Solid Wall High Density Polyethylene Pipe Systems. Methodology for Floatation and Submersion.

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Abstract

Installation of High Density Polyethilene Pipelines underwater is becoming frecuent over the last few years due to the advantages against other types of materials.
Structural and hydraulic parameters as well as sanitary considerations are taken into account during the preparation of a HDPE Pipeline Project, but often the installation procedures are given a secondary importance.
Before to proceed with the floating and submersion of a HDPE Pipe , some important paramaters have to be taken into consideration. The preparation of pipe submersion plan desk study, the design of blind flanges for the floating and sinking of the pipe , seabed survey , pipe submersion rigging preparation to guarantee the correct location on the seabed and the scheduling of the submerging activities based on weather forecast.
Particular attention is required during the submersion phase of the pipe, to the connection system between one or more consecutive separate long segments of the pipeline wich will depend on the pipe diameter , the lenght of each segment , the method for sinking , the type of joint and the on site team leader criteria.
All these require a well dimensioned human team and the use of suitable equipment in order to succesfully achieve the completion of the project.

Key words

HDPE, pipeline, submersion

CONSIDERATIONS BEFORE THE FLOAT AND SINK PHASE

Pipeline Float and Sink Desk Study:

During floatation and submersion phases, the pipe is subject to various strains and stresses wich could lead to undesired pipe collaps. The Desk Study is design to identify and assess the forces acting upon the pipe on each phase of the project and to draw the necessary precautions to be taken in order to accomplish a safe and efficient pipe lay on the seabed. Each Study will be done taking into acount the pipe diameter, SDR, lenght on the pipe segment to be installed , maximum depth of installation and ballasting percentage.

It is important that the Desk Study is based on what is "really" going to be executed on site, wich may or may not coincide with what is on the original/initial Construction Project , in particular the ballasting percentage to be used , the final lenght of each pipe segment, the equipment available on site, the type of floats to be used (if any) etc.

The Float and Sink Desk Study will define each step of the process, the necessary precautions to be

taken and the equipment to be used:

- The use of floats to minimize the pipe stresses, describing their distribution , type and working principle distinguishing between constant volume units (rigid floats) or variable volume units (inflatable floats).
- Spacing of the ballast units in such a way that allow the water to flood the pipe at the end wich is to be submerged first, so the air can be exhausted from the opposite end. This will avoid the insufficient sinking of this pipe section , wich could , together with the waves movement , create an undesired air pocket at the centre of the pipe segment due to water ingress on undesired areas.
- Recomended equipment like air compressor for air injection on the pipe and water pump for pipe flooding acceleration , etc.
- The valves for water flooding and air exhaust produce the equilibrium between the internal and external pressures.

The Desk Study should be check and reviewed if needed , once the first pipe segment has been laid on the seabed. Corrections can be made if deemed necessary to improve the rest of the project.

Blind Flange Assembly Design

Are used to prevent water ingress inside the pipe segments during towing as well as to control at all times the different phases of the pipe sinking process. The thickness of the plate should be adequate to withstand the water pressure and fittings with valves for water flooding and air exhaust will be tapped. It is important the adecuate location and size of the valves as well as the number to be installed on each plate of the flange assembly.

The wide experience gained on this type of projects tell us to install two oposite valves on each blind flange. The advantages are the following:

- The water flooding valve installed on the lower section of the blind flange assembly is always below the sea surface allowing us to flood the pipe from the very begining of the sinking process without the need of any traction on the pipe.
- In case that the seabed is sandy, an obstruction of the lower flooding valve may happened by suction of loose material wich in turn will stop the sinking of the pipe. This can be overcome by installing a second flooding valve on the top section of the blind flange assembly.
- The installation of oposite valves also improve the pressure balancing and air exhaust.
- Increased sinking speed when both valves are open.

The size of the valves will depend on the pipe diameter, lenght of pipe segment to be submerged and the depth on wich is to be laid.

Another important factor during the installation is the diver´s safety specially when manipulating the water flooding valve. Suction of parts of the body or equipment may happend. To avoid this, an extension could be used to keep the subtion away from the diver.

The election of the type of valve to be installed is given by the ease of use and functionality. Ball valves are common for smaller diameters and gate valves for great diameters.

Preparation of the pipe segment to be installed
Sometimes we may end up in a situation where the different butt welded pipe segments are ready to be submerged , but due to temporary site conditions, they have to be kept waiting in sheltered waters untill conditions are apropiate for final installation. If the waiting time is due to be long , then it will be worth to sink the pipe segments instead of keeping them afloat with the associated risks to do so.

Considering all the above it is clear that the scheduled day for the final pipe lay will start with the refloating of the chosen pipe segment in sheltered waters and a check up of the ballasting system elements. This will include the re-tightening of all the bolts securing the ballast units to the pipe to avoid any loosen element due to pipe compressions/expansions suffered by the polyethilene with the variations in temperature. We cannot risk to start with the towing and sinking until all the ballasting elements are properly secured and attached to the pipe.

Preparation for pipe sinking
Two main activities at this stage of the operation. Positioning of the pipe and preparation and installation of rigging equipment.

The choice of pipe positioning system will be given by the practicallity of use and the accuraccy of the equipment. It looks from the practical point of view, that a shore based Total Station is not an option for operations in open sea. From the accuracy point of view, it seems more logical to use a DGPS with around 1m error , than a normal GPS with around 60 to 100m error against the theoretical position. The longitudinal axis of the pipe will be defined by small buoys at both ends of the pipe moored to previously installed concrete blocks positioned with the DGPS.

We call manouvering elements (dead man anchors) the concrete blocks used to position the main working boat and those used to guide the pipe segment down to the right location on the seabed. Dimensions of manouvering elements will depend on the type of forces they will have to withstand during pipe installation.

Sinking Plan.
One of the more important factors interfering with the pipe sinking operations is the weather and in particular wave hight and wind speed. The sinking operations will be carried out when the weather conditions are considered optimal and even then it is a last minute decision to sink the pipe or not.

Operations Scheduling will start with a close look at the weather forecast for the site . Wind speed and direction, wave hight and the average period (Tp) and peak period (Tz).

When planing a pipe sinking on the surf zone is important to consider that the waves activity information included on the weather forecast is for open sea. It cannot be given a general rule for the wave activity on the beach. It will depend , among other things , on the prevailing direction of the waves in open sea, type of seabed, type of coast line and beach orientation.

CONSIDERATIONS TO TAKE INTO ACCOUNT DURING THE SINKING AND CONNECTION PHASE.

Sinking Phase

The pipe segment will be towed floating to the sinking location marked with previously DGPS positioned buoys. At this point the pipe segment will be moored to the previously installed manouvering elements (dead man anchors). The lower flooding valve is then opened allowing the pipe to sink and guiding the head of the pipe with the use of tirfors to the required position. This position will depend on the pipe segments connecting process.

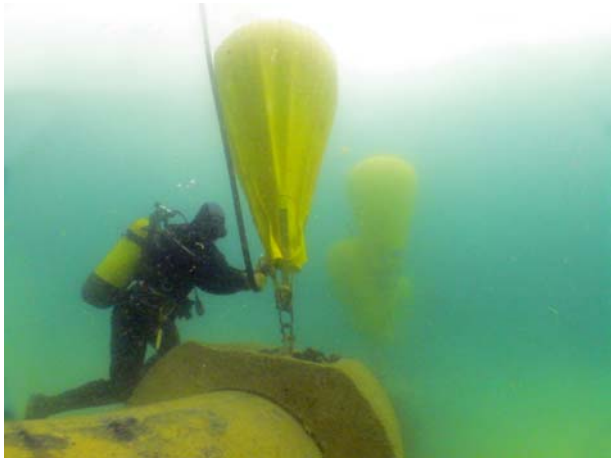
Before the pipe end touches the seabed , the lower flooding valve is slowly closed and the top valve is opened. In this way we avoid the obstruction of the lower valve due to suction of loose material. Once a certain ammount of pipe is resting on the seabed the lower flooding valve is opened again to increase the sinking speed. The decision to open the air exhaust valve at the opposite end of the pipe will depend on the desired sinking speed. It can be opened from the begining of the sinking process or wait until the touch down has hapenned and then proceed to the valve opening.

Pipe Segments Connections

The connection of the diferent pipe segments that form the pipeline can be done in several ways depending if is on surface or underwater and if it can be accomplished on the same day of the pipe sinking according to the criteria of the person responsable for the operation.

Surface joints are convenient for small diameter pipes (up to DN 710). Here the pipe heads are lifted over the sea level in a flange to flange mode proceeding to bolt together the two segments.

For large diameter pipes (from DN 1600) and long segments with complicated sinking manouvers, the best option is to execute the sinking in such a way that the head of the new sunken segment lies on the seabed in paralel to the head of the already laid pipe. This will allow for easy removal of the blind flange plates assemblies. Then, divers will lift the two heads with lifting bags and proceed with the final bolting of the flanges.



Last case is the connexion of pipes segments with diameter between 710 and 1600 wich are less complicated to sink. Here the connections between segments can be done on the same day using long studs to joint the flanges together.