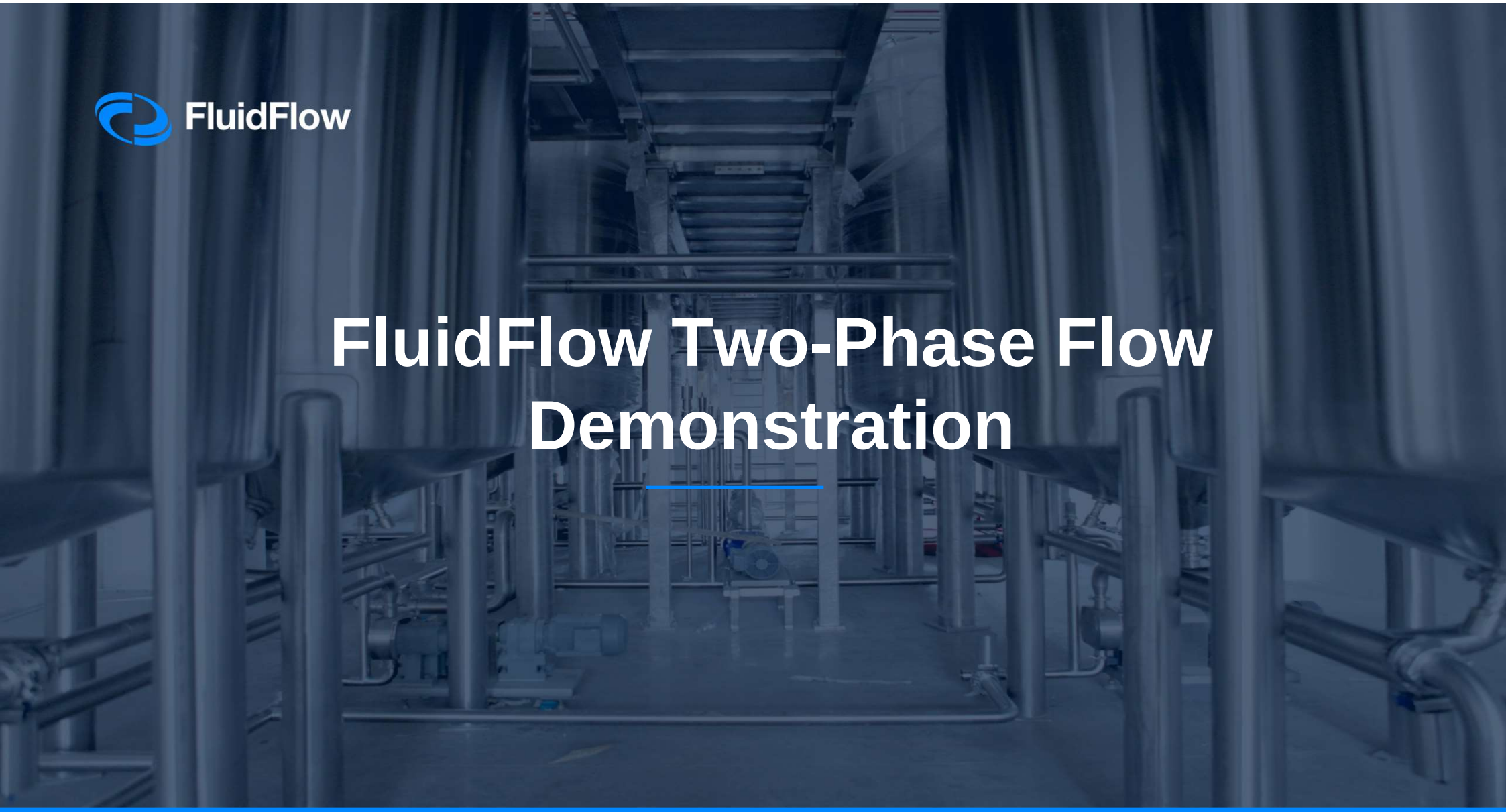


FluidFlow Two-Phase Flow Demonstration

Discussion Outline

1. Disclaimer
2. FluidFlow: Hydraulic Calculation Software Objectives
3. FluidFlow Database
4. FluidFlow Demo
5. Basic and Advanced Training

Disclaimer

“In order to model a two-phase flow, it is necessary to activate both the liquid and gas FluidFlow calculation modules.”

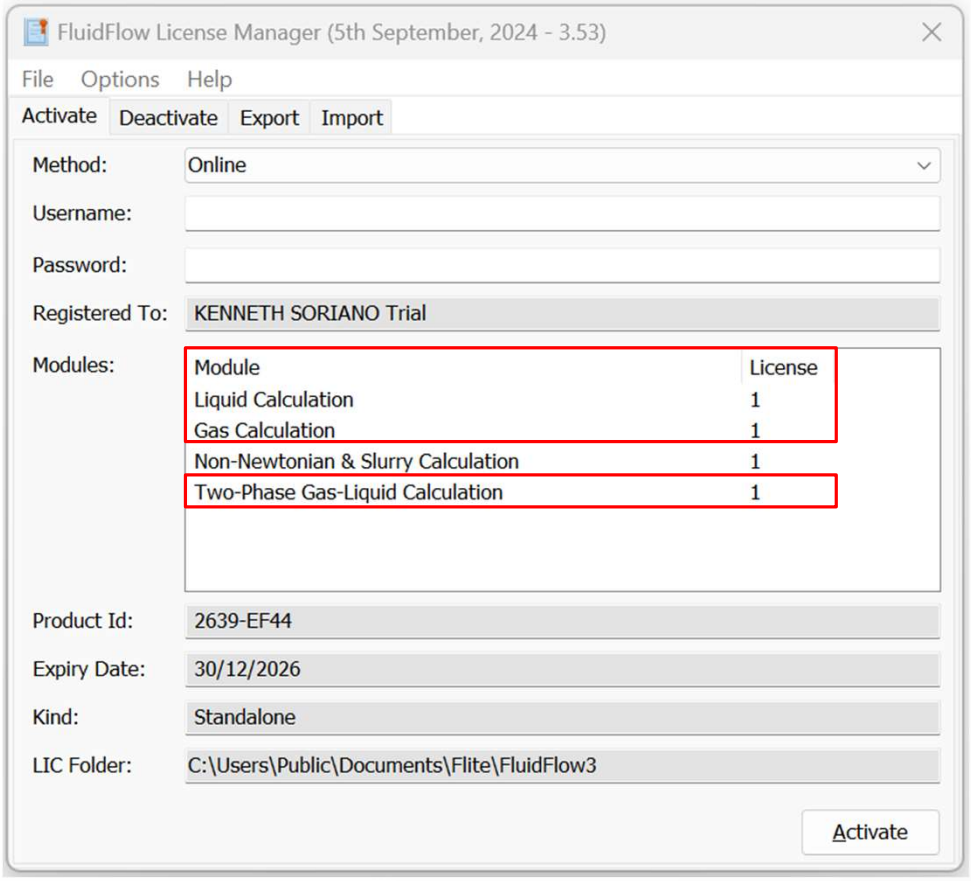
FluidFlow Modules

Liquid

Gas

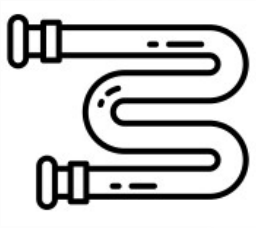
Slurry

Two Phase Flow

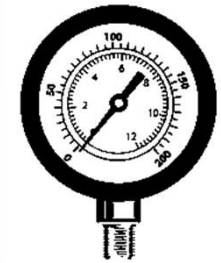


FLUIDFLOW:
HYDRAULIC CALCULATION SOFTWARE OBJECTIVES

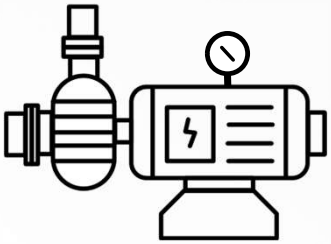
FluidFlow: Hydraulic Calculation Software Objectives



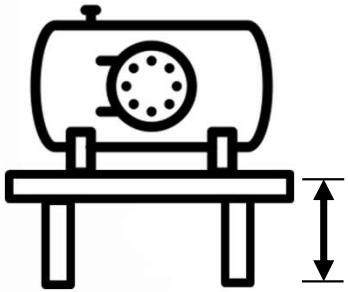
LINE SIZING



OPERATING PRESSURE



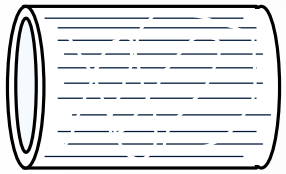
EQUIPMENT SPECIFICATION



ELEVATION



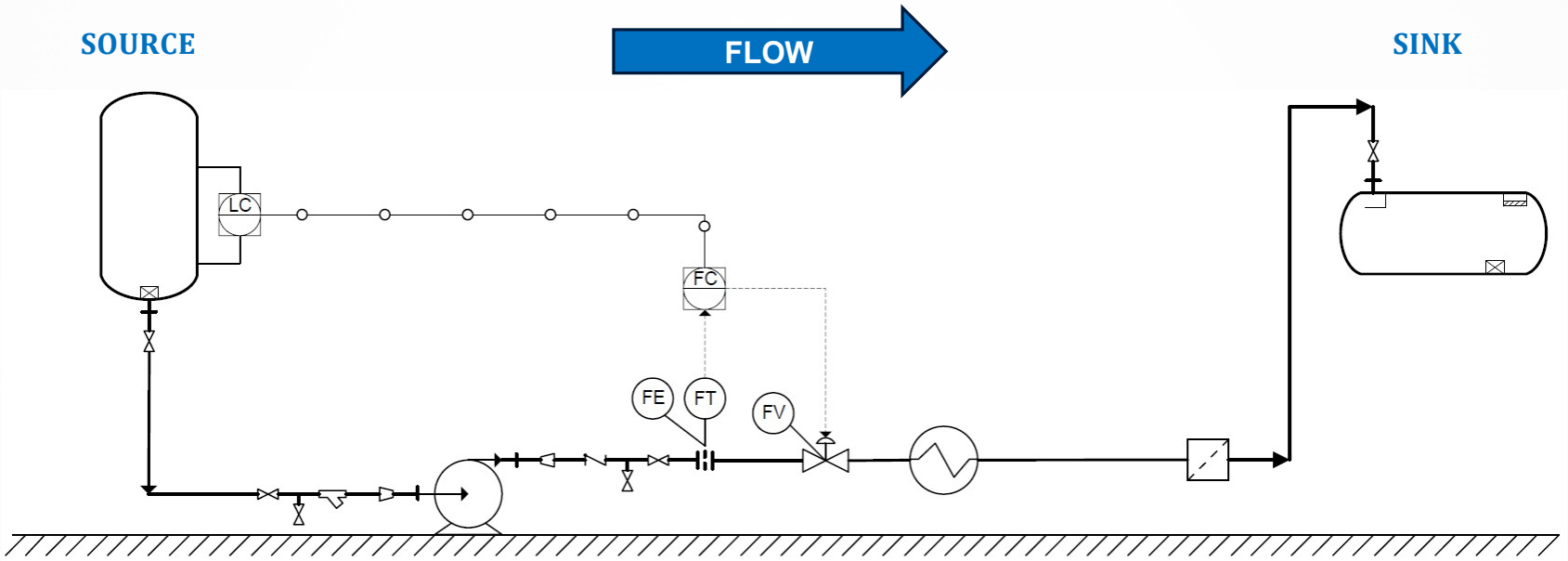
INSTRUMENT SPECIFICATION



FLOW REGIME (FOR TWO-PHASE)

FluidFlow: Hydraulic Calculation Software Objectives

- To **ensure delivery of fluid** from source to sink



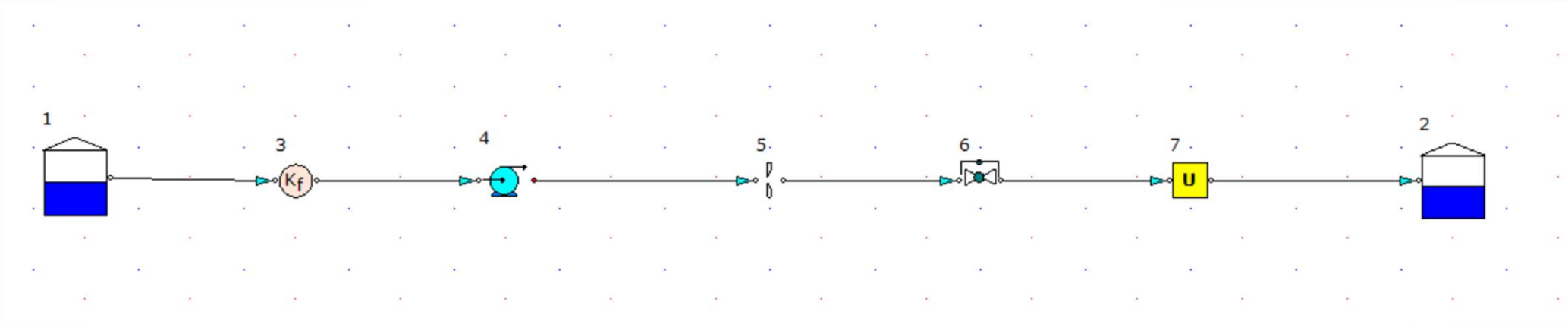
FluidFlow: Hydraulic Calculation Software Objectives

- To **ensure delivery of fluid** from source to sink

SOURCE

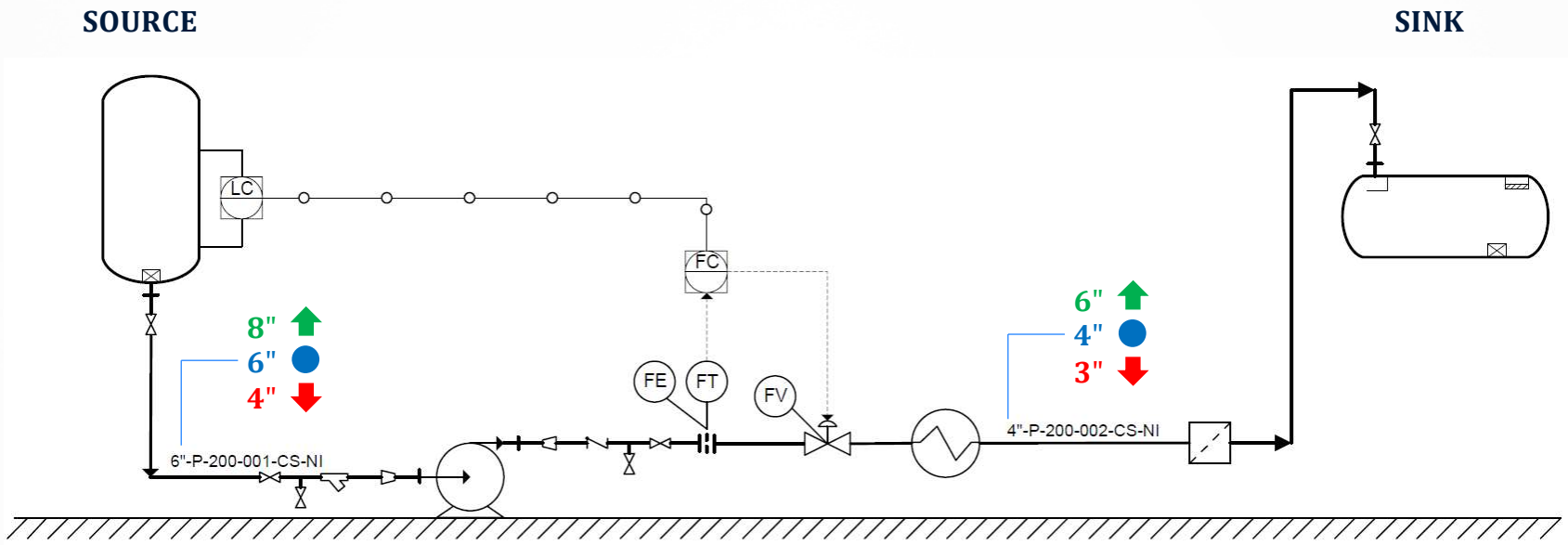
FLOW

SINK



FluidFlow: Hydraulic Calculation Software Objectives

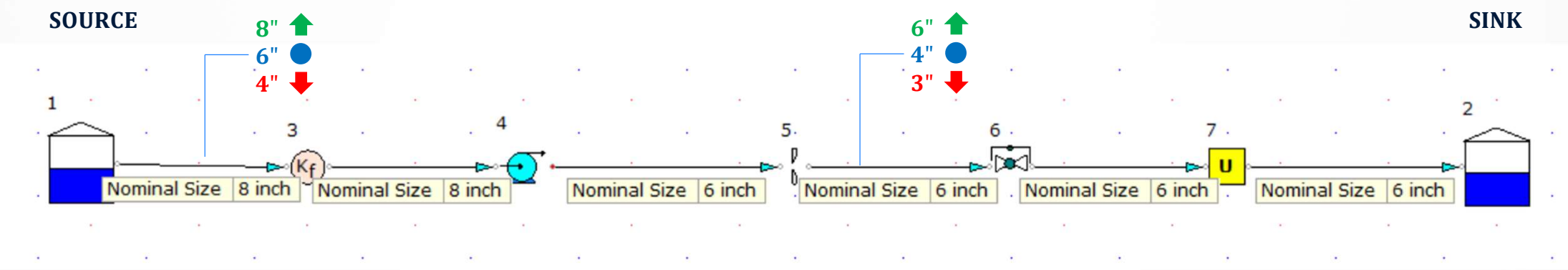
- To determine the **optimum line size**



FluidFlow: Hydraulic Calculation Software Objectives

- To determine the **optimum line size**

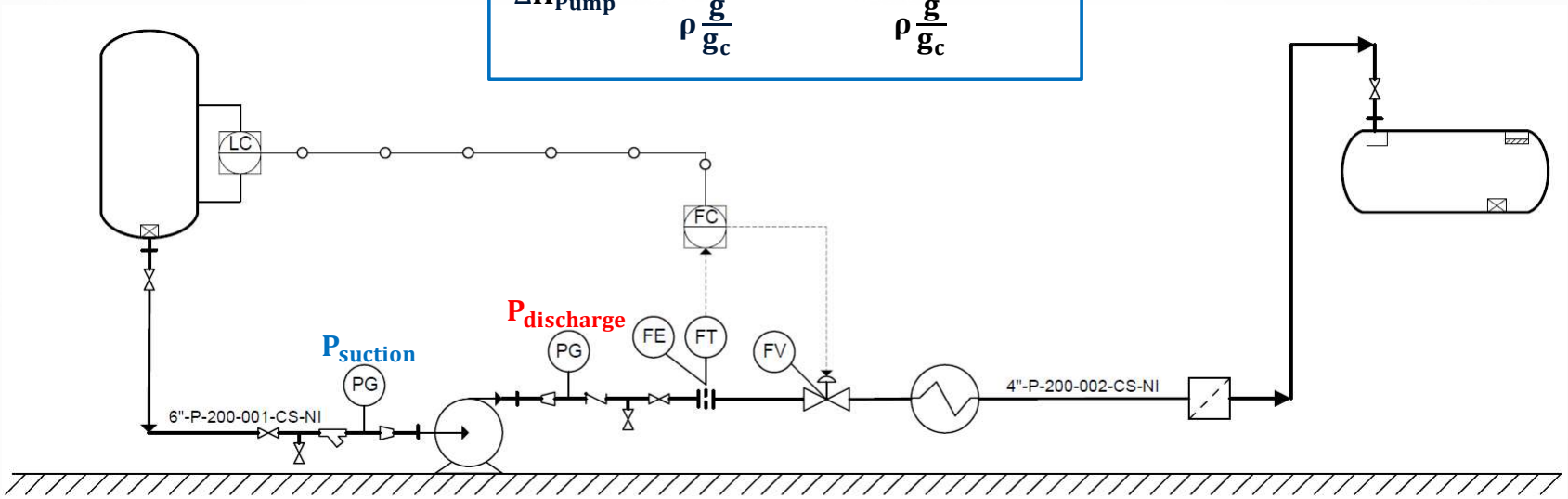




FluidFlow: Hydraulic Calculation Software Objectives

- To determine the **pump head**

$$\Delta H_{Pump} = \frac{\Delta P_{Pump}}{\rho \frac{g}{g_c}} = \frac{P_{discharge} - P_{suction}}{\rho \frac{g}{g_c}}$$

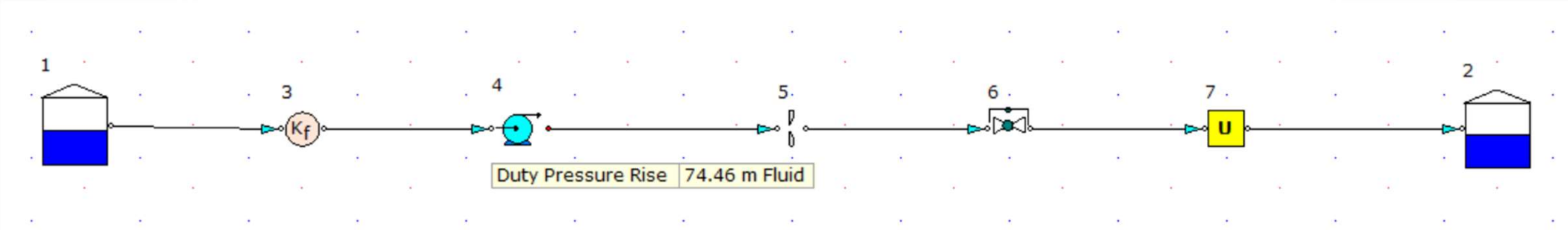


FluidFlow: Hydraulic Calculation Software Objectives

- To determine the **pump head**

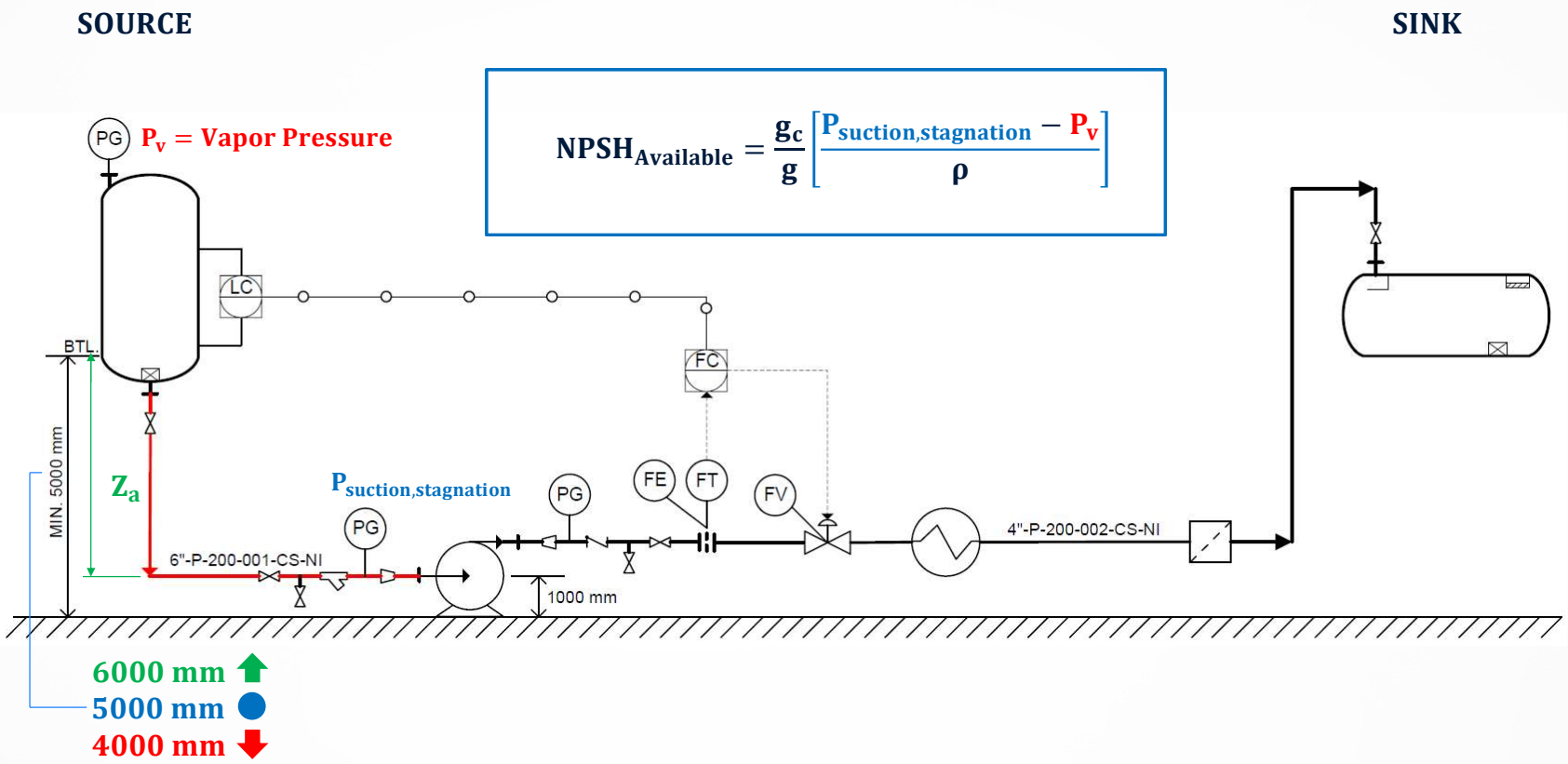
$$\Delta H_{Pump} = \frac{\Delta P_{Pump}}{\rho \frac{g}{g_c}} = \frac{P_{discharge} - P_{suction}}{\rho \frac{g}{g_c}}$$

SOURCE **SINK**



FluidFlow: Hydraulic Calculation Software Objectives

- To determine the **pump suction vessel height** by checking the **pump NPSHA**

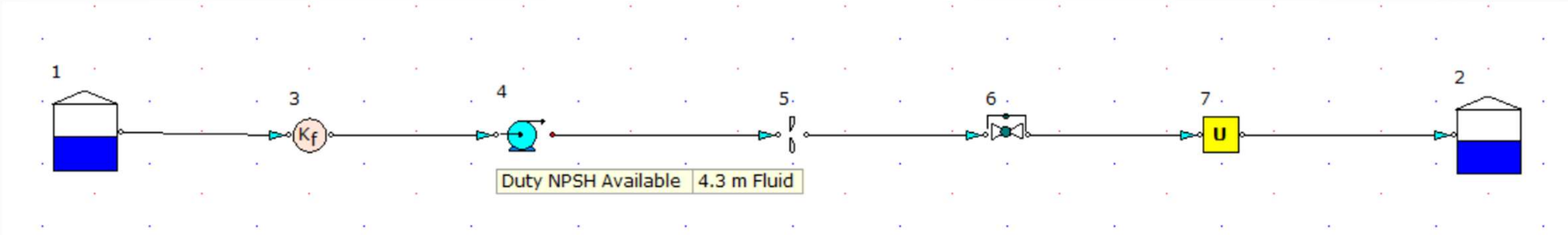


FluidFlow: Hydraulic Calculation Software Objectives

- To determine the **pump suction vessel height** by checking the **pump NPSHA**

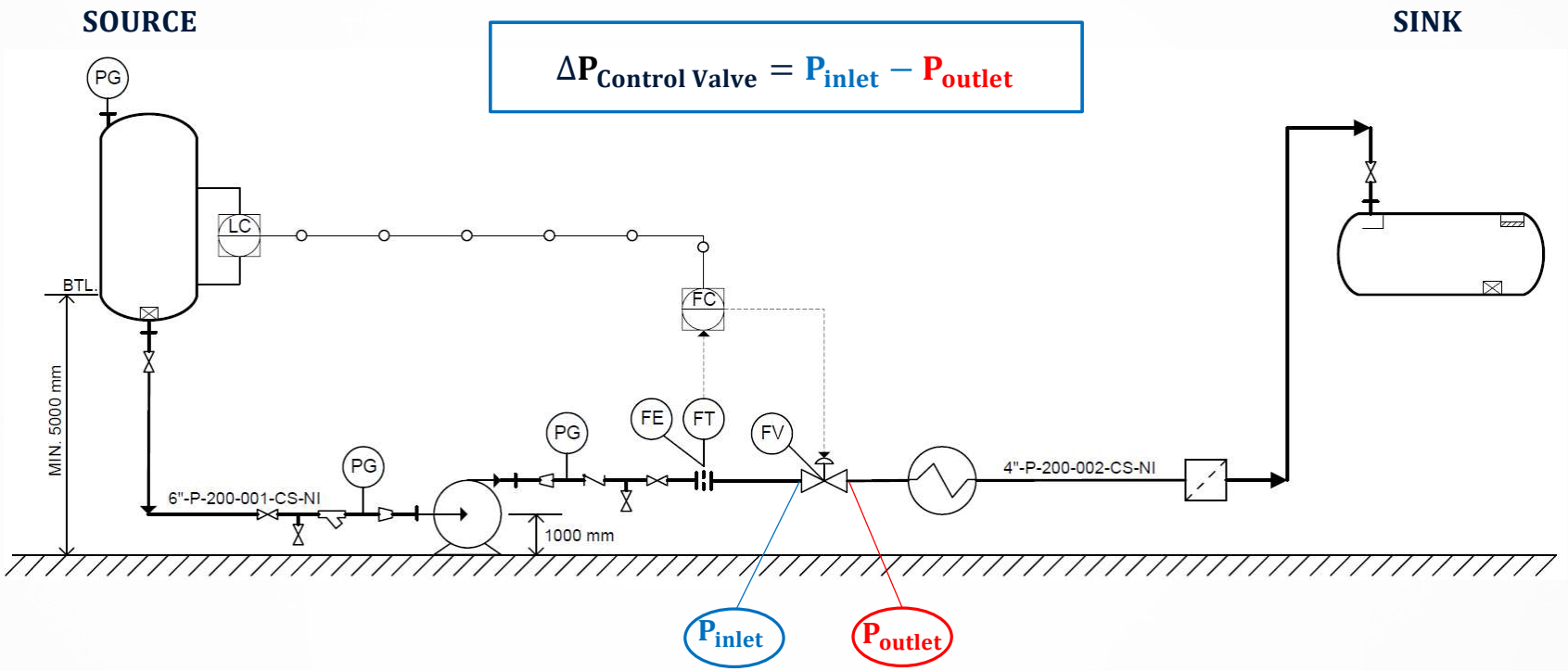
$$NPSH_{Available} = \frac{g_c}{g}\left[\frac{P_{suction,stagnation} - P_v}{\rho}\right]$$

SOURCE **SINK**



FluidFlow: Hydraulic Calculation Software Objectives

- To calculate the **control valve pressure drop** and **calculate the Cv value.**

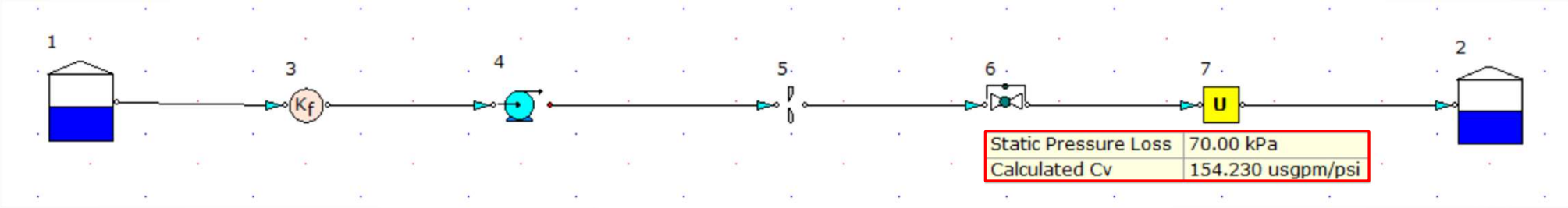


FluidFlow: Hydraulic Calculation Software Objectives

- To calculate the **control valve pressure drop** and **calculate the Cv value.**

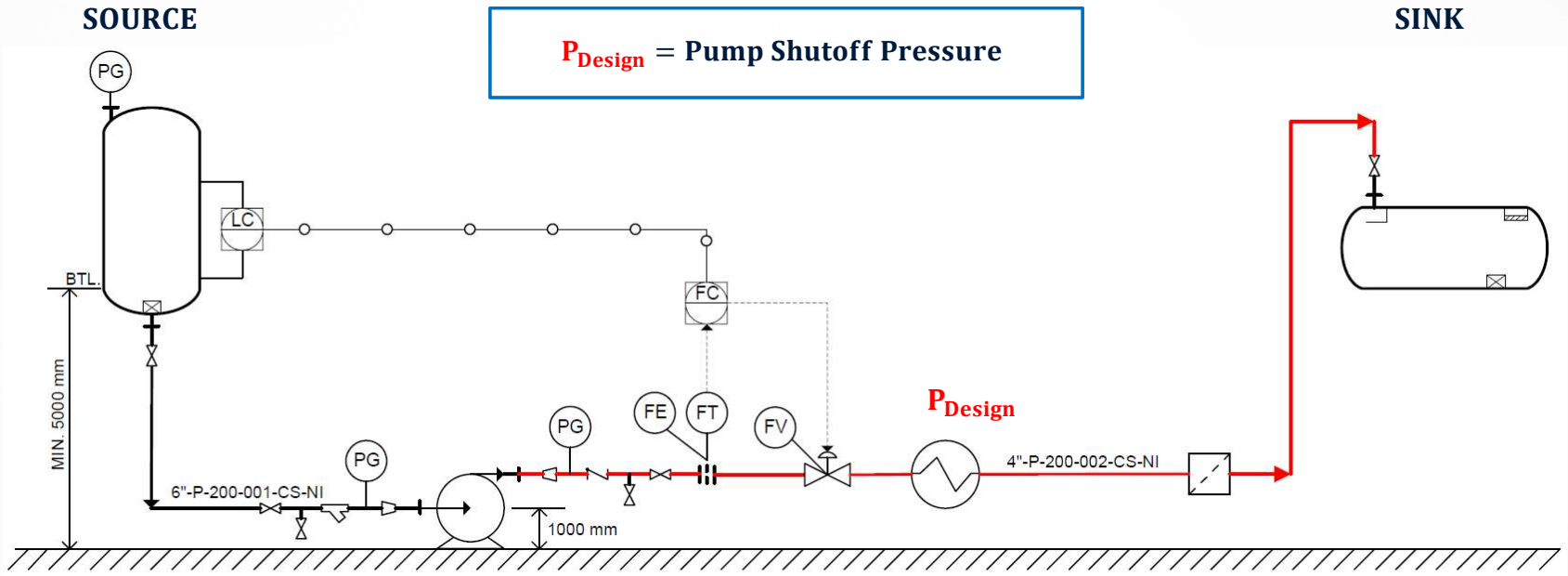
$$\Delta P_{\text{Control Valve}} = P_{\text{inlet}} - P_{\text{outlet}}$$

SOURCE **SINK**



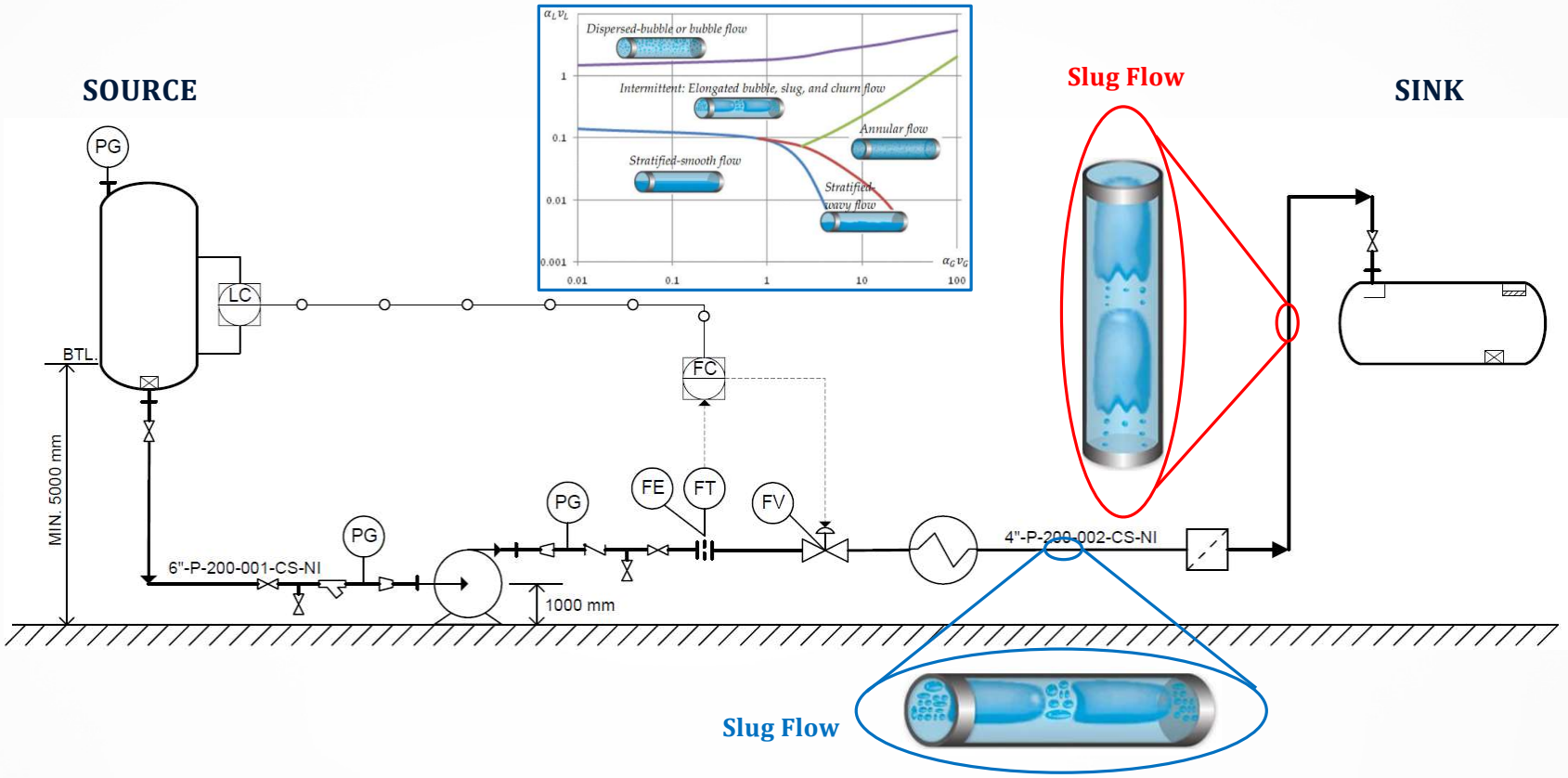
FluidFlow: Hydraulic Calculation Software Objectives

- To determine the **design pressure** in the pump discharge line/equipment



FluidFlow: Hydraulic Calculation Software Objectives

- To check the flow pattern (**for two-phase flow**)



Two-Phase Flow Regimes

When gas and liquid flow together inside a pipe, it can be observed that there are many different types of ***flow regimes*** **(or flow patterns)**.

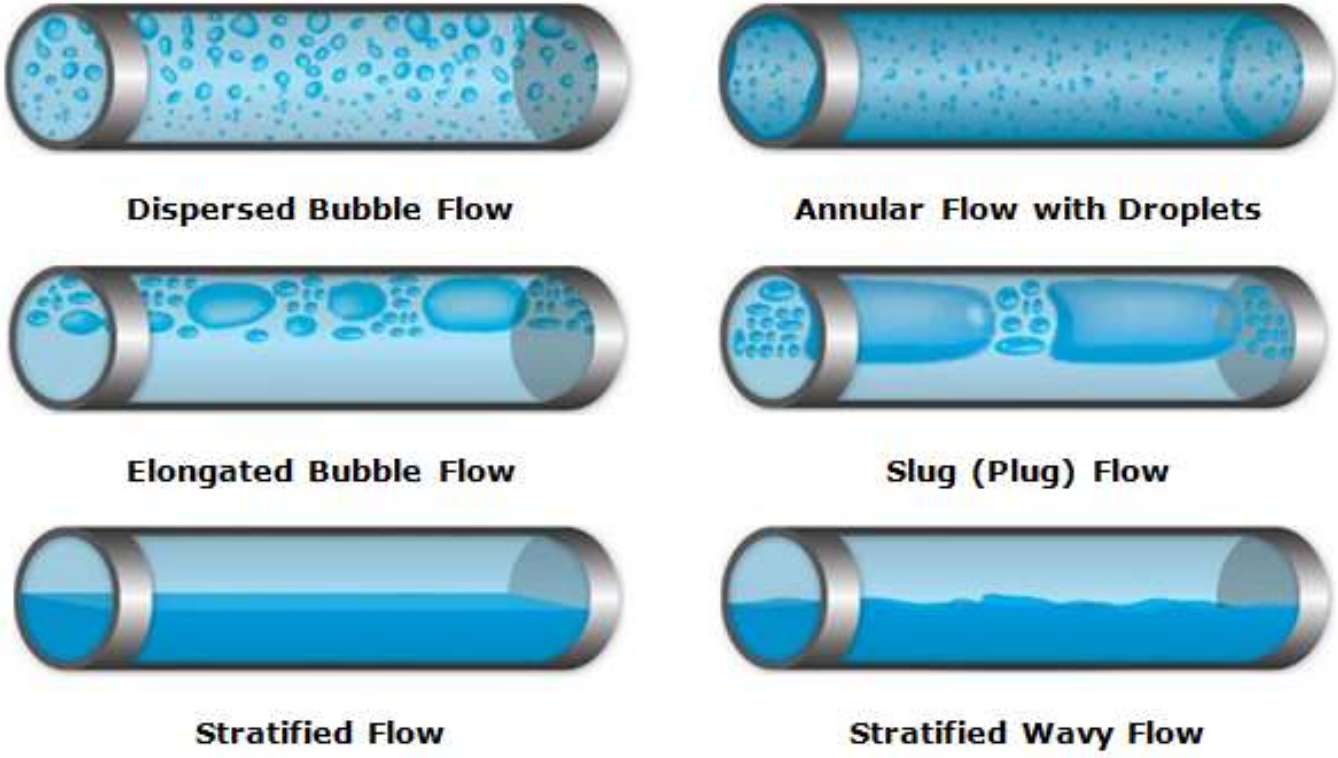
The regime depends on the following:

- ❑ **Fluid Physical Properties (ρ,μ,ϒ,)**
- ❑ **Pipe Size**
- ❑ **Gas Flow Rate (Q_G)**
- ❑ **Liquid Flow Rate (Q_L)**
- ❑ **Pipe Orientation (Horizontal/Vertical)**

.

Two-Phase Flow Regimes

Common Flow Regimes in Two-Phase Flow in Horizontal Pipelines



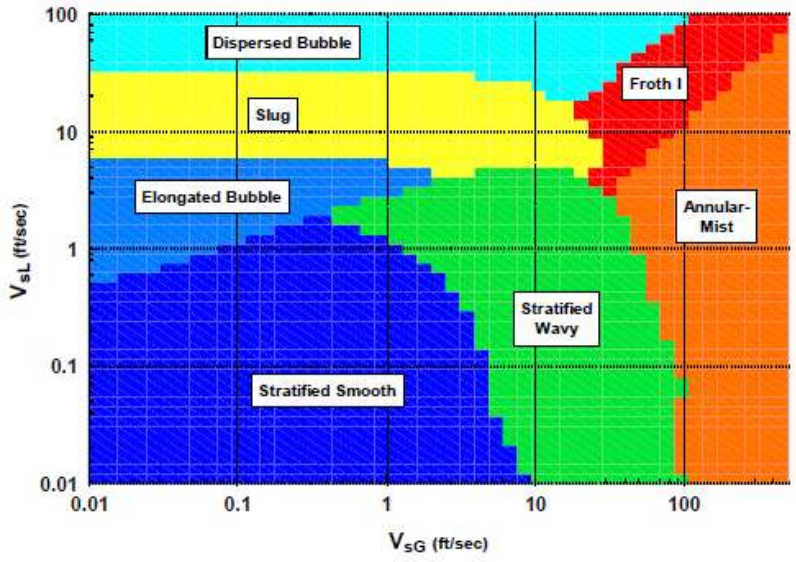
Two-Phase Flow Regimes

Common Flow Regimes in Two-Phase Flow in Vertical Pipelines

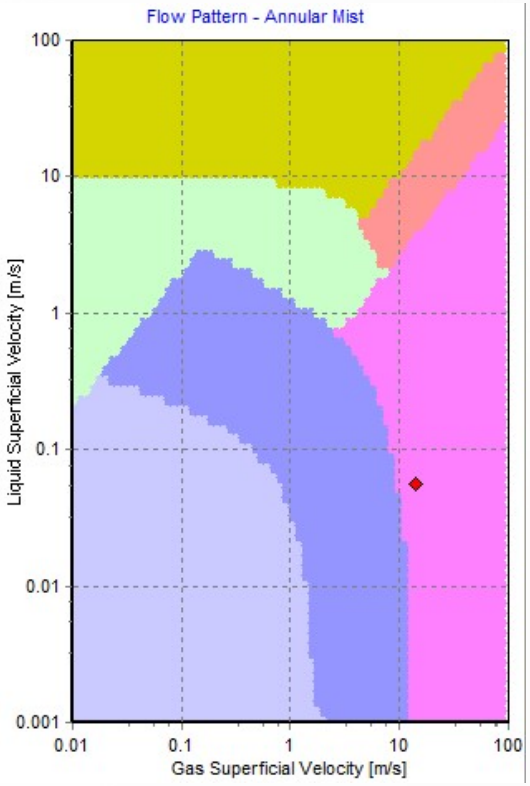


FluidFlow: Hydraulic Calculation Software Objectives

- To check the flow pattern (**for two-phase flow**)

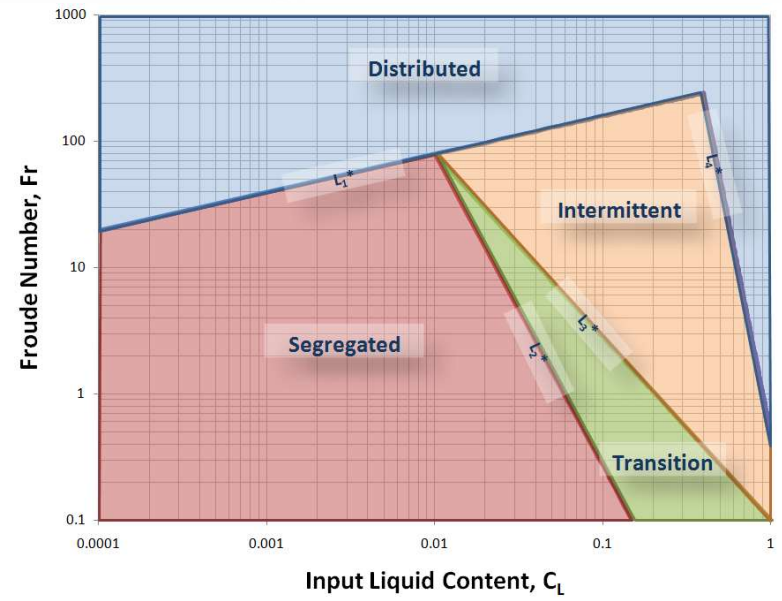


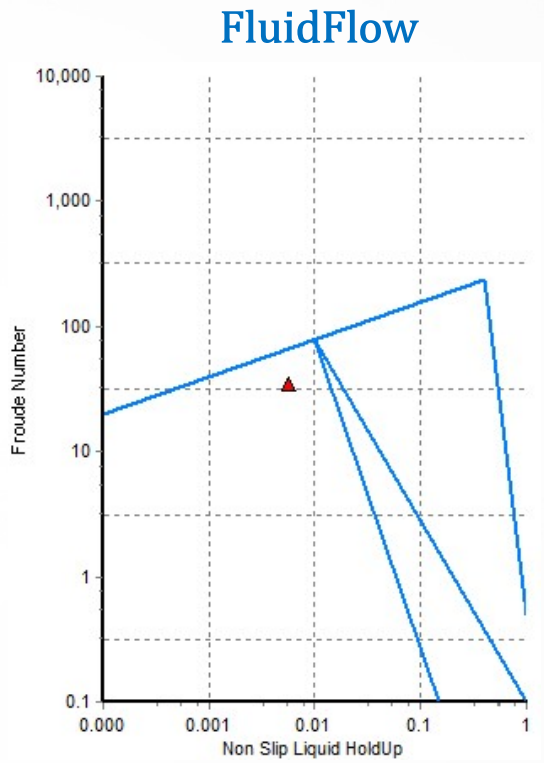
FluidFlow



FluidFlow: Hydraulic Calculation Software Objectives

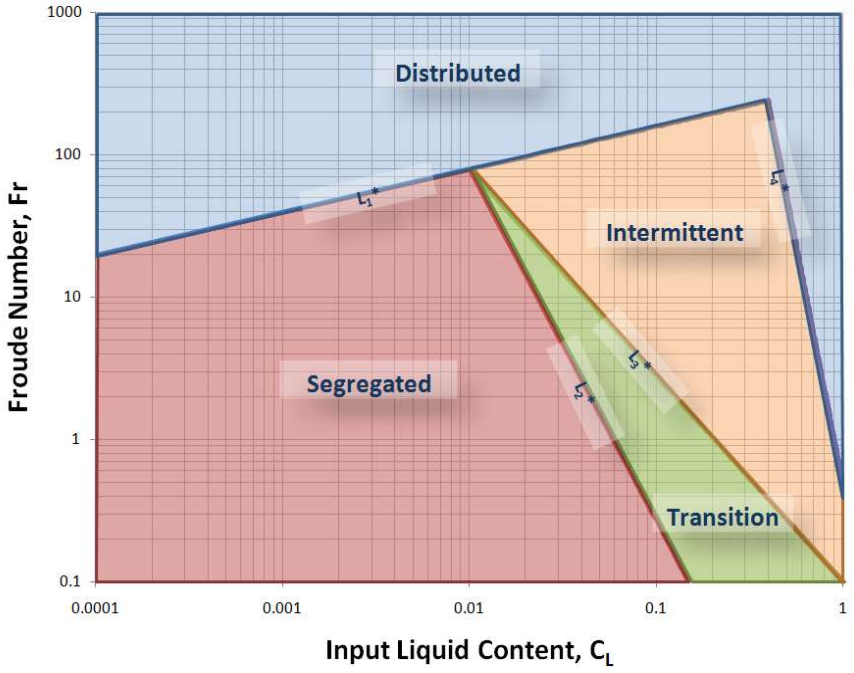
- To check the flow pattern (**for two-phase flow**)





Two-Phase Flow Regimes

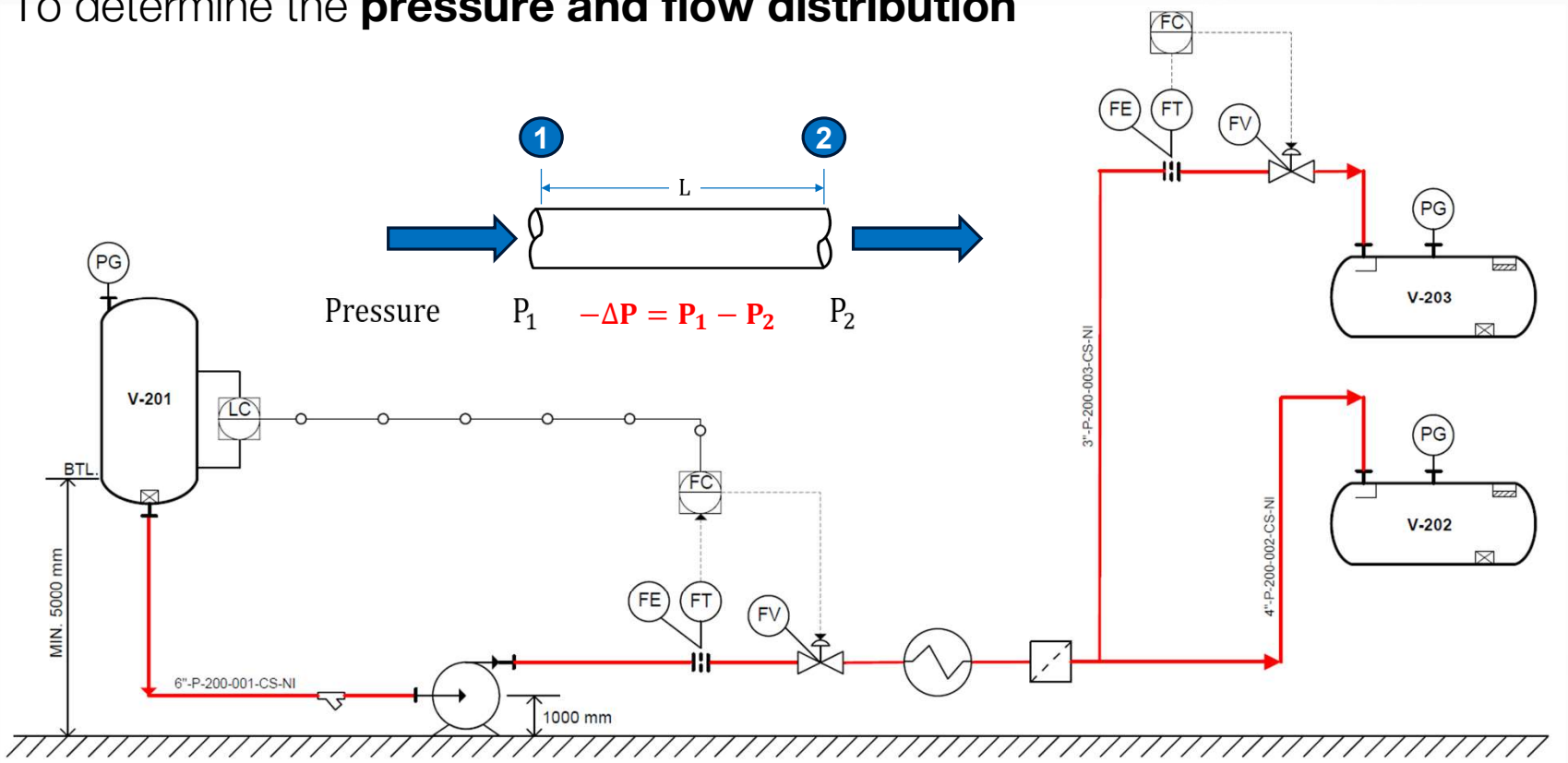
Flow Regime Description – Beggs & Brill



Flow Regime	Description
Segregated	Stratified, wavy and annular flow
Intermittent	Plug and slug flow
Distributed	Bubble and mist flow
Transition	Flow pattern included after a modification of the original publication that considers the region (transition) between the segregated and intermittent grouped patterns.

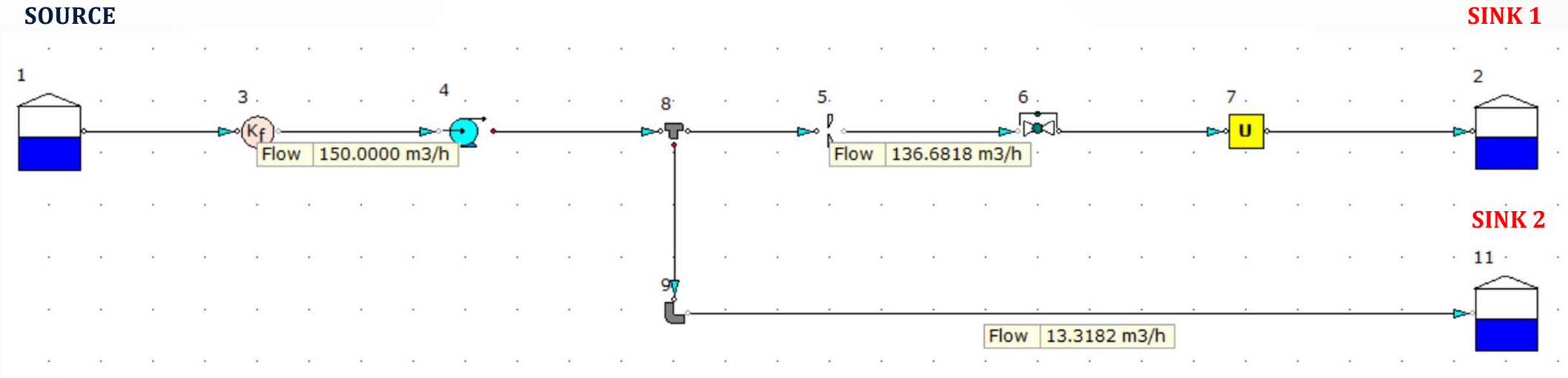
FluidFlow: Hydraulic Calculation Software Objectives

- To determine the **pressure and flow distribution**



FluidFlow: Hydraulic Calculation Software Objectives

- To determine the **pressure and flow distribution**



Two-Phase Flow Modelling Approach

The Experimental (Empirical) Approach.

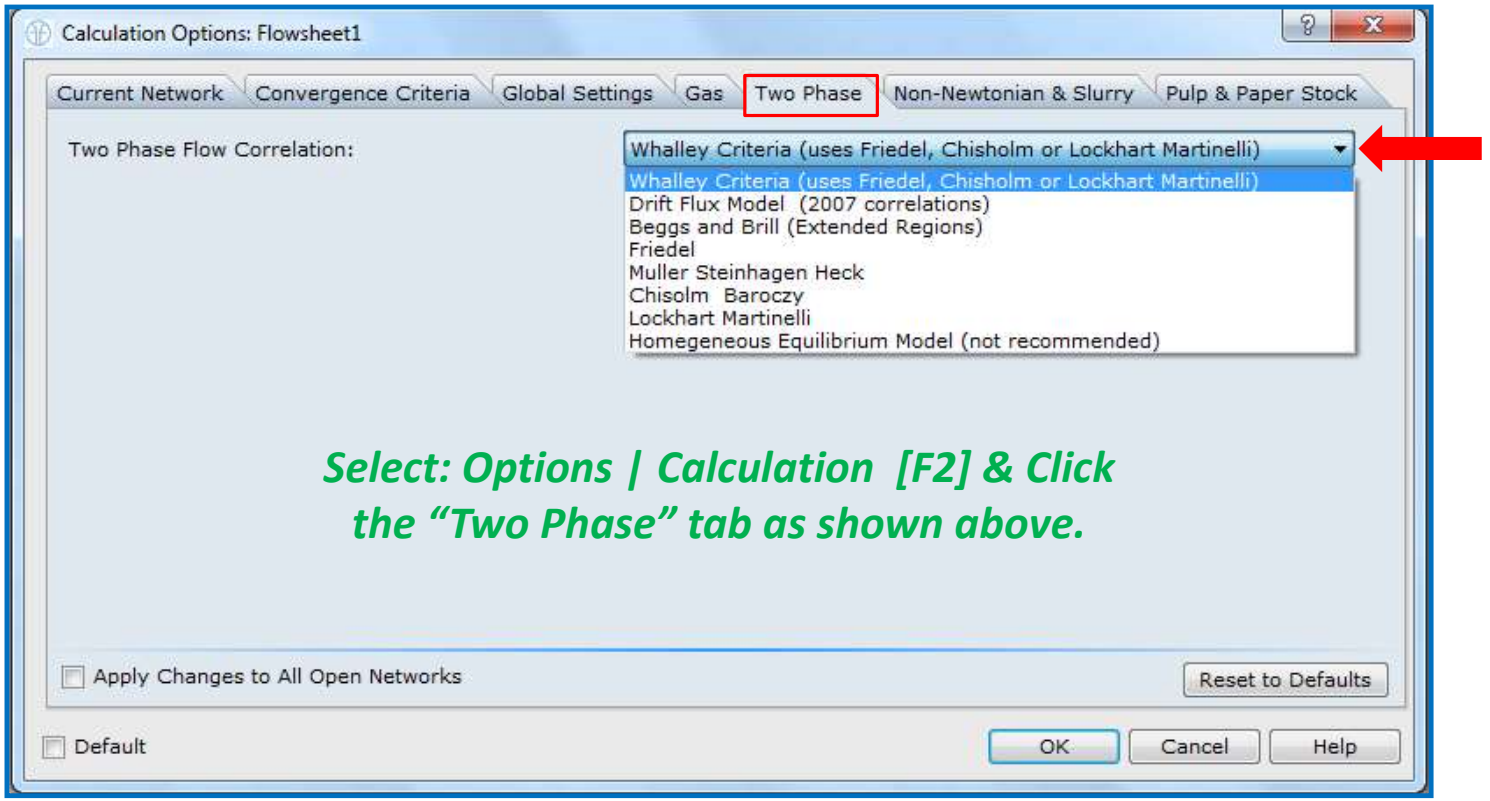
In this approach, correlations are developed from experiments. The following empirical correlations are used by **FluidFlow**:

- **Friedel**
- **Chisholm-Baroczy**
- **Lockhart-Matinelli**

  } **Whalley Criteria**

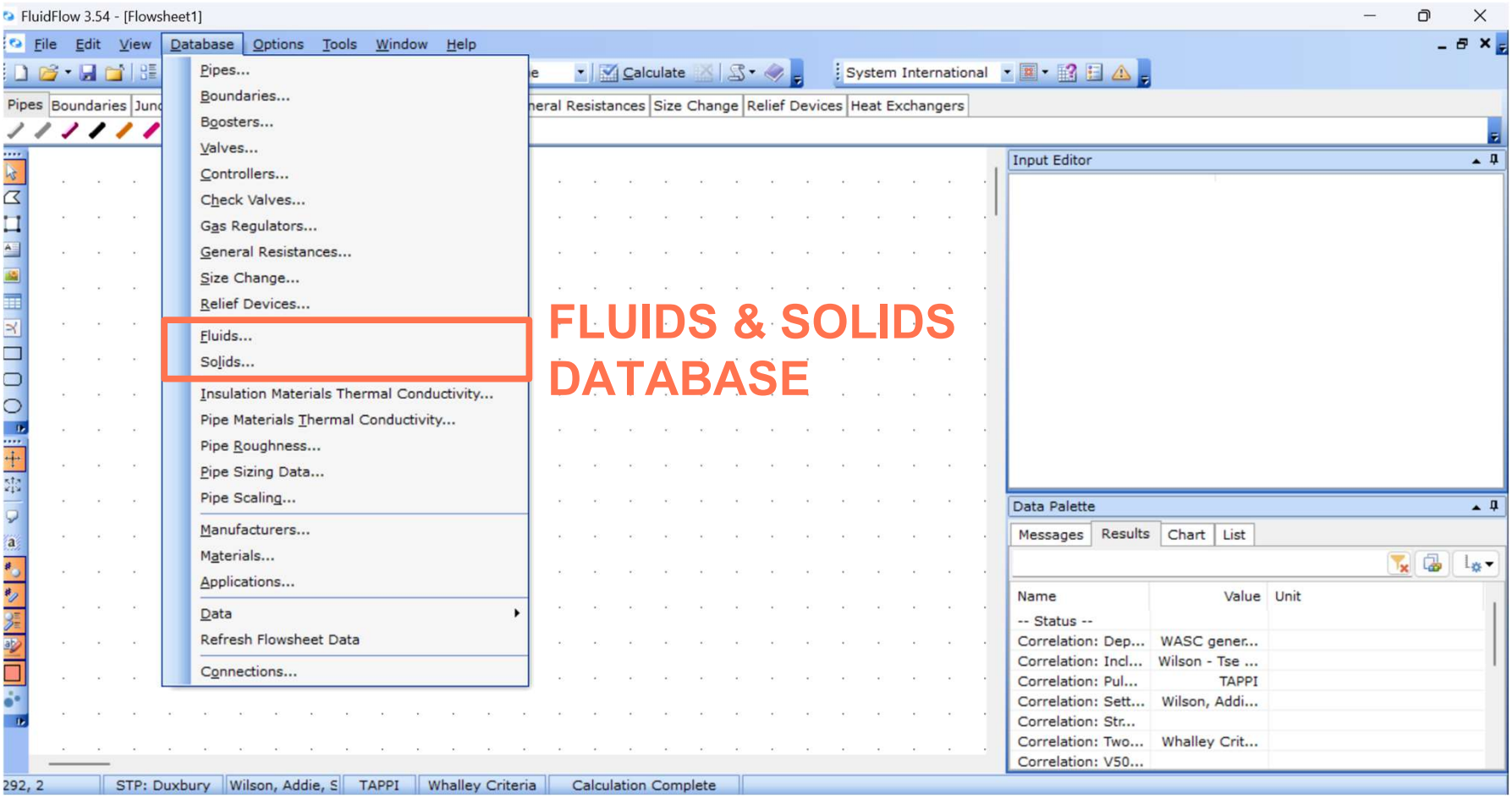
- **Muller, Steinhagen, and Heck**
- **Beggs-Brill**
- **Drift-Flux**
- **Homogeneous Equilibrium Model**

Two-Phase Flow – Calculation Settings

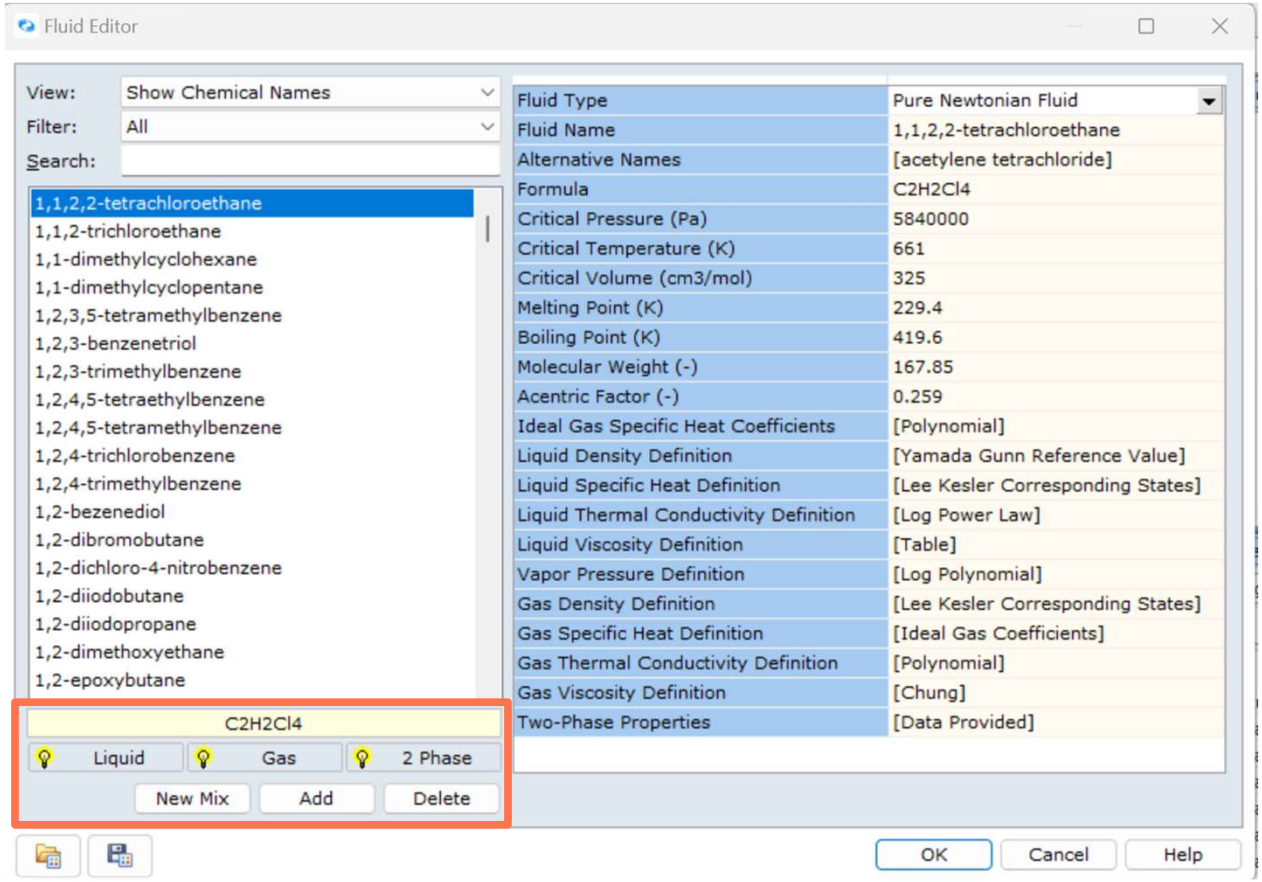


FLUIDFLOW DATABASE

FluidFlow Database



FluidFlow Database (Fluids)



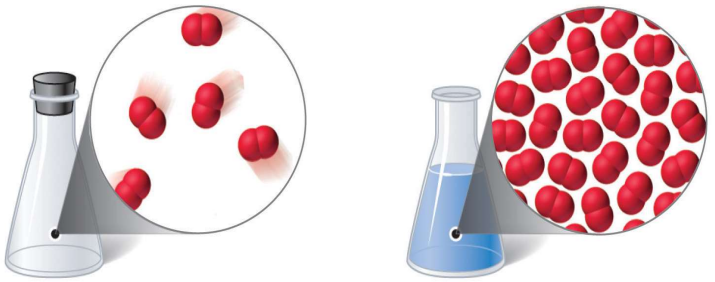
FluidFlow Database (Fluids)

Pure Newtonian Fluid (w/ Phase Change)

Fluid Type	Pure Newtonian Fluid
Fluid Name	1,1,2,2-tetrachloroethane
Alternative Names	[acetylene tetrachloride]
Formula	C2H2Cl4
Critical Pressure (Pa)	5840000
Critical Temperature (K)	661
Critical Volume (cm3/mol)	325
Melting Point (K)	229.4
Boiling Point (K)	419.6
Molecular Weight (-)	167.85
Acentric Factor (-)	0.259
Ideal Gas Specific Heat Coefficients	[Polynomial]
Liquid Density Definition	[Yamada Gunn Reference Value]
Liquid Specific Heat Definition	[Lee Kesler Corresponding States]
Liquid Thermal Conductivity Definition	[Log Power Law]
Liquid Viscosity Definition	[Table]
Vapor Pressure Definition	[Log Polynomial]
Gas Density Definition	[Lee Kesler Corresponding States]
Gas Specific Heat Definition	[Ideal Gas Coefficients]
Gas Thermal Conductivity Definition	[Polynomial]
Gas Viscosity Definition	[Chung]
Two-Phase Properties	[Data Provided]

Simple Newtonian Liquid

Fluid Type	Simple Newtonian Liquid
Fluid Name	Aviation Gasoline
Alternative Names	[]
Formula	N/A
Liquid Density Definition	[Table]
Liquid Specific Heat Definition	[Table]
Liquid Thermal Conductivity Definition	[Table]
Liquid Viscosity Definition	[Table]
Vapor Pressure Definition	[Table]



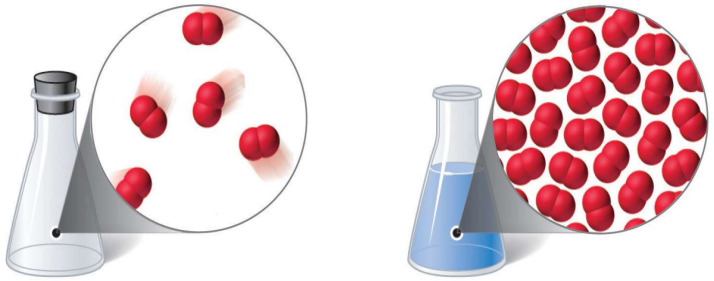
Gas

Liquid

FluidFlow Database (Fluids)

Non-Newtonian Liquid

Fluid Type	Non Newtonian Liquid
Fluid Name	Honey
Alternative Names	[]
Formula	N/A
Liquid Density Definition	[Fixed Value]
Liquid Specific Heat Definition	[Fixed Value]
Liquid Thermal Conductivity Definition	[Fixed Value]
Liquid Viscosity Definition	[Non Newtonian - Power Law]
Vapor Pressure Definition	[As Water]



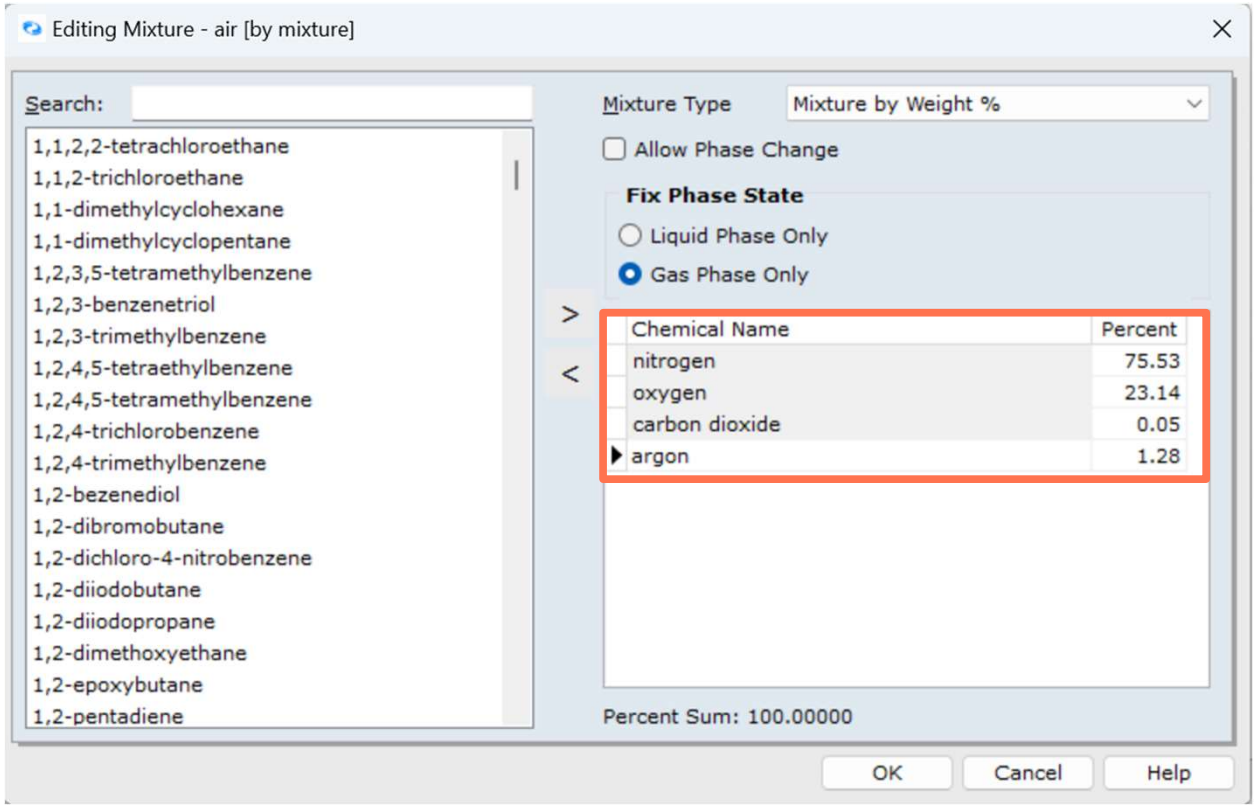
Gas Liquid

Gas (No Phase Change)

Fluid Type	Gas (No Phase Change)
Fluid Name	silicon tetrafluoride
Alternative Names	[]
Formula	SiF4
Critical Pressure (Pa)	3719000
Critical Temperature (K)	259
Critical Volume (cm3/mol)	165
Molecular Weight (-)	104.079
Acentric Factor (-)	0.385
Ideal Gas Specific Heat Coefficients	[Polynomial]
Gas Density Definition	[BWR HS EOS]
Gas Specific Heat Definition	[Ideal Gas Coefficients]
Gas Thermal Conductivity Definition	[Polynomial]
Gas Viscosity Definition	[Polynomial]

FluidFlow Database (Fluids)

Mixture by Weight % / Mole %



FLUIDFLOW DEMO

Two-Phase Flow Modelling

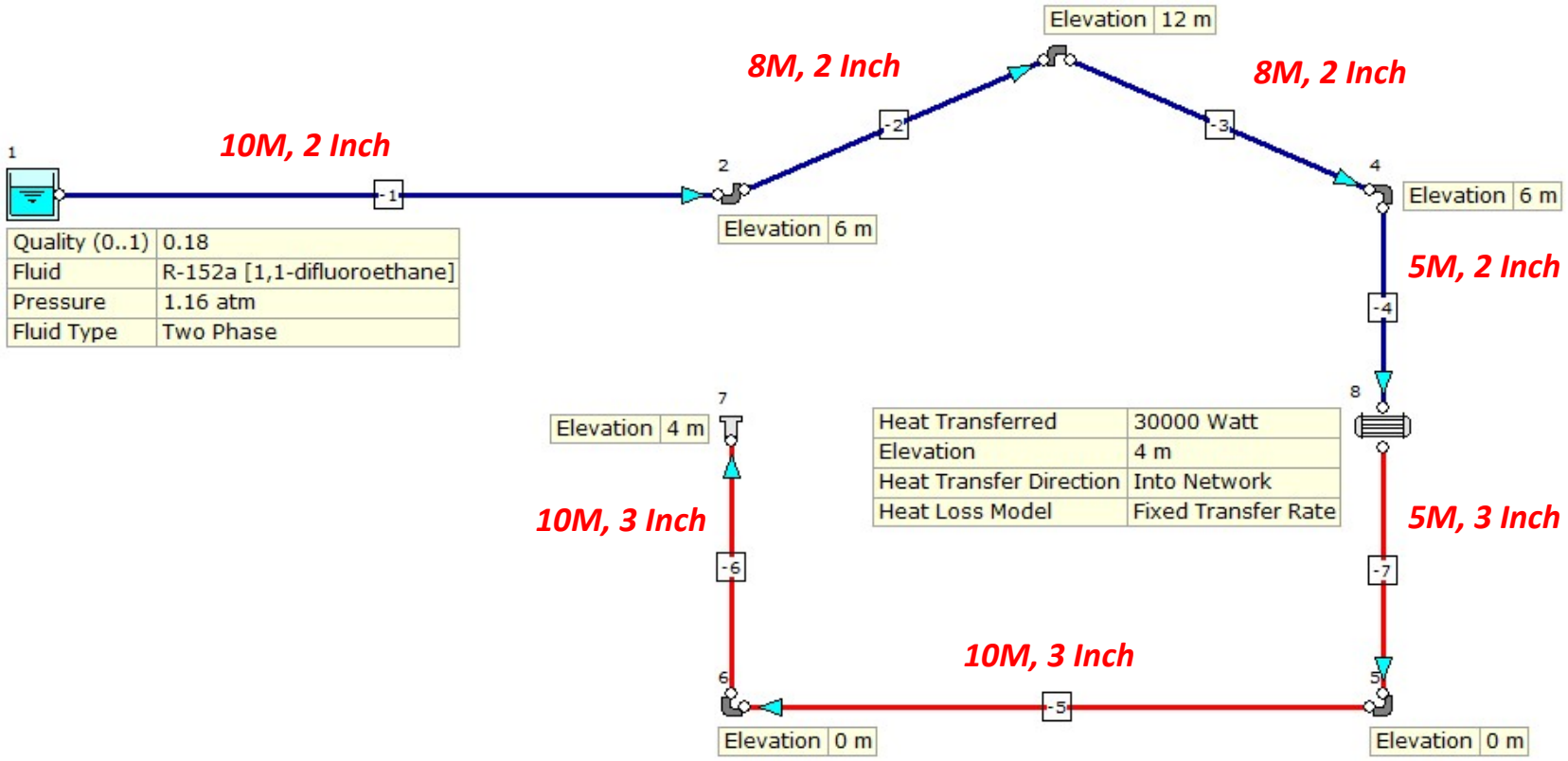
There are essentially three different approaches you can take to modeling a two-phase system in **FluidFlow**.

Option 1: Define two-phase flow at the model boundary **(Changing Quality).**

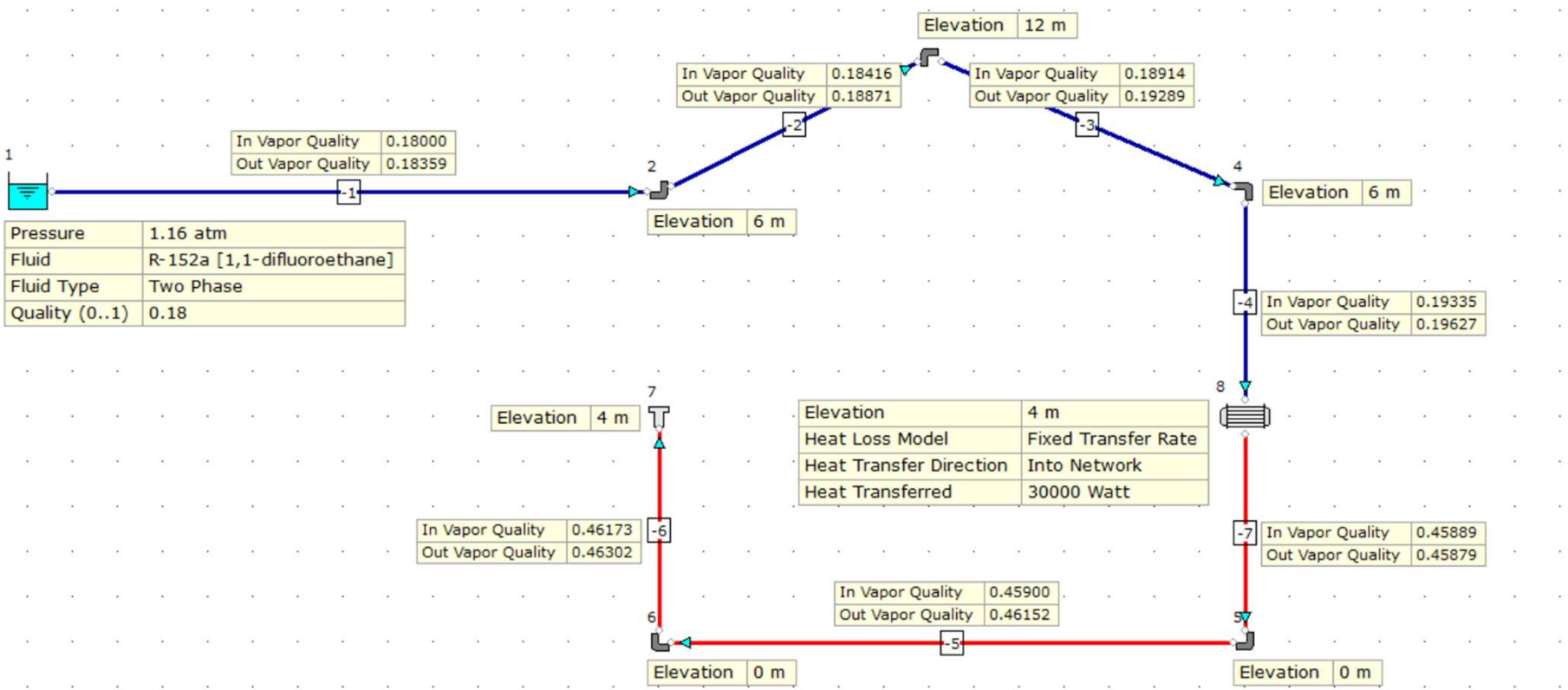
Option 2: Create two-phase mixtures dynamically on the flowsheet. This requires a minimum of two inlet boundaries. One shall include a liquid and the other a gas. At the point where the two fluids mix, the software will automatically detect the two-phase conditions and apply the two-phase correlation **(Constant Quality).**

Option 3: Define a single inlet boundary, set to Newtonian Fluid and the software will automatically detect the two-phase condition based on flowing fluid physical properties **(Changing Quality)**.

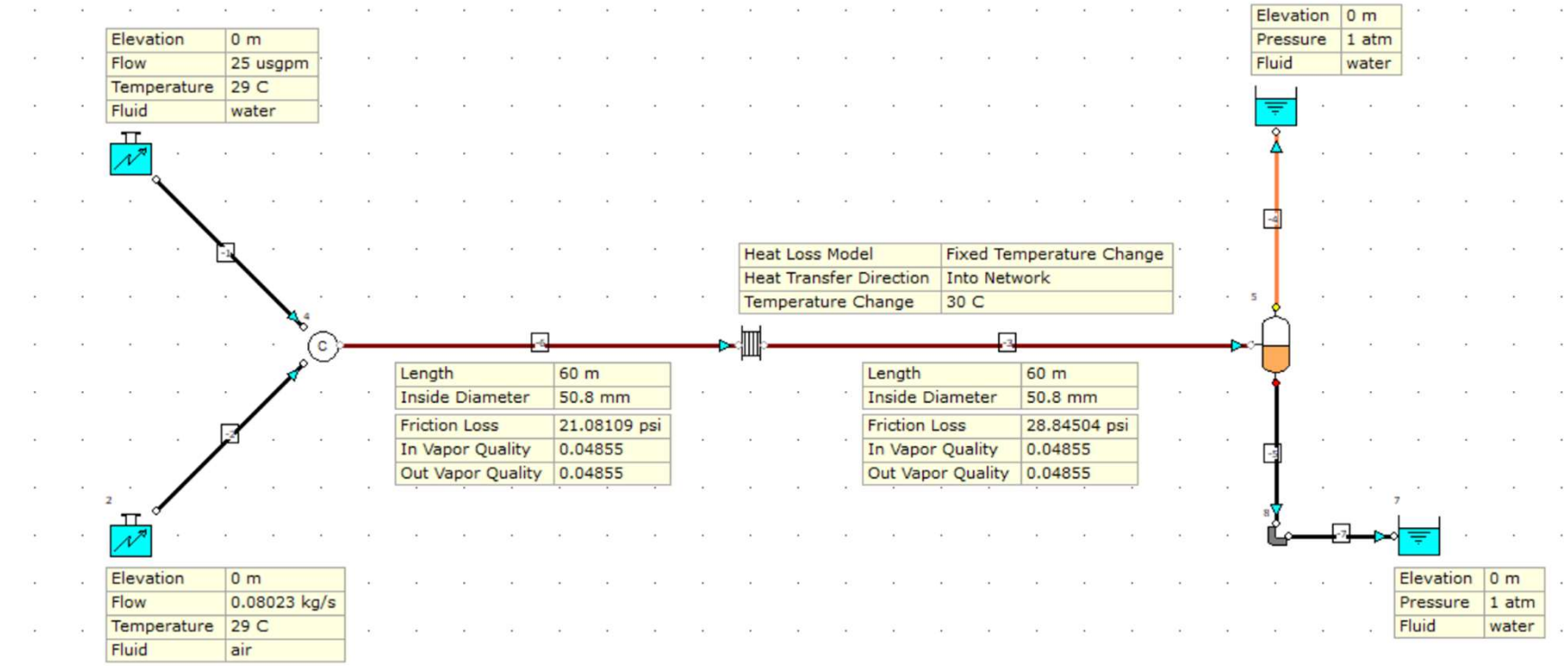
Two-Phase Modelling – Changing Quality



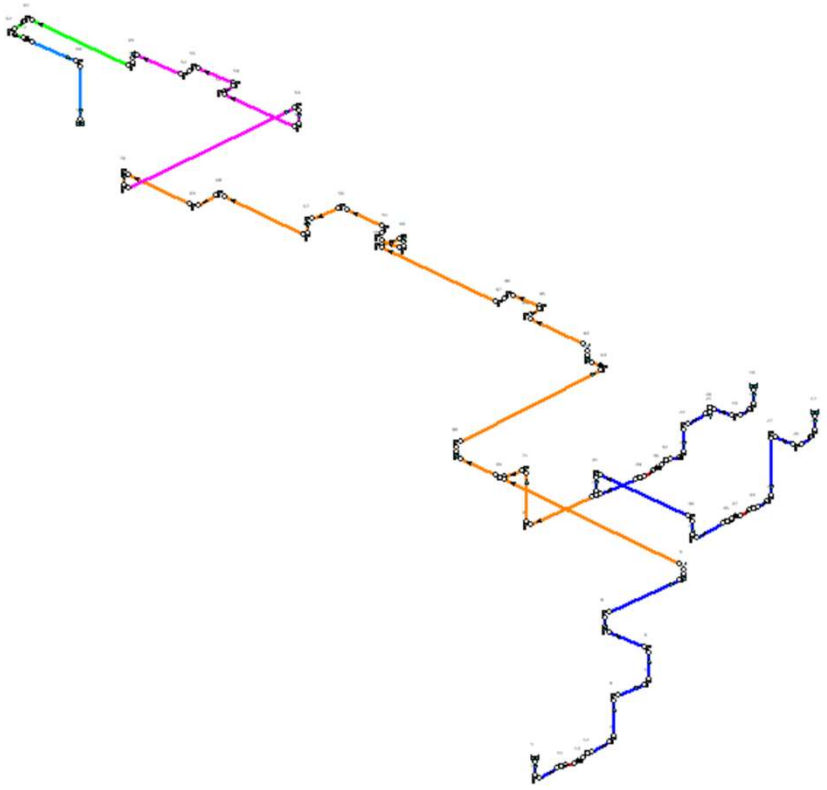
Two-Phase Modelling – Changing Quality



Two-Phase Modelling – Constant Quality



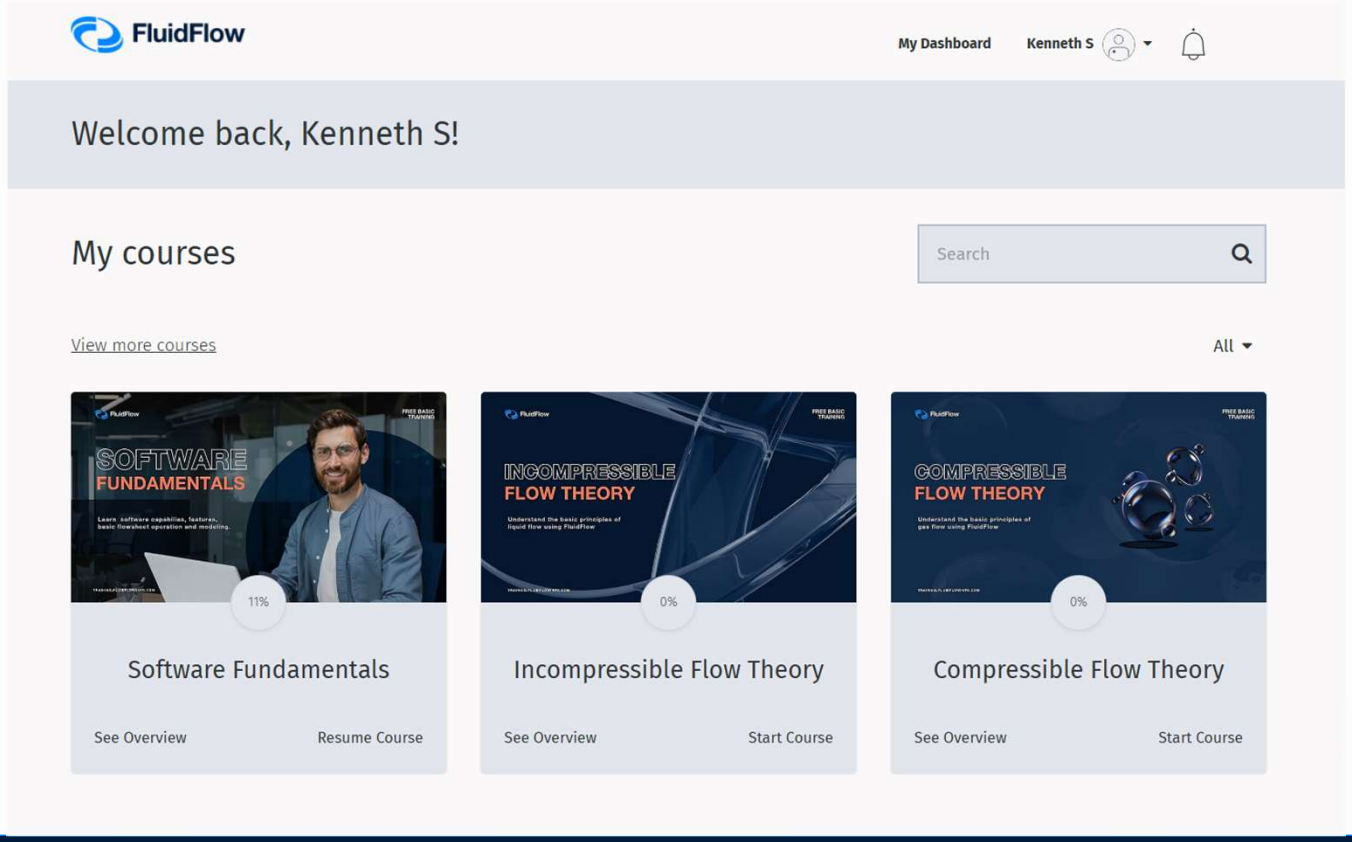
Two-Phase Modelling – Changing Quality



FLUIDFLOW
BASIC AND ADVANCED
TRAINING

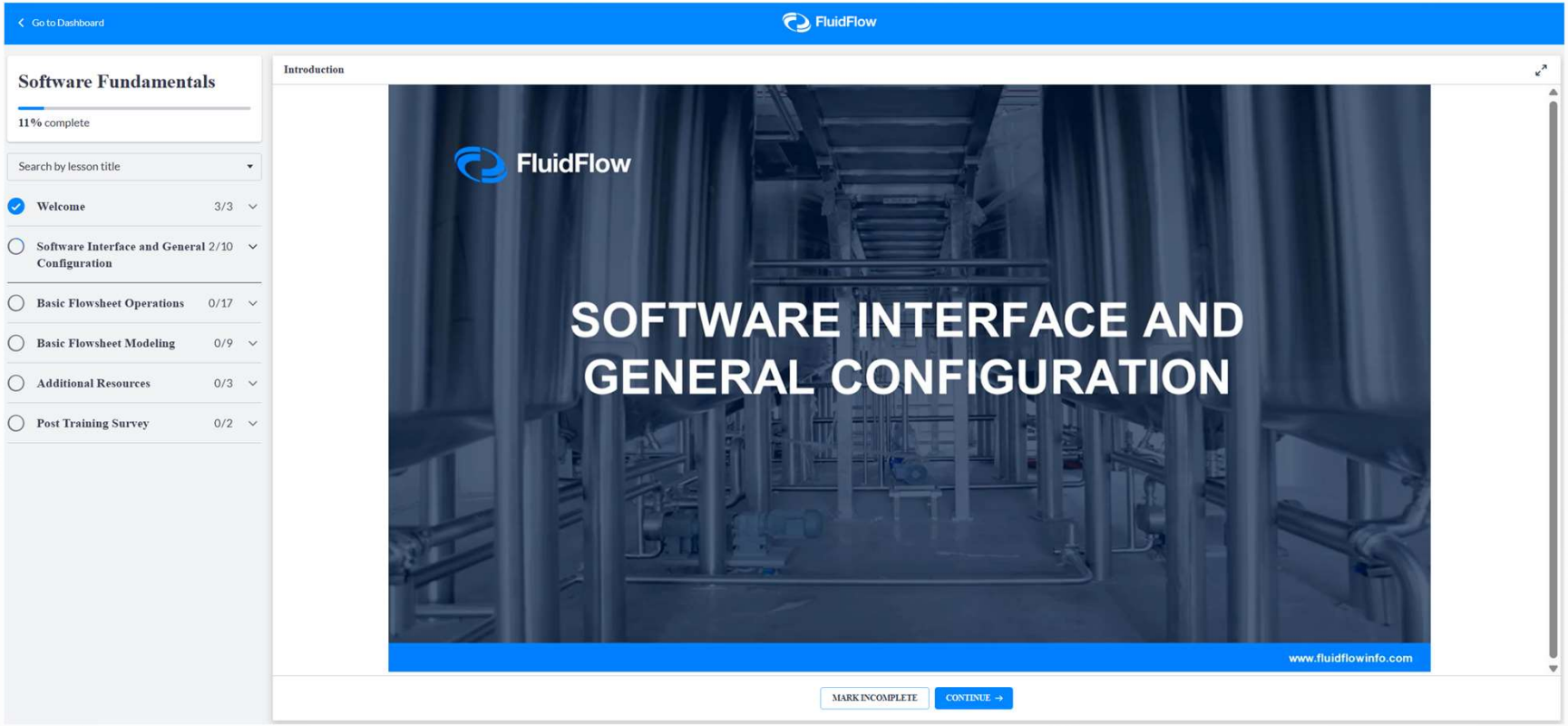
FluidFlow Basic and Advanced Training

❑ Basic Training (FREE)



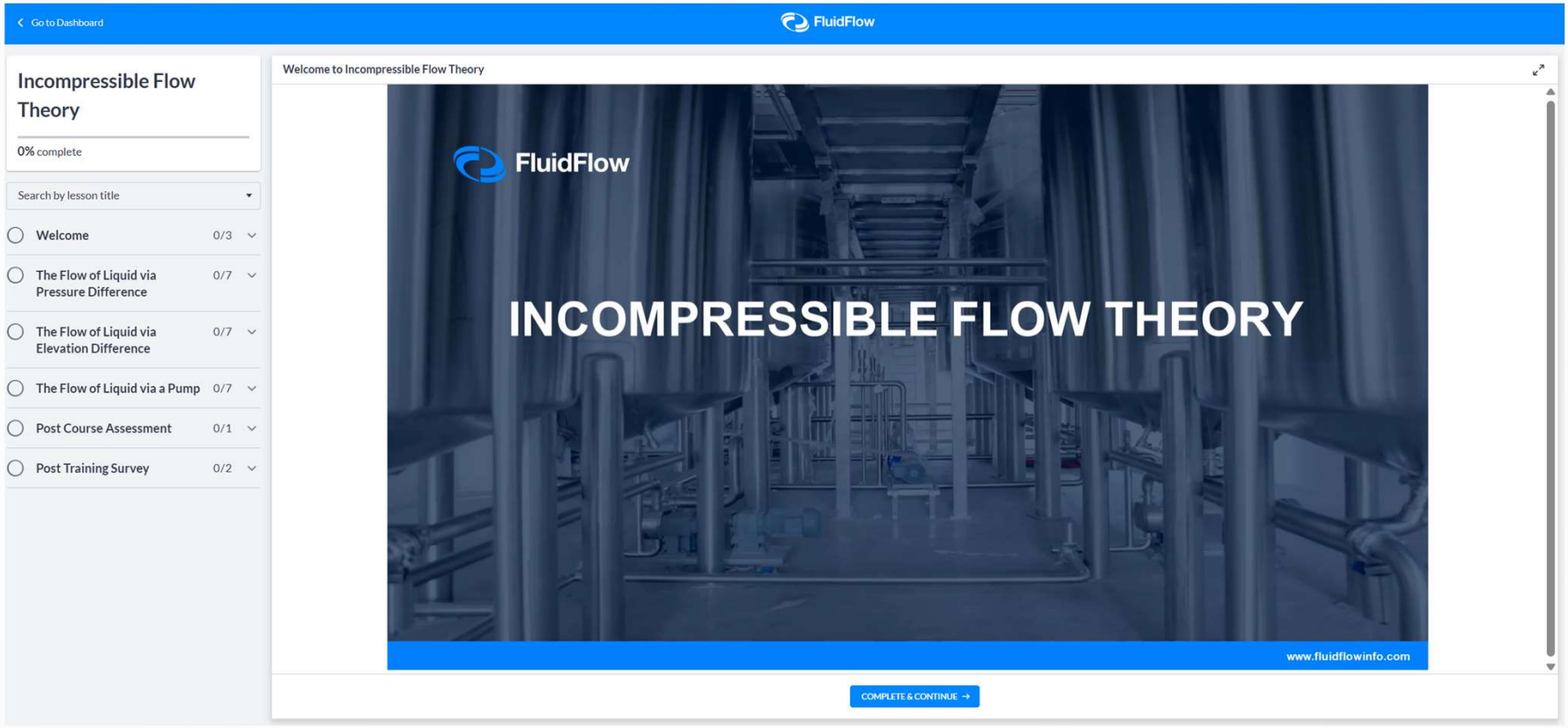
FluidFlow Basic and Advanced Training

❑ Basic Training (FREE)



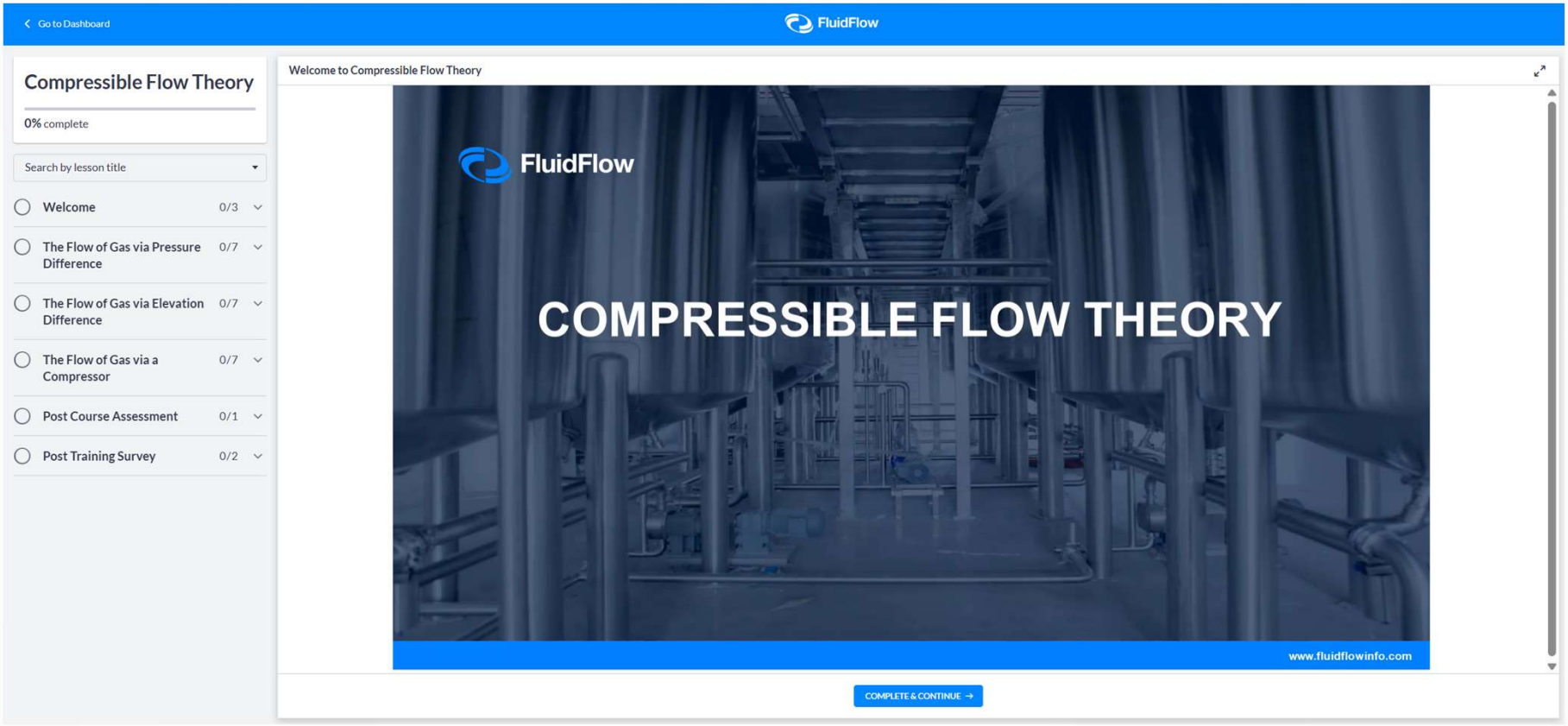
FluidFlow Basic and Advanced Training

❑ Basic Training (FREE)



FluidFlow Basic and Advanced Training

❑ Basic Training (FREE)



FluidFlow Basic and Advanced Training

❑ Advanced Training

Explore Our Comprehensive Course Modules

Detailed Course Content:

Fundamentals Module:

- Software Interface and General Configuration
- Basic Flowsheet Operations
- Fundamentals of Fluid Network Modeling
- Database Operations
- Hydraulic Calculation Procedure
- Results Analysis and Interpretation

Two-Phase Module

- Two-Phase Flow Theory
- Two-phase flow patterns and modeling approaches
- Flow regime mapping and visualization
- Pressure drop correlations for two-phase systems
- Line Sizing for Two-Phase Flow

FluidFlow Basic and Advanced Training

❑ Advanced Training

Liquid Module

- Introduction to Pumps
- Pump Sizing Principles
- Developing Pump Process Datasheets
- Centrifugal Pump Performance Modeling
- Centrifugal Pump Curve Viscosity Correction
- Centrifugal Pump Affinity Laws
- Liquid Service Control Valve Sizing
- Analyzing Pump Performance in FluidFlow

Gas Module

- Compressible Flow Principles and Calculations
- Pressure Drop in Gas Networks
- Gas Property Modeling and Equations of State
- Control Valve Basics, Sizing & Selection
- Line Sizing for Gas/Vapor
- Choked Flow Analysis
- Heat Transfer in Gas Systems
- Fan and Compressor Selection

Slurry Module

- Introduction to Slurries
- Slurry Pipe Characteristic Curve
- Settling Slurry Model Input Data
- Settling Slurry Friction Loss
- Slurry Flow Characteristic Velocities
- Specific Energy Consumption
- Non-Horizontal Settling Slurry Flows
- Centrifugal Slurry Pump Performance
- Introduction to Non-Newtonian Liquids
- Newtonian vs. Non-Newtonian Hydraulic Modeling
- Non-Newtonian Viscosity Models
- Defining Non-Newtonian Viscosity
- Non-Newtonian Friction Loss Calculations
- Non-Newtonian Centrifugal Pump Viscosity Correction

Got Questions? Send us an email!

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Customer Success
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