Miscellaneous Publication 2010-04

Conversion of a gasoline-powered 1955 Allis Chalmers 'G' tractor to battery power

2009 Agriculture Day parade in Palmer, Alaska, featuring the converted Allis Chalmers tractor.

UAF UNIVERSITY OF ALASKA FAIRBANKS

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SNRAS
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Project Background:

The Allis Chalmers 'G' tractors have long been favorites with market gardeners because the model combines excellent toolbar visibility, overall maneuverability, and good fuel economy in a relatively simple mechanical design. Unfortunately, the tractor's small size and unique style make it a prime target for tractor collectors. This means that buying repair parts for the model 'G's can be expensive, since the suppliers cater to the hobbyist-restoration market rather than those using the machines on working farms. Conversion of the tractor to electric power eliminates the excessive costs involved in repairing the engine with original parts.

Photo A: The Allis Chalmers 'G' used for the conversion.

The farmer who originally converted a conventional Allis Chalmers 'G' to a solar-powered cultivating tractor received partial funding through a Sustainable Agriculture Research and Education Grant. He was very happy with the re-powered tractor and developed a website describing both the process of conversion and the resulting tractor (www.flyingbeet.com).

The conversion of an Allis Chalmers 'G' to an electric (and ultimately solar-powered) cultivating tractor provides several benefits for the University of Alaska's Matanuska Experiment Farm:

- 1) The Agricultural Experiment Station plays a leadership role in developing sustainable farming practices appropriate for Alaska, and using a tractor that does not operate on limited fossil fuels provides a working example of sustainable agricultural practices.
- 2) Among other duties, the tractor is used to cultivate inside 30' x 96' high tunnels where carbon monoxide would be a hazard to the operator.
- 3) The price of the conversion kit was only slightly more expensive than a replacement gasoline engine, and repair of the electric engine is considerably cheaper than repair of the gasoline engine.

Preparation:

Photo A shows the model `G' that was used for the conversion. Although initially outfitted with a custom planter for small grain research (see AFES Circular 135, Growing Small Grains in Your Garden), the non-functional machine had been cannibalized for parts for the rest of the Agricultural Experiment Station's 'G' fleet. In addition to the motor not working, the right rear axle was broken.

Taking off much of the unnecessary sheet metal (fenders, radiators, and gas tank) improved access to the engine, which was then easily disconnected by removing a few bolts. An overhead lift made removing the engine an easy task. The parts visible in Photo B within the engine housing were left in place and later connected to the replacement electric motor.

A framework was constructed using ½" by 1" steel stock to hold the batteries and the electric motor and its controller in place, as well as serving as a hitch base. (Photo C)

Assembly:

A major complaint about using the 'G' tractors among our operators is not having enough leg room while sitting on the tractor. In order to address this concern, an 8" extension was fabricated to stretch the frame (Photo D) thereby providing additional leg room.

Photo B: The Chalmers 'G' being stripped down (seeder removed). Below: engine housing.

Photo C: More views of the disassembly. Above: engine housing. Below: housing frame.

Above, sandblasting the tractor frame and below, painting it in the shop.

Photo D: Legroom extender for the frame.

Although detailed drawings are available for fabricating the housing plate, a completed plate was purchased along with all of the necessary bearings and other required mechanical parts from Niekomp Tools Inc., the fabricator that worked on the initial conversion tractor. The mechanical portion of the conversion went smoothly.

A separate kit of electrical components was purchased from Electric Vehicles of America (EVA) and assembled according to the extensive instructional manual. The few issues that arose were easily resolved with the help of their tech support. EVA intended to change their future instruction books to address these issues.

A waterproof metal case was modified to hold the batteries and other electrical components (Photo E). The case protects the batteries and electrical components from the elements, and protects people from accidentally contacting the high-voltage terminals.

The tractor has two separate electrical systems: a 48 volt electric drive motor and a 12-volt system that operates all of the tractor's accessories and controls.. Since the high current of the 48-volt drive system would burn out a key switch, turning on the 12-volt system activates an electromagnet to complete a circuit in the 48-volt system, thus energizing it.

The instrument panel in Photo F has a voltage meter, an amperage meter and an engine hour meter. The key is the on/off switch for the 12-volt system. Removing the key automatically disconnects the 48-volt batteries from the high-energy circuits, which is an important safety feature with the number of public tours that occur at the station.

Photo E: Battery box holding four 12-volt batteries and miscellaneous other electrical components.

The controller (visible in Photo G) controls the speed of the electric drive motor. After assembling all of the electrical parts, the system would not respond to any commands. The problem turned out to be an error in the manufacturer's programming, and their technical support provided a software patch to correct the problem.

Because the original transmission remains intact, the operator determines the proper motor speed and gear for each task.

Photo E: side view of waterproof battery case.

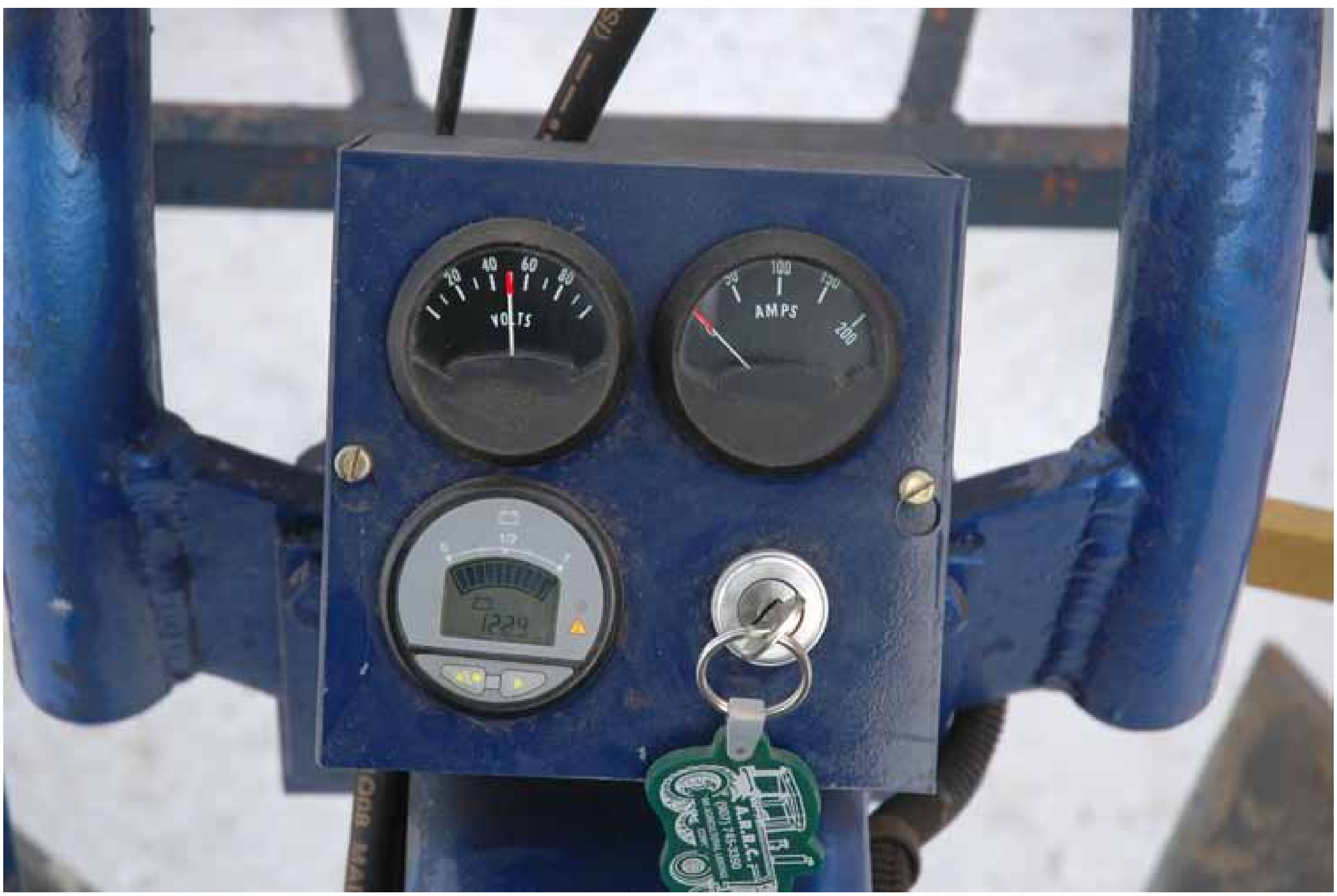

Photo F: Instrument panel. From bottom left clockwise: engine hour meter, voltage meter, amperage meter, on/off switch with safety shutoff on key removal.

Photo G: electric drive controller.

Additional Modifications:

Photo G also shows the protective frame built around the motor housing and the motor controller. In addition to providing support for the drawbar extension, the frame offers a level of crash-protection to the critical parts. The frame was designed to allow easy access to the motor.

Photo H shows the 12-volt hydraulic pump that controls the underbelly toolbar. The original hydraulic cylinder was reinstalled and the electric pump raises the fully loaded toolbar at a similar speed as the original pump did.

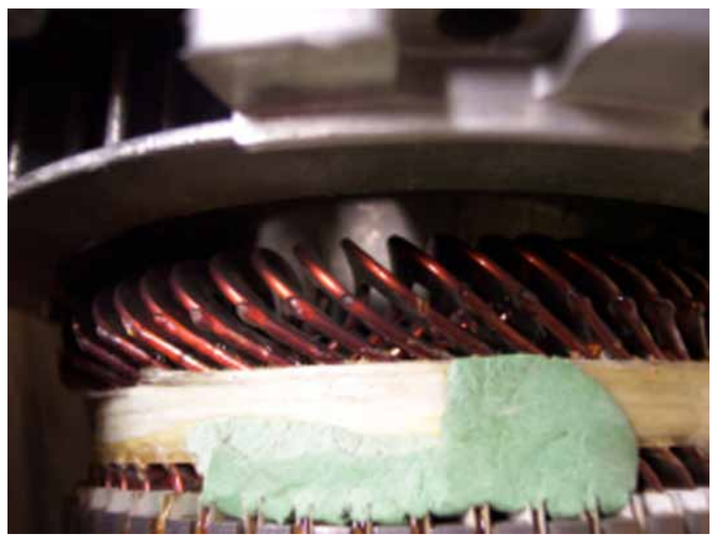

Photo H: View of the protective frame around the electric motor.

Current Issues:

Performance:

The cultivating abilities of the electrified Allis 'G' are as good as the original gas powered version. The tractor is able to cultivate several acres on a single battery charge. While the tractor has never needed to run all day, the tractor showed no signs of 'running down' after four hours of cultivating.

Motor failure:

After only 57 hours of operation, the motor emitted noises similar to an arc welder electrode contacting a piece of metal and was removed. The above photos show the mechanical damage to the motor. Unfortunately, the replacement motor suffered a similar fate after less than 10 hours of operation. Currently the cause of the motor damage is being investigated in order to protect future motors from a similar fate. None of the websites documenting similar conversions have experienced problems with their motors. The manufacturer indicated that the motor failure was a result of operating at excessive RPMs so one solution would be a simple tachometer to warn the operator that the motor is reaching critical RPMs. The ideal solution, however,

Photo I: Hydraulic pump and toolbar of the refurbished tractor.

would be to design a mechanism to prevent the engine from ever reaching these critical RPMs.

Solar Panels:

The batteries charge very rapidly on the electric battery charger that was recommended by Electric Vehicles of America. Even though this charger uses a minimum amount of electricity, for maximum sustainability solar charging is preferred. There are two solar panel strategies used by various Allis 'G' conversions. One strategy is to mount the panels on the tractor to both power the tractor and to serve as a sun shield for the driver. The other strategy is to make a charging station where the tractor operates on battery power and then is driven to the charging station where the solar panels recharge the batteries. The farmer who did the original conversion estimated that the $2,000 solar panel array they purchased only saved them about $25 a year in charging costs. Since a cost analysis based on Palmer rates predicted a similarly minimal savings for this tractor, the decision was made to continue using the recommended charging unit rather than making the solar panel investment. The financial benefit would likely be greater when used in rural Alaska where electricity is significantly more expensive, so solar charging will remain a future goal for this project.

Further Information:

Flying Beet Website: www.flyingbeet.com

Electric Vehicles of America: www.ev-america.com

SARE Project Report: www.sare.org/MySARE/ProjectReport.aspx?do=viewProj&pn=FNE03-472

Niekamp Tools, Inc.: www.niekampinc.net

Tractor Conversion by Brooks Solar Inc: www.brookssolar.com/pdfs/electrictractor.pdf