# The Magic of EC Condensers

**'Magic' is a strong word. So is 'revolutionary' – which is another word we could use to describe EC condensers.**

You might think that descriptions like that are a bit of an overstatement. After all, just how different can EC condensers be? Could they possibly justify words like these?

- What if we said that traditional condensers wasted energy 99% of the time, and EC heat exchangers could SAVE energy 99% of the time?
- What if we said you could have a heat exchanger that is guaranteed to run below certain noise levels and still maintain capacity?
- What if you could slash power use AND reduce noise, STILL without losing capacity?
- And what if we could provide you with a tool that allowed you to analyse all of these variables (and more), so that you could fine-tune the finished product – both at the design stage and throughout its working life?

We think those things are pretty magical. Unlike normal magic tricks, though, this one is not illusion. With EC condensers, the revolution is real.

- Throughout this issue we t alk about condensers however the principles apply equally to all heat exchangers.

# EC: Controlling Capacity

## IT'S ALL ABOUT CONTROL…

EC stands for Electronic Commutation, but it could just as easily stand for Extraordinary Control – because that's what it delivers.

EC heat exchangers deliver unprecedented – and easily achieved – control over capacity, head pressure, noise and operating costs. The sort of control that allows flexible design, precise, cost effective, product selection, straightforward trouble-shooting and better performance.

But before we can take full advantage of all of these benefits, we need to understand just how EC condensers differ from the traditional alternatives.

So let's break it down…

**Controlling Fan Speed**

At the heart of the EC condenser – and its controllability – is the EC fan.

**Because the speed of an EC fan is controlled by electronics, rather than the power supply, they can be controlled very easily – right down to stationary and back up to full speed – with NO loss of efficiency OR increase in noise.**

**Because electronics are built into them, they are also EASY to control.**

**So, unlike AC fans, EC fans can be controlled both easily and effectively.**

It sounds so simple; one could be forgiven for thinking that it was unimportant. But in fact, it is almost impossible to overstate the importance of speed control in improving the performance of your condenser.

The ability to control fan speed affects EVERYTHING – build cost, running costs, capacity, noise control, system pressures and avoiding system failure.

## Controlling Capacity: When Less is Better

The speed of the fan within a condenser has a direct relationship to its capacity. In practice, the actual operating point is influenced by the other components of the system but basically, if you increase the fan speed, you increase the capacity. Lower it, and the capacity drops.

Let's assume that this condenser is under a fair load – almost a maximum load.

Now let's move on 7 hours or so. The sun has gone down, the temperature has dropped by 15 degrees. The load on the refrigeration system has dropped markedly and the capacity of the condenser has increased significantly, but has the condenser adjusted to reflect that change?

**An EC condenser, would have adjusted to the lower load and increased capacity, by reducing the fan speed.** Remember that EC fans are efficient through their full speed range, easy to control and can be programmed to respond to all sorts of inputs – including a reduction in load, or increases of capacity.

So unlike the traditional condenser, which wastes power most of the time by producing more capacity than is needed, **the EC condenser draws just as much power as is needed at any given time – no less and, more importantly, no more.**

**Efficient fan speed control allows the EC condenser to precisely match condenser capacity to load – and in the process save energy and running costs.**

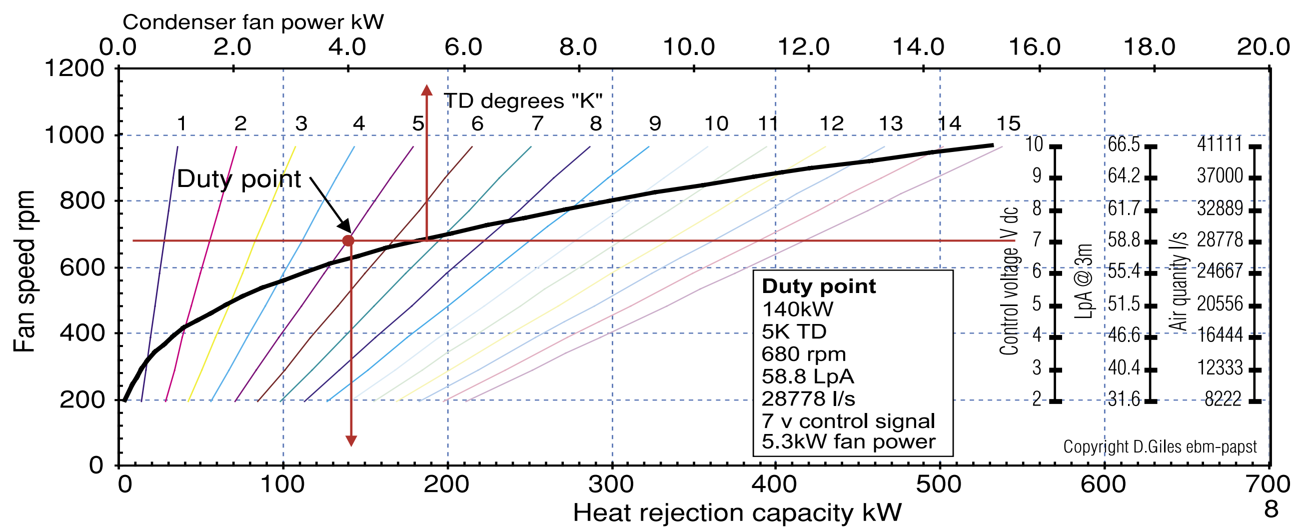
## Controlling Capacity: When More Is Needed

We've seen that when the load lowers, an EC heat-exchanger can adjust the capacity to match, easily and efficiently. But what about when the load increases? How does an EC heat-exchanger help when the going gets tough?

Let's imagine that today, it isn't just warm, it's a scorcher, the load on the condenser naturally increases. Suddenly, it has a whole lot more heat to reject, and it needs more capacity to do it.

# EC: The Complete Condenser Performance Chart

**EC condenser performance chart**




## Legend

**Constant TD (˚K)**
Variable: – Fan speed, control voltage, sound level, air quality, heat rejection (kW), condenser fan power (kW).

**Constant: – Heat Rejection Capacity (kW)**
Variable: – Fan speed, control voltage, sound level, air quality, T.D., condenser fan power(kW).

**Condenser Fan Power Curoe: –**
Use this to establish fan power from the duty point.

**Constant: –** Fan speed, control voltage, sound level, air quality, condenser fan power (kW).
Variable:– T.D., heat rejection capacity (kW).

## Controlling Information: Knowledge is Power

The ABILITY to control all the factors is one thing, but getting the information you need to do so effectively is another thing.

## Controlling Selection

This chart is obviously invaluable to designers, as it shows them how they can manipulate the fan speed and TD to optimise the condenser capacity, noise and operating cost to suit the system.

But it is equally priceless when it comes to selection and application of the condenser. By giving the reader a clear understanding of the interrelationship of all the variables, the chart:

- Gives the applications engineer a complete understanding of the how the heat rejection system operates
- Allows confident application where noise regulations exist
- Allows greater freedom in selecting other system components to maximise their performance
- Allows the design of control functions that maximise the performance and minimise the operating costs of the total system
- Allows confident application of the product in areas previously considered marginal.
- Allows confident application of the product between the traditional ‘rule of thumb’ TD selection guidelines.
- Nominates the required control signal voltage to manipulate the condenser performance.
- Allows compressor capacity to be overlayed to predict performance.

**Knowledge is power. EC technology is control.**

# EC: Controlling Capacity

*Increase speed: Increase capacity*

**Logical – but with a traditional condenser, not always possible.**

**The problem is that traditional, non-EC, condensers use traditional fans – and traditional fans are limited in two crucial ways.**

**One is that they have an in-built speed barrier.** Their speed is limited by the frequency of the alternating current.

**The other problem with traditional fans is that they are only really efficient when they are running at full speed.** So, from an efficiency point of view, it makes no sense to choose a fan with tons more speed than the condenser needs on a day-to-day basis.

**With an EC condenser, we can do a whole lot better than that.**

With EC fans, a condenser designer can choose a fan that provides maximum efficiency at the maximum likely load while running at less than full speed.

What this means is that when EC condensers encounter loads greater than the expected maximum they have the extra speed needed to increase the condenser capacity to match

**In short, when an EC condenser needs more capacity, it can find it simply by increasing the speed of the fan.** Traditional condensers can't.

*Increase TD, Increase Capacity.*

As we said, though, increasing fan speed is only one of the ways to increase condenser capacity. The other way is using the magic of Temperature Difference (TD).

As more heat is sent through for the condenser to get rid of, the temperature of the refrigerant in the condenser (the condensing temperature) rises. Since the difference between the condensing temperature and the ambient air temperature is the TD, if the condensing temperature rises, so will the TD.

**The good news for the condenser's ability to cope with this increased load is that a small increase in TD brings with it a significant increase in capacity.**

**As you can see, it only takes a 1K rise in temperature difference (from 5K) to produce an increase of (~ 20%) in capacity.** At face value, this TD effect seems to be the answer to all our traditional condenser designer's capacity problems. He or she simply chooses a fan with a maximum speed that covers the maximum likely load and relies on a rising TD to increase capacity in times of unusually high load.

**The solution has its limits. If the condensing temperature rises too high, the refrigeration system will fail**.

The way designers of traditional condensers deal with this problem is by designing the unit and selecting components such that the unit runs at a low condensing temperature (and consequently, a low TD) under normal conditions. **It has a devastating effect on the energy efficiency of both the condenser and the system as a whole.**

**The solution, for the traditional condenser user, is a much larger condenser.** So much for efficiency!

So, traditional condensers walk an uneasy line between inefficiency and system failure – seemingly only able to purchase a moderate amount of efficiency and freedom from failure by the expenditure of massive amounts of input power and capital investment.

**In an EC condenser we can increase capacity by increasing fan speed, so we don't need to specify an artificially low TD in order to avoid failure.**

**In short, by combining a variable speed fan with TD changes, EC condensers can *precisely* match their capacity to the load – whether regular, minimal, peak or anywhere in between – while maintaining a level of efficiency that puts traditional condensers to shame.**

With traditional condensers, designers and users are controlled by the limitations of the components. **With EC condensers, you are in the driver's seat, able to manipulate the variables to produce a condenser that is the perfect fit for all the needs of your application.**

# EC: Controlling Noise

## Controlling Noise: Sound Varies With Speed

For almost all refrigeration and air-conditioning applications, noise is as important a consideration as capacity and efficiency. More so in some cases, as it is affected by, and enforceable by, law.

**When it comes to noise control, EC condensers have two advantages.**

**The first is that EC fans naturally run more quietly than many of their AC counterparts.**

The second is that, **with EC condensers, the noise can be minimised by – wait for it – controlling fan speed.**

With traditional AC condensers, reducing the fan speed would not necessarily help with noise, as they usually protest audibly when speed controlled. And of course, as we have already seen, AC fans running at less than full speed are undesirable from an efficiency standpoint.

**With EC fans, speed control is an integral part of their design, so when you reduce their speed, the only effect it has on noise is to reduce it.**

**Knowing this allows for precise condenser selection to meet noise criteria**, as the chart shows. Simply specify your maximum sound level and you can work out which condenser to choose based on fan speed.

**As well as helping with initial selection, knowing that sound varies with fan speed can help with day-to-day, or indeed, day-to-night, noise management.**

**If you require a lower sound level at night, for instance, you can adjust the speed of your EC fan to meet that requirement.**

## Controlling Noise while Maintaining Capacity

Of course, as we showed before, lowering the fan speed also lowers the capacity of the condenser.

In most cases, it is reasonable to expect that the load *will* drop at night and the ambient temperature is almost always lower at night

But what if the load doesn't drop? You might be in an area, or it could be a time of year, where the ambient temperature doesn't drop much at night. Or you might be cooling a process that operates 24 hours a day.

**How does EC help when you need to reduce noise and maintain capacity?**

**Once again, the flexible fan speed offered by EC condensers is the key, this time combined with what we know about variations in TD.**

**Because we know that sound varies with speed – and because we have had the foresight to install an *EC* condenser – we know that, by slowing down the fan, we can achieve the required noise reduction.**

But we also know that reducing the fan speed will reduce the capacity, which will leave the condenser unable to cope with its load – won't it?

No, it won't. By 'allowing' the TD to rise by just a small °K – well short of any risk of system failure – we can maintain our condenser's capacity even at the lower speed needed to achieve the required noise reduction.

**Combine knowledge of TD with an *EC* condenser, and you can use the TD/capacity relationship to help you fine-tune your machine to work just the way you want it to – in this case, to control noise while maintaining capacity.**

It's what we said at the beginning, demonstrated all over again, this time with noise. **EC technology is all about control – and giving that control to *you*.**

Here, EC is the difference between using TD as a blunt instrument and using it as a precision tool. That's why we talked about 'allowing' the TD to rise. We didn't really 'allow' it – the TD rise was automatic under these conditions. **But with the control that EC provides, we have the confidence to predict and use the TD rise as part of a pre-determined plan to manage the situation**.

# EC: Controlling Input Power and Operating Costs

## Controlling Noise: Automatically

So EC condensers allow us to control noise much more simply and effectively than fixed fan-speed condensers. But simple is not always the same as easy. How easy is it to use the speed control of EC to control noise?

**We are pleased to say that, with an EC condenser, changing fan speed to adjust to night-time noise requirements is more than easy – it is *automatic*.**

It is normal for both load and temperature to reduce at night. EC fans are programmed to respond *automatically* to both reduced load and reduced temperature by reducing their speed. **Since reduced speed means reduced noise, that basically translates to automatic noise control at night.** It doesn't get much easier than that. Knowing Load and ambient temperature allows one to predict the sound level.

**That is what EC technology does. It converts difficult and rigid into to easy and flexible. It makes tricky and impractical control, easy and automatic. It converts 'near enough' and 'rule of thumb' to precision engineering and perfect fit.**

It's enough to make you ask "why didn't someone think of that before?"

Isn't that the sign of a technology that is truly revolutionary? We think so.

## Controlling Energy Wastage

Early on in this document, we said that non-EC condensers waste energy 99% of the time.

That's a big claim, so it seems appropriate to explain the reasoning behind that number.

In the section on 'capacity', we said that condenser designers base their component selection on the condenser's maximum likely load. Obviously, they don't just make up that load; they base it on empirical data. Since ambient temperature is the key factor in creating load and limiting capacity of a condenser, the most important piece of data used is the 'design ambient temperature' for the location.

Design ambient temperatures vary from place to place, but the percentage of the year that they represent is much the same wherever you go, less than 1% of the year. In Alice Springs for instance, the design ambient temperature is 40.5˚C (critical process 24hr) which is reached approximately 25 hours per year. In Melbourne it is 36˚C which is reached ~29 hours per year. Well short of 1% of the 8760 hours in a year.

**Therefore, compared to the traditional, fixed fan-speed version above, an EC condenser will, indeed, SAVE energy 99% of the time.**

## Control Energy Input

**We have alluded elsewhere to the energy savings you can achieve by deliberately reducing fan speed. Just how big are those savings?** Very big…

**By simply dropping the fan speed by 20%, we approximately halve the power consumption of the fan.**

Given that we have already seen that the system only needs to run at full capacity for about 1% of the time, think of the savings you can make on energy costs!

Do we need to say it again? You can't do this kind of thing with traditional, AC condensers.

**EC control delivers results – seriously good results in efficiency, sound control, system management and operating/capital cost savings – and this combination is what ebm-papst specialises in delivering.**

**The only question now is whether you can afford to do without those results.**

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