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PROPER CALIBRATION:

ARE YOUR SOLID MATERIALS SPREADERS AND LIQUID DISTRIBUTION SYSTEMS CALIBRATED PROPERLY?

by

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The Clear Roads Continuing Pooled Fund Research Project has recently published two documents that may assist you in answering the title question. They are entitled: "Calibration Accuracy of Manual and Ground Speed Controlled Salt Spreaders" and "Calibration Guide for Ground-Speed-Controlled and Manually Controlled Material Spreaders."

These are available at:

<http://clearroads.org/about.html>

The former describes the research efforts that attempted to define the accuracy of six manual and ground speed controlled solid and liquid materials controllers and related distribution systems that are in general use, and the variables that impact the accuracy of the calibration process and what actually ends up on the road. The "Calibration Guide" provides step-by-step instructions for calibrating the common manual and ground-speed-controlled systems. I was fortunate



totally compatible. Most of the observed inaccuracies during the project related to the hydraulic and spreader systems not being able to totally support the controller. Second, the most sophisticated controller is of little value, unless it is calibrated to deliver the desired amount of product over the range of spreading speeds and discharge/application rates being used.

to be a member of the research team that conducted the research and prepared the Report and Calibration Guide. This article will draw from both documents and my personal experience.

FUNDAMENTAL CONCEPTS

First, it is vitally important to understand that having a spreader controller (manual or automatic) does not guarantee that accurate discharge/application rates will be achieved on the road. The controller is part of a **system** that must be

TYPES OF SPREADER CONTROLLERS

There are three types of controllers in common use:

- * Manual
- * Ground Speed - Open Loop
- * Ground Speed - Closed Loop

Manual controllers provide a constant rate of product delivery (weight or volume per unit of time) for each setting as long as the capacity of the hydraulic system is not exceeded. By knowing the

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relationship between the rate of delivery for each setting (from calibration) and truck speed, some control of discharge/application rate is possible by driving at prescribed speeds. This is probably the least accurate control method, as the truck operator usually cannot maintain constant speed.



controller setting and discharge/application rates are determined by mathematically relating the discharge rates to likely operational truck ground speeds.

Ground speed controlled systems are calibrated by determining the weight or volume of the discharged material over a known distance. There are three

Open Loop ground speed controllers are the next most accurate method of controlling discharge/application rate. The controller senses the ground speed of the spreading vehicle from the speedometer or other sensing point, and changes product delivery rate in proportion to vehicle speed.

Closed loop ground speed controllers are the most accurate method of controlling discharge/application rate. The controller senses ground speed from the speedometer or other point, and the speed of the auger/conveyor or the liquid flow rate on the discharge end. The controller uses both data sources to control and balance the application rate.

OPERATIONAL APPLICATION RATE VARIABLES

The primary application rate variables are:

- Gate or orifice opening that discharges material on to the spinner
- Conveyor, auger or pump speed
- Truck speed
- Number of lanes being treated

During operations the only variables that can practically be changed are conveyor, auger or pump speed, and truck speed. However, most systems have a spinner speed control that may be able to change the number of lanes being treated, if there is no downstream deflector control. Ground speed controllers are designed to take truck speed out of the equation, leaving the operator to concentrate on the multitude of other required tasks.

CALIBRATION METHODS FOR MANUAL AND GROUND SPEED CONTROLLERS

The methodology for calibrating all spreading/distribution systems is fundamentally the same. The weight or volume of the discharged product is determined for a known or simulated distance of travel or unit of time. Control elements are changed until the desired discharge/application rates are achieved.

Manual control systems are usually calibrated with a stationary truck having the engine RPMs at a level normally used during operations. The discharge per minute is determined for each

methods in common use for determining distance (speed x time):

- Connecting an electronic speed simulation device to the controller that provides the same data as the truck speedometer and collecting material discharged at desired speeds and time
- Jacking the truck drive wheels (with proper safety methods and devices) and collecting discharged material with the wheels turning at desired speedometer readings and time
- Operating the truck/spreader over a known distance, at desired speeds, and capturing the material discharged by the spreader

These are arrayed in order of decreasing accuracy.

There are two “constants” developed for most ground speed controllers during the calibration process. The first is sometimes called the “speed constant” and is developed by traversing a known distance with the truck, and entering the data in to the controller. This makes sure that the controller is using the speed/distance relationships correctly. The second or “rate constant” is developed by determining the weight

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or volume of product discharged per revolution of a drive shaft that is associated with the delivery of the product.

APPLICATION RATE AND DISCHARGE RATE

I have used the term discharge/application rate above. The reason is that they are often separate and distinct entities. Discharge rate is the amount of product being dispensed by the spreader per unit of distance (gal or lbs/mi.) or (l or kg/km). Application rate is the discharge rate divided by the number of lanes being treated (lbs or gal/lm or l or kg/km). If the discharge rate of a spreader is 200 lbs/mi, and a centerline, or 2 - lane spread is being performed, the application rate is: 200 lbs/mi divided by 2 = 100 lbs/mi. If that 200 lbs/mi is being distributed on one lane, the application rate is 200 lbs/lm. **CALIBRATION ONLY DETERMINES DISCHARGE RATE.**

HOW TO ASSURE ACCURACY DURING THE CALIBRATION PROCESS

There are a number of nuggets of wisdom that come in to play during calibration. These include: "A product is only as good as its individual parts," "garbage in - garbage out" (the GIGO rule) and "think critically about every task you perform, every time you do it, and commit the accumulated knowledge to policy and procedure" (the doctrine of continuous improvement). In a practical sense, this all boils down to systematically paying attention to, and controlling variables during the calibration process.

Method Variables

There are many acceptable methods and procedural variations that can be used during the calibration process. The controller manufacturer's recommendations are usually the best starting point. There are generic procedures found in the "Calibration Guide" that is the subject of this article. The "Calibration Guide" also contains the Salt Institute procedure and form for calibrating manual and ground speed controlled material spreaders. This is also available at: <http://www.saltinstitute.org/content/download/605/3484>

The minimum weight of solid material discharged during a "catch and weigh" test is often debated. In my judgment, 100lbs is a reasonable minimum. It is also a good idea to observe the delivery stream of material being discharged. If discontinuities are observed, the test must be aborted.

Equipment Variables

There are a number of items used for measurement during the calibration process. These may include: scales, liquid measurement containers, distance measuring equipment and procedures, stopwatches and shaft rotation measurement aids. These devices should all be calibrated.

Product Variables

Solid products should be representative of what is actually used in the field. Variations in gradation and moisture content can affect the accuracy of the calibration. A prepared sample of about 1/2 truckload of product that has been screened to exclude material larger than the gate or orifice opening is a good idea.

Truck, Controller and Delivery System Variables

There are a number of procedures that can be used to control truck and delivery system variables:

- Warm the truck and hydraulic system sufficiently, prior to calibration.
- Tailgate type spreaders should be calibrated with the bed level that is used during operations.
- "Gate" openings should be straight (top of opening parallel to the bed).
- Make sure any controller "programming" that opens control valves to "full open" for a period of time, before going to the desired opening, has been disabled.
- When doing repetitive collections of discharged material, use the "power" switch on the controller to start and stop material flow (assuming the control valve opening does not change with loss of power).

Verification Testing or Checking

There is a fairly simple procedure in the "Calibration Guide" for ground speed controlled systems that provides a basis for setting an initial "gate" opening, allows the assessment of the need for calibration, and provides data necessary to



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“fine tune” calibrations over the full operating range of discharge rates being used. It involves performing “catch and weigh” tests for specified time intervals at various discharge rates. The time intervals are chosen to provide a discharge of about 100 lbs. of solid material. Variations outside of the “acceptable” range can be corrected by fine - tuning the “rate” constant in the controller, and re-testing until an acceptable result is obtained. There is a similar procedure for liquid pre-wetting systems.

A composite table (not in the “Report” or “Guide”) for solid material that is based on data from Tables 5-1 and 5-2 in the Calibration Guide appears to the right:

Discharge Rate Set in Controller (pounds per mile)	Test Speed (miles per hour)	Test Time (seconds)	Target Discharge (pounds) * due to rounding to the nearest full second	Acceptable Range (pounds)
200	25	73	101.4*	97.3 - 105.5
300	25	49	102.1*	98.0 - 106.3
500	20	36	100.0	96.0 - 104.0
600	20	30	100.0	96.0 - 104.0

FINAL THOUGHT

Calibration is a procedure and a process. As with most things in life, maximum accuracy is achieved by “paying attention to business”.

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