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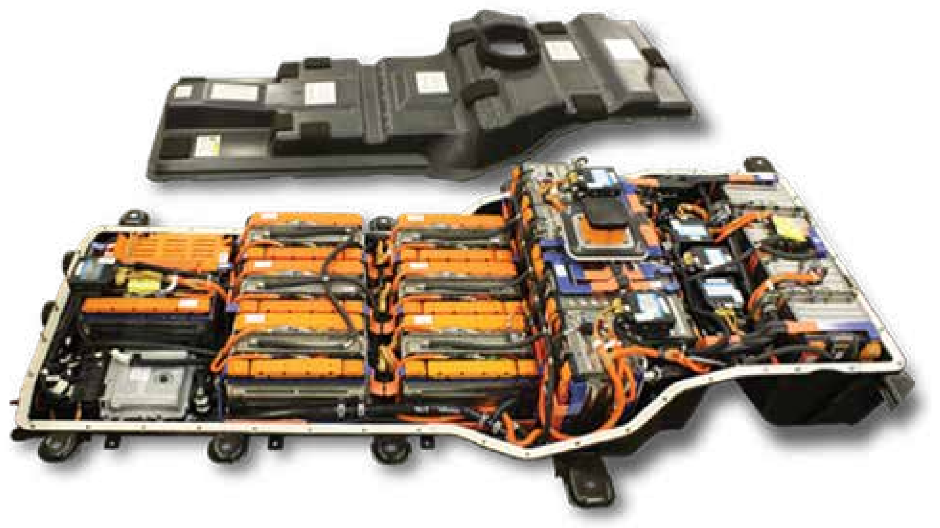
EV BATTERY PACK MANUFACTURING

IMPORTANCE OF AC SERVO SYSTEMS AND ROBOTICS TO EFFICIENTLY AUTOMATE MANUFACTURING

This document examines the increase in demand for electric vehicle (EV) batteries and explores different steps in their manufacturing process where AC servos and robotics can be used to efficiently automate their assembly

Servo and robotic automation will be paramount to achieve the demand required to supply the EV battery market

Various kinds of battery technology are used in the manufacture of EV batteries



OVERVIEW

Electric vehicle (EV) manufacturing is on the rise, creating a high demand for EV batteries.

With the demand for these batteries increasing, efficient automation of the manufacturing process is paramount to achieve the demand required to supply the EV market.

AC Servo motors and Robotics will be important in automating the manufacturing of these batteries.

Many different types of electric vehicles are creating demand for batteries.

Although electric automobiles first come to mind, there is also increasing demand for batteries to electrify aircraft, motorcycles, RVs, agricultural tractors, and residential lawn equipment.

All of these vehicles and equipment use batteries. However, various kinds of battery technology are used depending on requirements.

Below are some of the different battery technologies being used, along with the pros and cons of each.

Battery Type	Advantages	Disadvantages
Lithium-Ion	• Have a very high energy density allowing them to store a large amount of energy in a small package	• Higher cost than the traditional Lead-Acid battery
Lead-Acid	• Can store a large amount of energy at a relatively low cost. • Technology is mature, safe and reliable	• Very low energy density • Performance is significantly degraded in cold temperatures
Nickel-Metal Hydride (NiMH)	• Longer lifetime than Lead-acid • Safe and robust solution • Decent energy density	• Highest cost of the three technologies • Generate a large amount of heat and have a high self-discharge

Table 1: Advantage and disadvantages of different EV batery technologies

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Lithium-ion batteries are the most popular choice for EVs.

Their demand is increasing, causing a need to ramp up production for EVs.

EV BATTERY TYPES

Lithium-ion batteries are most used in portable consumer electronics and are currently the most popular choice for EVs and plug-in hybrids.

Lead-acid batteries have the lowest cost of the three battery types above. However, their low power density makes them an unappealing solution for EVs.

NiMH batteries offer a high energy density and have proven very durable. They are commonly used in Hybrid Electric Vehicles (HEVs); however, their high cost, comparably higher heat generation, and self-discharge limit their uses in EVs.

With Lithium-Ion being the most popular battery choice for EVs, the demand for Lithium-Ion batteries is increasing rapidly. There is a need to ramp up production of Lithium-Ion batteries for EVs.

CELL HOUSINGS

There are 3 different kinds of cell housing used for EV batteries.

- **Cylindrical cells** have a cylindrical shape as the name states. These cells can be stacked in large quantities to create a battery pack containing hundreds or thousands of cylindrical cells.
- **Prismatic cells** are rectangular in shape and can be very efficiently stacked within a work envelope. A single prismatic cell may contain the same amount of energy as hundreds of cylindrical cells.
- **Pouch-type cells** vary in design greatly, and they use a flexible metal bag, allowing them to fit into small or unique spaces.

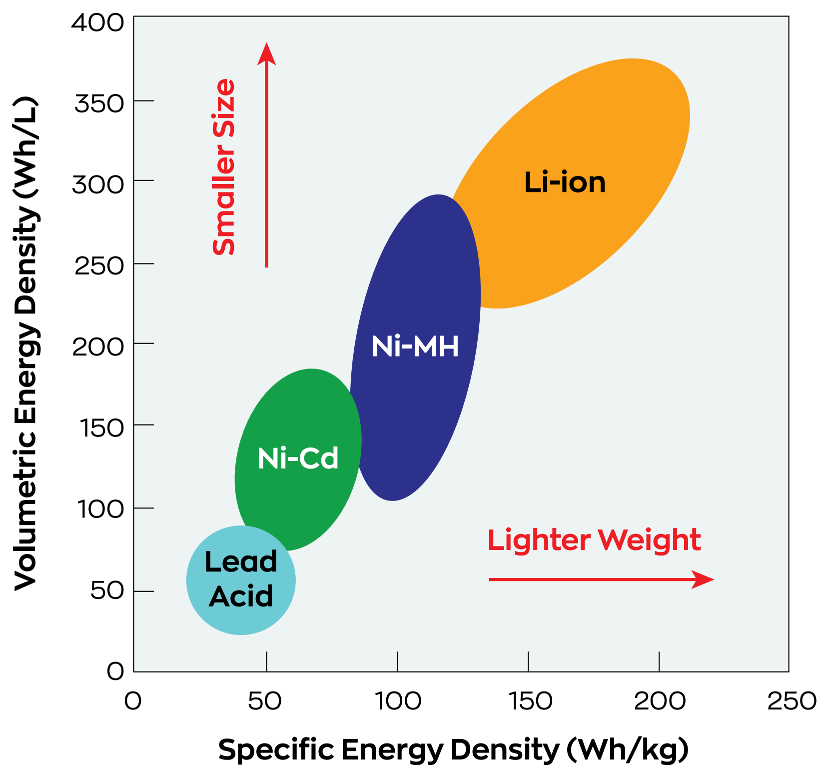

Figure 1: Battery Energy Densities

Multiple steps in manufacturing processes create an opportunity for AC Servos and Robotics to automate the assembly of battery packs

A robot offers a balance of repeatability and flexibility to properly depalletize battery cells

All three technologies are used today by various EV manufacturers. EVs, however, require many of these cells to be able to generate enough power for the vehicle.

Integrating these cells into viable battery packs requires a significant amount of labor that can be automated to yield the throughput required for large-scale production.

Multiple steps in the manufacturing process create an opportunity for AC servos and Robotics to automate the assembly of these battery packs

DEPALLETIZING

Battery cells are most likely to be delivered to the EV manufacturer as groups of cells in boxes that are stacked on a pallet.

The 1st step for these cells to be able to enter the manufacturing process will be for them to be removed from the pallet and placed into the manufacturing line. This process is called depalletizing.

One of the most effective ways to automate this process is using a depalletizing robot. A robot offers a balance of repeatability and flexibility to properly remove cases from the pallet and place them onto the conveyor.

Pallets often shift, flex, or compress during shipment, so a combination of machine vision and a robot is usually required to solve this application properly..

Figure 2: Robotic Depalletizing

Uncasing, loading, and unloading are applications that can be handled with a 6-axis robot or a servo controlled gantry mechanism

Figure 3: Gantry Solutions using AC Servos can be used for uncasing, loading or unloading. Photo: Courtesy Macron Dynamics

UNCASING

Once on the conveyor line, the battery cells need to be removed from the cases that they were shipped in.

Depending on the complexity of the cases and cells this may be handled with a 6-axis robot and/or a gantry solution that uses AC servo motors.

UNLOAD/LOAD INTO BATTERY HOLDER

Like the Uncasing process, the battery cells must be moved into the battery holder or pack. This will be the final container that will hold the groups of cells that represent a single battery pack.

This process can also be solved with AC Servos or a 6-axis robot.

If the manufacturing line needs to handle various types of products a robot may be the best solution due to its flexibility to be repurposed for new products.

If the line, however, is dedicated to a small number of products, a Gantry solution using AC servos and mechanical actuators may offer a better combination of throughput and cost of ownership

Adhesives can be applied with a 3-axis gantry coordinated with a servo driven dispenser

A wire bonder may use multiple AC servos to traverse rapidly from cell to cell for a flexible solution to connect all batteries in the pack.

ADHESIVE DISPENSING

Adhesives may be used in multiple parts in the battery assembly process. This may include using adhesives to bond the battery cells together or to the pack, adhering the battery cells to the cooling plate, and applying a sealing adhesive to connect the top cover to the bottom tray of the pack.

Many adhesives can be applied with a 3-axis XYZ gantry coordinated with a servo-driven dispenser.

Depending on the complexity of the dispensing pattern the controller may be best programmed using G-Code.

WIRE BONDING AND LASER WELDING

Once the battery cells are properly nested in their pack, the cells need to be connected to each other electrically. A common process to do this is called wire bonding.

Wire bonding offers a flexible solution to connect all the batteries in the pack. An automatic wire bonder may use multiple AC servos to traverse rapidly from cell to cell.

Another process that may be used to connect the cells together is called laser welding.

In this process, a stamped bus bar template is placed on top of the battery cells. Next, a laser welder fuses the cells to the bus bars with a controlled burst from a laser.

AC servos are often used to move the laser welder across the battery cells.

Figure 4: Servo-controlled gantry systems can be used for adhesive dispensing. Photo: Courtesy Macron Dynamics

BATTERY PACK STORAGE AND PICKING

Completed battery packs need to be removed from the manufacturing line. For large production lines, these packs may enter an automatic storage and picking system. These systems, which are used to store, sort, and pick the battery packs when needed, may be best automated with the use of a large 6-axis robot and a 7th-axis linear positioner that can allow the robot to traverse the system from end to end.

The robot's ability to reach multiple locations, articulate the battery packs, and ultimately place them in the desired location makes it an ideal solution for this application

Articulated robots are ideal for picking battery packs from the manufacturing line.

Figure 5: Picking Robot

CONCLUSION

EV manufacturing and EV battery manufacturing are creating a lot of new automation opportunities as automobile manufacturers retool their assembly process to support electric vehicles.

Many of the applications are similar or slight variations of processes that are seen in other industries. Solutions using AC servos and Robotics will continue to play an important role in automating the applications that this new industry is creating

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YASKAWA AMERICA, INC. | Drives & Motion Division
1-800-YASKAWA | Email: info@yaskawa.com | yaskawa.com

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