

Deltares' Large scale multiphase flow facility Alpha Loop

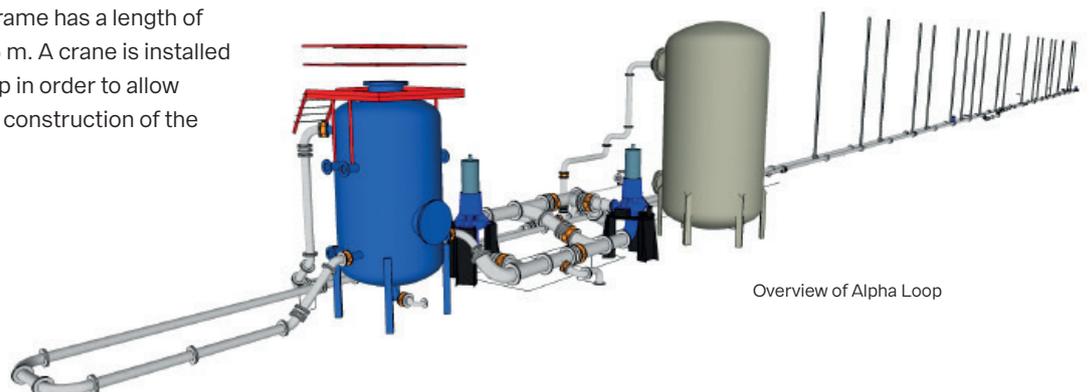
Alpha Loop is a multiphase flow facility in Deltares. This facility enables the possibility for flow investigations in a wide range of academic and industrial multiphase research topics. The Alpha Loop allows for single-phase (water), two-phase (water & air) and three-phase studies (water, air, and sediment) in pipeline systems. Different hydraulic components such as valves and pumps can be tested using Alpha Loop. Moreover, various flow phenomena like cavitation, sedimentation, fast pressure transient, and etc. can be investigated in this facility. The exceptional configuration of Alpha Loop allows for different geometries of pipes (length, slope, and etc.) to be installed. This provides the opportunity to perform various types of tests in this system.

Facility Description

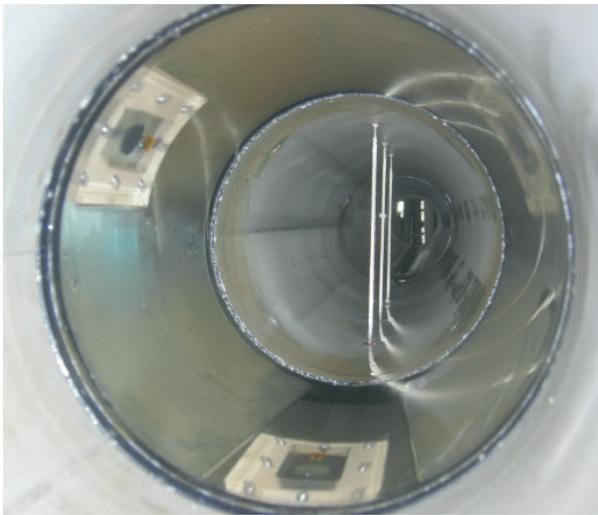
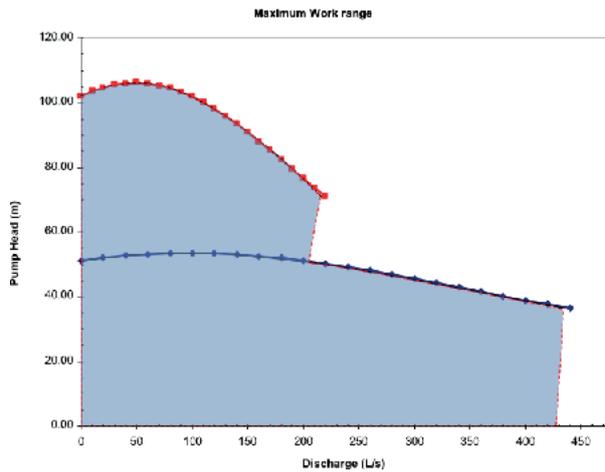
The facility consists of a 320 m long pipeline loop, steel PN16 DN200; other diameters up to about 500 mm can be installed for assessment of scale effects. Transparent sections can be installed in various locations of interest in order to enable visual inspection of the flow patterns.

A part of the loop is connected to a frame in order to enable the construction of arbitrary 2D pipe profiles (length-height). The frame has a length of 120 m and a height 7.5 m. A crane is installed parallel to the flow loop in order to allow for simple and flexible construction of the specific loop design.

The facility is equipped with two pumps. Each pump supplies water at a discharge ranging from 10 to 200 L/s at a pump head of about 50 m. The pumps can be arranged in series or parallel in order to provide additional head or flow rate capacity.



Overview of Alpha Loop



Flush mounted wall shear stress probe and bubble generation wires for transient PIV measurements

The air is supplied from a 70 m³ tank (PN16), which is filled by an air compressor. Optionally, an additional external compressor can be connected to the air tank for a supply up to about 3000 Nm³/h. If needed, a separator vessel (20 m³, PN16) can be used to separate the flow phases. The intelligent design of the vessel's internal lay-out allows for dedicated separation depending on the needs. The separator is connected to the air tank in order to pressurize the entire flow loop.

Instrumentation

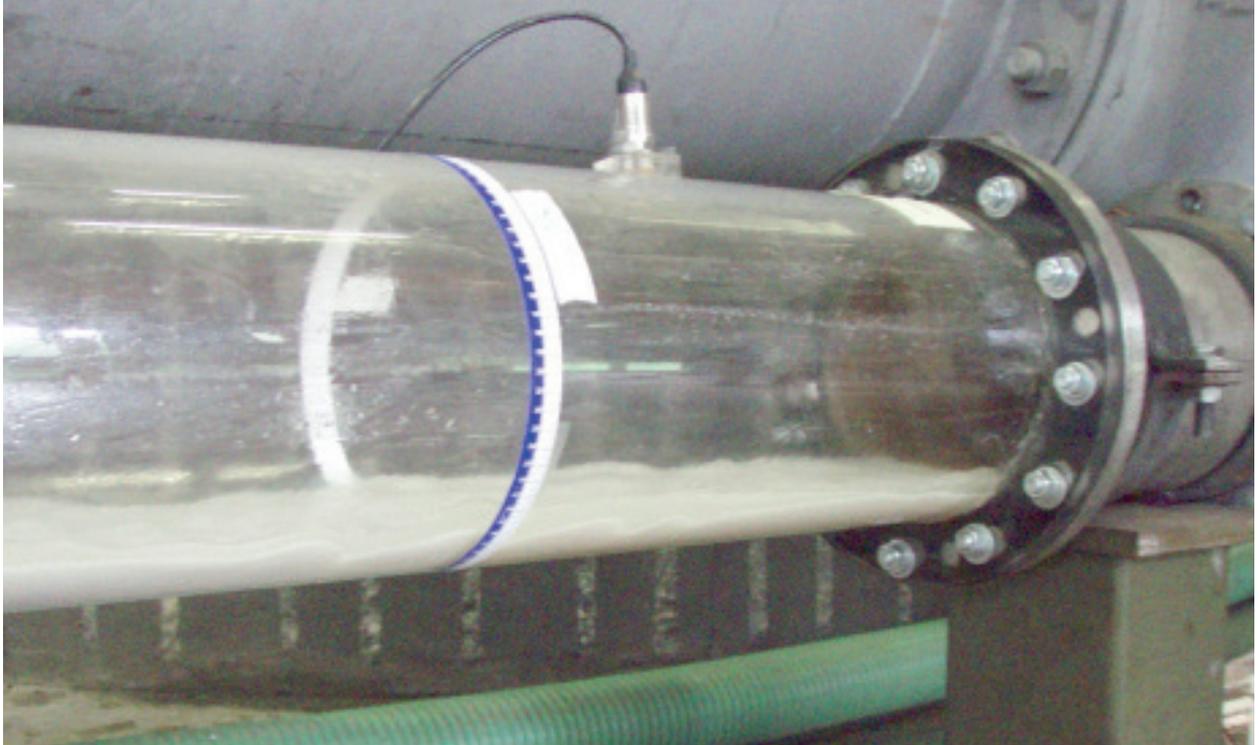
Deltares has a wide variety of instrumentation available. Pressure can be measured at arbitrary locations of the loop using high performance pressure gauges. The flow rate is monitored using electromagnetic flowmeters and air vortex flowmeters. For challenging interface measurements, reliable instruments are installed.

Deltares has experience with a wide range of measurement techniques, such as optical and conductive void fraction measurements, accurate liquid level meters, Particle Image Velocimetry, Laser Doppler Anemometry and Tomography. Deltares co-operates with Delft University of Technology for dedicated instrumentation.

Instrumentation can also be custom made for a project. Deltares' experienced instrumentation staff can design and build instruments to required specifications. Certain fluid properties, such as surface tension, can be measured and controlled during the experiments.

Pressure sensors installed in several locations





Solids re-entrainment

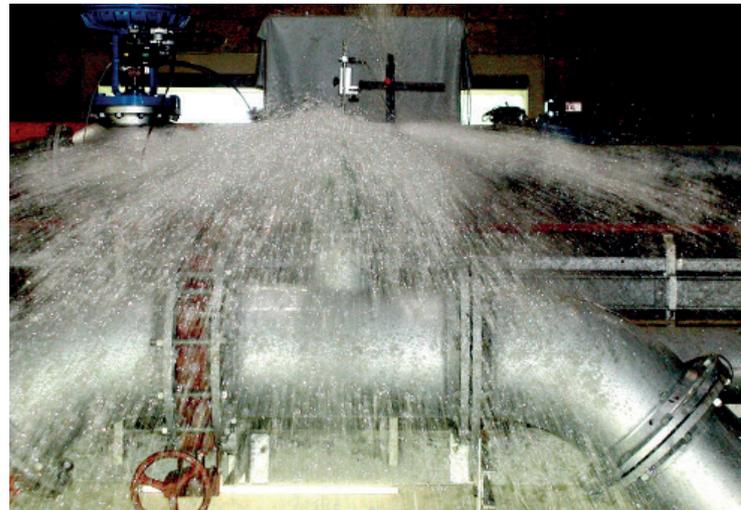
Applications

The test facility is designed such that a wide range of applications can be investigated, including:

- Multi-phase flow research for the oil & gas and water industry
- 2-phase and 3-phase flows in inclined pipe sections (to model terrain slugging in gas-condensate lines with or without sediment loading)
- 2-phase flow in downward sloping pipes, such as capacity reducing gas pockets
- 2-phase and 3-phase flows in very long horizontal pipe sections in order to establish flow patterns in large diameter pipes (in particular the slug flow regime)
- Collect validation data for multi-phase simulation software (in particular slug flow models)
- Component behaviour (air valves, separators, by-pass pigs, flow meters, pumps, process vessels) in 2- and 3-phase flows.

Due to the flexibility of the Alpha loop a wide variety of transient phenomena can be investigated, including:

- Slug flows in long inclined pipelines (upward & downward)
- Solids re-entrainment in inclined pipes by air-water flow
- Acceleration of liquid slugs resulting from a gas blow out
- Rapid priming of pipelines (assessing the danger of rapidly filling pipelines)
- Dynamic performance of pressure relief valves
- Performance and interaction of air valves in undulating pipelines
- Pigging & flushing of pipelines (how to clean a pipeline in a fast and efficient way)
- Leak detection (identification and positioning).



Transient air valve behaviour



Hydraulic jump demonstrated in a transparent pipe sections

Experience

As an independent research foundation, Deltares has over 40 years of experience with research and testing in large scale single and multiphase pipe flows for various markets, including the water industry, oil & gas companies and component manufacturers.

Our experimental projects include confidential contract research, performance evaluation and design support of multiphase flow components, numerical model development and validation and joint industry projects with a strong focus on knowledge dissemination, enabling a rapid transfer from scientific knowledge development to practical applications.



Pressure measurement in a gas-entraining hydraulic jump

Reference list of projects (selection)

Project	Client	Year
Experimental studies for cavitation in long pipelines	Deltares (WL Delft Hydraulics)	1970
Several research projects in sand and solids transport	Multiple dutch dredging companies	1980 - 2000
Cleaning pipelines with air-water mixtures	KIWA	1998
Air-valve tests at large scale	EC – Hydralab II	2003
Efficiency of air separation Efficiency of particle separation	Flamco BV. Taco	2003
Solids re-entrainment in inclined pipes	Chevron	2006 - 2007
Two-phase flow in downward sloping pipes – CAPWAT project	Joint industry Project with Dutch water industry	2003 - 2010
Unsteady friction in pipes and ducts	Hydralab III	2008
Transient vaporous and gaseous cavitation in pipelines	Hydralab III	2009
Shockwave interaction on liquid slugs	Deltares (internal research)	2012-2013
Joint cavitation validation experiments	Dynaflow - Deltares	2014
Air supply for bubble screen testing	Deltares	2015
PIV measurement of a closing valve	Deltares (internal research)	2015
PIV of high Reynolds flow	TU Delft - Deltares	2019-2020



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Deltares is an independent institute for applied research in the field of water, subsurface and infrastructure. Throughout the world, we work on smart solutions, innovations and applications for people, environment and society. Deltares is based in Delft and Utrecht.

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