Ultracapacitors – NaS battery assistance

Given the very similar voltage range for ultracapacitors as NAS battery cells, packs of ultracapacitors could easily be integrated alongside an NAS battery system to provide additional energy storage backup capability. The ultracapacitor packs would also easily be able to provide the low system output impedance that would be necessary to interface to the synchronous grid tie inverter, distribution transformer and switchgear of many modern wind farm and solar grid tie systems.

There are two operating modes for ultracapacitors when used with NaS batteries. The first is to keep the ultracapacitors in either an uncharged state, and the second is to use the ultracapacitors in a charged state, depending on the type of load. Given that most applications are energy storage and ride through applications, only the second will be discussed here. Service life is not a factor for ultracapacitors because of the high number of charge – discharge cycles that are possible (> 500k cycles).

The second mode of operation, with an ultracapacitor power array, or ultracapacitor packs floating, means that either passive balancing or active balancing of each ultracapacitor cell must be happening in real time. With today's power electronics technology, this is not a problem, and cells can be individually balanced, in real time, to whatever voltage band is necessary without one balancing circuit affecting the other.

Ultracapacitors help NaS service life

Long service life of the NaS batteries is necessary to achieve a good economic benefit. With the threat of moisture being so important, regular NaS battery servicing is necessary, as well as individual cell inspection to ensure long term operation. Battery servicing has to include the very important work of replacement of those cells that show any sign of leakage, so that failed cells can be replaced with new ones. During this time, ultracapacitor arrays can take the critical load off of the NaS battery pack to allow for servicing.

Ultracapacitors buffer load guarantee requirements

An NaS battery, no matter what its energy density is, still suffers from the situation that it may see an abrupt increase in load, even when the battery is not at 100% state of charge. Statistical analysis of NaS battery reliability reveals that meeting specific abrupt load demands is more difficult when the state of charge of the battery is reduced. Because ultracapacitors possess, by several orders of magnitude, higher specific power than batteries, they can be used as an almost seamless buffer to enhance the servicing of NaS battery arrays. Floating ultracapacitor arrays can be connected and disconnected if needed, with minimum change in voltage, and minimum generation of electromagnetic interference, since ultracapacitor arrays can be matched to active, real time NaS battery array voltage before connection or disconnection.

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The preferred combination

The NaS battery has the ability to deliver long term power, but also has the drawback of high temperature operation, coupled with the need for periodic maintenance and inspection to make sure that any leaky cells are detected, and replaced promptly. The NaS battery is kind of like the "weight lifter" of the group. The ultracapacitors can provide short to medium times of large amounts of compatible power like the NaS battery, and have the advantage of flexibility and ease of handling with virtually no maintenance. Thus, the ultracapacitor arrays are kind of like the "sprinter of the group." The two together make the perfect power combo team - each doing their own function to help meet the overall power needs – short term and long term.

Ultracapacitors increase overall system energy time

The use of ultracapacitors in conjunction with lead acid batteries for locomotive starting has shown an increase in cranking time by more than a factor of 2 times. While providing grid backup is not exactly the same application, a very favorable increase in the power available-time curve is also expected with the use of ultracapacitors in conjunction with NaS batteries.

Conclusion

When comparing the use of ultrcapacitors with NaS battery arrays, we can come to the following conclusions:

- The ultracapacitors can take upon themselves, all of the power functions, except for extended time operation, and this is actually only dependent on the ultracapacitor system size.
- Ultracapacitor power arrays, in conjunction with the NaS batteries, can deal with any abrupt or unusual system power demand, up to or exceeding the power demand capability of the NaS battery array alone.
- State of charge of the NaS battery array does not affect the characteristics of the ultracapacitor energy delivery capability.
- Due to buffering by the ultracapacitor array, the NaS battery array is not subjected to large current loading, which makes its operating conditions, under all conditions of line and load more moderate.
- When combined with ultracapacitors and given specific NaS battery system sizes based on load requirements in the past, the size of the specific NaS battery system can be reduced and still supply the required short term to moderate term power. Ultracapacitors can offer hundreds of thousands of charge-discharge cycles. Since the depth of discharge of the NaS battery array is reduced, this represents an increase in the service life of the NaS battery array. If NaS battery/ultracapacitor maintenance and repair expenses follow the trend of lead acid battery/ultracapacitor combination trends, then users can expect to see their costs cut approximately in half.
- Ultracapacitor are not only compact, but also are sealed, and maintenance free. This means that they can be installed in almost inaccessible places.

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