Maximum Pressure Surge Generated by Instantaneous Valve Shutoff

Introduction

This application calculates the excess pressure generated by water hammer when a valve at the end of a pipeline instantaneously closes

```
> restart :
  with( Units[Standard] ) :
```

Parameters

Fluid density:

```
> ρ := 62 lb ft^-3 :
```

Fluid velocity change:

```
> Δv := 14.10 m s^-1 :
```

Bulk modulus of fluid:

```
> K := 2·10^8 Pa :
```

Young's modulus of pipe:

```
> E := 7·10^10 Pa :
```

Pipe wall thickness:

```
>  t := 0.001 m :
```

Intermediate Calculations

Effective bulk modulus:

```
> Ke := PipeID → K / (1 + PipeIDm ·K / (t·E)) :
```

Speed of sound:

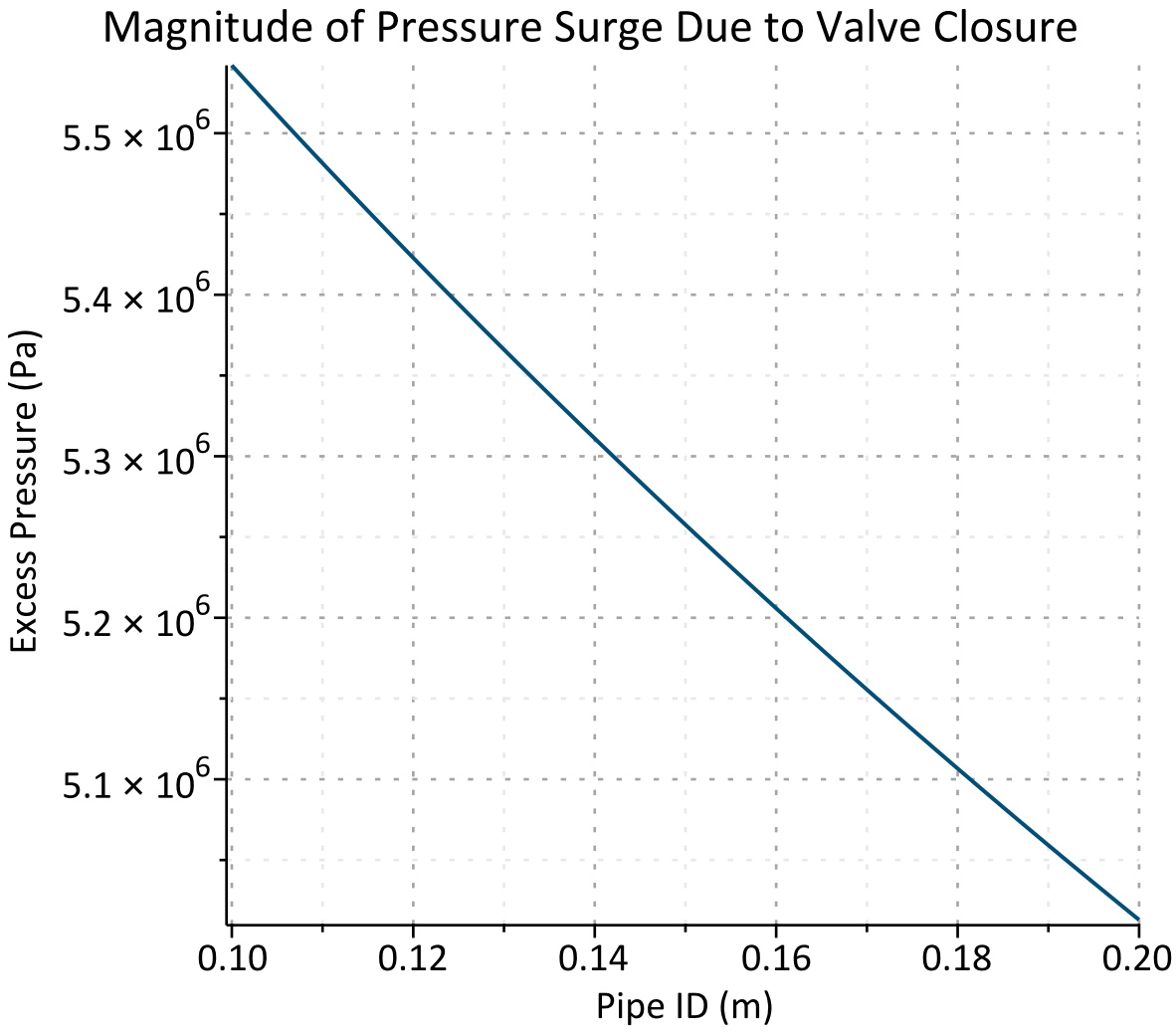
> $c := \mathrm{PipeID} \rightarrow \left(\frac{\mathrm{Ke}(\mathrm{PipeID})}{\rho} \right)^{\frac{1}{2}}$:

Maximum pressure surge:

> $\Delta P := \mathrm{PipeID} \rightarrow \rho \cdot c(\mathrm{PipeID}) \cdot \Delta v$:

Results

> plot(ΔP(PipeID), PipeID = 0.1 ..0.2, labels = ["Pipe ID (m)", "Excess Pressure (Pa)"], labeldirections = [horizontal, vertical], labelfont = [*Calibri*], title = "Magnitude of Pressure Surge Due to Valve Closure", titlefont = [*Calibri*, 14], size = [600, 400], axesfont = [*Calibri*], *axis*[1] = [*gridlines* = [*linestyle* = *dot*]], *axis*[2] = [*gridlines* = [*linestyle* = *dot*]], *color* = *ColorTools*:-*Color*("RGB", [0/255, 79/255, 121/255]))



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