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REVIEW ARTICLE

ANHYDROUS AMMONIA APPLICATION EQUIPMENT DESIGN AND DEVELOPING

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ABSTRACT

Anhydrous ammonia is chemical compound used as a fertilizer in agricultural today. It is rich in nitrogen (82.2%). Anhydrous ammonia (NH_3) exists in liquid form under high pressure. Anhydrous ammonia turns to a gas when applied to the soil. Anhydrous ammonia is used and stored under high pressures. Specially designed and well-maintained equipment require in the application and storage phase. For this reason, the use of anhydrous ammonia as a fertilizer in the agriculture of our country is undeveloped. In this research, in order to application of anhydrous ammonia a suitable equipment was designed and developed. Injection unit consists of a knife type with an injection tip behind it designed to place the AA 15-20 cm deep in the soil.

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INTRODUCTION

Anhydrous ammonia is a clear, colorless gas at standard temperature and pressure conditions. Chemical formula is NH_3, which means that it consists of one atom of nitrogen and three atoms of hydrogen per molecule. Because the atomic weights of nitrogen and hydrogen are not the same, the weight ratio is 82.5 percent nitrogen to 17.5 percent hydrogen. It has a very characteristic odor. Anhydrous ammonia will stay in liquid form when stored under its own pressuren which is dependent on temperature. Anhydrous ammonia is heavier than air. At 21º C, AA will create a tank pressure of about 8 kilograms per square centimeter (Hanna, 2001). Anhydrous ammonia is classified as a hazardous substance. To remain in liquid form it must be stored under high pressure. Specially designed and well-maintained equipment require in the application and storage phase. Anhydrous ammonia requires specialized and expensive storage facilities, and transport and application equipment (Schmitt and Rehm, 1993). For this reason, the use of anhydrous ammonia as a fertilizer in the agriculture of our country is undeveloped. The Anhydrous ammonia application in agricultural areas has minimal damage. More anhydrous ammonia is used as fertilizer in North Dakota than any other nitrogen fertilizer source (Nowatzki, 2011). Injecting AA below the soil surface is required to avoid volatile losses during application. The traditional injection system in use for many years has been a shank and knife system, with an outlet at the bottom sides of a delivery tube behind the knife (Stamper and Mengel, 2009). Anhydrous ammonia application equipment commonly used in small grains is typically spaced between 38 and 50 centimeters (Wyckoff, 2009). Research by Maxwell *et al*. (1984) found no significant yield difference between 38 and 50 cm spacing but suggested this might not hold true in all soils and conditions. They also acknowledged noticeable waviness in plant growth associated with the wider spacing but these visible effects did not negatively affect yield. Hanna *et al*. (2005) found gaseous losses to be at an unacceptable level from a prototype unit of coulter type injection units. Leaf N and grain protein showed a response to N rate but were unaffected by application spacing. A significant grain yield response to applied N was observed. Leaf N affected by applications (Wyckoff, 2009). The use of anhydrous ammonia as fertilizer in our country has not been possible due to information and equipment failure. Today, ın America the use of anhydrous ammonia as fertilizer 32% has been reached (Terry and Kirby, 2006). However, in our country there has not been no studies on this subject. The objective of this study was to developed a suitable equipment in order to AA application and Anhydrous ammonia application equipment commonly used in small grains is to provide the use of this equipment in our country agriculture.

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MATERIAL AND METHODS

Anhydrous ammonia: Our main experimental material is anhydrous ammonia. Table.1 lists some of the important chemical and physical properties of Anhydrous ammonia.

Table 1. Physical and Chemical Properties of Anhydrous Ammonia

Physical Form	Gas (liquid under pressure)
Color	Colorless
Odor	Strong
Boiling Point	-33 ºC at 1 atm
Melting point	-78 ºC
Ph	App. 12.0 (neat)
Molecular Weight	17.03
Density	0.696 g/L
Critical Temper.	133º C
Critical Pressure	1636 psi

Nitrogenous fertilizers used in our country are urea, ammonium nitrate, ammonium sulphate. Urea contains 46% nitrogen and ammonium nitrate 26-33%, ammonium sulphate 21% but Anhydrous ammonia (NH) contains 82.2% nitrogen. It is rich in nitrogen.

Equipment Design

A equipment was designed and developed according to the characteristics of Anhydrous ammonia. The equipment was consists of a main frame, tank, injection unit and fittings. Anhydrous ammonia (NH_3) exists in liquid form under high pressure. In the air, it becomes a gas form. Anhydrous ammonia (AA) turns to a gas when applied to the soil. It must be kept in special pressurized tanks (nurse tanks) under pressure. So, the tanks are made of pressure-resistant. Injection unit has been selected as a type of traditional knife.

The main target of the study;

- To give at once nitrogen requirement of the plant in the period before planting,
- To inject directly into the soil in the right soil texture, and soil moisture and to prevent ammonia gas escaping directly to the atmosphere.
- To provide the use of anhydrous ammonia fertilizer in our country agriculture.

RESULTS AND DISCUSSION

Equipment For Anhydrous ammonia (NH_3): Equipment is include main chassis, tank, tines, dept adjustment whell, collector, hydraulic pump, Flow hose to the tank from the collector (for 0.5 m^3 and 3 m^3) and fittings. We chose the tank capacity of 0.5 m^3. We also used second tank (3 m^3) for storage periods. Equipment was performed as operated in two different positions. In first position; AA application with tank 0.5 m^3 on main chassis, in second position main chassis behind tank 3 m^3 is can be made.

Tank (0.5 m^3): Special pressurized tank, due to the corrosive action of AA has to be made from sheet material 10 mm thick (Figure 1). So, the tank capacity of 0.5 m^3 weight reached 350 kg. Operating pressure of nurse tank is 10 bar, test pressure is 16.5 bar. Due to the increase of the weight of the tank, main chassis characteristics have changed. Convex type was made to increase resistance to pressure (Akar *et al.,* 2014). The tank (0.5 m^3 and 3 m^3), including pressure gauges, hoses, safety valves, liquid fill valve, safety relief valve, fixed liquid level gauge, hydraulic valve and metering devices. All valves are on top of the tank. The pressure gauge indicates the interior pressure of the nurse tank. The liquid fill valve is used while filling the nurse tank from a storage tank. As liquid anhydrous ammonia is transferred into the nurse tank from storage tank. The safety relief valve also is known as the pressure-relief valve.

Tank (3 m^3): This tank is made for storage of ammonia. It can also be used to application. 3 m^3 tanks are positioned on the four-wheeled chassis. Storage tank is shown in Figure 2.

Chassis: In this research, in order to application under the soil of anhydrous ammonia a suitable equipment was developed. Chassis consist of three rows of 4-4-5. Totally, it has been 13 tines cultivator with coil springs. We set spacing of 50 cm. Ammonia application is made only of the front tines (4). An example of this type of unit is illustrated in Figure 3.

Figure 1. Tank (0.5 m^3)

Figure 2. Tank (3 m^3)

Figure 3. Chasis (4-4-5)

Figure 4. Traditional knife applicator

Figure 5. Protective special clothes for AA application

Injection unit: Knife type ınjection unit is shown in Figure 4. AA was injected 15-20 centimeters beneath the soil surface to ensure maximum absorption by the soil. AA must be injected directly into the soil and covered immediately to prevent ammonia gas escaping directly to the atmosphere and allowing reaction with the soil system for retention. Loss of AA is dependent on the depth of injection and application spacing. Injection is done on the front four feet. Wider spacing in the Anhydrous ammonia application equipment was selected as a 50 centimeters.

Special safety clothing: Physical and Chemical Properties of Anhydrous ammonia create problems for the application and storage of AA, also make it a dangerous compound to use. It can be various damage anhydrous ammonia vapor on the human body. In this study, at stages application and storage of

AA have been made wearing special safety clothing, taking necessary precautions. This includes unvented goggles; rubber gloves; respirator; heavy-duty, long-sleeved shirt; and long pants (Figure 5).

Figure 6. Anhydrous ammonia application

Anhydrous ammonia application: Photos of applications in wheat are shown in Figure 6. Anhydrous ammonia turns to a gas when applied to the soil. Therefore, it should be given under the soil. Ammonia loss is minimal. Fertilization norms can be adjusted on the machine.

Conclusions

In this study, an suitable equipment of anhydrous ammonia application is made and used successfully.

Positive results in the all examined parameters were obtained. The use of anhydrous ammonia as fertilizer in the agriculture of our country may be possible. All these results indicate that anhydrous ammonia applications should be increased. Many safety features must be built into the anhydrous ammonia handling and application system.

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