Profesional paper

Researches on functioning of machines for chemical application

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Abstract
The paper synthesizes the researches made by the author on agricultural machines for chemical applications, concerning the main component parts, the adjustments that can be made, the calibration of fertilizer distributors. A special attention is given to the sprayer pumps used of these machines, the main types more frequent used and the pressure regulator used at these machines.

Key words: chemical applications, fertilizer distributors, pressure regulators, pumps

Introduction
Chemical are applied to fields for many purposes, such as: as killers of weeds, brush, insects, nematodes, fungi and as defoliants and growth regulators. The use of herbicides has replaced much of the mechanical cultivation done formerly. These chemical applications can be made mostly with attachments to tillage machines and seeders. Together with chemicals, fertilizers may be applied at various times, using different machine methods. Controlled amounts of fertilizer may be added at seeding time with mechanisms attached to the seeders. Adding fertilizers to fields with growing plants is done with attachments to cultivators and with anhydrous ammonia applicators. Fertilizers can be applied in gaseous, liquid or solid forms. The applicator's construction depends on the form in which the fertilizer is applied.

In fig. 1 is presented an attached fertilizer distributor auger used to fill planter's fertilizer boxes.

Results and discussion
Types of fertilizers used at machines and their characteristics

Dry fertilizer
The fertilizers applying machines which use dry fertilizer must provide a wide range in the rates of application, must have a mechanical agitation and corrosion resistant parts. The characteristic parts of these machines are as follows:
Augers are realized as screw conveyors of a helix over the outlet tube. These mechanisms agitate the material and produce a strong flow. Application rates are changed by varying the rotational speed of the auger with respect to ground speed.

Belt conveyors are used where large quantities of fertilizers are applied. The belt carries the fertilizer from the bottom of the hopper past a variable height scrape–off plate to the delivery tube.

Variable orifice with rotating agitator are typical of full width field distribution machines. The horizontal rotor acts as an agitator and a feeder for the orifice.

**Liquid fertilizer**

The main advantage of liquid fertilizer is the possibility of reduced labor in handling since either pumps or gravity systems may be used. One mechanism much used is a gravity-flow, constant-head metering device. The tank should be filled to the top so that a minimum of air space remains.

In fig. 2 is presented a liquid fertilizer attached to a row planter.

The squeeze pump overcomes the disadvantages of having to operate the gravity-flow applicators at constant forward speed. Small volumes of liquid are trapped as the rollers on the rotor, press against the tightly held plastic tubes. As the rotor turns, the trapped volumes move along the tube and are released to the furrow opener.
Gaseous fertilizer
The most important gaseous fertilizer used in agriculture is anhydrous ammonia. It must be handled in tanks and by transfer equipment capable of withstanding pressures as high as 1.7 MPa. The transfer of liquid anhydrous ammonia from supply to implement tanks must be done with care. For this it is used a two-hose system. The liquid-carrying hose is connected to the lowest outlets of the two tanks.

The second hose conducts the vapors from the empty tank to the supply tank. This device uses some of the return vapors to power a pump, which transfers the rest of the vapor more rapidly than natural flow. Filling time is thus much shorter than that of using just the pressure differential between the two tanks. Usually less than 1 % of the vapors are released to the atmosphere.

Adjustments and calibration of fertilizer distributors
The rate of application and the placement position in the soil are the major adjustments for fertilizer applicators. Disk openers are usually used as furrow for placing both dry and liquid fertilizers. A range in adjustments permits several alternative depths and spacings relative to seed row.

The calibration of fertilizer application is difficult because of the variability in the action of metering mechanisms and the variability in fertilizer particle size. If three types of metering mechanisms are tested with a fertilizer in the middle range in regard to both particle size uniformity and moisture absorption, the obtained results are presented in Table 1.

Table 1. Variation in fertilizer application as a percent of the Mean

<table>
<thead>
<tr>
<th>Factor</th>
<th>Gravity-flow variable</th>
<th>Star wheel motoring</th>
<th>Wire auger motoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variation between mechanisms</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>average</td>
<td>25,5</td>
<td>17,1</td>
<td>11,5</td>
</tr>
<tr>
<td>range</td>
<td>17,7-21,5</td>
<td>8,1-22,5</td>
<td>5,7-16,7</td>
</tr>
<tr>
<td>Variation down rows</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>average</td>
<td>13,1</td>
<td>8,0</td>
<td>6,4</td>
</tr>
<tr>
<td>range</td>
<td>2,2-20,2</td>
<td>5,4-14,0</td>
<td>2,3-13,9</td>
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<tr>
<td>Overall performance variation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>variation</td>
<td>24</td>
<td>16</td>
<td>12</td>
</tr>
</tbody>
</table>

The conclusions are that variation in manufacturing account for most variation in mechanisms, variation in fertilizer particle size account for most of the down-row variations and the hopper size has some influence on metering variation.

Anhydrous ammonia applicators are very difficult to calibrate. It must be kept an account of the amount used while the machine is in operation and the adjustments must be made accordingly.

Liquid fertilizer applicators operating on a gravity principle require a special calibration technique that is represented of sprayer calibration. Forward speed of the machine is a fundamental measurement that effects the application rate. Speed must be kept constant, if the application rate is to be uniform.
Field sprayers

Chemical application by sprayers is a common field operation in crop production. Sprayers may be designed as attachments to tractors and planters or as individual implements, either as self-propelled or as trailed machines. The necessary components of any sprayer are a tank with agitator and strainer, a pump, a filter, a pressure regulator, valves piping and nozzles with dirt screens.

The sprayer pumps used may be either positive or non-positive displacement types.

The pressure regulator is a mechanism to maintain any preset pressure by bypassing some of the liquid to the tank (fig.3). In the case of automatic unloading, plunger-operated release valve maintains constant pressure until all boom outlets are closed, whereupon a bypass circuit opened the tank. The pump, when unloaded, does not have to work against pressure.

![Picture 3. Automatic unloading pressure regulator operation](image)

Conclusions

The machines for chemical application are frequently used in modern agriculture in order to obtain bigger quantities of crops. That is why the adjustments that can be made to these machines are very important in order to improve their mechanical characteristics and finally to be more efficient.

The paper present the main characteristics and adjustments for these machines, if they use dry, liquid or gaseous fertilizer.

References

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