

## *Catering for a Sustainable Future, Group*

### Refrigeration ~ Energy Efficiency.

When looking at the energy consumption of the commercial kitchen and the CO<sub>2</sub> emissions generated, the refrigeration equipment and plant used needs careful consideration, as the total energy used by the caterer for refrigeration is estimated to be 6% of the total energy used by the catering facility. Couple this with the major advances that have been achieved in refrigeration technology over the last ten years and it becomes clear that commercial refrigeration has many untapped opportunities if we are serious about reducing the energy used and the harmful emissions discharged. Where do we start?

The upright reach-in refrigerator, freezer cabinet is the most used method of refrigerated storage employed throughout the food service industry and it is estimated that it accounts for approximately 17% of all the commercial refrigeration energy used. Glass door cabinets are believed to account for 8% of the cabinet market.

The last ten years have seen major changes in the design of the reach-in cabinet with the following energy savings being recorded for solid door cabinets, the efficiency of the freezer cabinet has increased by up to 30%, and the refrigerated cabinet up to 35%. Substantial efficiency gains have also been achieved for glass-door models which can be as high as 45%. On average it is believed that with good housekeeping a cabinet will consume on average 35 -50% of its connected load over the working year.

A facility feeding up to 200 people three times a day (600 covers) needs 6,000 litres of refrigerated storage if frequent deliveries are available, which is 10 single door cabinets or 5 double door cabinets. If we assume that we are replacing cabinets that have reached the end of their working life after 10 years using a fix when broken policy and the split to be 40% freezer and 60% refrigerated the following will apply:

Existing situation:

- Four single solid-door freezer cabinets present yearly usage  $5,757\text{Kw} \times 4 = 23,028\text{Kw}$
- Six single solid-door refrigeration cabinets, present yearly usage  $4,649 \text{ Kw} \times 6 = 27,894\text{Kw}$
- Total yearly energy usage 50,922Kw
- Total cost of energy  $50,922 \times 5.5\text{p} = \text{£}2,800.71\text{p}$  per year
- Total emissions = 21,927 kgCO<sub>2</sub> (5,986kg/Carbon)

Option 1 ~ if we exchange the existing cabinets which are in excess of ten years old with their current day equivalent the following will apply:

- Four single solid-door freezer cabinets yearly usage  $4,030\text{Kw} \times 4 = 16,120\text{Kw}$
- Six single solid-door refrigeration cabinets yearly usage  $3,022\text{Kw} \times 6 = 18,132\text{Kw}$
- Total yearly energy usage 34,252Kw
- Total cost of energy  $34,252 \times 5.5\text{p} = \text{£}1,883.86\text{p}$  per year
- Total emissions = 14,728 kgCO<sub>2</sub> (4,020kg/Carbon)
- Yearly saving  $\text{£}916.85$  (32.7%) ~ environmental saving 7,199 kgCO<sub>2</sub> (32.8%)

To obtain the above savings it is important to consider the location of the cabinets, installing them in the coolest part of the kitchen possible while avoiding the cooking equipment as this will require the compressors to work harder to maintain the required temperature inside the cabinet. It must also be remembered that each cabinet requires at least 50mm of space to the sides and rear with 200mm at the top for free air to circulate around the cabinet. Don't overstock the cabinets, although the freezer

works more efficiently when loaded, remember to never block the circulation areas around the food as this will increase the energy usage. Always cool hot food by blast chilling before placing it in the cabinet as it is not only more energy efficient it avoids any risks to food safety.

It's more applicable to cold rooms rather than cabinets, but it is worth remembering the thicker the wall and door insulation, the more efficient the room or cabinet will be as temperature losses and gains are greatly reduced.

Unbelievably, but one of the most common problems is that kitchen staff leave doors to cabinets and cold rooms open and in some cases wedge them open, always shut the door and in the case of cold rooms if someone is constantly going in and out of the room then fit a plastic strip curtain to keep the cold air in.

Option 2 ~ if we exchange the existing cabinets as in option 1 and introduce planned preventative maintenance the following will apply:

- Four single solid-door freezer cabinets yearly usage  $3,708\text{Kw} \times 4 = 14,832\text{Kw}$
- Six single solid-door refrigeration cabinets yearly usage  $2,780\text{Kw} \times 6 = 16,680\text{Kw}$
- Total yearly energy usage  $31,512\text{Kw}$
- Total cost of energy  $31,512 \times 5.5\text{p} = \text{£}1,733.16\text{p}$  per year
- Total emissions =  $13,550 \text{ kgCO}_2$  (3,699kg/Carbon)
- Yearly saving  $\text{£}1,067.01$  (38.1%) ~ environmental saving  $8,377 \text{ kgCO}_2$  (38.2%)

Planned preventative maintenance is essential if we wish to maximise the cabinet's efficiency, a partially blocked condenser will increase energy usage by up to 23%, a faulty door seal will increase it by 11%, and incorrect temperature settings by 6% and a 15% refrigerant leak will increase the energy usage by 100%. Regular maintenance increases the cabinet's life, while reducing breakdowns and expensive repairs which all have an impact on the environment while increasing the running costs.

Option 3 ~ if we exchange the existing cabinets for new double door cabinets to the same specification as the single door cabinets mentioned in option 1 while implementing planned preventative maintenance the following will apply:

- Two double solid-door freezer cabinets yearly usage  $4,533\text{Kw} \times 2 = 9,066\text{Kw}$
- Three double solid-door refrigeration cabinets yearly usage  $3,526\text{Kw} \times 3 = 10,578\text{Kw}$
- Total yearly energy usage  $19,644\text{Kw} - 8\% = 18,072$
- Total cost of energy  $18,072 \times 5.5\text{p} = \text{£}993.96$  per year
- Total emissions =  $7,771 \text{ kgCO}_2$  ~  $2,121\text{kg/Carbon}$
- Yearly saving  $\text{£}1,806.75$  (64.5%) ~ environmental saving  $14,156 \text{ kgCO}_2$  (64.6%)

If you are replacing existing cabinets it is generally less costly to operate one larger unit than two smaller ones, to avoid unnecessary opening of doors which will increase energy usage you may wish to consider units with glazed doors so that the contents can be viewed without opening the doors or you may wish to consider a combination of drawers and half doors. If however the operation sees regular periods of low usage it may be more efficient to use two smaller cabinets, because during quiet periods individual cabinets can be switched off. One full cabinet is much more efficient to run than two half full cabinets.

Option 4 ~ If we exchange the existing cabinets for new double door cabinets using Hydrocarbons in place of conventional refrigerants while implementing planned preventative maintenance the following can be achieved:

- Total yearly energy usage  $18,072\text{Kw} - 15\% = 15,361\text{Kw}$
- Total cost of energy  $15,361 \times 5.5\text{p} = \text{£}844.86$  per year
- Total emissions =  $6,605 \text{ kgCO}_2$  ~  $1,803\text{kg/Carbon}$

- Yearly saving £1,955.85 (69.8%) ~ environmental saving 15,322 kgCO<sub>2</sub> (69.9%)

Currently HydroFluoroCarbons (HFCs) are widely used in many commercial refrigeration applications, HFCs are the replacement refrigerant for ChloroFluoroCarbons (CFCs) which were the refrigerant of choice for many years, but they are being phased out due to their high Ozone Depletion Potential (ODP) characteristics. HFCs have zero ODP, but still have a high Global Warming Potential, today, the focus is shifting from ODP to global warming and HFCs are included on the Kyoto list of gases whose emissions need to be reduced.

Hydrocarbons (HCs) have been identified as one of the possible alternative refrigeration gases for HFCs as they are environmentally benign (zero ODP and negligible GWP) and give a good technical performance. HCs work on a simple vapour compression cycle in the same way as the current HFCs with working temperatures and pressures that are close to those of HFCs so no substantially different equipment is required.

HCs have already been used as refrigerants in the EU and Asia for a number of years, but mainly in domestic refrigeration. Hydrocarbons are now being introduced in commercial refrigeration as a commercially viable alternative for HFCs and are a key component of the Greenfreeze programme being run by Greenpeace.

While units running on HCs are in general terms 15% more energy efficient than comparable units that run on HFCs, because of its flammable properties certain requirements exist that limits its use. The maximum charge per sealed system is 2.5kg or 10kg in open air for indirect systems. The precautions for recharging are that staff have special training, no ignition source should be within a radius of 10m, no power supply to be located in the charging area, sensors are to be provided for detecting leaks and dry powder fire extinguishers must be provided. Also Hydrocarbons are heavier than air so special consideration must be given to the kitchen drainage details in areas were leaks can occur.

At the present time Hydrocarbons can be satisfactorily used in upright freezer and refrigeration cabinets, but general opinion suggests that the larger cold room installations need to have some further research and development work undertaken.

Option 5 ~ if we exchange the existing cabinets for new double door cabinets using a Glycol secondary refrigeration system while implementing planned preventative maintenance the following applies:

- Total yearly energy usage 18,072Kw – 25% = 13,554Kw
- Total cost of energy 13,554 x 5.5p = £745.47 per year
- Total emissions = 5,828 kgCO<sub>2</sub> ~ 1,591kg/Carbon
- Yearly saving £2,055.24 (73.4%) ~ environmental saving 16,099 kgCO<sub>2</sub> (73.4%)

The Glycol secondary refrigeration system is capable of running a large number of different appliances, chilled areas and cold rooms on one system. It has outstanding rapid temperature pull down times; however it is not capable of dealing with freezer cabinets or rooms. A typical Glycol system will reduce the primary refrigeration gas used within a commercial kitchen by up to 72% which brings with it the obvious benefits for the environment; it will also reduce the energy usage by up to 25%, while in some foodservice applications caterers have achieved a 15% reduction in food loss through reduced wastage.

The Glycol secondary refrigeration system comprises of a pair of external chiller units circulating a food safe mixture of chilled glycol and water around a ring main connected to the independently controlled equipment. The chiller units run alternately, offering back-up, if one unit should develop a

fault, an alarm sounds and the remaining unit comes into operation. As the units are in a remote location the kitchen and servery are not exposed to the heat and noise emissions that integral units can create.

On the larger type installation, the Glycol system has an added benefit in that it is easier to install a heat recovery system that can harvest the heat rejected and use it to preheat the cold water feed to the water heater supporting the kitchen.

When purchasing refrigeration equipment look for appliances that are ECA accredited, this means that they are recognised as being energy efficient and in certain cases you can claim 100% tax allowance in the first year. It is also worth talking to your consultant or supplier as Carbon Trust interest free loans may be available for projects that greatly reduce the CO<sub>2</sub> emissions generated by your business.

Prepared by: David C Clarke FCSI  
30<sup>th</sup> September 2006

David Clarke is a director of design consultants CDIS-KARM (01603 721961) and a professional member of the Foodservice Consultants Society International UK (01483 761122)