Fresh air v Heat pumps

Ever since the first swimming pool ventilation unit incorporating a heat pump became commercially available more than 30 years ago the pool industry has been told that it is more cost effective to dehumidify using a heat pump than it is to bring in fresh air and heat it to the same temperature. When they first came on to the market this was true because all the fresh air systems at the time were very inefficient. But things have moved on fresh air units now have heat recovery on the exhaust air and the fresh air can be controlled using motorized dampers and speed control of the fans. So I think it's time we had a second look at what we feel is a misconception in the pool industry that using a heat pump is more cost effective than using a fresh air unit.

When comparing the costs for two different system you would normally ask the manufacturers to produce an estimate of the likely running cost of the two units, the problem with this is that there is no set rules on how this is done and manufactures will favour the method that shows there particular unit in the best light. But if we go right back to basics and except that both the heat pump and the fresh air/ recirculation units are capable of maintaining the correct conditions, then the heat losses and evaporation are exactly the same no matter which unit you use. The only difference in the running cost is therefore how each of the units deals with the evaporation load.

Those that promote the heat pump will tell you that it is expensive to bring in fresh air and heat it up to the room temperature they claim that it is better to dehumidify and recirculate all the air to keep running cost to a minimum. So let's compare how much it cost to run a commercially available heat pump unit of a similar size to a high efficiency Recotherm fresh air unit.

To do this we need two units of a similar size, we have used a heat pump unit that is widely available and has an air flow rate of 7000 m3/h, we can compare this unit with the Recotherm model VFEC 200 fresh air ventilation unit which has and air flow rate of 7200 m3/h (2m3/s).

Now to help the heat pump unit we are going to assume that it is working on a pool that has a constant 14 kg/hr of evaporation which means that the unit doesn't need to bring in any fresh air it can do this load using the dehumidification capacity of the heat pump and only needs to run the one fan. We are also taking a pool hall condition of 28 oC and 60 % RH because this is the condition used in the heat pump manual. Working out the cost of the heat pump is easy, all you need do is go to the manufactures owners manual and look at the nominal consumed power by the compressor add this to the power consumed by the fan and multiply by the cost of electricity. From the manual you can see that the compressor duty is 4.5 kW and the full load current of the supply fan is 4.6 Amps (which on a three phase motor equates to a load of approximately 1.8 kW). The cost of a kWh at the time of writing this article is 11 pence therefore:-

Cost per hour = 11 p x (4.5 +1.8) = 69.3 pence

In order to dehumidify the air you have to cool it, to remove 14 kg/hr you would need to cool the air down to 20 oC which equates to a heat loss of 19.4 kW but lets give them the benefit of the doubt and assume that they only have to reduce the temperature of the air to 22 oC which is a heat loss of 14.6 kW. The "waste heat" that is generated in the heat pump is put into the air and the water, under ideal conditions the heat added to the air and water on the heat pump in question is 20.5 kW (this information is taken from their technical schedule) but the cooling effect of the dehumidification process remove 14.6 kW from the air, hence the additional heat added is 20.5-14.6=5.9 kW.

The fresh air unit is a little more complicated because we are using fresh air and the amount required to remove the 14 litres of moisture varies depending on the time of the year. So we will have to do the calculation at three different ambient temperatures the first will be the winter condition at 0 oC 100 % RH the second an average condition of 8 oC 80 %RH and the third at a summer condition of 28 oC 47 % RH.

The air at these three conditions contains less moisture per kg than the air inside the pool hall so it is just a case of how much you need to introduce to remove 14 litres of moisture from the hall. At this point I could run through the way to calculate the amount of air but as I said at the beginning I am trying to simplify this process so the table below shows how much air is require at the three conditions

Time	Air volume
Winter	1068 m3/h
Average	1242 m3/h
Summer	3361 m3/h

This air has to be raised from the ambient temperature back to the original temperature of 28 oC. The first part of this would be done in the recuperator normally with an efficiency of 70 %. So in the winter the air comes in at 0 oC and the exhaust air passes through the recuperator at 28 oC you get 70% of the difference so the supply air will rise from 0 oC to ((28-0) x 0.7 + 0=) 19.6 oC. You need to heat the air from 19.6 oC to 28 oC therefore heat required is

(28-19.6) x 1.225 x 1.02 x 1068 / 3600 = 3.11 kW

Where
1.225 is the density of air
1.02 is the specific heat capacity of air
3600 is seconds per hour

In addition to this we have to add the extra heat generated in the heat pump which was 5.9 kW. So the total heat required is

3.11 + 5.9 = 9.01 kW

If the boiler efficiency is 80% and most modern boiler are more efficient that this and the cost of gas is 3.7 p/ kWh then the cost of heating this air is

9.01 x 3.7 / 0.8 = 41.67 p/h

The fans on the Recotherm units are variable speed so to work out the power absorbed we need to multiply the fan power at full volume by the cube of the actual air volume divided by the design air volume (some of you may have clouded over at this point but stick with me the calculation looks like this)

$2.43 \times (1068/7200)^3 = 0.0079$ kW

Hence electrical cost is

0.0079 x 11 = 0.087pence

Hence total cost of removing 14 kg of moisture with the Recotherm VFEC 200 unit in the winter is

41.67 + 0.087 = 41.76 pence

This shows that the cost of removing 14 litre of moisture using a fresh air unit that has recirculation, an air to air heat exchanger and fully variable speed control is considerably cheaper than the cost of removing 14 litre of moisture with the heat pump. If you have an oil fired boiler the fresh air unit would be higher at (69 pence) but still cheaper than a heat pump.

The figures for the other periods of the year are as follows

Time	Oil	Gas
Winter	69 pence	41.76 pence
Average	65 pence	39.48 pence
Summer	47.86 pence	30.1 pence

In producing this calculation we have been more than fair to the heat pump we have assume that the pool dehumidification load is only 14 kg/h because once the load is higher than this the heat pump unit has to introduce fresh air, this means it has to run the exhaust fan and the fresh air that is introduce is cold and untreated because it doesn't have a heat recovery device on the fresh air inlet. We have assume that it is operating at its maximum performance and we have assumed that the boiler efficiency for the fresh air unit is only 80 %, all of which should help the heat pump but still the fresh air unit is cheaper to run weather you have oil or gas. In this particular calculation we have used technical data taken from one unit but the principle is the same which ever size of unit you use or which ever manufacturer makes it. Using heat pump to dehumidify the air is going to cost more to run than using fresh air.

The heat pump association have done a marvellous job in promoting the use of heat pumps in this country and in some applications they work very well but these applications do not include dehumidifying swimming pools.
In addition to having cheaper running cost the fresh air unit is also less expensive and simpler to maintain, will last a lot longer and will provide a fresher atmosphere in the pool hall. But be careful not all fresh air units are the same the unit we have used is taken from our VFEC range, these units have variable speed fans not just step controlled fans and computer controls which allow us to utilise all the energy saving features to there full potential.