METHOD FOR CONSTRUCTING AN UNDERGROUND STORAGE TANK

Inventors: Akio Kobayashi, Tokyo; Tadao Yamada, Yokohama; Masuo Kawakami, Yamato; Hitoshi Ishioka, Tokyo; Hideyuki Nishiura, Soka, all of Japan

Assignee: Ishikawajima-Harima Jukogyo Kabushiki Kaisha, Tokyo, Japan

Filed: Jan. 2, 1973

App. No.: 320,005

Foreign Application Priority Data
June 12, 1972 Japan

47-58334

U.S. Cl. 52/742, 52/169

Int. Cl. E02d 15/02, E02d 27/38

Field of Search 52/169, 742

References Cited

UNITED STATES PATENTS

718,441 1/1903 Ewen 52/169 X

2,177,859 10/1939 Brice 52/249

2,332,227 10/1943 Jackson 52/169

3,151,416 10/1964 Eakin 52/742

3,300,986 1/1967 Hirata 52/742 X

3,562,987 2/1971 Eakin 52/269

FOREIGN PATENTS OR APPLICATIONS

907,669 10/1962 Great Britain 52/742

28,625 12/1924 France 52/169

Primary Examiner—Alfred C. Perham

Attorney, Agent, or Firm—Ernest F. Marmorek

ABSTRACT

A method for constructing an underground storage tank for low-temperature liquefied gas is provided which comprises the steps of driving into the ground a shell having a wall-thickness capable of withstanding the leakage; disposing compound segments on the bottom of the shell whenever the soil within the shell is excavated to a predetermined depth, stacking the compound segments one upon another for forming a compound segment layer in a predetermined spaced apart relation with the shell; and placing a concrete layer in the space between the shell and the compound segment layer.

2 Claims, 8 Drawing Figures
METHOD FOR CONSTRUCTING AN UNDERGROUND STORAGE TANK

The present invention relates to an underground storage tank for storing a large quantity of volatile, low-temperature liquefied gas such as liquefied petroleum gas, liquefied natural gas, liquefied ethylene gas or liquefied ammonia. In general the underground storage tanks for storing a large quantity volatile, low-temperature liquefied tanks are superior to the storage tanks constructed on the ground in many respects, but it is generally extremely difficult to thoroughly test the soil at the field site so that the construction schedule tends to be delayed by unexpected high groundwater and earth pressures and large leakage of groundwater. Moreover the cost tends to increase because of the unexpected high heat leaks into the storage tanks and because of the incorrect analyses of the results of the soil tests even after the storage tanks are constructed.

The present invention was made to overcome the above and other defects and problems encountered in the prior art methods for constructing the underground storage tanks. Briefly stated, according to the present invention, a reinforced concrete shell that is circular or polygonal in cross section and having a wall-thickness capable of withstanding the leakage is driven into the ground. When the soil in the shell is excavated to a predetermined depth, compound segments are laid on the bottom of the shell and stacked one upon another so as to be spaced apart from the shell by a predetermined distance which is dependent upon the soil conditions thereby forming a compound segment layer. The intermediate concrete layer is formed by placing concrete into the space between said shell and said compound segment layer; and the adjacent inner plates of the compound segment which are made of a metal capable of withstanding low temperature are then joined to each other through retaining walls or plates in such a manner that the inner metal plates may expand or contract (depending upon the change in temperature and pressure of liquefied gas). The present invention will become more apparent from the following description of one preferred embodiment thereof taken in conjunction with the accompanying drawings.

FIGS. 1-4 are schematic vertical sectional views used for explanation of the steps of construction of an underground storage tank in accordance with the present invention;

FIG. 1 illustrating a cylindrical shell driven into the ground until it reaches the sound foundation;

FIG. 2 illustrating the excavation of the soil within the side wall and the laying and stacking of compound segments;

FIG. 3 illustrating the concrete being placed between the shell and the compound segment layer; and

FIG. 4 illustrating the completed underground storage tank;

FIG. 5 is a sectional view taken along the line, 5-5 of FIG. 4; and

FIGS. 6-8 are fragmentary vertical sectional views on an enlarged scale of the portions encircled by the circles A, B, and C, respectively.

First referring to FIGS. 1-3, a concrete shell 4 is placed in an annular hole formed by excavating the soil 1 until the sound foundation 2 such as hardpan, bed rock or frozen soil is reached.

The thickness of the shell 4 is such that the leakage may be prevented. The conventional construction method may drive the shell 4 with a wall-thickness of one meter a depth of 50 meters, and if leakage should occur because of defects in the prefabricated shell 4, a chemical grout may be used to fill the cracks, voids or the like or the cut-off walls or a freezing method may be used so that the excavation may proceed.

After the soil 1 within the shell 4 is excavated to a desired depth which is required to stack a desired number of compound segments 6 to be described in more detail hereinafter, the compound segments 6 are stacked one upon another from the bottom of the excavated hole in spaced apart relation with shell 4 and are welded to the flanged retaining walls (not shown) in such a manner that the compound segments 6 may be expandable and contractable for example between dowels (not shown) provided on the shell 4. (See FIG. 2). The compound segment 6 which in the form of a square or rectangular lagging and has major surfaces having a radius of curvature equal to that of the shell 4, generally consists of a reinforced concrete slab and a metal plate which is capable of resisting a low temperature and which is bonded to the inner surface of the reinforced concrete slab. The spacing between the compound segments 6 and the shell 4 is determined depending upon the soil conditions, and is used to form an intermediate reinforced concrete layer to be described hereinafter.

The soil excavation may be made preferably by a mechanical shovel excavator whereas the compound segments may be stacked preferably by a hydraulically-operated crane.

The intermediate concrete layer is placed in the space 5 between the compound segments 6 and the shell 4 preferably by a concrete pump. The roof and bottom of the shell 4 have conventional heat insulating layers and cladding plates made of a metal capable of withstanding a low temperature and are welded to the inner plates of the compound segments. Thus the underground storage tank for low-temperature liquefied gas may be constructed.

Next referring to FIGS. 4-8, the construction of the underground storage tank of the present invention will be described in detail.

In FIGS. 4-8 the soil surrounding the storage tank is designated by the reference character 1. There is provided a concrete shell 4 which is comprised of an intermediate concrete layer 5 and a compound segment layer 6 which is lined with a heat insulating layer 7. A thin metal wall 8 is the innermost wall of the storage tank. The bottom 9 of the storage tank is constructed below the metal wall 8 and comprises concrete, sand heat insulating material and the like. An upper, insulating layer 12 is suspended from a roof 3 by means of stays 13.

As shown in FIG. 8, the bottom of the storage tank comprises the insulating layer 7 below the thin metal wall 8 and a fine sand layer 9 in which are disposed a plurality of heating coils 11 for heating the bottom and a plurality of drain pipes 10 for draining groundwater. The drain pipes 10 are in communication with a duct, and water in the duct is pumped up onto the ground surface through a pit.

When there is much seeping water in the foundation below the bottom of the storage tank, water close to the bottom is frozen together with the drain pipes because
3,854,265

3. The temperature of liquefied gas is very low so that it becomes impossible to drain groundwater. The pressure of groundwater directly acts upon the bottom of the storage tank so that the bottom is destroyed. To overcome this problem, the present invention provides the heating coils so as to prevent groundwater in the drain pipes from being frozen. The present invention is not limited to the heating coils, but any other suitable heating means may be used.

As described above the compound segments are stacked one by one upon the bottom of the excavated hole so that the scaffolding or the like is not needed at all. The thickness of the intermediate concrete layer may be determined depending upon the soil conditions and adjusted by the spacing between the shell and the compound segments which in turn may be adjusted by the positions of the compound segments. Therefore a large quantity of heat leak into the storage tank may be prevented. Moreover the shell, the intermediate concrete layer, and the compound segments cooperate with each other to withstand the earth, groundwater and liquefied gas pressures. The metal plates may expand and contract depending upon the liquefied gas pressure and temperature so that their mechanical strengths may be much enhanced. Furthermore the drain pipes and the heating means for heating the drain pipes are provided in the bottom of the storage tank so that the drain pipes may be prevented from being frozen. Therefore, even when much groundwater seeps into the foundation below the bottom, it may be easily drained so that the pressure of groundwater may be always maintained at a constant level. Thus the present invention provides a very reliable, dependable and safe underground storage tank for liquefied gas.

What is claimed is:
1. A method for constructing an underground storage tank for low-temperature liquefied gas, said method comprising the steps of excavating an annular hole in the soil until a sound foundation is reached; forming a first concrete, outer shell in the annular hole with the outer shell resting on the foundation; removing the soil to the desired depth from the area within the outer shell; vertically stacking a plurality of segments within the outer shell, the stacked segments being positioned inward of the inner wall surface of the outer shell to define an annular space between the outer shell and the vertically stacked segments; filling the annular space with a second, inner shell of concrete; and adding a roof and a bottom to the inner and outer shells.
2. The method according to claim 1 wherein there is further included the step of coupling the segments to each other so that expansion and contraction is permitted.

* * * * *