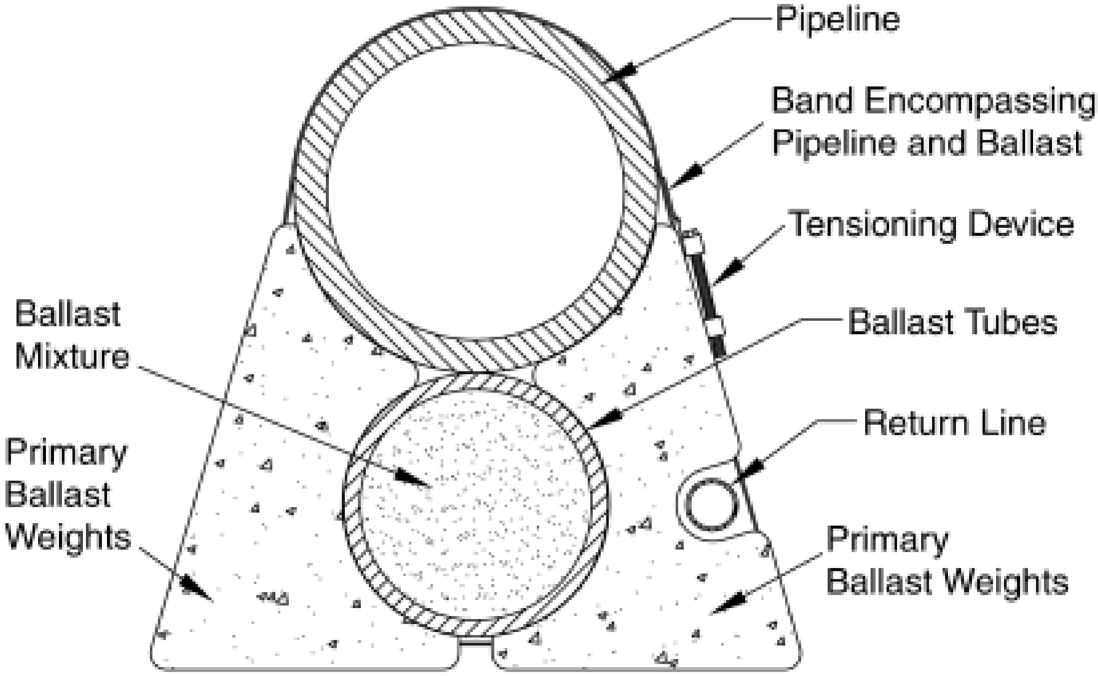
Figure 1: Cross-Sectional View of a Pipeline Weighed Down by the Ballast



Anchors Aweigh

New Methods for Installing Synthetic Underwater Pipelines: Part 2

Part 1 of this article discussed the amount of ballast weight needed to submerge a pipe and detailed the traditional method of installing an underwater pipeline.

New Process

The new process allows the final ballast weight to be achieved after the pipeline has been positioned on the sea bed. For sinking purposes, the pipeline weight is minimized to only the amount necessary. After positioning the lightly weighted pipeline on the sea bed, the ballast tubes attached to the pipeline are filled (by injection or other means) with a mixture consisting of a substance that possesses a relative density that is greater than water. The process also makes provisions for any ratio of final ballast weight to be applied to the pipeline after its final positioning on the sea bed. The invention makes further provisions to allow for an increase or decrease of the amount of final ballast weight applied to specific sections along the length of the pipeline by making changes to the diameter of the ballast tubes as required at the specific sections.

The purpose of this process is to allow the designers and installers of synthetic pipelines the ability to reduce the amount of axial tension required during the sinking process, by reducing the amount of weight affecting the pipeline during the sinking phase of the installation. The invention allows for any percentage of offset weighting to be achieved, while minimizing the axial tension requirements during the sinking phase. For example, a synthetic pipeline with a final offset weight requirement of 200 percent can be installed in much the same fashion as a synthetic pipeline with a final offset weight requirement of 5 percent. This method also will mitigate the damage risk to the pipeline due to insufficient axial tension applied during the sinking process.

Preferred Embodiment

The invention can be configured to accommodate any practical number of ballast tubes as required to suit the particular design of the pipeline final ballast weighting and is not limited to the number of ballast tubes shown on the drawings.

As stated, the main advantage of the invention is to allow the reduction of weight during the launching and sinking phases of the pipeline installation. This is especially critical for synthetic pipelines designed with offset weight requirements near to or exceeding 100 percent as well as for pipelines manufactured from metal or other compounds. The pipeline can be assembled from a floating platform or on land using known and proven techniques and then launched into the water from a floating platform or pulled off of the land and into the water. The pipeline is positioned on the sea bed using known and proven techniques. The final ballast weight is achieved with the introduction of a ballast mixture possessing a relative density greater than water into the ballast tubes from one end, preferably the shore end of the ballast tubes, and the ballast mixture is allowed to fill the entire ballast tube to achieve the required amount of final ballast weight.

As shown in Figures 1 and 2, the diameters of the ballast tubes remain at a constant internal diameter for their entire length. The pipeline is assembled with the primary ballast weights, the ballast tubes and the return line encompassed together with the use of a band. The band is preferably manufactured from a synthetic fabric. The band is contained in a state of permanent tension with the use of a tensioning device as shown.

The tensioning device utilizes a threaded draw bolt to pull the ends of the band together and is preferably manufactured from an alloy such as stainless steel. It also is possible to permanently join the ends of the band together after creating the proper tension. The ends then can be stitched or riveted. In the case of metal or synthetic bands, welding may be used. Suitable bonding agents also may be used.

Stainless steel can become covered with organic sediments in an oxygen-deficient area, corrode and lose its integrity. Therefore, the tensioning device, should be positioned above the portion of the pipeline that is not touching the sea bed. The band encircles the pipeline components, renders them in a fixed bundle and is tensioned prior to the launch of the bundle into the water. Additional bands are applied as required between the areas that have the primary ballast weights installed as a means of containing the ballast tubes closely to the pipeline.

The primary ballast weights can be cast from concrete or any substance with a relative density greater than water. They are designed so that their shape lends to forming the pipeline components into a tightly contained bundle while not deforming them while under tension. Figures 1 and 2 show the primary ballast weights formed with a transverse indentation around the outside of their perimeter. The primary ballast weights contain formed openings to accept the return lines.

The primary ballast weights are installed at regular intervals along the length of the pipeline. They are spaced so undue stress is not formed because of the buoyant sections of the bundle forming humps between the primary ballast weights while the pipeline is floating on and between the water's surface or resting on the sea bed. The primary ballast weights can be as low as 0.5 pounds of weight per lineal foot of pipeline. As an added benefit, the orientation of the pipeline is maintained throughout the launching and sinking phase due to the design of the primary ballast weights. The primary ballast weights have their greatest mass below the center of buoyancy of the pipeline bundle. Pipelines designed to have intake or diffuser ports protruding from the top portion of the pipeline must retain their orientation when positioned on the sea bed. The design and method of attachment of the primary weights in this way assures that the bundle is properly oriented when it comes to rest on the sea bed.

The primary ballast weights also may be fastened to the pipeline and ballast tubes with the use of a draw bolt as shown in Figure 3. The draw bolt, preferably manufactured from a corrosion resistant alloy, is installed through holes cast into the primary ballast weights.

The pipeline, after being assembled and hermetically sealed (with a provision to introduce water at one end and vent escaping air from the opposite end), is launched into the water to float on its inherent buoyancy. The ballast tubes are allowed to be completely filled with water during the launching of the pipeline bundle. The piston is free to travel through the ballast tubes and keep separate the ballast mixture and the water within the ballast tubes. The piston is made of a flexible non-compressible material capable of making a seal between the wall of the ballast tube and the piston body and maintaining the seal while travelling ahead of the ballast mixture.

Both the supply cap assembly and end cap assembly are joined to the ballast tubes. After positioning the floating pipeline bundle on the water's surface with the ballast tubes already flooded during the launching, the pipeline itself is flooded using known methods such as S bend sinking. The bundle is allowed to come to rest on the sea bed.

Figure 2: Side Elevation View of a Pipeline Weighed Down by the Ballast

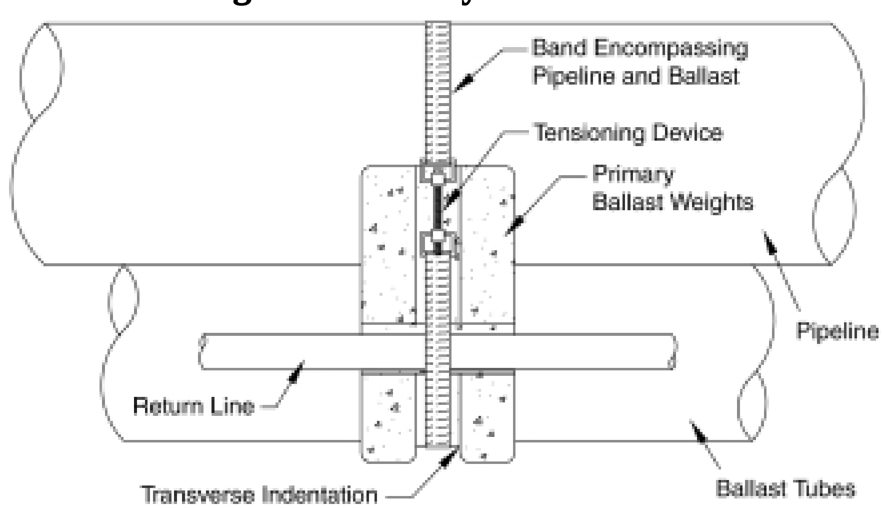


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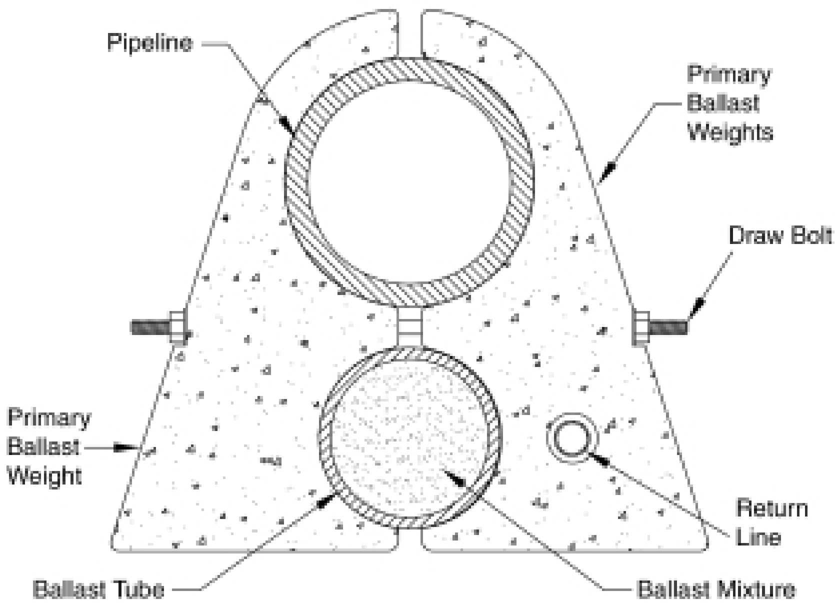
Figure 3: Variation of the Ballast's Embodiment



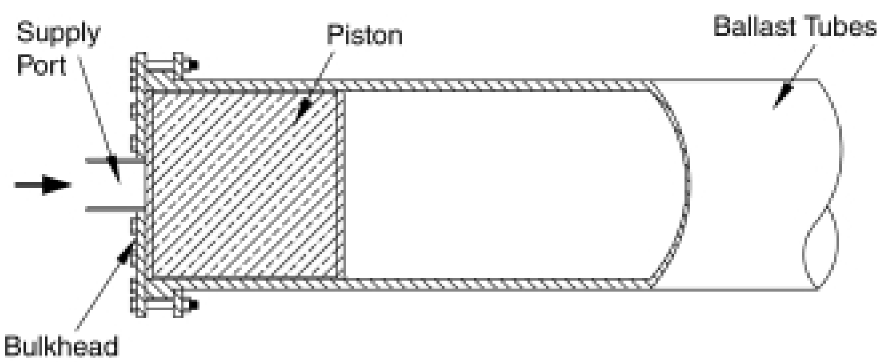
The ballast mixture is introduced to the ballast tubes through the supply port located on the supply cap assembly as shown in Figure 4. As it is introduced, the piston is pushed ahead of the ballast mixture, forming a barrier between the ballast mixture and the water within the ballast tubes. The water is displaced through the vent port on the end cap assembly.

The ballast mixture may contain additives to facilitate its introduction, and to become solid, if so desired, after a suitable amount of time has elapsed.

The ballast mixture to be effective must have a relative density that is greater than the water in which the pipeline is to be installed. Therefore, the weight of the column of ballast mixture will exert a hydrostatic head pressure within the ballast tube. This pressure will be greatest at the lowest point of the ballast tube. The return line equalizes the pressure differential realized by the hydrostatic head pressure exerted by the weight of the ballast mixture within the ballast tubes for pipelines terminating in exceptional depths of water.

In most applications, the two ends of the ballast tubes will be at different elevations due to the nature of the sloping sea bed, thus the two ends of the ballast tubes will be exposed to different external ambient pressures. (Ambient pressure increases with depth.) The higher of the two ends generally is the introduction point of the ballast mixture.

Figure 4: End Cap Assembly of the Ballast Tube Showing the Piston Within the Tube



The invention makes provisions for changes in offset weighting by making allowances for an increase or decrease of the diameter of the ballast tubes with the use of diameter transition adapters. Any number of final offset weight changes can be accommodated. The diameter transition adapter is installed between two different sizes of ballast tubes during the assembly of the pipeline bundle. While the drawing depicts a larger diameter ballast tube being filled with ballast mixture, connected by means of a flange coupling via a diameter transition adapter to a ballast tube of a smaller diameter, it is obvious that the arrangement could be reversed and configured so that a smaller diameter ballast tube can be attached to one of a larger diameter. The diameter transition adapter is composed of two separate chambers (primary and secondary). The primary chamber is the one where the flow of the ballast mixture is first to enter. These chambers are separated by a bulkhead. The bulkhead provides a stop for the piston that is travelling ahead of the ballast mixture and displacing the water out through the vent port. The piston now blocks the vent port in the primary chamber. The ballast mixture is forced to divert through the crossover pipe and the flow of the ballast mixture is allowed into the secondary chamber. A second piston of a different diameter but the same properties as the first piston is acted on by the flow of ballast mixture entering the secondary chamber. This flow pushes the second piston ahead of it and into the next section of ballast tube, which repeated until the piston meets with another diameter transition adapter or an end cap assembly.

The vent ports are connected to and emptying into the return line as a matter of economy in utilizing the existing return line that is already connected to the end cap assembly. If the return line is deleted for applications of shallow depth the throttling valves can be installed directly to the vent ports and operated by divers or actuated remotely from the surface.

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