pipeFLOW®

taking the pressure out of fluid flow calculations

Liquid pipe diameter

Verification of Calculation Results

For Non-Compressible Flow

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Table of Contents – Results Data: Systems Solved by Liquid Pipe Diameter

Introduction

Pipe Flow Liquid Pipe Diameter is a software application that calculates the minimum pipe diameter that allows a given fluid rate at a specified maximum pressure drop. The calculation uses the Darcy Weisbach equation with Colebrook-White friction factors to compute friction losses. The software takes account of the internal roughness of the pipe material, the length of the pipe, the flow rate of the liquid, the maximum allowed pressure drop, the fluid density, the fluid viscosity, and the pressure loss through any fittings and bends.

The liquid pipe diameter calculations produced by the Pipe Flow Liquid Pipe Diameter software can be verified by comparison against published results from a number of well-known sources. The information in this document provides a general description of a published problem, the **Reference Source**, the **Published Results Data**, the **App Results Data** and a commentary on the results obtained.

For each of the calculation problems detailed in this document, the results data produced by the **Pipe Flow Liquid Pipe Diameter software compares well with the published results data.**

Calculations

Friction Factors are calculated using the **Colebrook-White** equation.

Friction Loss for non-compressible fluids is calculated using the **Darcy-Weisbach** method, which provides accurate results for Newtonian fluids, including general process fluids.

Software Releases

The Pipe Flow Liquid Pipe Diameter App is currently available only on iOS (Apple Mobile Devices).

Pipe Flow Software produces a range of different software applications for calculating flow rates and pressure losses in pipe systems, including our premier Pipe Flow Expert software for Windows, which is used to design energy efficient piping and pumping systems.

Pipe Flow Software programs are used by engineers in over 100 countries worldwide.

We have clients in a variety of industries including aerospace, chemical processing, education, food and beverage, general engineering, mining, petrochemical, pharmaceutical, power generation, water distribution, and wastewater processing.

Case 01: Design of a Uniform Pipeline

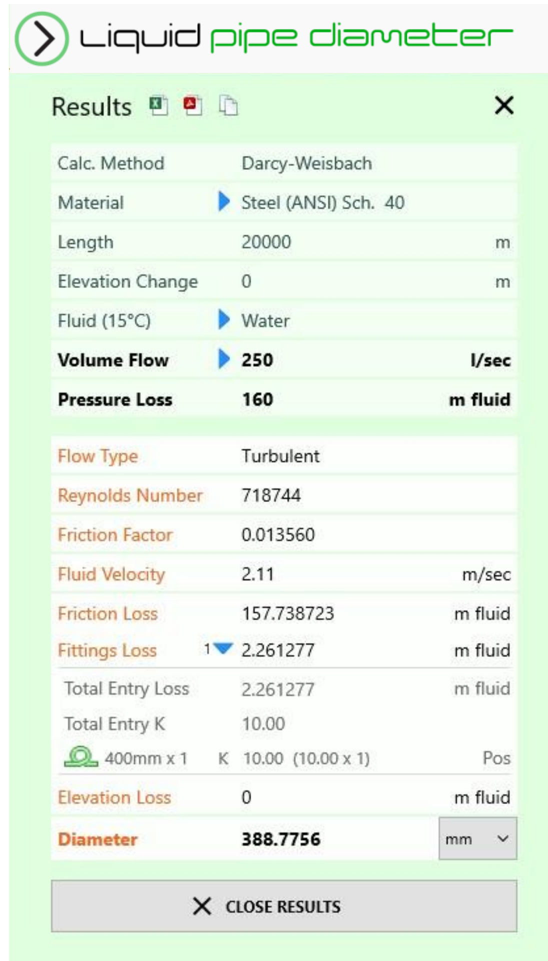
Reference: Nalluri & Featherstone's Civil Engineering Hydraulics sixth edition, 2016, Martin Marriott, Page 105, Example 4.7

Liquid Pipe Diameter App: Find_Diameter_Case_01_Pipeline_Diameter_Between_Two_Reservoirs.pfwd

Calculation Problem:

A uniform pipeline of length 20 km is to be designed to convey water at a minimum rate of 250 L/s from an impounding reservoir to a service reservoir, the minimum difference in water level between which is 160 m. Local losses, including entry loss and velocity head, total $10V^2/2g$.

Determine the diameter of a standard commercially available lined spun iron pipeline which will provide the required flow when in new condition (k= 0.03mm).



Fluid Data: Water.

Commentary:

See the Results Comparison Table below.

The published data and the calculated results compare well.

The final row shows the App calculated the diameter at 388.78 mm for the minimum flow rate of 250 L/s, which would lead to the selection of a pipe with a 400mm diameter.

Results Comparison:

Data Item	Published Data	App	With Local Losses	At Flow Rate
Inner Diameter	350 mm	350.05 mm	0	191.1 L/s
Inner Diameter	400 mm	400.01 mm	0	271.5 L/s
Inner Diameter	400 mm	400.02 mm	$10V^2/2g$	269.4 L/s
Inner Diameter	Not Calculated	388.78 mm	$10V^2/2g$	250 L/s

Case 02: Pump – Storage Power Scheme – Pipeline design

Reference: Nalluri & Featherstone's Civil Engineering Hydraulics sixth edition, 2016, Martin Marriott, Page 110, Example 4.10

Liquid Pipe Diameter App: Find_Diameter_Case_02_Pipeline_Diameter_Four_Pump_Turbine.pfwd

Calculation Problem:

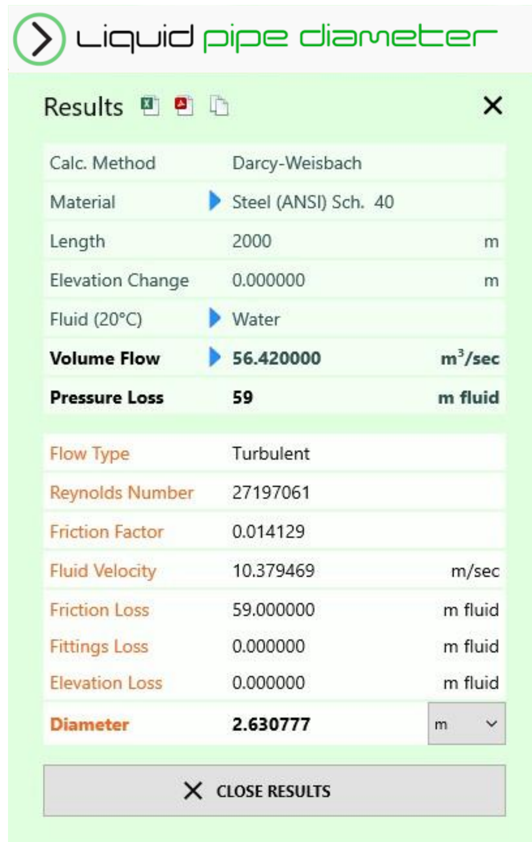
The four pump turbine units of a pumped storage hydroelectric scheme are each to be supplied by a high-pressure pipeline of length 2000 m. The minimum gross head (difference in level between upper and lower reservoirs) is 310 m and the maximum head is 340 m.

The upper reservoir has a usable volume of 3.25 x10^6 m^3 which could be released to the turbines in a minimum period of 4 hours.

Maximum power output required/turbine = 110 MW
Turbogenerator efficiency = 80%
Effective roughness of pipeline = 0.6 mm

Taking minor losses in the pipeline, power station, and draft tube to be 3.0 m, determine the minimum diameter of pipeline to enable the maximum specified power to be developed.

The book calculated a flow rate of 56.42 m^3/s is required to achieve a maximum power of 110 MW.



Fluid Data: Water.

Commentary:

See the Results Comparison Table below.

The published data and the calculated results compare well.

The book uses a slight variation on the Colebrook white equation, and this likely explains the small difference in calculated diameters.

Results Comparison:

Data Item	Published Data	App
Inner Diameter	2.65 m	2.63 m

Case 03: Water - Galvanized Steel Pipe

Reference: Mechanics of Fluids 9th edition, 2012, Bernard S. Massey, John Ward-Smith Page 256, Example 7.3

Liquid Pipe Diameter App: Find_Diameter_Case_03_Galvanized_Steel_Pipeline_Diameter.pfwd

Calculation Problem:

A galvanized steel pipe carries water over a distance of 180 m at 85 L/s with head loss of 9 m**.**

Determine the size of galvanized steel pipe needed.

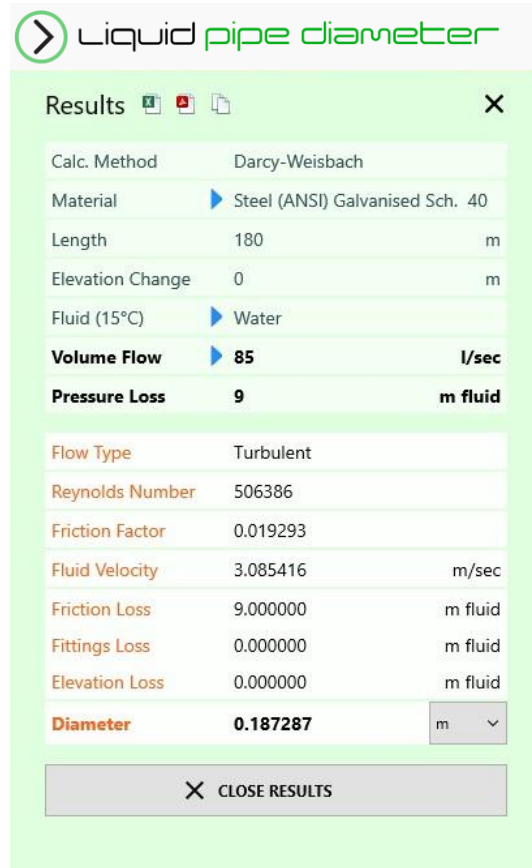
Fluid Data: Water at 15°C, viscosity = 1.14 mm²/s.

Commentary:

See the Results Comparison Table below.

The published data and the calculated results compare well.

The published problem reports a fanning friction factor which is one quarter of the Darcy friction factor reported by the Pipe Flow Liquid Pipe Diameter software.



Results Comparison:

Data Item	Published Data	App
Inner Diameter	0.1867m	0.187287 m
Reynolds Number	508000	506386
Friction Factor	0.0048	0.00482325

Case 04: Heavy Fuel Oil – Sizing a Horizontal Pipe

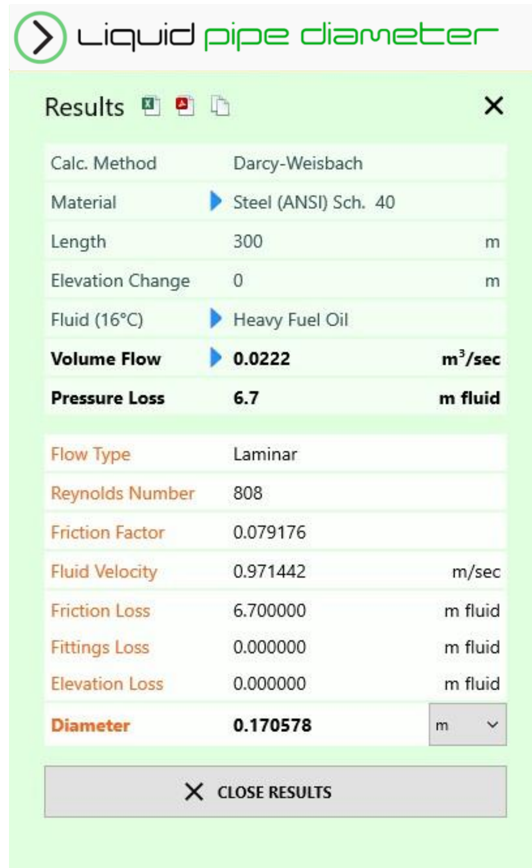
Reference: Fluid Mechanics and Hydraulics – Third Edition, 1994,
Ranald V. Giles, Jack B. Evett, Ph.D., Cheng Liu, Page 149, Example problem 8.11

Liquid Pipe Diameter App: Find_Diameter_Case_04_Horizontal_Oil_Pipe_Size.pfwd

Calculation Problem:

A 300 m length of horizontal pipe carries 0.0222 m^3/s of heavy fuel oil with an available head loss of 6.7 m.

What size pipe should be installed?



Fluid Data: Heavy Fuel Oil at 16°C
Viscosity = 0.000205 m^2/s
Specific Gravity = 0.912.

Commentary:

See the Results Comparison Table below.

The published data and the calculated results compare well.

Results Comparison:

Data Item	Published Data	App
Inner Diameter	0.170 m	0.171 m
Reynolds Number	812	808

References

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