Flow Control of Agricultural Spraying Machines

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Abstract

New Zealand relies heavily on its agricultural industry. A large portion of this industry is pastoral farming, where livestock are raised to graze on pasture. This includes beef, sheep and dairy farming. An important aspect of this style of farming is maintaining pasture quality. In order to increase growth fertilisers are often applied to the pastures. This increases yields in both meat and milk production. However, the increased application of fertiliser is linked with diminishing water quality. While the effects of nitrogen leaching and the best ways to manage fertiliser use are still being investigated, it is clear that control over the application will become more and more important.

The Tow and Fert is a range of fertiliser machines designed and built in New Zealand by Metalform Dannevirke. The Tow and Fert range is capable of spraying a wide range of fertilisers including both soluble and non-soluble fertilisers. The Tow and Fert is unique in its ability to spray fertiliser slurries consisting of mixture ratios of up to three-parts fine particle fertiliser to one-part water. This is achieved by the use of a recirculating system. Currently there is next to no control on the flow rate of the machines and the application rate is determined by the speed the operator maintains.

The purpose of this thesis is to design and build a flow control system for the Tow and Fert product range and investigate the effect of the changing flow rate on the spray characteristics. The ability to spray such a wide range of fluids with drastically different properties presents many challenges.

Many flow meters were considered and a low cost ultrasonic sensor (TUF2000M) was installed and investigated. After limited success of the ultrasonic sensor, a simple turbine flowmeter was installed. A flow controller was developed and tuned. Based off a PID control loop, the controller was able to maintain flowrate well between 10 L/min and 25 L/min depending on the installed nozzle.

After flow control had been achieved, methods for assessing the impact of flow rate on spray characteristics and specifically spray distribution were investigated. Several prototypes were created and tested. A stationary patternator capable of continuous measurement was developed and tested. The patternator does not correctly measure the flowrates in low flow sections. Only half of the flow being applied to the platform is being measured. This causes highly nonlinear results in spray distribution measurement. The testing did show an increase of spray area with increasing flowrate. However, the true distribution can be improved when the low flow issues have been resolved.

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