NEC ENERGY SOLUTIONS

When it comes to powering your AGVs, charge time is more important than runtime but uptime is king.

By NEC Energy Solutions

Battery-operated Automatic Guided Vehicles, or AGVs, are quickly becoming an appealing option in manufacturing, warehousing and distribution across a myriad of industries. AGVs can speed up the workflow by handling tasks such as moving raw materials, pallets and finished products, and loading and unloading trailers and containers.

Once thought of as a tool only for large-scale manufacturers, the ability to scale production of AGVs has reduced the overall cost and increased the popularity within small and midsize businesses.

There is significant upside to using AGVs, most notably the improvement of plant-floor efficiencies and reduction of overall operating costs. AGVs are more productive than humans in part because they can work for more hours. Whereas people typically work 8-10 hour shifts, AGVs can work 24 hours a day, stopping only when they need to recharge their batteries. The drive for higher and higher levels of productivity has caused some AGV manufacturers to select larger batteries that can last longer between recharge periods. This is understandable: more runtime means more time doing work, right? As it turns out that is not always the case. What some end customers and OEM's may be overlooking is how long it takes the battery to recharge.

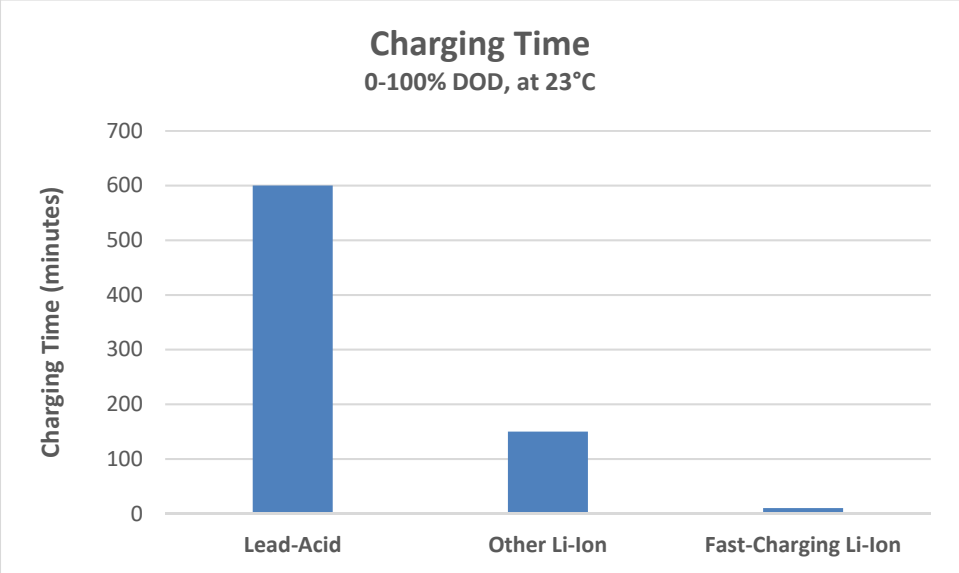
To better understand this, let's first define some things. When we talk about runtime, we typically think about the amount of time that an AGV can be operated before the need to charge it. Charge time is how long it takes to recharge the battery once it is depleted. Uptime is the amount of time the AGV is available to do work over a specified period, for example over 24 hours. Uptime takes into account the downtime needed to recharge. While runtime is important, what's even more important is the uptime.

Now, let's look at several different battery technologies and their charging characteristics.

The most common type of battery that most people are familiar with are lead acid batteries. Lead acid batteries are relatively inexpensive but they are big and heavy and don't last long in applications where the batteries are constantly being charged and discharged. They also require a lot of time to recharge, often more than 10 hours. Although lead acid batteries were very common in fork trucks and in early AGV's, their size, weight, poor cycle life and long charge times make them a poor fit with AGV

applications. As a result, as the cost of lithium ion batteries has come down, most AGV manufacturers are now specifying lithium ion batteries in their products.

Although people refer to lithium ion batteries as a category, in reality there are many different chemistries and constructions of lithium ion batteries, all with different characteristics. Understanding these different characteristics is important because among other things they affect things like charge time and cycle life. For example, some lithium ion battery chemistries require 2.5 hour charge times whereas other battery chemistries can be charged very rapidly, say in 10 minutes or less. As you can imagine, picking the right battery with short charge times can have a significant impact on uptime, and therefore overall productivity.



Shifting the focus from runtime to uptime

When a plant manager is considering AGVs for their manufacturing or warehousing, one of the first questions they may ask is the simplest: what is the runtime?

That, for the most part, makes sense. Factories and warehouses have traditionally been managed around 8 hour shifts and it makes sense to think of AGVs needing to run for at least as long as a shift. While this is reasonable, there is another question that they should also be asking: How long does it take to charge the batteries? This question is equally important because it impacts the uptime of the AGV.

Let's take the following example…

Battery A gives you six hours of runtime. In exchange, you need two hours to fully charge the empty battery. Battery B gives you five hours of runtime, but in exchange, you need just 10 minutes to fully charge the battery.

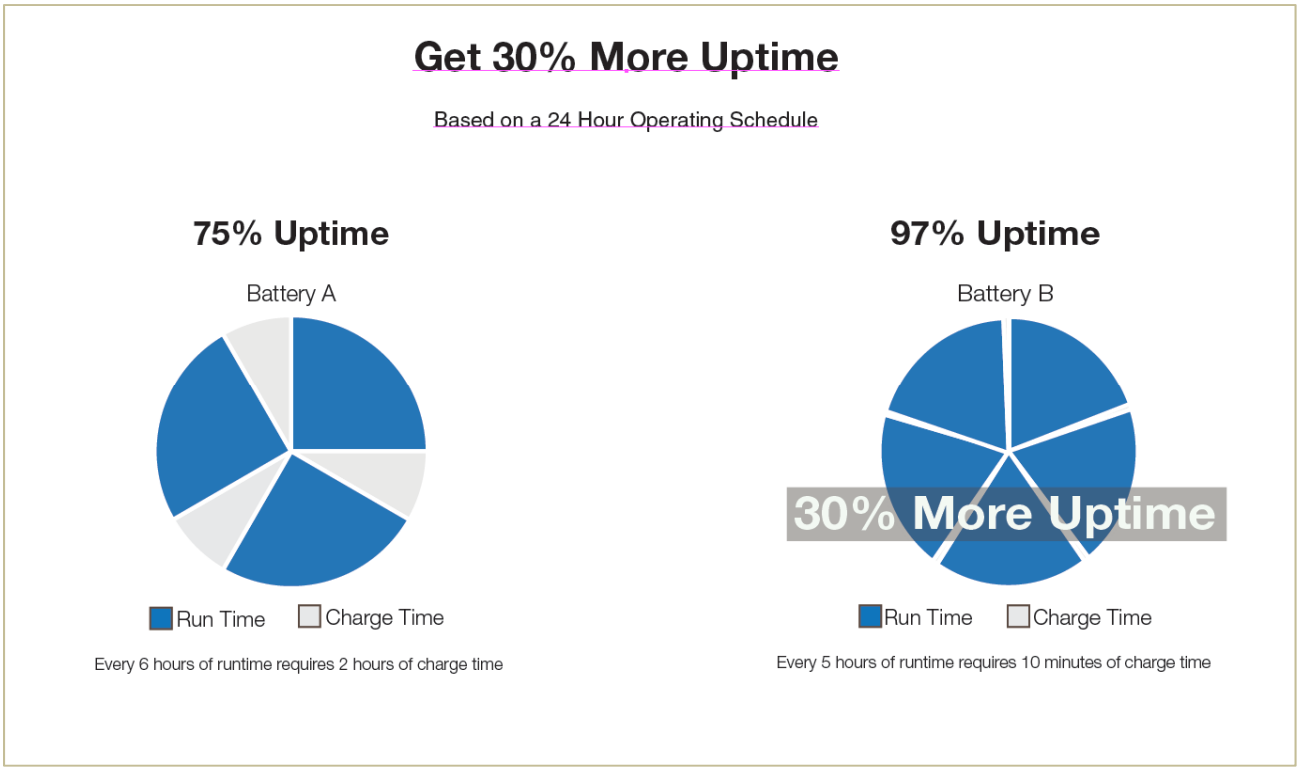
If you're comparing just the runtime, you might think that Battery A, giving you 20% more runtime is the better choice. But if you start by considering the downtime needed to charge the battery, Battery B should be the clear choice.

Let's do the math…

In a 24-hour cycle:

Battery A – Every 6 hours of runtime requires 2 hours of charge time so 18 hours runtime requires 6 hours of charge time.

Battery B – Every 5 hours of runtime requires 10 minutes of charge time so 23.25 hours runtime requires 45 minutes of charge time.



As you can see in the above charts, a fast charging battery allows the AGV to go from 75% uptime to 97% uptime. That is a 30% improvement in productivity! That's why

at least an equally important question to consider when choosing an AGV battery must be how much charge time is required. Not only does Battery B give you more uptime, it is also likely to be physically smaller and lighter, taking up less precious room in the AGV.

Opportunistic charging

An additional advantage of a fast-charging battery is that it is easier to take advantage of any idle time that the AGV may have. In any given factory or warehouse, an AGV may find itself waiting for some other part of the process to complete before it can do its job. In this scenario, with a fast charging battery, the AGV can go to its charging station and get a partial recharge with whatever available time that it has.

Let's use the above calculations for Battery B, a fast-charging lithium ion battery. We said that for 5 hours of runtime, it would require 10 minutes to fully charge the battery. But what if you don't fully drain the battery?

Let's say that in a given process, for every 30 minutes of work, the AGV must wait 1 minute for another process step to complete before it can resume work. For Battery B, 1 minute of recharge time provides 30 minutes of runtime. The AGV can use its idle time to recharge and get back to work without ever needing to stop for a complete recharge.

Furthermore, most batteries prefer smaller depth of discharge cycles vs. complete discharge cycles. Batteries that are completely discharged and recharged every cycle will typically wear out before batteries that are only partially discharged and recharged. Therefore an additional benefit of opportunistic charging is that your batteries are likely to last longer than if you completely discharged them every cycle.

Assume an AGV runs at 2A average current. It has a 10 Ah capacity battery – but is high power and can charge at 60A. During the day the AGV finds it can recharge for 1 minute at 60A. Charging for 1 minute will restore 1 Ah of charge (1 min x 60A = 1 Ah). Now with its short charging window completed, upon returning to its duty, it can run for a total of 30 minutes (1 Ah / 2A = 0.5 hr. = 30 minutes).

Specifying the battery early in AGV design build process

Battery selection may never be the most important thing AGV designers consider when designing their robot. Understandably, things like job function and even aesthetics will always take priority. That said, AGV designs can benefit significantly by taking consideration of the battery earlier in the process. Selecting a battery early allows designers to take advantage of the aforementioned performance benefits of certain batteries but only if they also select a charging system that can deliver the fast charge to the battery. Early battery selection may also enable the use of off-the-shelf batteries.

Off-the-shelf batteries are typically in standard rectangular form factors that may not fit into a robot if this is not considered early in the process. But the advantage of using an off-the-shelf battery is that these batteries are already being manufactured in high volume and therefore can offer availability and cost advantages as opposed to custom batteries with similar performance.

Off-the-shelf batteries can be strung together in various series and parallel configurations to enable different AGV models while using a single battery specification. Moreover, if the AGV designer selects an off-the-shelf battery that already is UL 1973 certified for example, they will be able to avoid having to invest in that certification process themselves.

By definition, an off-the-shelf battery is immediately available compared to a custom battery which needs to go through an expensive and time consuming design and verification process. Using an off-the-shelf battery also allows the AGV designer to focus on other, more important aspects of the AGV design.

Perhaps most importantly, because these off-the-shelf batteries are already in high volume production, their manufacturing processes are proven and as a result these batteries are likely to have a higher quality level than a new, custom battery design. As your AGV production volumes grow, you can be confident the off-the-shelf battery will be available in quantities and at a quality level that meet your need.

Safety is paramount

Whenever a lot of energy is stored in one place, safety must be an important consideration. As with other energy storage methods, this is also true with batteries.

Due to their performance and decreasing costs, lithium ion batteries, already ubiquitous in consumer electronics, are being adopted in more and more applications. Here again, selection of a lithium ion battery is critical.

Poorly manufactured or designed lithium ion batteries have generated negative news recently as videos of cell phones, laptop computers and hover-boards catching fire have gone viral. Therefore, rarely is it the wise choice to select the lowest cost lithium ion battery.

Different lithium ion batteries have different chemical, mechanical, electronic and software designs and these designs each have an impact on safety. For example, some lithium ion battery chemistries are inherently less prone to catching on fire than other chemistries. Also, a thoughtfully-designed battery cell is better able to withstand abuse such as crushing or heating than a less well designed cell.

At the module level, a higher-quality battery is mechanically designed to handle vibration and shock of the type an AGV would regularly experience whereas in some battery designs, especially custom batteries, the cells are literally held together with shrink wrap. Also at the module level, a well-designed battery has hardware and software that carefully monitors the cells for voltage and temperature and can effectively protect the battery from being put in an unsafe condition. Finally, proven, well-controlled manufacturing processes at the chemical, cell and module levels are also critical to prevent manufacturing defects that could cause unsafe conditions.

Summary

There are many things to consider for OEMs and end users of AGVs when choosing the correct battery. But when making that choice, make sure one question you are asking yourself is how efficient is the battery for charging. Because picking the right battery with short charge times can have a significant impact on uptime, and therefore overall productivity.

It is also important to remember a fast-charging battery that also provides the highest level of performance throughout the range of charge can not only increase productivity but can also extend the life of the battery, reducing the overall cost of operation.

Additionally, if you understand how your battery charges and operates, the ability to opportunistically charge a battery can further increase productivity while often times increasing the life of the battery.

For OEMs, the earlier you consider the battery that your AGV will need, the more you can align the needs of your AGV with a proper battery, thus saving time and increasing the efficiency of the AGV. Understanding the benefits of off-the shelf batteries including scalability, safety technology and certifications can save significant time and money as opposed to custom building your battery.

Finally, safety must always come first. Commercial lithium ion batteries need to operate under extreme conditions and still perform at both a safe and efficient level. Choosing a battery with multiple levels of safety designed in and certified to relevant UL standards is critical.

Introducing the ALM-series of batteries from NEC Energy Solutions

The ALM-series batteries address all of these issues. As a fast-charging, scalable, off-the-shelf product with the highest level of safety standards and safeguards, you can feel confident when choosing the ALM battery that you are getting the best product to increase efficiency and productivity and, ultimately, your bottom line.

ALM batteries charge from 0-100% in as little as 10 minutes, making them ideal for opportunistic charging that can create a seamless recharge process to deliver a maximum Total Available Time.

The ALM batteries are completely scalable up to four in a series (48V) and 10 in parallel for expanded capacity (up to 350 Ah) without external controls. They also provide consistent performance across a wide range of temperatures.

And most importantly, ALM-series batteries provide robust safety under the most adverse conditions. Its EverSafe™ Battery Technology provides built-in, fully redundant electronic fusing and sensing protection against short circuits, over-current and over-temperature conditions with automatic recovery.

For more information about the ALM-series batteries, contact: Paul DeBruyn - NEC Energy Solutions - Direct 508-497-7136, Mobile 508-665-8074 or by email at pdebruyn@neces.com