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A Guide To Selecting Industrial Battery Chargers For Material Handling Applications

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One of the responsibilities that accompany today's rapid advancements in technology for both batteries and chargers is the task of choosing which of the many chargers on the market are best-suited to your particular battery-powered material handling and warehouse applications. Specifiers of industrial battery chargers need to understand how the requirements of their particular application influence the choice of charger type.

This article outlines the key considerations including what questions need to be asked, and describes at a high level the differences between the three major charger technologies—ferroresonant, high-frequency and SCR. In addition to providing an overview of the internal power supply technology found within these chargers, this article also calls out some of the typical charger specifications. Furthermore, it introduces the concept of opportunity charging. While this article is aimed primarily at specifiers of industrial battery chargers, it may also be useful to novice designers of these chargers.

First Things First

We don't have to tell you that selecting the right charger is crucial to your overall facility operations, especially when it relates to power management. Having the wrong charger for your application could result in a significant reduction in battery life, causing serious cost overrides and productivity losses—not to mention serious safety concerns.

Before you go shopping for chargers, however, you need to perform a "power study" of your application to ensure your goal of maximum efficiency is met. Using battery data analysis devices, you can thoroughly evaluate your entire plant or warehouse for energy usage and environmental conditions.

What To Consider

Any effective power study takes into consideration the following factors:

- The charger history at the site which includes identifying the technology, usage (conventional, opportunity, fast, etc.), maintenance and repair.
- The electrical cost per kilowatt (kW), critical to understanding the cost savings of high-frequency versus ferroresonant versus semiconductor or silicon-controlled rectifier (SCR) battery technology.
- The environmental conditions. For example, a facility with high dust levels in the air or high ambient temperatures with no environmental controls would be better suited for a solution that incorporates ferroresonant or SCR charging applications. Alternatively, a modern building with a controlled environment would most likely equate to high-frequency charging technology and opportunity charging applications.

What To Ask

1. Where are chargers and battery changing stations located throughout your facility?
2. What combination of voltages (24 V, 36 V, 48 V and 80 V) and corresponding chargers do you operate?
3. What is your forklift's/fleet's amp-hour consumption? This matters for the charger because it's a domino effect since the ultimate goal is to ensure that the forklift ultimately receives the most efficient charge possible for its application. Matching the right charger with the right battery ensures energy isn't being wasted.
4. How many shifts do you operate/how much time is available for charging?

5. How many hours is each forklift in operation per shift?

6. How long do batteries have to cool down after charging?

7. What is your current charging style/schedule? For example, are you hoping to continue charging in the conventional 8/8/8 shift pattern, or does it make more sense to opportunity or fast-charge? (This has a direct impact on how many batteries you'll need per truck: for conventional charging you need three batteries per truck, while with more modern methods you can get away with one.)

Getting To Know Battery Chargers

The most important mission of the industrial battery charger is to charge lift truck batteries as quickly as possible without shortening the battery's lifespan due to overheating and overcharging. To protect batteries from such damage, today's chargers contain the latest technology, including complex networks of cards, sensors and preset parameters that will actually stop the charging cycle. If a problem does occur, the charger will display error codes so the operator can make the needed adjustments.

Whether the charger is a small portable unit that plugs in a wall socket or the wall-mounted variety that require large amperage capacities with dedicated wiring, they all allow you to customize the charge cycle and control everything from the amount of voltage, amperage, charging time, and even the fill rate over a given time span.

The Charger Makeup

To fully understand industrial chargers and how to apply them to your needs, it is important to know what they consist of. Basically, there are four parts:

- The case—the outer shell housing all internal components.
- The "works"—circuit cards, large capacitors and transformers. Some chargers will have as many as four transformers that weigh up to 100 pounds each. Each is responsible or transforming the charge from ac to dc.
- The digital display—the operator can view the battery's vital statistics, charge cycle and status at any given time during the charging process.
- The cables—for transferring the high amp loads and voltage to the battery.

Types Of Chargers

Depending on the application, industrial chargers fall into three basic categories with various features in each one. They are ferroresonant, high frequency, and SCR chargers.

Ferroresonant Chargers

At the heart of an efficient charger is the ferroresonant transformer where power conversion circuitry maximizes battery life with its constantly tapering charge that is automatically regulated by the "on charge" battery voltage. The output current of the charger is determined by the state of battery discharge.

By definition, ferroresonance or nonlinear resonance is a type of resonance in electric circuits which occurs when a circuit containing a nonlinear inductance is fed from a source that has series capacitance, and the circuit is subjected to a disturbance such as opening of a switch. It can cause overvoltages and overcurrents in an electrical power system and can pose a risk to transmission and distribution equipment and is characterized by a sudden jump of voltage or current from one stable operating state to another one.

The relationship between voltage and current is dependent not only on frequency but also on a number of other factors such as the system voltage magnitude, initial magnetic flux condition of a transformer's iron core, the total loss in the ferroresonant circuit and the point on wave of initial switching. Fig. 1 shows an example of a ferroresonant charger.

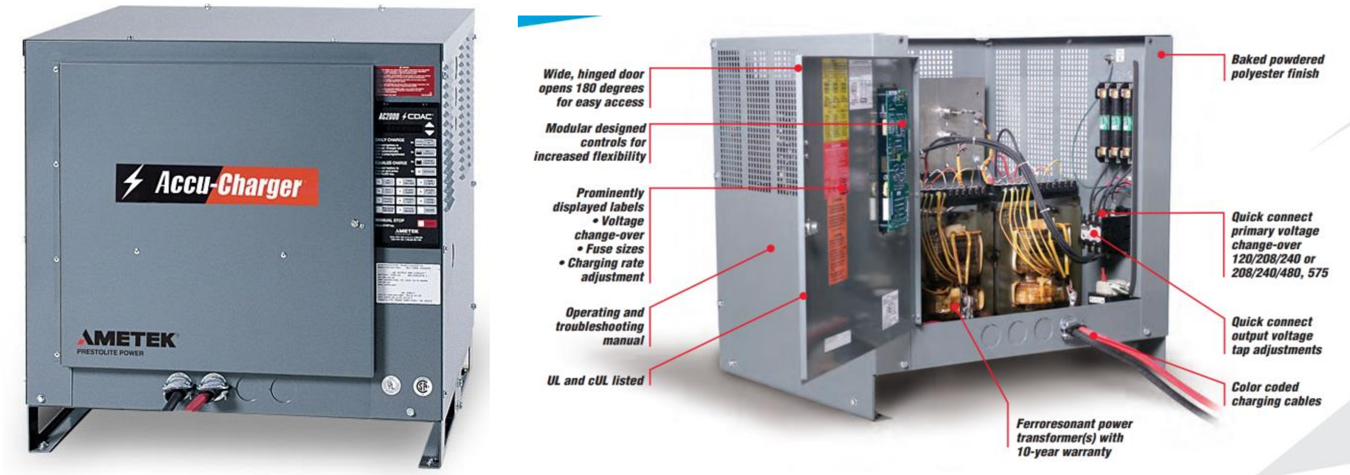

Fig. 1. An example of a ferroresonant charger, Ametek's Accu-Charger is virtually maintenance-free, and provides years of service. Members of this product family can recharge batteries with capacities up to approx. 1500 Ah in 8 hours. Units can weigh anywhere from 100 to 500 lbs. the internal view shown on the right reveals the large size of the line-frequency transformers.

High-Frequency Chargers

Because of their extreme flexibility, high-frequency chargers are well-suited for opportunity and fast-charging applications, and adapt to all types of batteries. Since ferroresonant and SCR chargers are more robust, they are less susceptible to poor power or environmental conditions than high-frequency chargers. Therefore, a history of past high-frequency technology problems equates to possible site conditions that are not favorable to high frequency, such as an environment with high levels of dust particles in the air or very low ambient temperatures, where a ferroresonant or SCR charger might better serve as an alternative.

High-frequency chargers are small in size, light weight and use IGBT technology that delivers high efficiency and precisely controlled charger curves that are current and voltage constant (I-E-I). Fig. 2 shows an example of a high-frequency charger.

Fig. 2. An example of a high-frequency charger, the eclipse II employs IGBT-based switching to achieve 93% efficiency. Members of this product family will fully recharge lead acid batteries with capacities ranging from 500 to 1600 Ah in 8 hours or less in compact units weighing approx. 100 to 135 lbs. The internal views reveal the use of smaller magnetics and more electronics circuitry—hallmarks of a switched-mode power supply.

SCR Chargers

Silicon-controlled rectifier (SCR) type battery chargers are designed for conventional charging applications where one complete charge cycle per day per day is required. They regulate charging current by allowing the battery to determine its own charge cycle rate in accordance with its state of discharge. SCR chargers provide a constant current-constant voltage-constant current (I-E-I) charge that eliminates the possibility of overcharging, even with line voltage variations of ±10%, and allows the battery to finish at the proper current, regardless of its age or temperature. SCR chargers are best suited for slow-charging conditions. For fast-charging, full-wave rectified charging voltage is needed.

Examples Of Charging Conditions

- Extreme cold—Batteries with low electrolyte temperature require a higher rate of charge. In extreme cold applications, charger oversizing may be recommended on certain ferroresonant chargers such as the AMETEK Prestolite Accu-Charger and Battery-Mate 100 chargers.
- High ambient temperatures—Conversely, batteries with high electrolyte temperature require a lower rate of charge. For high heat applications, ferroresonant chargers should be undersized.
- Multiple Shifts—Chargers selected for multiple shifts are dependent on recharge time requirements. The higher the output, the quicker the charge. AMETEK's Ultra and Accu chargers, for instance, will recharge an 80% discharged battery in six to seven hours, while its Battery-Mate 80 can complete the recharge in just over eight hours.
- Single shift—With lower start rate chargers the only compromise is charge time. The battery will still receive a complete charge, but it will require more time to do it. For instance, the AMETEK Battery-Mate 80 requires eight hours to recharge an 80% discharged battery while the Battery-Mate 60 model requires 10 hours.
- Light duty—The recommended chargers for light duty applications still have the same proven quality. With a reduced start rate the pricing is less expensive. Charge time on the recommended units vary from eight to 12 hours to recharge an 80% discharged battery.

Opportunity Charging

Until now, when lift-trucks lost battery power during a shift they had to be removed from service so the spent batteries could be replaced with newly charged ones. This resulted in downtime and lost productivity. That scenario is no longer the case with the advent of opportunity charging.

Simply, it is a system that permits batteries to be charged several times during the work cycle (usually eight hours). This permits one battery to remain in the vehicle much longer than the traditional power sources and allows plant or warehouse operators to apply sufficient charge to the battery when the utility vehicle is on a break during work shifts. A battery can last two or more shifts as a result, depending on the power demands of the application it is used for.

Other benefits of opportunity charging:

- There is no longer much need for dedicated battery rooms, spare battery storage, battery-handling and battery-changing equipment (and personnel).
- It also reduces the time spent on travel from worksites to battery-changing and charging rooms, significantly increasing productivity as well as decreasing the risk of injuries suffered while hoisting heavy batteries in and out of trucks.

Technically, opportunity charging means users apply charge rates up to 25 A per 100 AH of the battery's rated capacity. Fast or rapid charging means that operators apply charge rates between 25 and 50 A per 100 AH of the battery's rated capacity.

The traditional method used to estimate a lift truck battery's life for an application is to allow for one "cycle" per day, defined as eight hours of work (discharge), eight hours of charging, and eight hours of rest or cool-down time. This limited a battery's use to one cycle per day.

The eight-hour charge time allowances have been based on charging rates of about 14 to 20 A for every 100 AH of a battery's rated six-hour capacity.

Final Thoughts

Whatever your charging needs, do not skimp on quality. Major industrial charger manufacturers, including AMETEK Solidstate Controls, offer a wide variety of models in different sizes and configurations, each designed for custom applications. When deciding which chargers are best for your application, make sure the products you select are rated high in meeting industry standards for advanced technology, efficiency, accuracy, flexibility and durability.

About The Authors

Jeff Harrison, a 25-year industry veteran who has served as director of sales and marketing for AMETEK Prestolite Power for the past four years, is responsible not only for leading the company's sales efforts but also implementing its marketing strategies and increasing market share. A business unit of AMETEK, a global manufacturer of electronic instruments and electromechanical devices, Prestolite Power produces a wide range of industrial motive power battery chargers. Harrison holds a bachelor of arts degree from the University of Missouri.

For further reading on the design of battery chargers, see the How2Power Design Guide, select the Advanced Search option, see the Power Supply Function category and select Battery Chargers.