

Li-ion Battery Development for Forklift Trucks in North America

北米フォークリフト向けリチウムイオン電池開発

* 1

Matt Wavrek

* 1 Raymond Corporation

Abstract

Rapid growth in multiple material handling sectors has driven needs in the industry for more powerful, effective equipment. That growth drove a need for improved, more capable power sources. In response to the need for increased power and data enabled devices, Raymond developed the Energy Essentials line including Lithium batteries (LIB). In addition, business operations began needing more storage space to cope with growing product variability. The LIB removed the need for large battery rooms and regular battery maintenance. This returned floor space to operations and required less intervention from personnel, who could now return battery maintenance time to value added activities. Developing a telematics enabled, NMC (Nickel Manganese Cobalt) chemistry power source maximized battery capacity and performance of our lift trucks. The battery's long cycle life, with stable performance, ensures a good investment for our customers. Market acceptance has gone well, and adoption continues to increase year over year.

Keywords: Lithium ion Battery, NMC, Cycle life, UL certification

要旨

マテリアルハンドリング分野では、より高性能、高効率な機器を求めるニーズが急速に高まっている。高性能電池はそのニーズの一つであり、レイモンドでは出力向上と“つながる”機能ニーズに対応したEnergy Essentialsと称する電池製品群を開発・展開している。特にリチウムイオンバッテリー (LIB) は高エネルギー密度、省メンテナンスでお客様の省スペース化、作業負担軽減に貢献できる。今回開発したテレマティクスに対応したNMC型 LIBはフォークリフトトラックのバッテリー容量と性能を最大化し、長寿命化を達成した。

キーワード: リチウムイオン電池、NMC、サイクル寿命、UL認証

1 Introduction/Background

The material handling industry continues to seek energy power sources, capability of providing increased performance and superior uptime. Lithium-ion batteries (LIB) continue to expand the horizons of vehicle performance and rapid charging capability. The concept of charging at point of use and high C-rate¹⁾ charging was now possible. Customers began to demand maximum performance and quick return on investment.

1) C-rate: It is a measure of the rate at which a battery is discharged relative to its maximum capacity. A 1C rate means that the discharge current will discharge the entire battery in 1 hour. For a battery with a capacity of 100 Amp-hrs, this equates to a discharge current of 100 Amps.

Raymond developed the Energy Essentials battery to address these customer needs and application requirements. Through this premium LIB offering, some customers, because of their application / lift truck usage, have been able to reduce battery counts on site and achieve more throughput with a single battery. When it is possible to deploy a single battery solution, per truck, the need for battery changing is removed,

as part of the process and improvements in operational efficiency and floor space utilization can be realized [Figure 1].

Raymond has now released multiple UL Listed battery voltage offerings to support the class I-III model lineup. Telematics and integrated data support, with the PSI²⁾ battery communication option, now enable improved fleet optimization and real time battery data reporting. Additional, complimentary product offerings are being developed now to support the Energy Storage Solutions needs of the future.

2) PSI: Power Source Integrated. It enables data liberation for both lithium and hydrogen fuel cells, reporting 12 unique performance metrics through the iWAREHOUSE GATEWAY™.



Figure 1 LIB family from Energy Essentials

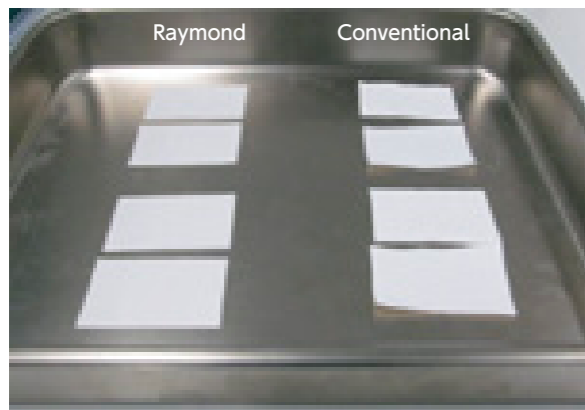
2 Features and Benefits of Product

The Raymond LIB offerings are technology rich and have industry leading features. UL compliance, reliability, and durability were designed in. The battery requires limited maintenance over its lifetime – no daily watering and emits no harmful vapors or gases during normal operation.

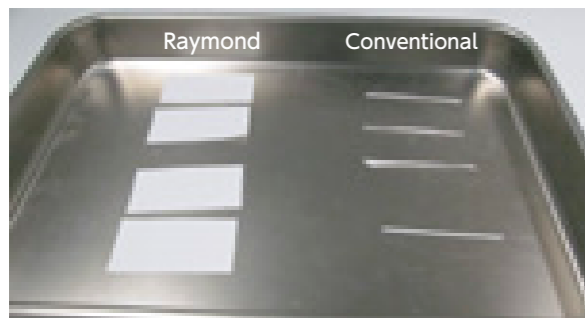
Projects to release 24V and 36V battery offerings have been completed. 48V batteries will be launched by time of this article's release. Premium cycle life and energy density were top priorities and resulted in the decision to utilize NMC chemistry and these features on this critical path.

2.1 High cycle life

The special ceramic separator technology used allows the battery to be used in wider temperature ranges and helps to maximize the cell's potential. Figure 2 shows the ceramic separator's results during characterization testing for heat.



(1) Before test



(2) After test (15min at 130°C)

Figure 2 Ceramic separator

NMC chemistry was selected for its energy density. Due to the proprietary cell chemistry, special ceramic separator, and customized Battery Management System (BMS), the Energy Essentials battery delivers industry leading cycle life. Figure 3 shows Lab testing results that demonstrated cycle life in excess of 5000 cycles. This means much higher cycle life performance than current competitor levels of up to 3000 cycles. This allows Raymond to offer a product with industry leading performance and value.

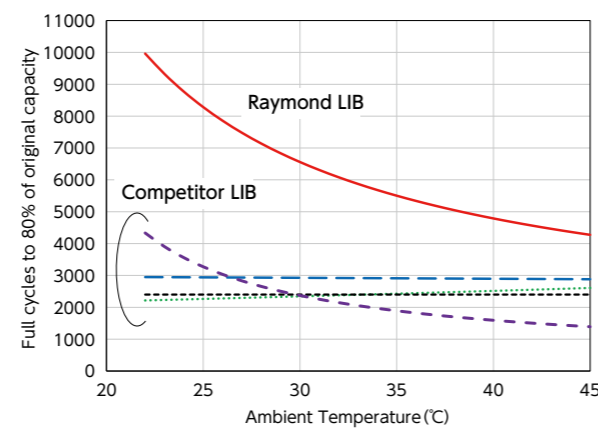


Figure 3 Characteristics of cycle life
Cycle life testing is based on controlled laboratory conditions and shows equivalent life expected. ELV is the industry leader.

2.2 UL certification

Energy Essentials batteries are inherently designed to UL2580 to ensure compliance and strong performance.

Should battery customization be required, or even the need for an alternate battery be pursued, Raymond supports requests through our third-party EPS approval process. Customer first, always.

3 Conclusions

The results of years of development and testing, offerings under the Energy Essentials distributed by Raymond brand are now available across the full product line with UL2580 listings [Figure 1]. These batteries have already been

delivering strong performance in applications and adoption continues to increase, year over year. Sales trends show accelerating sales and more customer interest in LIB. Raymond is delivering industry leading total cost of ownership with these batteries [Figure 4, Table1].

Overall customer adoption continues to grow. During this development, we created a joint working group to provide more high efficiency products to meet customer satisfaction as one TMHNA. A development cadence is in process for next generation batteries, with even more improved performance.

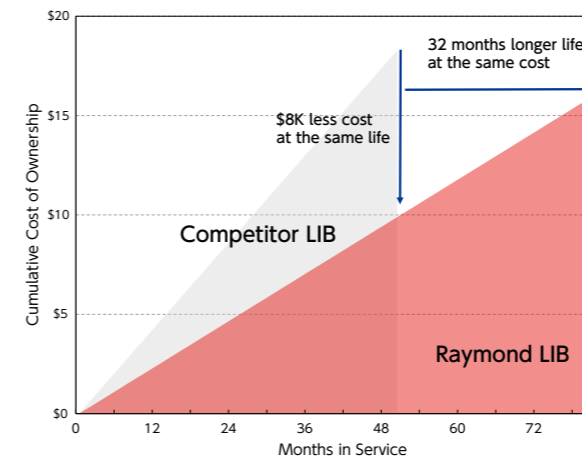


Figure 4 Total cost ownership

Table1 Comparison of useful life and cost

	Competitor	Raymond	Difference
Operation shift	2	2	–
Days/Year Usage	365	365	–
Design cycle life	3000	5000	+ 2000
Useful Life Mo	50	82	+ 32
\$/Mo Operation	\$366	\$198	–\$168

Author



Matt Wavrek
Product Development Engineering
The Raymond Corporation