HYDROCARBON REFRIGERANT SYSTEM COMMISSIONING REPORT

FOR

Duvel International Trading (China) Limited

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Cool Room Size and Use

The Cool room measures 2,633 square metres and is 8.1 metres high.

The Cool room is used to store imported Belgian and American craft beers, at a controlled temperature of 10 Degrees C. The Coolroom is located in Northern Shanghai.

Cool Room Equipment

Twelve high level direct expansion evaporators are mounted throughout the area to offer balanced cooling throughout the room. Each evaporator has a cooling capacity of 108 kilowatts.

Externally is a twin compressor rack system, incorporating two Hanbell screw compressors, liquid receiver, suction accumulator and oil separator. The system was designed and installed by Shanghai Lan'Ge Refrigeration Company Limited.

The rack system is directly connected to a three stage (1 fan, 2 Fans, 3 Water) hybrid evaporative condenser, again being designed, built and installed by Shanghai Lan'Ge Refrigeration Company Limited. The total design capacity of the system is 1280 kw.

The controls are an electronic digital electric configuration which is installed within the controlled space. An isolation room was built to enclose the panels to reduce and eliminate the possibility of corrosion and or faulty connections due to condensation. It also eliminated the very small potential of the refrigerant entering the control panel cabinet in the event of a leak.

Again, to eliminate any risk should there be a refrigerant leak, 30 hydrocarbon refrigerant safety sensors were installed at low level, and wired back to the control panel, and wired in such a way that should one, or more sensors alarm, the liquid line solenoid closes, the unit pumps down, and isolates all the refrigerant in the external units (rack system and condenser).

Whilst the sensors normally operate on mains electricity, they also have an inbuilt (rechargeable) battery back-up, an audible alarm, and a level indicator.

General System Preparation

Once the system was fully installed by the main contractor, the system was then triple stage vacuumed to remove any non condensables and moisture, then filled with a holding charge of dry nitrogen to a static pressure of 150 psi.

During the pressure test period, one leak, on the oil separator was identified, the faulty valve was isolated, the controlled area was vacuumed, and then the holding charge of dry nitrogen was returned to 150 psi.

All pipework was inspected and tested for leaks. No further leaks were found, and the pressure of the nitrogen charge did not drop.

Refrigerant Charging with Engas M50

With assistance from the team of Shanghai Lan'Ge Refrigeration Company Limited, the system was then charged with **ENGAS M50** hydrocarbon refrigerant.

Operational Energy Savings

As this was a 'clean' hydrocarbon refrigerant installation, there was no 'before' data to compare with, however on speaking with the management of Shanghai Lan'Ge Refrigeration Company, who have vast experience of design, build and installation of these systems, they stated that under normal running conditions they normally see the running current (for two compressors) at 2 x 250 amps average. The maximum continuous running current for the system is 2 x 310 amps. The voltage is 380/3/50 Hz.

When running on **Engas M50** refrigerant, all the pressures and temperatures are normal and the typical average running current is 2 x 181 amps. That represents a 27.80% reduction in power consumption.

Reduction in Running Costs

If we look at the running costs of the equipment on an hourly, daily, weekly and annual usage, we expect the compressors to run for 60% of the time, so 14.4 hours a day, and due to the climatic conditions in the area (Northern Shanghai) we would expect the unit to run for 7 months of the year. So annually we calculate it to run for 210 days at 14.4 hours a day.

Therefore, if it had been running on R22 and drawing 2 x 250 amps @ 380v /3ph, the kw/hr usage would have been 295.83 kw/hr. Multiply that by the hours, days and weeks etcetera and they would have used 894,589.92 kw/hrs.

However, if you then recalculate the readings for Engas M50, at only 2 x 181 amps the annual figure comes to 645,896.16 kw/hours.

If you then calculate the difference (248,693.76 kw/hrs) by the cost of electricity – you can see annual savings in the region of RMB 273,563.14.

TYPICAL R22 RUN COSTS, BASED ON INFORMATION FROM EQUIPMENT MANUFACTURER and INSTALLER

AMPS	VOLTS	KW	COST/Kw RMB	RUN HRS PER DAY	DAYS PER WEEK	WEEKS PER YEAR	TOTAL RUN COST PA (60%)
500	380	295.83	1.10	24	7	30	984,048.91

RUN COSTS OF ENGAS M50 BASED ON AVERAGE AMPERE READINGS

AMPS	VOLTS	KW	COST/Kw RMB	RUN HRS PER DAY	DAYS PER WEEK	WEEKS PER YEAR	TOTAL RUN COST PA (60%)
361	380	213.59	1.10	24	7	30	710,483.31

Reduction in Environmental Impact

GWPs (Global Warming Potential) are used by, among others, policymakers to compare the impact on the climate system of emission of different greenhouse gases. The GWP index is relative to carbon dioxide (CO2), which is normalised at 1. As greenhouse gases differ in their atmospheric lifetimes, GWPs also have a time component. Time horizons of 20 years and 100 years are used to enable the proper evaluation on the environment.

Research has shown that for most Refrigeration or Air-conditioning systems the impact for Global Warming will be greater from energy consumption (Indirect

Global Warming Impact) than from CO2 equivalent emission (release) of refrigerants. (Direct Global Warming Impact)

Therefore the Total Equivalent Global Warming Impact = leakage + energy consumption.

Leakage

The Duvel Coolroom Refrigeration System was designed to have an approximate refrigerant charge of 650 KGs of HCFC 22. (R22) Refrigerant R22 has a GWP of 5,160[1] of CO2 equivalent per KG over 20 years.

Therefore 3,354,000 KGs of CO2 equivalent saved from the atmosphere.

Energy Consumption

The Duvel Coolroom Refrigeration System has a calculated electricity consumption of 894,589.92 kilowatt hours per year. (This is based on the Chiller compressors running 24 hours per day, 7 days per week, 30 weeks per year at 85% of full load amps, with a 28% saving after conversion to Engas M50) The estimated CO2 emission per kWh generated equals .7 (This is an Industry Standard figure).

Therefore 894,589.92 x .7 = 626,212.944 x 28% = 175,339.62432 x 20 years =

3,506,792.48.

Total Equivalent Warming Impact

The total equivalent warming impact = 3,354,000 + 3,506,792.48 = 6,860,792.48 KGs.

Conclusion

The Energy saving based on the recorded data and taking into consideration actual power saving appears to be **28 %** at the point of the conversion.

The calculated environmental benefit is estimated at **6,860,792.48 KGs** of CO2 equivalent saved from the atmosphere over the next 20 years.

[1] 20 year GWP of R22 – Source IPCCC Fourth Assesment Report - 2007