Lift Truck Comparisons—DC Drives Versus AC Drives

BACKGROUND

In 2004, EPRI published the document "Evaluation of Opportunities for Fast Charging Application at Del Monte Foods," Palo Alto, CA: 1002237. This document considered the economic impacts of forklift operations utilizing propane, conventionally charged batteries, and fast charged batteries. This analysis considered both warehouse and production operations and the impacts of rate structures for secondary and primary power delivery.

Resulting from their investigations of various chargers and lifts, Del Monte Foods is proceeding with plans to use AC motor-driven lift trucks powered by fast charged batteries. At one facility the AC lifts operate from 48V batteries while another facility utilizes lifts that operate from an 80V battery system. The new fast-charger being used by Del Monte Foods is capable of charging both the 48V and 80V fast-charge battery systems associated with this new equipment. With these new 48V and 80V AC forklifts available alongside new DC units, EPRI took advantage of the opportunity for comparison studies of these new technologies.

APPROACH

EPRI investigators developed comparative data from equipment vendor interviews, forklift operator interviews, and field measurements. Equipment vendor interviews provided insight into the comparative capital and maintenance costs associated with the different forklifts, battery configurations, and fast-charging equipment. Forklift operator interviews provided an understanding of forklift performance issues. Information from the forklift operators was compared with monitored data obtained from the chargers and from independent revenue meters placed on the AC supply to the fast-chargers.

RESULTS

Interview and monitored data were gathered for 3 different forklift systems. Economic analysis compared annual operational costs. Results are summarized in the comparison table on Page 2.

CONTACT INFORMATION For more information, contact the EPRI Customer Assistance Center (EPRI CAC) at 800.313.3774 or askepri@epri.com

TECHNICAL CONTACT A. Rogers, 650.855.2101, arogers@epri.com

Issue	48V DC Forklift	48V AC Forklift	80V AC Forklift
Performance	Lifting and motive performance degradation is noticeable when battery state of charge (SOC) is between 30% and 20%. Speed is regulated (Note 2).	Lifting and motive performance is constant regardless of battery SOC above 20% (Note 1). Speed is regulated (Note 2).	Lifting and motive performance is constant regardless of battery SOC above 20% (Note 1). Speed is regulated (Note 2).
Runtime	Under same work load and operating conditions the AC lift will operate longer than the DC lift. This is due to energy savings associated with AC lift regenerative breaking and lack of hydraulic systems.	Under same work load and operating conditions the AC lift will operate longer than the DC lift. This is due to energy savings associated with AC lift regenerative breaking and lack of hydraulic systems.	Under same work load and operating conditions the AC lift will operate longer than the DC lift. This is due to energy savings associated with AC lift regenerative breaking and lack of hydraulic systems.
Noise	While the operational sounds from the AC and DC lifts differ, both are sufficiently quiet to be ignored.	While the operational sounds from the AC and DC lifts differ, both are sufficiently quiet to be ignored.	While the operational sounds from the AC and DC lifts differ, both are sufficiently quiet to be ignored.
Environmental	Brushes are inherent in DC motors to couple electrical energy into the motor rotor. Brush wear produces dust that can be released into the environment on a daily basis or during brush replacement.	Brushless AC motors do not produce dust that might be released into the environment.	Brushless AC motors do not produce dust that might be released into the environment.
Reliability	Very reliable assuming maintenance issues are appropriately addressed.	Relatively new technology, is expected to be more reliable then DC lifts due to lower maintenance issues. Drive reliability is expected to be very high. However, more operational history is needed to support this assessment.	Relatively new technology, is expected to be more reliable then DC lifts due to lower maintenance issues. Drive reliability is expected to be very high. However, more operational history is needed to support this assessment.
Maintenance	Brush replacement and cleaning of dust residue is required for DC forklifts. Break replacement is required more often for DC lifts.	AC lifts are brushless and require less break maintenance than DC lifts due to regenerative breaking capability.	AC lifts are brushless and require less break maintenance than DC lifts due to regenerative breaking capability.
Equipment Cost	100 % (Note 3)	Estimated to be 104% the cost of a DC forklift.	Estimated to be 110% the cost of a DC forklift.
Maintenance Cost	100 % (Note 3)	Estimated to be 34% of DC forklift based on savings associated with longer break life and not having to deal with brush replacement issues.	Estimated to be 34% of DC forklift based on savings associated with longer break life and not having to deal with brush replacement issues.
Battery Life	No appreciable difference with same voltage system.	No appreciable difference with same voltage system.	110% that of 48V system due to cooler charge and discharge cycles. More operational history is needed to support this assessment.
Battery Recharge Rate	No appreciable difference with same voltage system.	No appreciable difference with same voltage system.	Faster recharge rate for higher voltage battery having the same run time as 48V system. Additional studies required to quantify this assessment.
Charger Costs	No cost difference. Same charger may be used for all listed voltage levels.	No cost difference. Same charger may be used for all listed voltage levels.	No cost difference. Same charger may be used for all listed voltage levels.
Energy Consumption	No appreciable difference with same voltage system.	No appreciable difference with same voltage system.	Comparison data not available. Slightly higher consumption is expected due to larger physical size and less efficient tires.
Economics	1.00, (Note 4)	0.92	1.11
Features			
– Running Motor	DC	AC	AC
– Power Steering	Hydraulic	AC	AC
– Lifting Motor	Hydraulic	AC	AC
– Breaking	Conventional Pad and Drum	Regenerative with Conventional Assist	Regenerative with Conventional Assist
– Empty Weight	8086 Lbs	8086 Lbs	8086 Lbs
– Battery Weight	3396 Lbs	3396 Lbs	4600 Lbs
– Lift Capacity	6000 lbs	6000 lbs	6000 lbs
– Tires	Cushion Tire	Cushion Tire	Solid Pneumatic Tires for Outside Use

Notes:

1 No testing was performed below 20% SOW to avoid permanent battery damage.

2 Speed is electronically regulated on all lifts for safety.

3 Comparison Basis

4 Economics considers annual equipment and maintenance costs. Values are based on per unit cost of a DC lift. For example: If it costs $1000 per year to lease and maintain a DC lift, a comparable 48V AC lift would cost $920 per year and a comparable 80V AC lift would cost $1100 per year.

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Electric Power Research Institute • 3412 Hillview Avenue, Palo Alto, California 94304 • PO Box 10412, Palo Alto, California 94303 USA
800.313.3774 • 650.855.2121 • askepri@epri.com • www.epri.com