ABSTRACT

In a vertically extending tank open at its top and used for the temporary storage of garbage before it is processed in a disposal plant, the garbage is charged into the tank through one of its side walls slightly above the bottom of the tank. Initially the garbage is dumped into a horizontally arranged duct and then is forced by a reciprocating ram mounted in the duct through an upwardly inclined passageway into the lower end of the tank. The passageway is funnel-shaped with its upper and lower surfaces inclined upwardly and diverging as they approach the tank.

7 Claims, 2 Drawing Figures
STORAGE TANK FOR GARBAGE

SUMMARY OF THE INVENTION

The present invention is directed to a tank used for the temporary storage of garbage before it is processed in a disposal plant and, more particularly, it concerns the arrangement of a storage tank in which the garbage is forced into the bottom of the tank through an upwardly inclined passageway.

In garbage disposal plants, particularly garbage incinerators, the garbage is not brought to the plant at the same rate at which the incineration takes place. As a result, it is necessary to provide temporary storage tanks which hold the garbage until it is ready to be burned, such as in a grate-type furnace.

The temporary storage tanks, hereinafter referred to as tanks, have a considerable volume to meet the greatly varying requirements of the plant. Further, the tanks also provide a reserve for those days on which no garbage is collected, for example, on holidays. Normally, such tanks stand a considerable height above the ground, often rising to a height of more than 10 meters. The garbage is dumped into the tanks, which are open at the top, and is also removed from the top by suitable hoisting equipment, for instance, a grab, and is fed by such equipment to a furnace.

Since the bulk density of the garbage decreases constantly, due to the continuous admixture of light-weight packing material, for example, loose paper or corrugated board, it is necessary to construct tanks of considerable volume, to modify them if necessary, or to replace them by larger tanks. However, frequently, the space is not available for tanks having a large base area.

Therefore, there has been a tendency to build the tanks underground, that is, to bury the tanks in the ground. When such a type of construction is possible, some of the difficulties mentioned above, such as supplying and dumping the garbage, can be eliminated. When constructing such a tank, excavations of considerable depth must be made, frequently up to 8 meters, and heavy sheet piling and reinforcement are indispensable. Moreover, tanks set in the ground are uneconomical if the ground water level is high. Further, considerable construction difficulties are experienced if it is necessary to blast the excavation when it is in rock, for example, as in Scandinavia. Another complicating factor is that fires often occur in such tanks and must be quenched with water. If the tank is set in the ground, the water used to put out the fire cannot be easily removed and the garbage remains wet and cannot be incinerated. For this reason alone, above-ground tanks are preferred, particularly since below-ground tanks require structures which rise considerably above ground level and also because the charging holes for the incinerators are located at a high level for constructional reasons.

If the tank is built above ground, the dumping of the garbage into the tank is expensive and presents certain difficulties, such as driving the garbage trucks up a ramp, which frequently are more than 10 meters high, so that the garbage can be emptied into the top of the tank. Another problem with ramps is that they are often slippery, particularly in the winter, and they must not be too steep because of the weight of the garbage truck. Another consideration is that the garbage trucks must be able to turn around at the top of the ramp. To satisfy these various requirements, structures of considerable size and expense must be built. However, such structures can be avoided if the garbage is transported from the trucks by means of conveyors or hoisting equipment, for example, shovels or bucket elevators, which deliver the material to the upper end of the tank. Such a solution also requires various considerable expenditures.

One of the primary objects of the present invention is to eliminate the construction costs described above. The problem of construction costs is solved, in accordance with the present invention, by building the tank above the ground or so that it is only slightly set below ground. Instead of dumping the garbage into the open top of the tank, it is dumped into a duct which opens through a funnel-shaped passageway into the lower end of one of the side walls of the tank. A reciprocating ram displaces the garbage from the duct upwardly through the passageway into the tank so that the garbage is continuously moved upwardly within the tank. An essential feature of the invention is that the funnel-shaped passageway through which the garbage passes into the tank is located a considerable distance below the upper end of the tank and rather close to its bottom. The material dumped into the duct is pre-compressed by the ram which moves back and forth through the duct and is forced along an upwardly inclined path into the tank through its side and not through the top, but rather it is introduced at a position close to the bottom of the tank. Because of the position at which the garbage is introduced into the tank, a dump is formed in the bottom which has an angle of slope depending on the nature of the garbage. It is difficult to avoid the retention of some of the material in the sump or dump within the tank. However, since the material constantly supplied to the tank contains large amounts of oxygen, the material within the sump rots rapidly. Moreover, the relative amount of material which remains in the sump is small. After the sump has been filled, any garbage forced into the tank is lifted gradually over the angle of slope of the sump and the level of material starts to move upwardly toward the top of the tank. Due to the funnel-shaped configuration of the passageway leading from the duct into the tank, the pre-compressed material is prevented from sliding back into the duct. The principle of a channel press is utilized here, but with the opposite sign, so that the constriction formed in the passageway prevents a return of the pre-compressed material, which has a tendency to expand, into the duct. Another important feature of the arrangement is the upwardly inclined orientation of the upper and lower surfaces of the passageway so that the material is directed obliquely upwardly, thereby imparting an upward motion to the garbage as it is introduced into the tank.

By means of the present invention, not only are the constructional disadvantages of the prior art avoided, but an essential advantage is gained in that the movement of the garbage into and through the tank always takes place in the same direction. Because of the manner in which the material moves through the tank, the garbage first introduced into the tank, moves gradually upwardly, and is incinerated first. Accordingly, the material does not accumulate in the bottom of the tank, so that it is incinerated only on those occasions when the tank is almost completely empty. Any material
which remains in the tank and is not continuously moved upwardly has a tendency to rot and to generate malodorous gases which are highly undesirable as far as environmental protection is concerned. Therefore, with the exception of the small amount of the garbage which remains in the sump, all of the garbage passes upwardly through the tank and is incinerated in the same order as it is charged into the tank. Concerning the design of the tank bottom, two different arrangements can be used and each has its own advantages. On one hand, the bottom of the tank can be inclined upwardly, corresponding to the upwardly inclined path of the material entering the tank. Such an arrangement is advisable under certain circumstances, however, it has the disadvantage that it is difficult for a grab or bucket to empty the tank completely in certain time intervals, because with the removal equipment working vertically, it is difficult to grab the material from an inclined surface. Such a disadvantage is avoided if the bottom of the tank is made horizontal. With a horizontal bottom, a sump is formed which is filled with the first few loads of garbage charged into the tank. As subsequent material is forced into the tank, the upper surface of the material in the sump adopts an upwardly curved surface. The type of tank bottom used depends on the local conditions and, it should be kept in mind, that the nature of the garbage varies in different localities.

The various features of novelty which characterize the invention are pointed out with particularity in the claims annexed to and forming a part of this disclosure. For a better understanding of the invention, its operating advantages and specific objects attained by its use, reference should be had to the accompanying drawings and descriptive matter in which there are illustrated and described preferred embodiments of the invention.

BRIEF DESCRIPTION OF THE DRAWING

In the drawing:

FIG. 1 is a vertical sectional view through a tank and tank charging member taken along the line I—I in FIG. 2, and

FIG. 2 is a plan view of the structure shown in FIG. 1.

DETAILED DESCRIPTION OF THE INVENTION

In FIG. 1, a tank 1 provides for the temporary storage of garbage before it is fed into incinerators or other types of garbage disposal plants. The tank consists of a vertically arranged shaft formed of vertically extending concrete walls. The rear wall 2 of the tank is spaced opposite the front wall 4 and a pair of side walls 3 extend transversely between the ends of the front and rear walls. A bottom 5 closes off the lower end of the tank while it is open at its upper end. Garbage, charged into the tank and moving upwardly through it for removal from the top by a hoisting bucket or the like, is indicated by a number of random lines.

The tank 1 is of a considerable height H and is built on the ground, that is, its bottom or base is not sunk into the ground, however, for reasons of strength, the base of the tank could be set below ground level. A typical height of the tank would be on the order of 10 meters, but this dimension could be exceeded.

For charging the material into the tank 1, a plurality of horizontally arranged reciprocating rams 6 are used, only one of which is shown in FIG. 1. Preferably, the ram 6 has a rectangular cross section and is displaced through a duct and passes between the bottom wall 7 and the top wall 8 of the duct. The top wall 8 has a funnel-shaped opening 9 through which the garbage is dumped into the duct. When the ram is in its retracted position, that is, when it is moved to the left of the opening 9, as viewed in FIG. 1, the garbage drops through the opening in front of the end face 10 of the ram and then is moved forwardly into the passageway 11 when the ram is moved by a drive member, not shown, in the direction of the tank. Any garbage within the opening 9 rides along the top surface of the ram 6 when it is moved toward the tank and then drops in front of its end face 10 when the ram is retracted away from the tank. Accordingly, as the ram 6 is reciprocated, it provides a pumping action moving the garbage from the duct into the passageway 11.

The design of the passageway 11 is of primary importance in achieving the desired effect in moving the garbage into and through the tank 1. The passageway is closed along its upper side by a top wall 12 and along its lower side by a bottom wall 13. In addition, two side walls, not shown, extend upwardly from the bottom to the top wall and are assumed as being vertical for simplicity's sake. It is essential that the two walls 12 and 13 are inclined to the horizontal, upwardly from the duct to the tank, for providing desired upward component of movement to the garbage. As illustrated in FIG. 1, the top wall 12 extends at an angle a to the horizontal and the bottom wall 13 extends at an angle b. For effective movement of the garbage, it is important that the angle b must always be greater than zero and that the angle a always be greater than the angle b. To assure the desired effect, the angle b must not be reduced to zero. Thus, for the present invention, the following unbalanced equation is appropriate:

\[ 0 < b < a. \]

At the commencement of operation, garbage is forced by the ram 6 upwardly along the inclined bottom wall 13 into the tank 1. Since the point at which the bottom wall intersects the front wall 4 of the tank is located above the tank bottom 5, a dump or sump 14 is formed which receives the first garbage charged into the tank. The garbage within the sump 14 assumes an angle of slope increasing, as viewed in FIG. 1, from the left to the right, its initial angle of slope is equal to angle b, which is always greater than zero, and this angle increases in the rightward direction. The material in the sump 14 is bounded at the top by a surface 15 which increases from the left to the right and forms a base over which the garbage subsequently charged into the tank rides. The gravity surface 15 located above the upper surface 15 of the material in the sump 14, is introduced into the tank by continuous strokes of the ram 6 and it moves upwardly over the surface 15 and gradually fills the entire volume of the tank, provided, of course, that the tank is not being emptied at the same time by a lifting bucket or other type of excavating or removing member which reaches in through the open top of the tank.

While only a single ram is shown in FIG. 1, as indicated in FIG. 2, the tank can be charged through several ducts and upwardly inclined passageways.

The selection of the angles a and b depend on local conditions, that is, the amount of garbage delivered to
the tank per unit of time, the composition of the garbage and the dimensions of the tank. The optimum values of the angles are best determined by trial, since the properties of the garbage depend to a great extent on the type of garbage which originates from the region in which the tank is located. For proper operation of the invention, it is important for the garbage to be pressurized from the bottom by the ram 6. As the height of the charge within the tank increases, the friction resistance developed by the walls of the tank also increases. Accordingly, the energy consumption required to lift the garbage increases, so that the lowermost portion of the garbage 16 is compressed to a greater extent when the tank is full rather than when the tank is only partly filled. Therefore, as filling of the tank progresses, the material becomes more compressed and its capacity increases per unit of volume. By pressing the material in through the lower end of the side wall of the tank, it is possible to achieve a greater and more uniform density than if the tank were filled from the top. Furthermore, the oxygen content in the garbage and the fire hazards are reduced. A similar effect could be achieved by compressing the garbage by special compacting devices, however, there is insufficient room for this type of device, apart from the fact that such a device is very complicated.

In the known methods of dumping garbage into a tank through its top, there results considerable dust development, which is avoided in the present invention, and should be avoided not only for reasons of environmental protection, but also because the operator who empties the tank is unable to maintain visual observation of the material and effective transfer from the tank to a disposal unit cannot be achieved.

The following are several examples of the dimensions of tanks used in carrying out the present invention:

**EXAMPLE 1**

With a dimension of $T = 5$ meters, and $H = 11$ meters, note FIG. 1, an angle $b$ of 15° was found to be suitable.

**EXAMPLE 2**

With a dimension of $T = 4$ meters, it was found that the angle $b$ less than 20° and the angle $a$ in the range of 20° to 30° was satisfactory.

**EXAMPLE 3**

With a dimension of $T = 7$ meters, and $H = 18$ meters, a value for the angle $b$ of between 20° and 25° has been found to be expedient.

These examples are the results of tests performed with different types of garbage. Other types of garbage may yield different values for the angle $b$. Based upon tests performed to date, it appears that the angle $b$ should always be less than 45°. Experience has shown that as the value of $T$ increases with a constant value for $H$, then the angle $b$ must be decreased. When a small angle $b$ is used, the compression factor increases.

While specific embodiments of the invention have been shown and described in detail to illustrate the application of the inventive principles, it will be understood that the invention may be embodied otherwise without departing from such principles.

What is claimed is:

1. A tank for the temporary storage of garbage to be processed in a garbage disposal plant, comprising first walls forming a vertically extending storage chamber closed laterally and at its bottom and open at its top, wherein the improvement comprises a garbage charging duct having a first end to which the garbage passes toward said storage chamber, a ram mounted in said duct arranged to perform a reciprocating movement through said duct for displacing garbage dumped into said duct toward its first end, and second walls forming a passageway connecting the first end of said duct to the lower portion of said storage chamber, said second walls including a lower wall and an upper wall and said lower and upper walls inclined upwardly and widening from said duct to said storage chamber so that said passageway has an upwardly funnel-shaped configuration from said duct to said storage chamber.

2. A tank, as set forth in claim 1, wherein the one of said first walls forming the bottom of said storage chamber is horizontal and is located below the lower wall of said passageway at the location at which it intersects the vertically extending walls defining said storage chamber.

3. A tank, as set forth in claim 1, wherein the one of said first walls forming the bottom of said storage chamber is inclined upwardly in the same direction as the upward inclination of said lower wall of said passageway.

4. A tank, as set forth in claim 1, wherein said upper wall of said passageway is inclined upwardly at a greater angle to the horizontal than said lower wall so that said upper and lower walls are arranged in diverging relationship from said duct to said storage chamber.

5. A tank, as set forth in claim 1, wherein said duct is arranged horizontally and has an opening in its upper surface with the opening spaced from the first end of said duct and arranged for passing garbage into said duct when said ram is retracted away from the first end of said duct rearwardly of the opening.

6. A tank, as set forth in claim 1, wherein the laterally disposed said first walls are vertically arranged.

7. A tank, as set forth in claim 1, wherein the angle of said lower wall of said passageway relative to the horizontal is greater than zero and less than 45°.

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