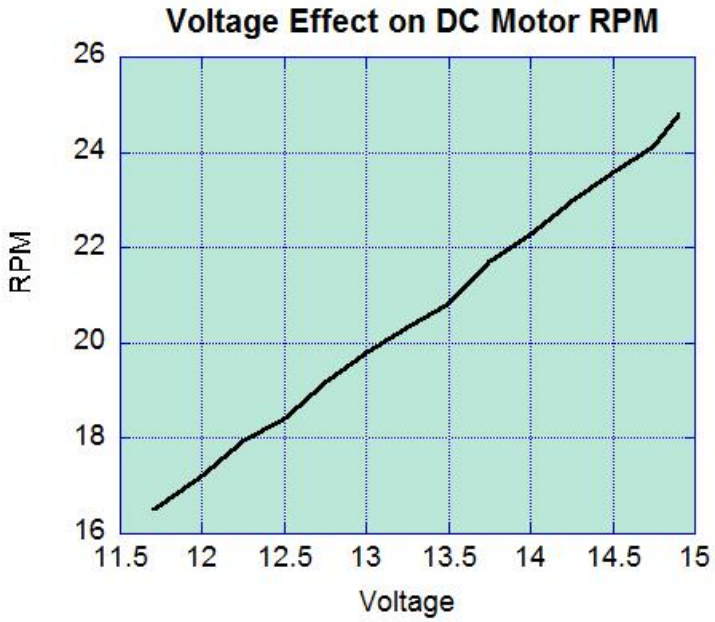
Effects of Battery Voltage on Chemical Pump Injection Rate

Technical Bulletin One

Chemical Pumps operating on batteries and solar power are going to have inherent problems related to accuracy and consistency due to voltage variations. Most of the times the discrepancy between recorded rates of injection and the amount of fluid injected over a longer period of time are misunderstood or unexplained. However, the principles behind it are quite simple.

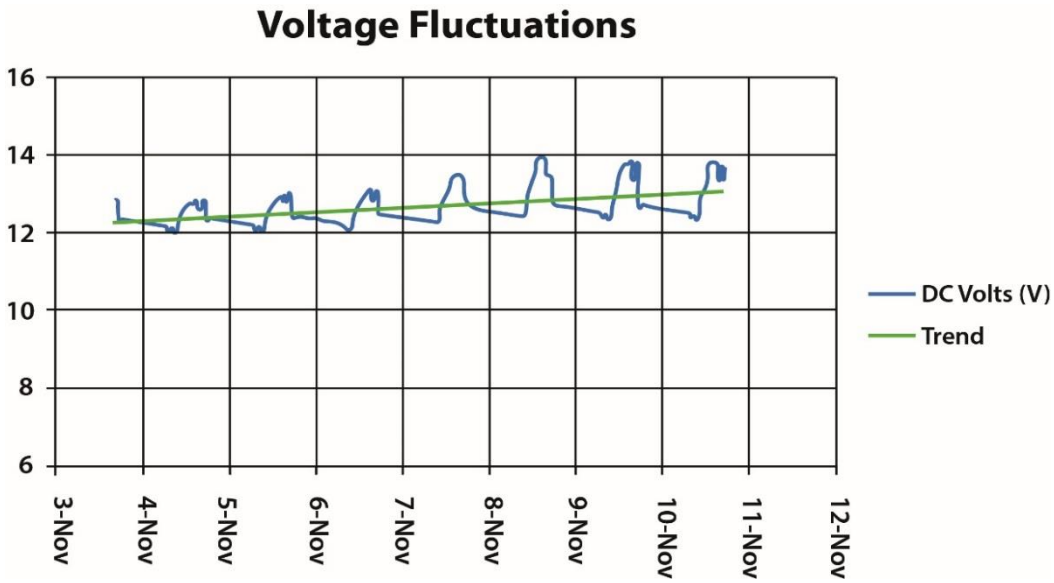
All brushed DC motors have a linear relationship between voltage and RPM, meaning as voltage decreases or increases so does the RPM of the motor. The vast majority of solar chemical pumps in the oil and gas industry use a DC motor coupled to a positive displacement chemical injection pump. This means that changes in battery voltage have a direct effect on injection rate.



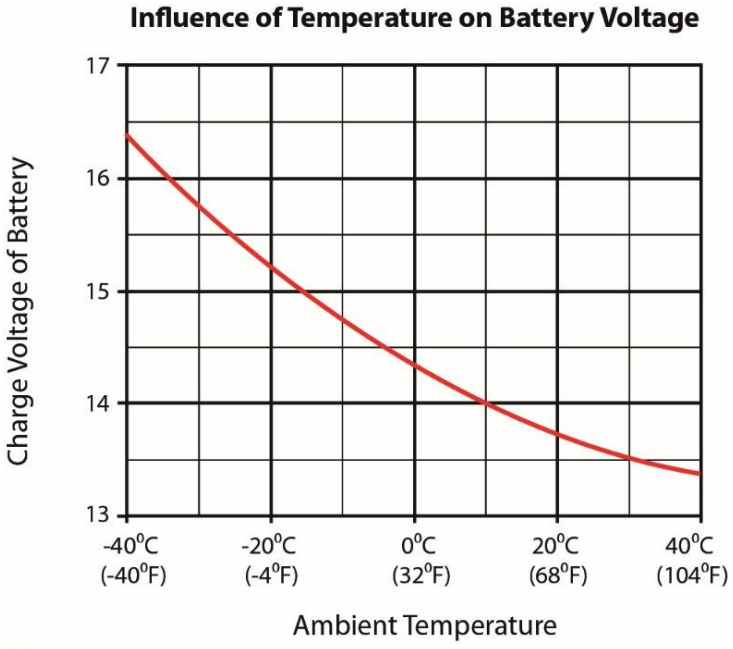
Isn't solar power always 12 Volts?

There are several reasons which can cause the voltage supply to the DC motor to fluctuate. The main causes are listed below:

- Solar panels are used to charge the batteries during the daylight. At night or during days of cloud cover the batteries discharge. Lead acid batteries in their fully charged state are about 13.8 volts and fall to 12.0 volts in a nearly depleted state, which is about a 13% difference. A properly designed solar system will fluctuate 1.0 to 1.3 volts from day to night; approximately 7.5 to 10% change in voltage. The variations in voltage of a solar pump due to 1) day night variation and 2) trend change over a week are depicted below.



- Ambient temperature changes alter the charge levels of standard solar charge regulators. From 68ºF (20ºC) to -22ºF (-30ºC) the voltage charge levels are adjusted by approximately 1.5 volts, or about 10%.
- Battery voltage also fluctuates with ambient temperature. As shown in the graph below a typical lead acid battery will change their voltage approximately 3 volts when temperatures fluctuate from -40ºF (-40ºC) to 104ºF (40ºC). Variations day to night of 18ºF (10ºC) can result in swings of 3% in voltage of the battery.



What does all this mean in terms of injection rate?

The fluctuations in voltage described above will result in similar changes in injection rate. Depending on how your system is designed, where you are geographically located, climate at a particular time, and the state of the battery when the system was calibrated, the rates can easily vary 10 to 25% due entirely to changes in voltage.

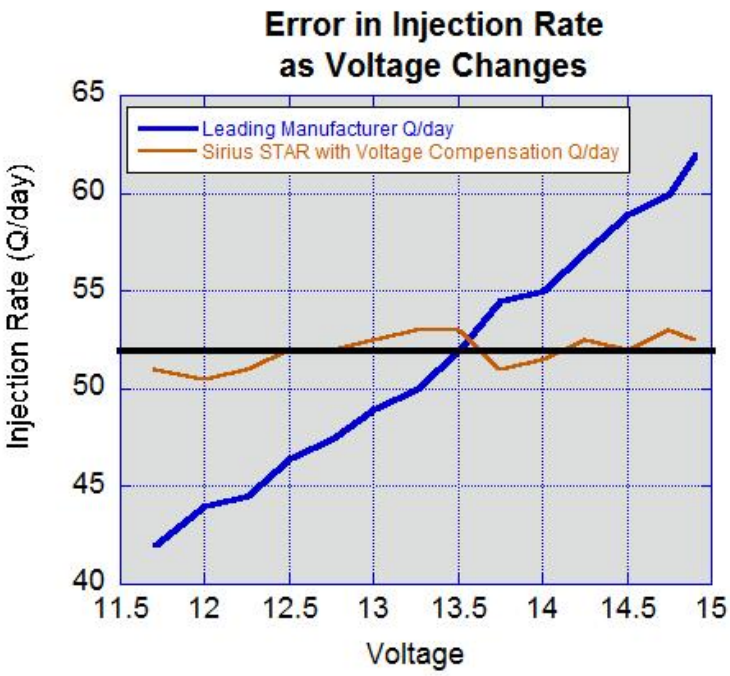
Under Injection: Calibrating a system on a voltage peak will result in under injecting.

Over Injection: Conversely, calibrating a system when the voltage is low results in over-injecting when the sun is shining or the batteries are fully charged.

Voltage Compensation for Solar Systems (patent pending)

Both over injecting and under injecting chemical comes with a significant cost. Over injecting is a waste of costly chemical while under injecting can result in well or pipeline damage. There is a solution to mitigate the effects of voltage and stabilize the chemical injection rate.

The graph to the right depicts two systems injecting chemical as the battery voltage is altered across the range from fully charged to depleted. The injection rate was set to 52 Q/day (horizontal black line). The blue line is a leading pump manufacturers rate over the range. As shown it varies directly with voltage. The bronze line is the same pump using Sirius' Star controller with the patent pending "voltage compensation" feature enabled. The error without voltage compensation can exceed 30% over the range.



The battery voltage is recorded during the calibration process and used to automatically compensate and adjust the injection rate as voltage naturally fluctuates. Adjustments can be made to either the "ON" time of the chemical pump, or to the average RPM of the motor in order to consistently deliver a calibrated rate.

The methodology above is a patent pending feature of Sirius' Star™, Gemini™, and Fusion™ Controllers.