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SOME LIQUID AND BULK BLENDING FERTILIZER FACILITIES NOW IN EXISTENCE

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The past decade has seen the establishment of a large number of liquid and bulk blending fertilizer plants. Plants of these types usually have capacities of 2,000 to 5,000 tons of fertilizer per year, and usually have low investment and operating costs. They are of particular interest to the basic producers of nitrogen, P_2O_5, and K_2O, since the plants provide the manufacturers an efficient means of marketing their products. This presentation will be a general discussion of some of the equipment used in the manufacture of liquids and bulk-blended fertilizers. The number of these plants is increasing rapidly and there are many new equipment innovations. However, time will permit only a discussion of those plants now in general use.

Liquid Plants

The use of significant amounts of liquid mixed fertilizers began in the West about 15 years ago. Soon thereafter, their use spread to the Midwest. Liquid mixed fertilizers now are used also to a lesser extent in other sections of the country.

Liquid fertilizer plants can generally be classified as one of two types: liquid hot-mix or liquid cold-mix plants. In a liquid hot-mix plant, phosphoric acid is neutralized with aqua ammonia or anhydrous ammonia and chemical heat is released. In a liquid cold-mix plant, the raw materials used are such that when they are mixed, no chemical reaction occurs.

Liquid Hot-Mix Plants

A typical liquid hot-mix plant is shown in Figure 1. In this plant, the liquid raw materials [phosphoric acid, aqua ammonia, urea-ammonium nitrate solution, and liquid base solution (10-34-0)] are stored in tanks with capacities that usually range from 10,000 to 20,000 gallons. All these tanks are fabricated of carbon steel; however, the acid storage tank has a rubber or a plastic lining. Solid raw materials (potash and urea) are stored in the building that houses the mix tank. The mix tank is usually of the batch type, and of 5- to 20-ton capacity. It is usually fabricated of carbon steel; however, in some plants this tank is made of stainless steel, or has a plastic liner. It is usually equipped with a portable agitator. Ordinarily, the tank is mounted on a scale, and the solid raw materials are weighed in it. The liquid raw materials are pumped from storage through meters to the mix tank. In preparing a mixture, the liquid raw materials (aqua ammonia, phosphoric acid, nitrogen solution, and water) are metered simultaneously to the mix tank. When all of the liquids have been added, the potash is conveyed to and weighed in the mix tank. During mixing, the liquid is recirculated through a cooler to prevent excessive boiling in the mix tank. The temperature of the solution is usually kept below 180° F. In some of the plants, this recirculation liquor is passed through a reaction tube in which the aqua ammonia, phosphoric acid, and recirculation liquor are mixed. There are various types of mixing tubes; however, a typical one consists of a section of large mild steel pipe surrounding a smaller concentric stainless steel pipe perforated with small holes drilled in its walls. Acid is fed through the small stainless steel pipe into the larger pipe. The recirculation liquor and aqua ammonia are fed through the larger pipe which discharges through a "tee" section that distributes the mixture across the bottom section of the mixing tank. In plants of other types, these mixing tubes are not used. In such plants, the recirculation liquor and the raw materials, except aqua ammonia, are added through open-end pipes onto the surface of the liquor in the mix tank. The aqua ammonia is added through perforated pipes mounted near the bottom of the tank, so that there is uniform distribution of the aqua ammonia across the bottom of the mix tank. After the materials are mixed, the finished product is pumped from the mix tank to storage or nurse tanks.

Base solutions such as 10-34-0 (produced from superphosphoric acid and ammonia) have been used extensively in plants of these types to sequester or essentially dissolve the impurities (iron and aluminum phosphates) formed when wet-process phosphoric acid is ammoniated. The 10-34-0 which is now produced commercially by several companies and the 11-37-0 produced by the Tennessee Valley Authority contain nonorthophosphates that combine with the impurities of the wet-process phosphoric acid to form compounds that are soluble in the ammonium phosphate solution. Therefore, a clear solution can be produced from wet-process phosphoric acid, provided a nonorthophosphate base solution is used in conjunction with it. When furnace phosphoric acid is used, the use of 10-34-0 or 11-37-0 is not necessary for the production of a clear solution.

In some liquid hot-mix plants, flow meters are not used. In such plants, the mix tank is mounted on a scale, and both liquids and solids are weighed, one at a time, in the tank. In still other plants, the desired quantities of liquids are measured in volumetric measuring tanks. Since each raw materials is individually weighed, the production rate of a plant of either of these latter two types is usually less than that of a plant in which meters are used.

In some hot-mix plants, a storage tank is converted to a reactor. A typical plant of this type is shown in Figure 2. In this plant, acid is added through a stainless steel pipe near the center of the tank. Anhydrous ammonia or aqua ammonia is added through a pipe that has holes drilled in its surface and is mounted near the bottom of the tank. Agitation is provided by recirculating liquor through recirculation spargers. This type of plant is usually used to produce nonpotash liquids.

Liquid Cold-Mix Plants

In liquid cold-mix plants, a high-phosphate liquid base solution, such as 10-34-0 or 11-37-0, is usually mixed with urea-ammonium nitrate solution (28, 30, or 32 percent nitrogen) and potash or a potash solution. A typical cold-mix plant is shown in Figure 3. In this plant, the liquids are weighed and mixed in a batch mix tank (usually 5-ton capacity) similar to that used in the hot-mix plant. Cooling equipment, acid storage tanks, and acid handling facilities are not required. Therefore, the investment cost for this plant is considerably less than that for the hot-mix plant. Some typical grades which are produced by cold-mixing are 19-19-0, 7-21-7.

Another typical liquid cold-mix plant is shown in Figure 4. This plant is so uncomplicated that it is usually referred to as a cold blending station. Such a station usually has four storage tanks. Base solutions (10-34-0) and urea-ammonium nitrate solutions are stored in two of the tanks, while high-potash solutions, such as 3-9-9 and 4-10-10, are stored in the other two storage tanks. These potash solutions are usually produced in a centralized hot-mix plant from which they are shipped to the various blending stations. The 10-34-0 and urea-ammonium nitrate solutions are shipped direct from the primary producer. The liquids are removed from storage using a pump. The desired quantity of each liquid is pumped through a meter into nurse tanks in which the mix is transported to the field.

There is a limited number of other types of liquid plants now in existence, such as continuous plants, and those which produce slurry-type liquid fertilizers; however, I will not attempt to describe them here.

Bulk Blending Plants

Bulk blending became popular in the Midwest several years ago and has recently spread to other sections of the country. In bulk blending, several solid, raw materials are dry-mixed to form mixtures of various nitrogen, P_2O_5, and K_2O contents. In typical bulk blending plants, the raw materials are removed from railway cars and conveyed to storage bins or hoppers. From this storage, the materials are moved to a weigh device. They are then mixed in one of several types of mixing devices. The mixture is then conveyed to a bulk truck or to a bagging machine.

Materials Handling System

A typical materials handling system is shown in Figure 5. This is the type of system used most frequently. The raw materials are moved from under the hopper-bottom railway cars by a screw conveyor. They are then elevated and dropped into bulk storage bins. These bins usually have concrete floors and wooden walls. The materials are removed from the storage bins by a front-end loader or scoop truck; however, some plants have installed bins of this type with sloping concrete floors so that they can be emptied by gravity into a screw conveyor that conveys the materials to an elevator which, in turn, elevates them to a weigh scale.

Weigh Device

A typical weigh device is shown in Figure 6. The materials are usually collected in storage bins mounted above a weigh hopper. Each material is weighed successively into the weigh hopper. In other plants, the raw materials are collected in a retaining hopper that is mounted above a weigh belt, and the materials are weighed and conveyed by this belt. In still other plants the materials are weighed in a front-end loader that is run onto platform scales. In some plants the materials are not weighed but are measured with volumetric belt feeders or screw conveyors that have been calibrated.

Mixers

Some of the types of mixers that are used are the (1) rotary mixer, (2) the mixing screw conveyor, (3) the ribbon mixer, and (4) the gravity-flow mixer.

Rotary Mixer

Most bulk blending plants now use rotary mixers. In a plant of this type the mixer either is installed in an elevated position so that the materials flow from it directly into a spreader truck by gravity, or is located at ground level, in which case the materials are elevated to the truck or to a bagging hopper.

Plant with Elevated Rotary Mixer

A sketch of a plant in which the mixer is installed at an elevation so that the materials flow vertically from the mixer to the bulk truck is shown in Figure 7. The raw materials are elevated to a screen for the removal of oversize or scrap which they may contain. This oversize is usually crushed in a chain mill and recycled to the screen for rescreening; however, with the present improved quality of raw materials, some manufacturers have found that they can eliminate this screening operation. The raw materials are weighed and then emptied by gravity into the batch mixer. When all the materials required for the batch have been added, mixing is started. Thorough mixing is usually accomplished in less than one minute. The total time usually required to weigh the materials, charge the mixer, mix the materials, and discharge the mixer is about three minutes.

Plant with Rotary Mixer at Ground Level

A sketch of a plant with a rotary mixer mounted at ground level is shown in Figure 8. This plant is similar to the one with an elevated mixer, except that materials from the mixer must be elevated (by an additional elevator) to a bulk truck or a bagging machine. The installation cost of this plant is usually somewhat less than that of the plant with the mixer installed at an elevated position, because a smaller manufacturing plant can be used and the cost of installing equipment at ground level is less than the cost of installing it at an elevation. The plant with its mixer installed at an elevated position, however, operates with less difficulties because it has only one elevator. The rotary mixer such as is used in a plant of either of these types has an excellent mixing efficiency.

Mixing Screw Conveyor

Several contractors now construct continuous-type plants that use screw conveyors for the mixing of raw materials. These mixers are similar to the conventional screw conveyor except that slots have been cut in their flights to provide for additional mixing. In some of these plants, other mixing devices, such as tanks with mixing flights or gates, are used prior to the mixing screw conveyor. In other plants, the mixture is recycled through a screw conveyor several times, and this recycling improves mixing of the ingredients. In still other plants, mixing is accomplished by recycling the mixture several times through a horizontal mixing screw and then through a vertical mixing screw.

Ribbon Mixer

A sketch of a ribbon-type batch mixer is shown in Figure 9. The capacity of mixers of this type varies from one to two tons. Mixing is accomplished by the ribbon-type agitator that tumbles the bed of the material in the mixer. The mixer is discharged by opening a gate at its bottom. A plant using a mixer of this type can produce between 15 and 20 tons per hour of a mixture.

Gravity-Flow Mixer

There are several types of mixers in use in which the gravity flow of materials is utilized to cause the mixing of the raw materials. One mixer of this type utilizes mixing cones. A sketch of such a plant is shown in Figure 10. The weighed raw materials are usually collected in a surge hopper that is mounted above the cones. The materials flow from the surge hopper through a quick-opening gate. Mixing is accomplished as the materials fall alternately over and into the cones. In some plants the cones are enclosed in a tank, and in others they are in the shape of separate bins such as those shown in Figure 10.

Gravity-Flow Mixing Tower

A sketch of a gravity-flow mixing tower which several manufacturers of bulk blends have constructed is shown in Figure 11. The companies consider the tower to be satisfactory and are constructing additional blending units each of which will utilize such a tower. TVA has also constructed a large-scale tower.

A large-scale tower is constructed of wood and is rectangular in shape. Its overall measurement is about 30 feet, with a cross section of about 4 by 4 feet. It is usually made up of four sections, a retaining section at the top and three mixing sections. The retaining section is usually large enough to hold one to two tons of material. This section is closed at the bottom with a gate that is constructed of either steel or plywood.

The tower has five sloping flights, each of which has two diagonal cleats extending across it. Tests indicate that the flights should be installed at an angle of 30 degrees with the vertical so that they will empty properly.

This type of mixer can be used readily in plants that have elevated storage bins. A sketch of a plant of this type with a mixing tower mounted on the side of the storage bin is shown in Figure 12. Raw materials are removed from hopper-bottom railway cars by a screw conveyor that is mounted under the railway tracks. This screw conveyor discharges into an elevator that elevates the materials to elevated storage bins. Each of these bins should have a capacity of at least 100 tons. The bins discharge by gravity into a weigh hopper that weighs the desired quantities of raw materials. The weigh hopper empties by gravity into the boot of the elevator that is used to fill the storage bins. The flopgate in the discharge chute of this elevator is changed so that the raw materials may be directed to the mixer. The elevator is then used to elevate the raw materials to the retaining section of the tower. The gate below the retaining section is opened, and the materials are mixed as they pass through the tower and into the bulk truck or bagging machine.

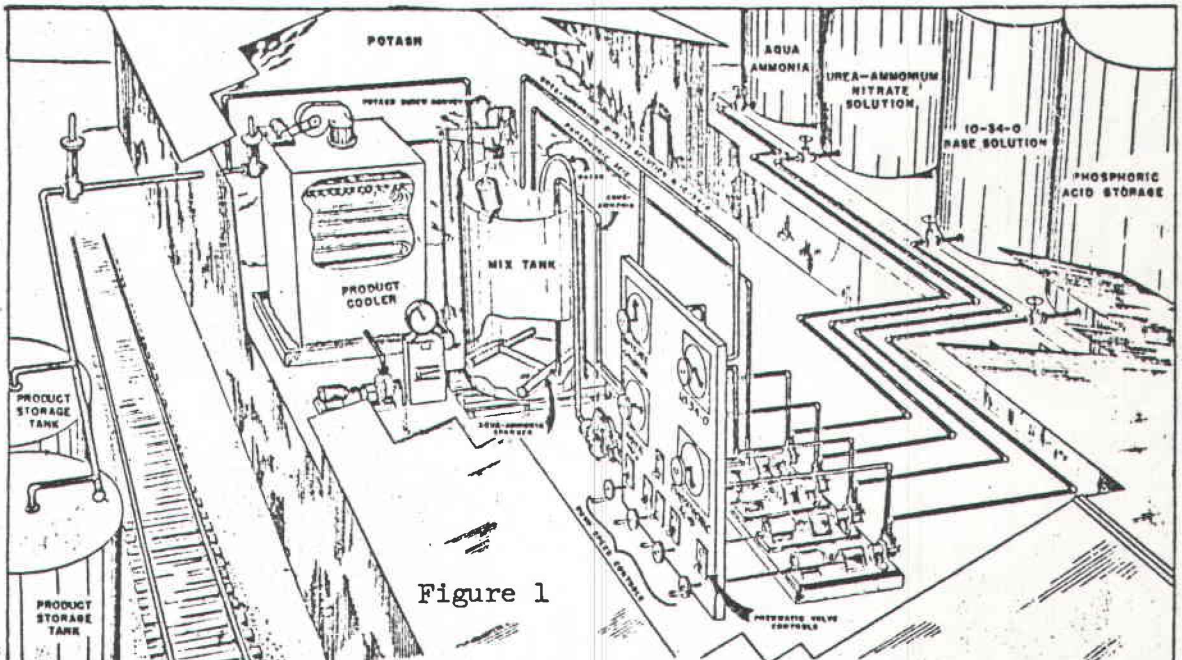

Figure 1

LIQUID HOT MIX PLANT

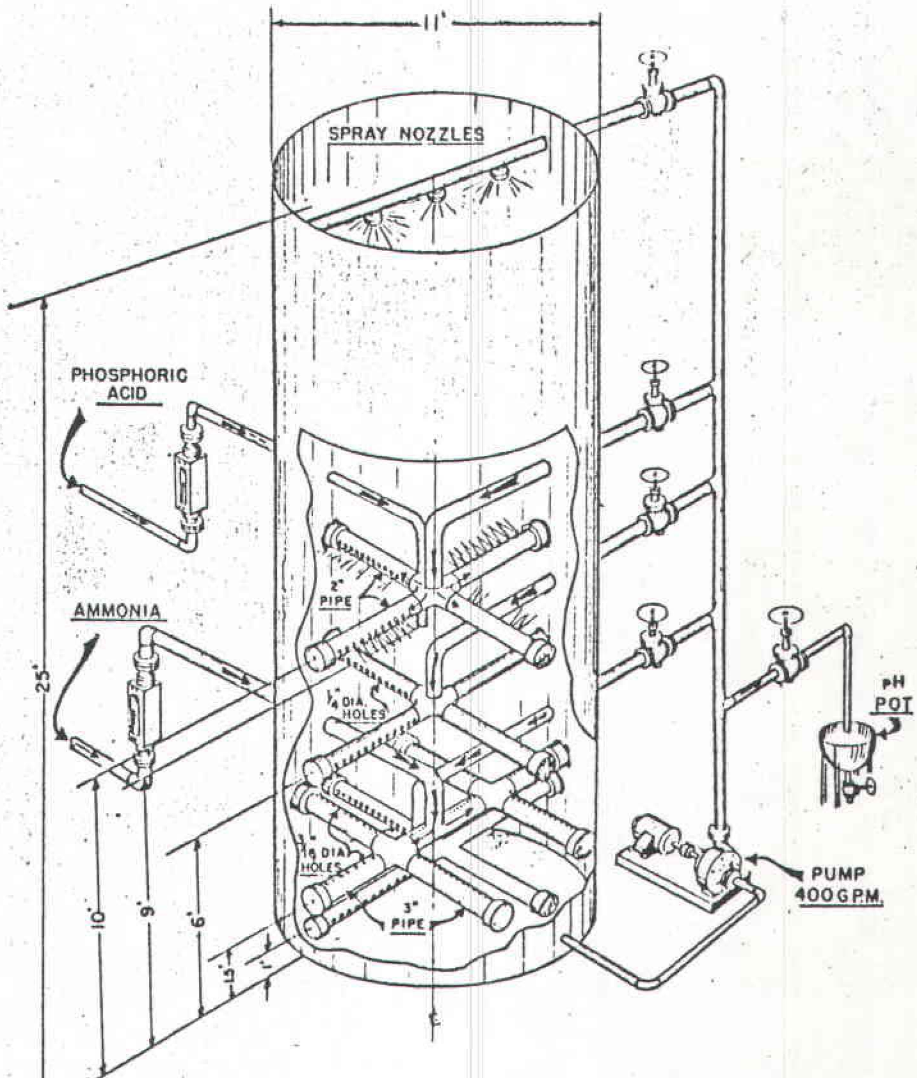

Figure 2

STORAGE TANK USED AS A LIQUID FERTILIZER REACTOR

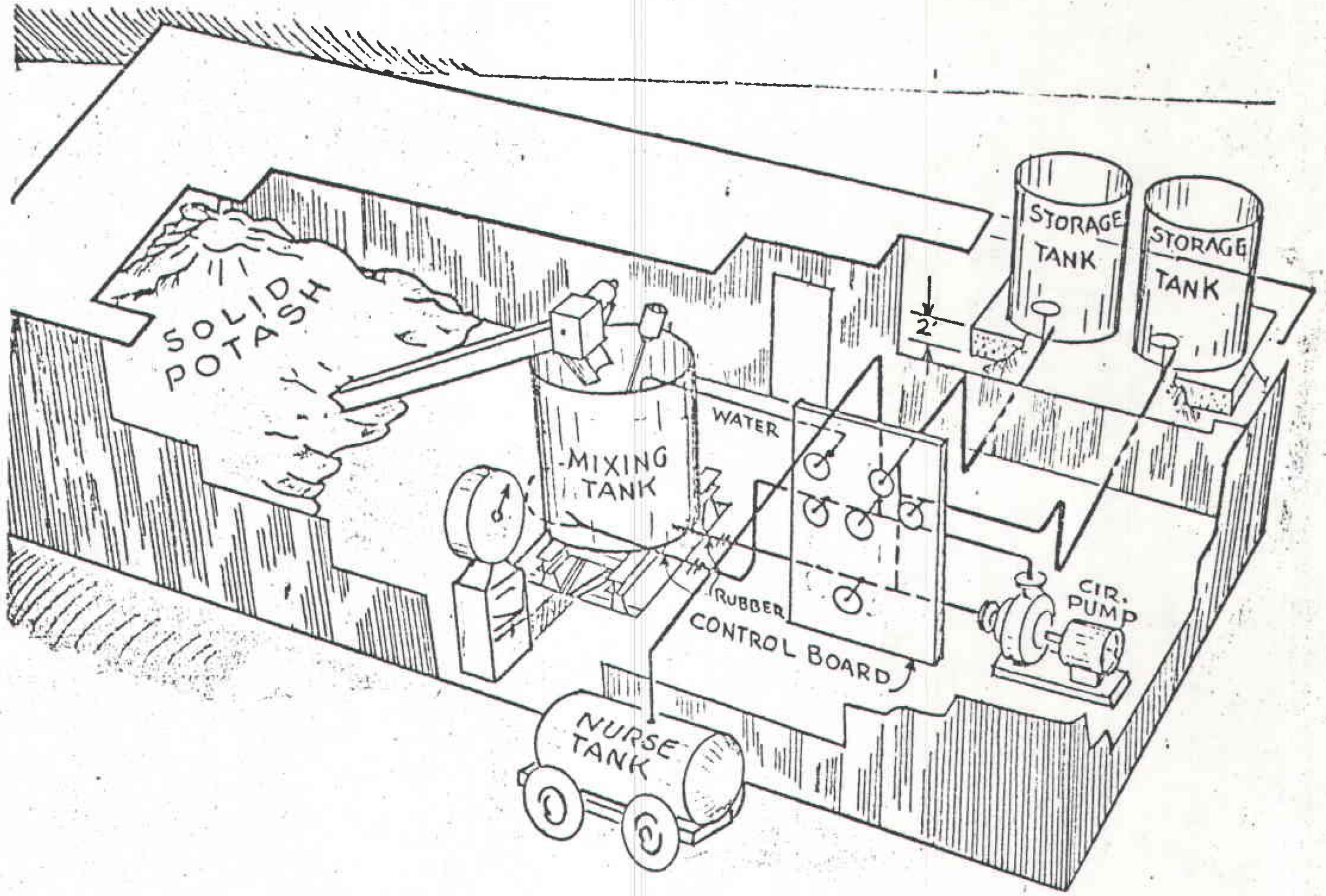

Figure 3
Typical Cold-Mix Plant

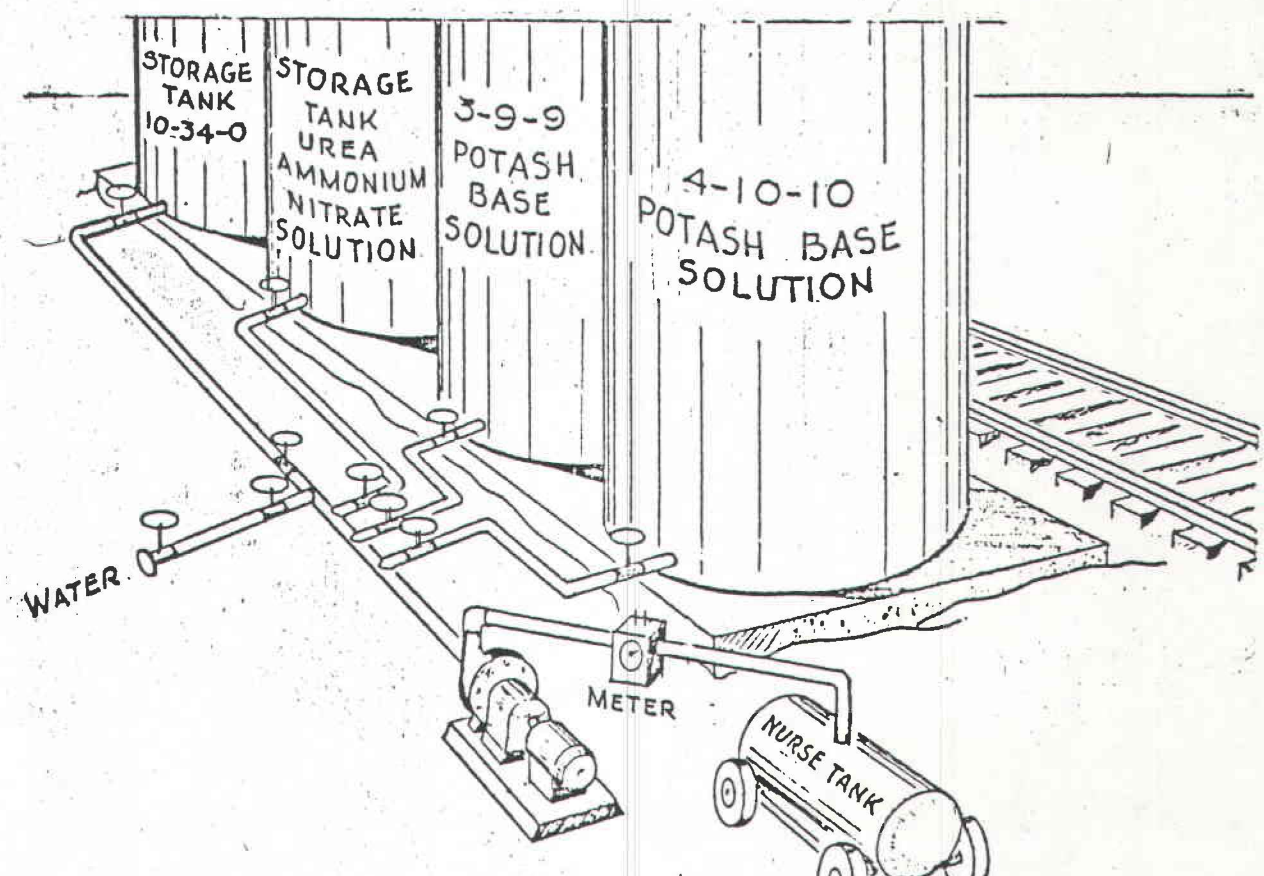

Figure 4
Typical Cold Blending Station

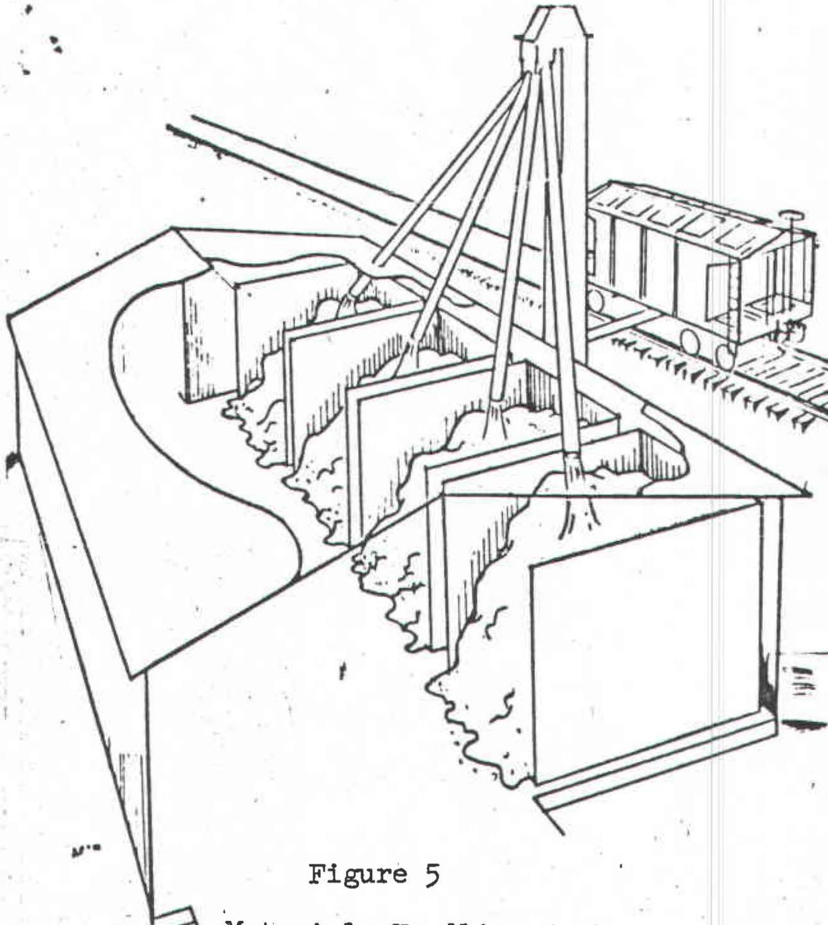

Figure 5

Materials Handling System

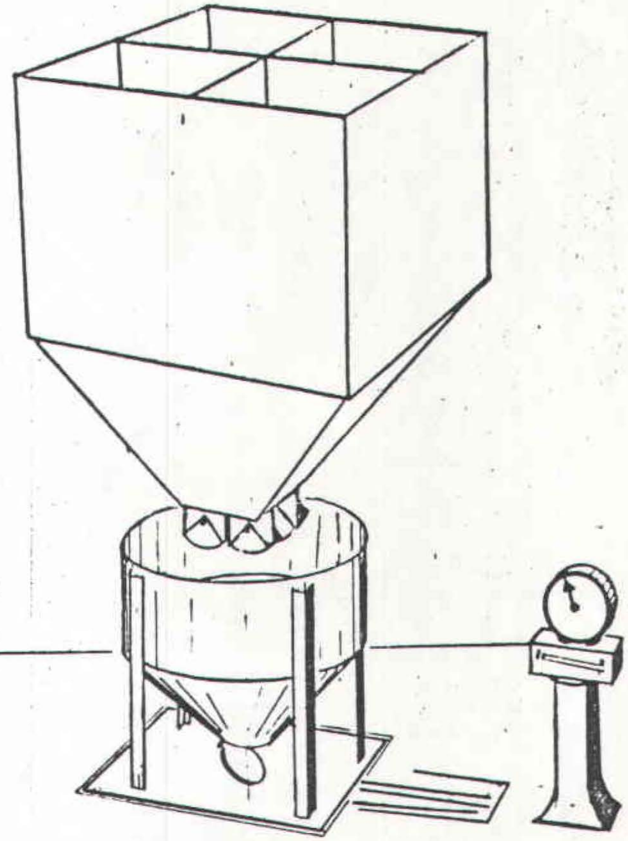

Figure 6

Typical Weigh Device

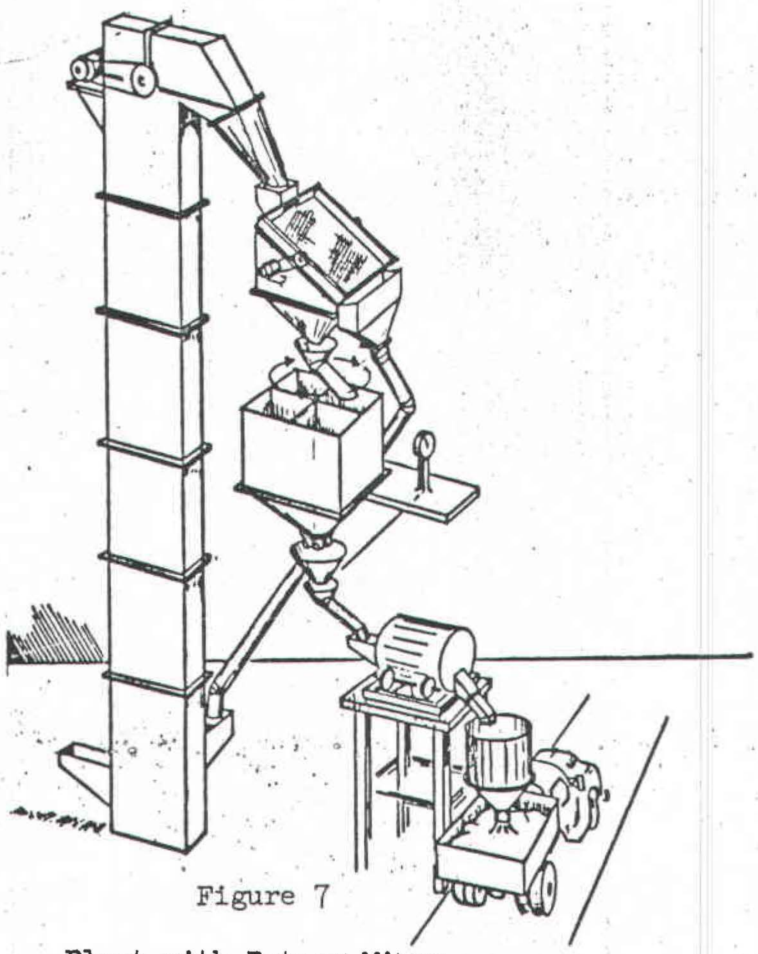

Figure 7

Plant with Rotary Mixer at Elevated Position

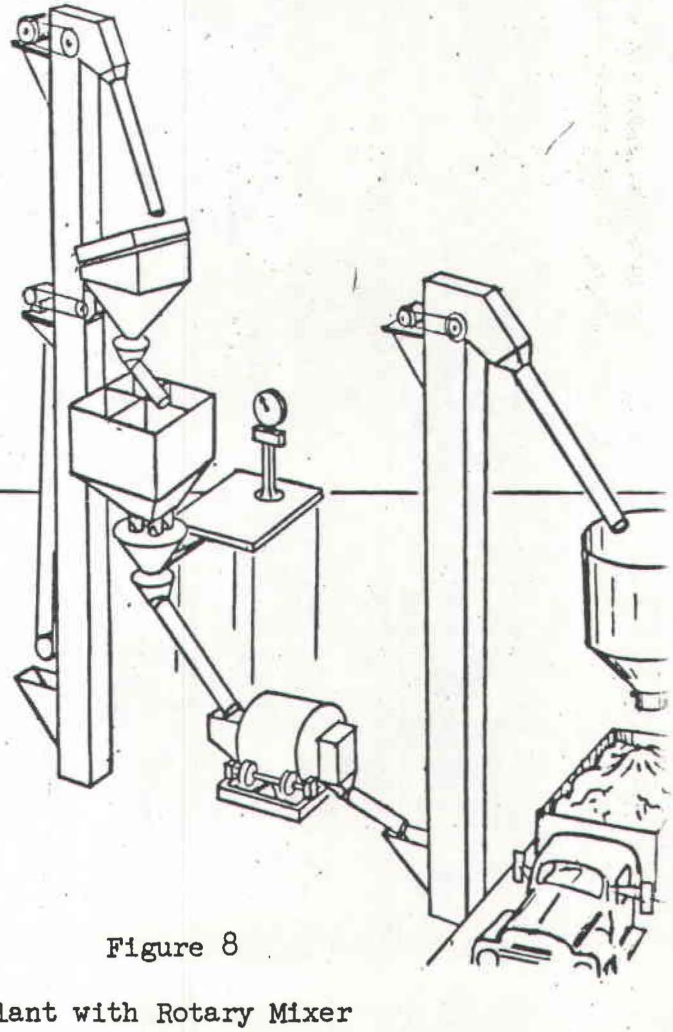

Figure 8

Plant with Rotary Mixer at Ground Level

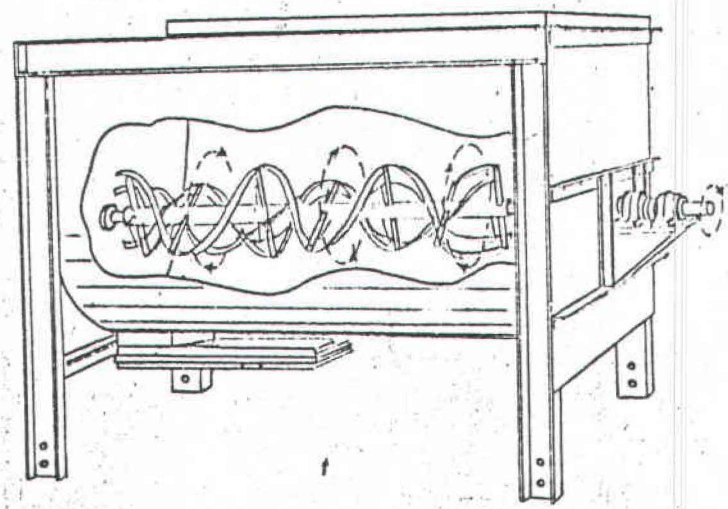

Figure 9
Ribbon Mixer

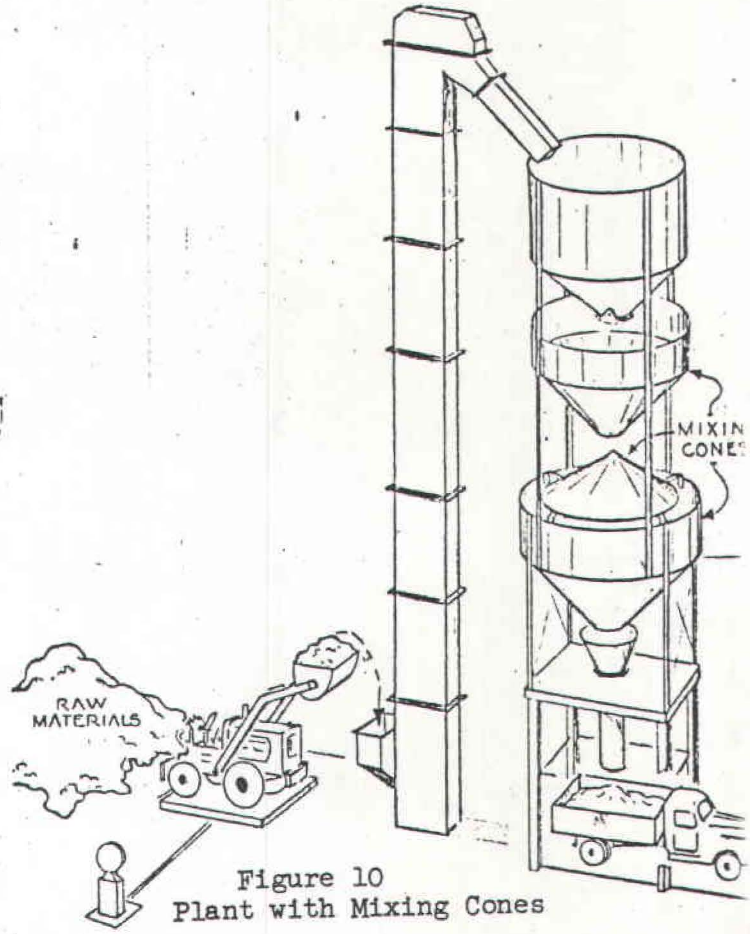

Figure 10
Plant with Mixing Cones

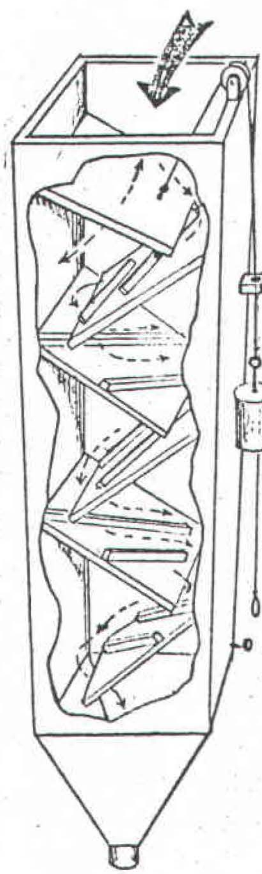

Figure 11
Gravity-Flow Mixing Tower

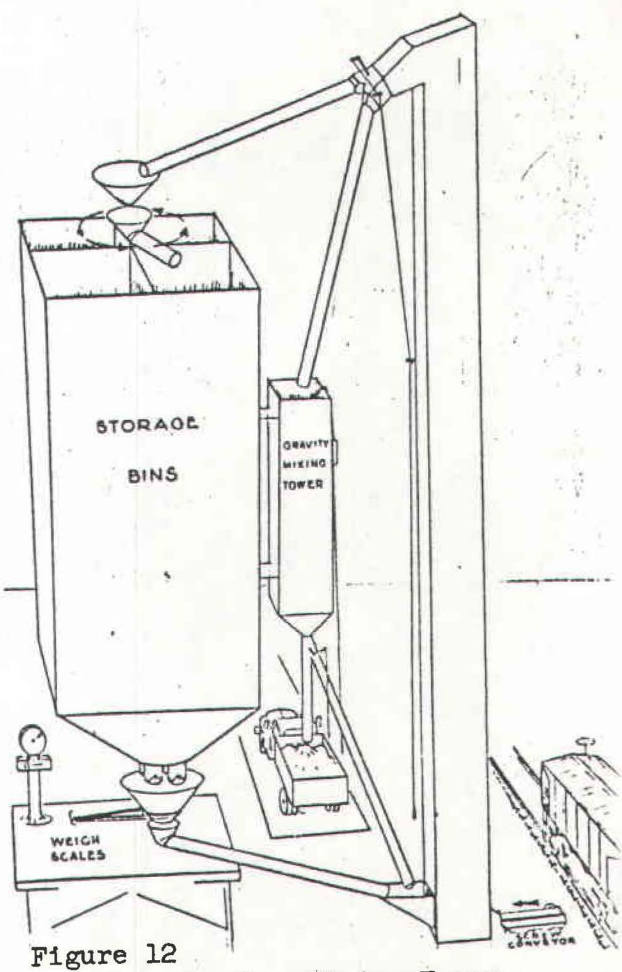

Figure 12
Plant with Gravity-Flow Mixing Tower
Mounted on Side of Storage Bins