Any system alarms or failures are inserted in the operation and trend log at time of occurrence regardless of log’s recording interval.
  - Indicate where the events came from (local key pad, network PC, modem, including node number).

- **Alarm Log**
  A record of the last 100 system alarms

- **Failure Log**
  A record of the last 100 failures.

- **User Log**
  A record of the last 50 users logged on to the system including location of log on.

- **Gas detection and alarm system**
  Fully integrated plant room ventilation systems with emergency plan and ammonia scrubbing (ASHRAE & IIAR).

**PC OPTIONS**

- **Real-Time Graphics**
  Engine room, floor plan, etc.

- **Standard reports**

- **E-mail / Text Message notification of alarms or failures**

- **Networking**
PAC chiller options

Various options can be selected for improved chiller and overall plant performance:

- **VFD (Variable Speed Drive)**
  For improved compressor part load efficiency.
  *NEMA 1 ventilated enclosure is standard.*
  *Input line contactors included.*
  *Load reactors or DV/DT filter (optional)*
  *Bypass contactor, solid state soft start starter as back-up (optional)*

- **Water Heat Recovery (mounted)**
  De-super-heat heat exchanger

- **Economizer (mounted or supplied separately)**
  For improved COP and increased chiller capacity
QUALITY ASSURANCE

Codes & Standards Applied:

**Mechanical Design**
- ASME, ANSI

**Electrical Design**
- UL *(Underwriters Laboratory)*
  
  *Door mounted key pads and displays (UL listed)*

**PACKAGED AMMONIA CHILLERS (PAC) – COMFORT COOLING**

Standard PAC chillers are fabricated in USA and in full compliance with current US norms and standards.
Other applications

- Ice Rinks

- Dairies

- Breweries

- Liquefaction of CO\textsuperscript{2} and other gases

- Many other process cooling applications