



# Fluid Flow Analysis– the Key to Your Success in Chemical Engineering

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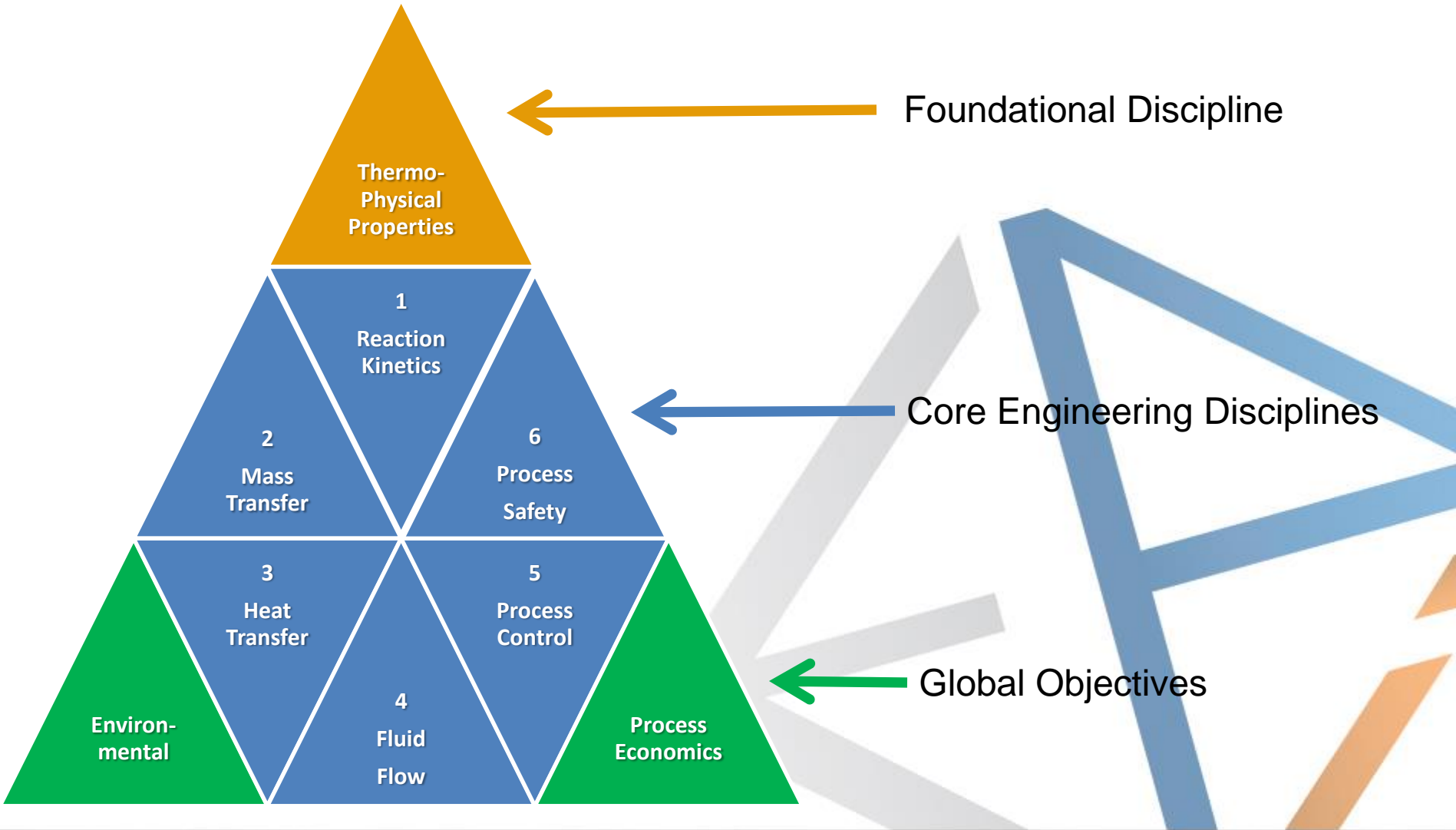


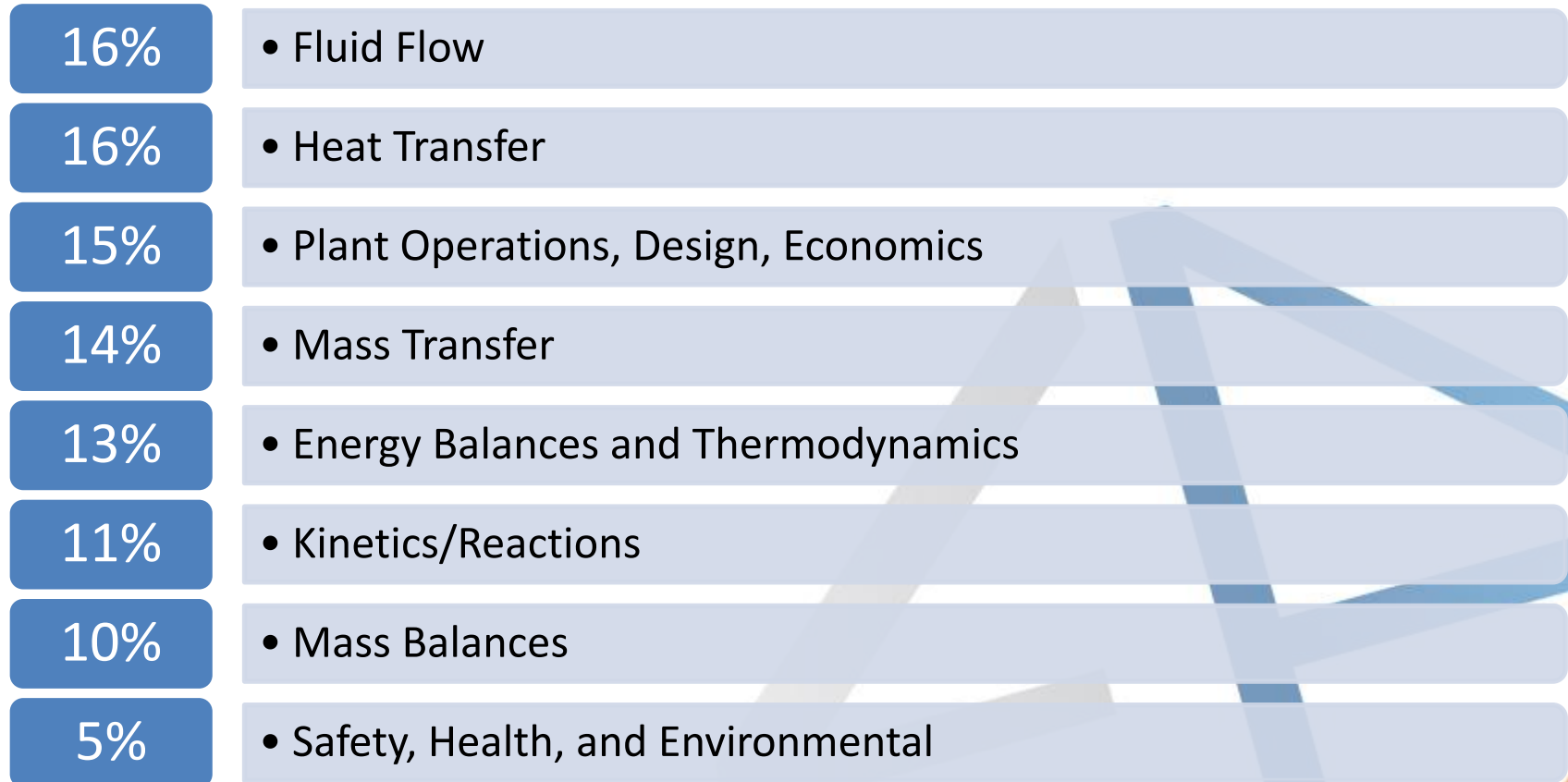
## EPCON SOFTWARE™

In 1981, EPCON Software began developing process engineering software

- Over the past 32 years, EPCON Software has accumulated multiple patents that protect its award-winning technology
- EPCON's flagship product Engineer's Aide SiNET is the most widely used pipe flow analysis software
- EPCON Software also develops the thermophysical property software standards for the American Petroleum Institute and the Gas Processors Association
- Since 2000 many EPCON Software clients such as Dow Chemical, 3M, Eastman Chemical, Shell Chemicals LP, Phillips 66, Chevron, BP, Citgo, Texas Petrochemicals and Lyondell have requested that our team of experts model, simulate, analyze, and optimize their respective utility systems using our software technology.
- Due to high demand of our service, EPCON Software created EPI Engineering in 2000 and expanded into specialized services specifically for utility systems. IN 2012, EPI Engineering was recognized as the fastest growing engineering company in the greater Houston area according to the Houston Business Journal

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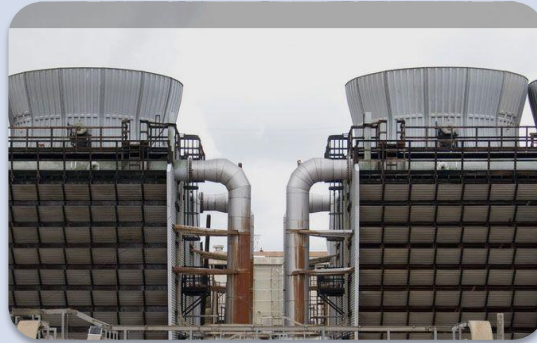






- Choose your Event
  - What is your passion in Chemical Engineering? (if you are not sure, Fluid Flow Analysis has lots of opportunities I'll be sharing this evening)
  - Work on this passion even if it's on your own time
  - Choose mentors who have experience in your passion
  - Put together a good team
- Practice Hard
  - Focus on the fundamentals
  - Choose your mentors
- Have a Vision!
  - Develop short and long term visions
  - Don't listen to the wrong voices (ear plugs sometimes required)
- Go for the Gold!
  - Usually at least 4 years of hard work
  - Sometimes it will take several Olympics to realize Gold
  - Stay with it – you are in the race until you step off the track

- Process Systems – *Increased Throughput*
- Energy Systems – *Reduced Fuel, Electrical, Chemical and Water Costs + Increased Throughput*
  - Steam Networks, Letdown Valves/Turbines
  - Condensate and BFW Systems
- Water Systems – *Reduced Electrical, Chemical and Water Costs + Increased Throughput*
  - Cooling Water Distribution Systems
  - Process Water Distribution Systems
- Safety Systems – *Personnel and Asset Protection*
  - Fire Water Distribution Systems
  - Flare Header Gathering Systems
  - Pressure Relief Valves



## Energy

Steam Systems  
Condensate  
Fuel Systems

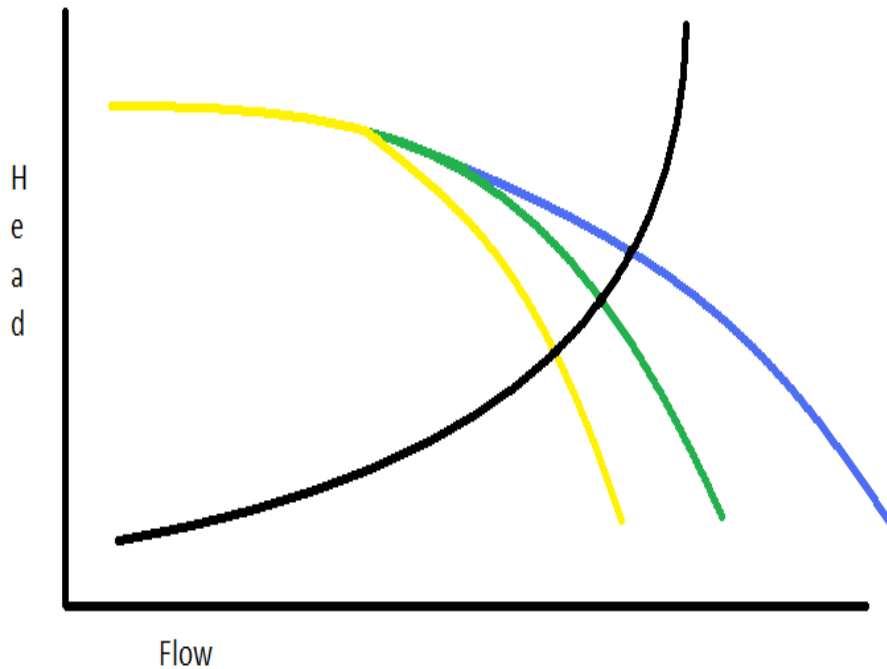
## Water

Cooling Water  
Boiler Feedwater  
Clarified Water

## Safety

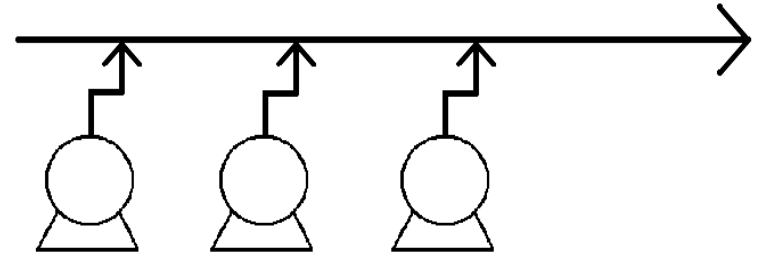
Flare Headers  
Firewater  
Safety Showers

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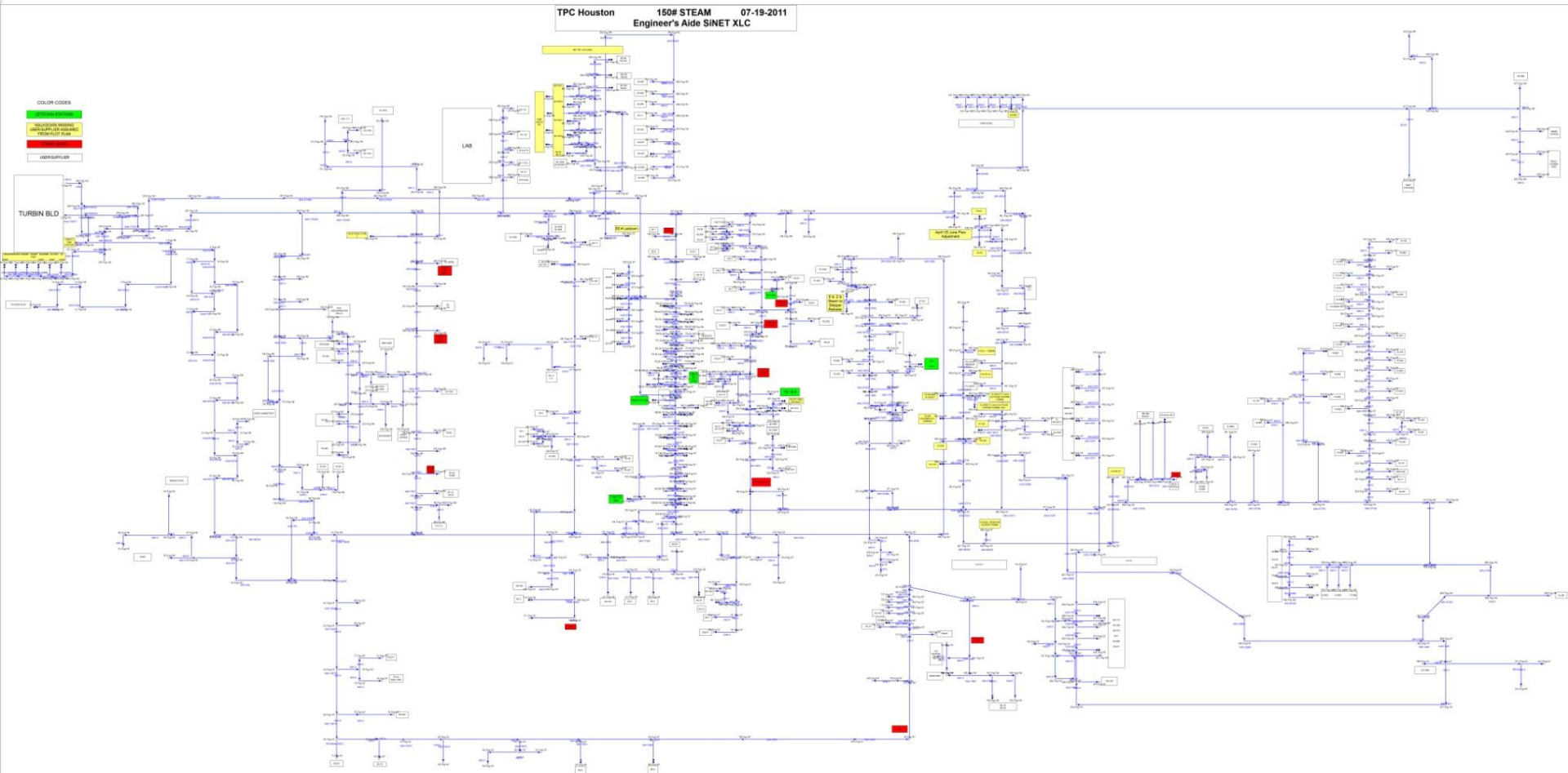


X2 Capacity?

X3 Capacity?

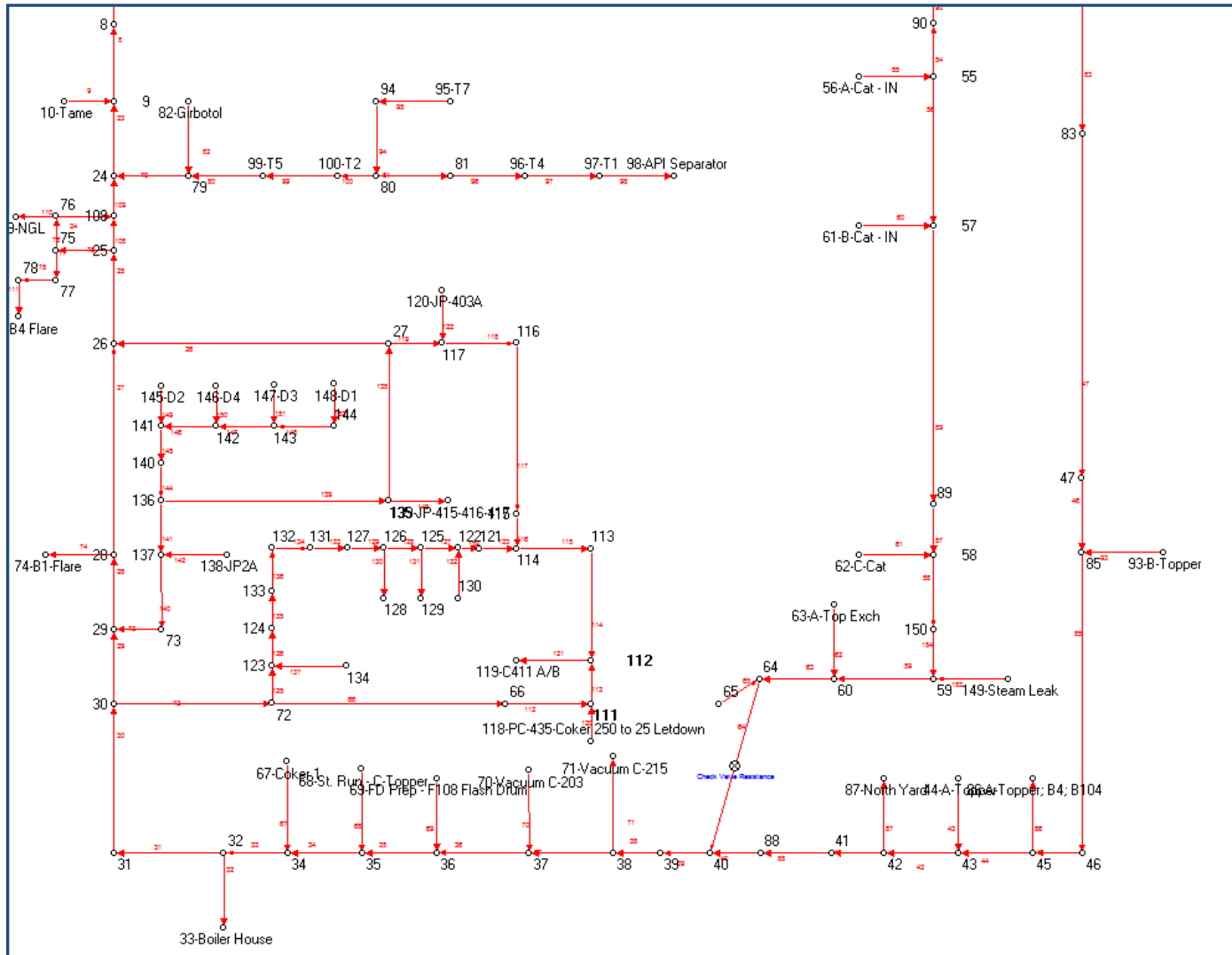


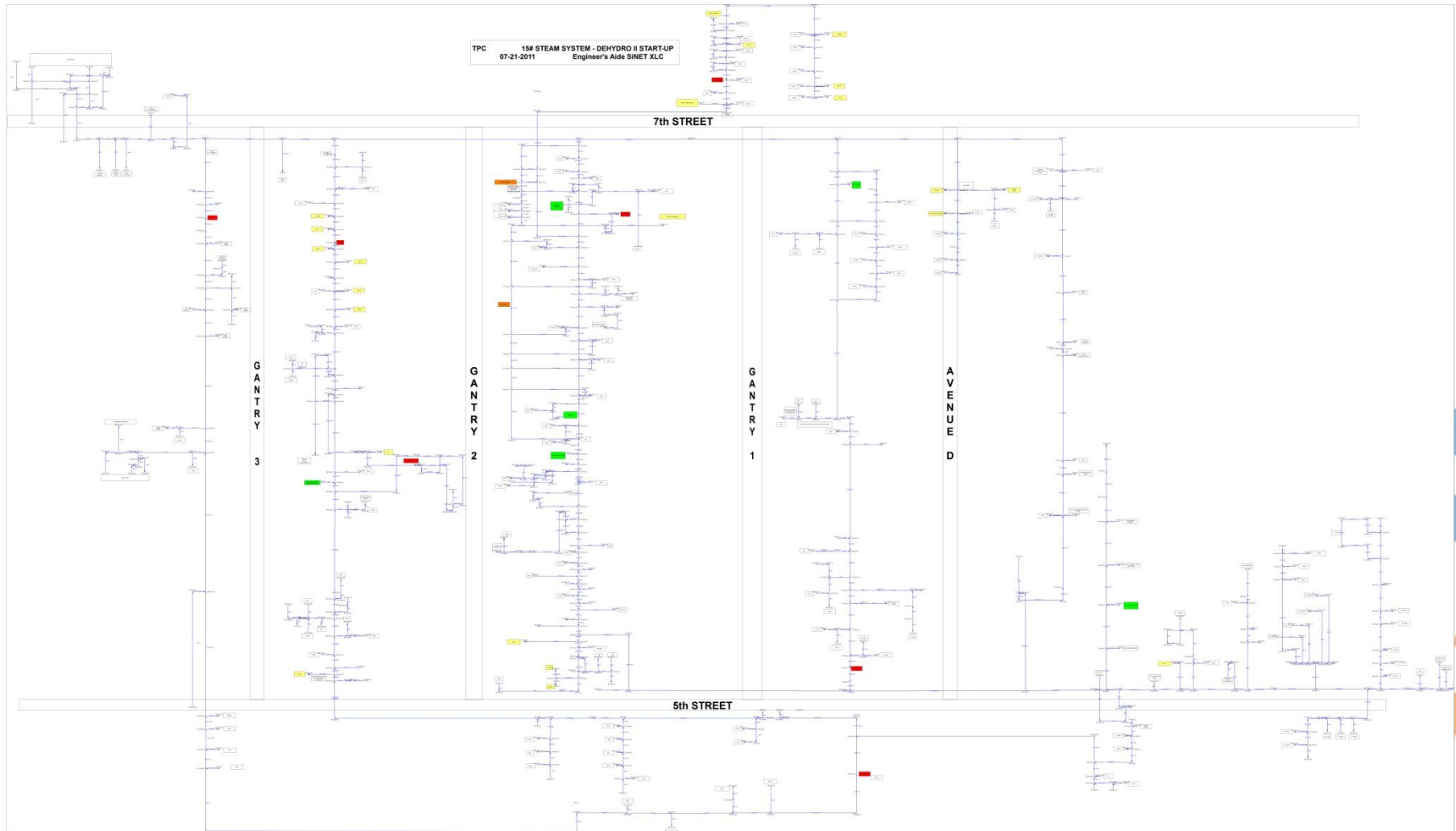


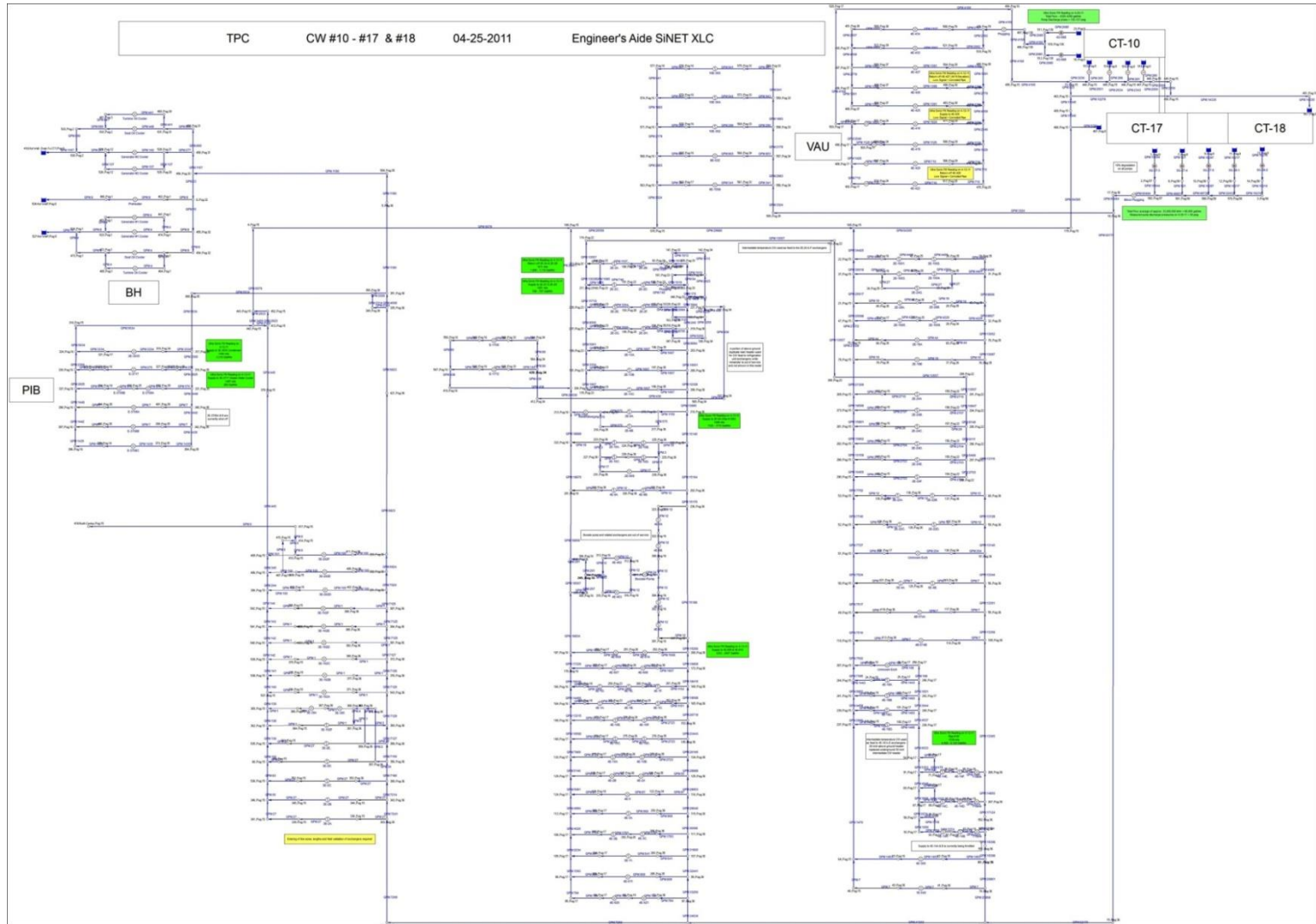




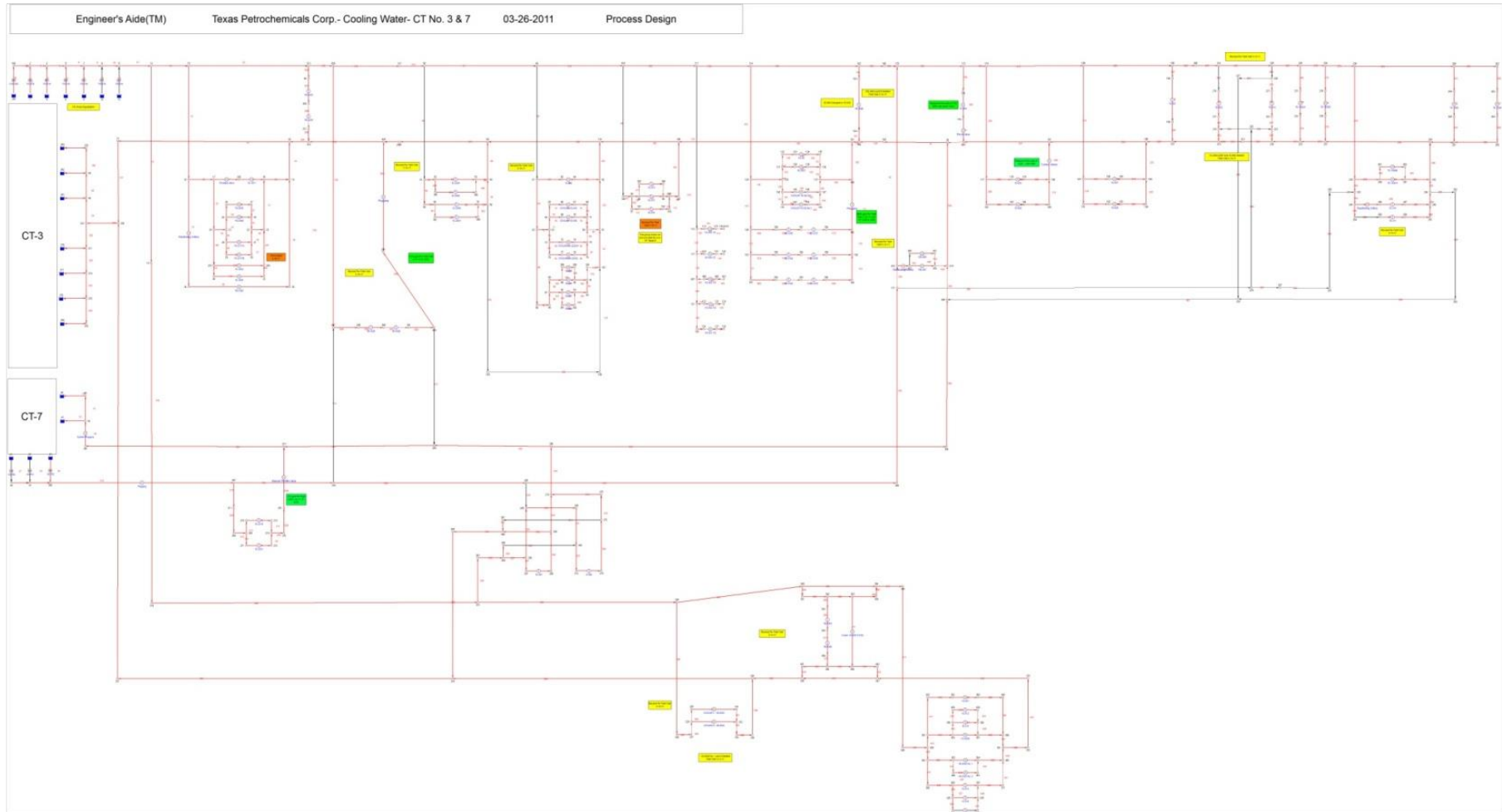
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$$P_1 + \frac{\rho v_1^2}{2g_c} + \frac{\rho Z_1}{144} = P_2 + \frac{\rho v_2^2}{2g_c} + \frac{\rho Z_2}{144} - \sum_{1,2} F + W$$

For determining pressure drop from pipe inlet (1) to pipe outlet (2)

P=Pressure (lbf/in<sup>2</sup>)

v= Kinetic Energy (ft/sec)

Z=Potential Energy (ft)

W= Work done on or by the fluid (lbf/in<sup>2</sup>)

ρ= Fluid Density (lbf/ft<sup>3</sup>)

$g_c$ =Acceleration of Gravity (32 ft/sec<sup>2</sup>)

144 in<sup>2</sup> = 1 ft<sup>2</sup>

$$P_1 - P_2 = \left( \frac{\rho v_2^2}{2g_c} - \frac{\rho v_1^2}{2g_c} \right) + \left( \frac{\rho Z_2}{144} - \frac{\rho Z_1}{144} \right) - \sum_{1,2} F + W$$

PRESSURE ENERGY = KINETIC ENERGY + POTENTIAL ENERGY + FRICTION ENERGY + WORK ENERGY

+ Kinetic Energy Change

+ Potential Energy Change

+ Frictional Energy Change

+ Work Energy Change

= Pressure Energy Change (what we are solving for!)

$$F = \rho/144 \left( \frac{fL}{D} + \sum K \right) \frac{v^2}{2g_c} \quad K = \frac{fL}{D}$$

To calculate pressure drop from pipe friction and minor losses

F=Frictional Energy Loss in Pipes (lbf/in<sup>2</sup>)

f= Moody or Darcy Friction Factor (dimensionless)

L= Pipe Length (ft)

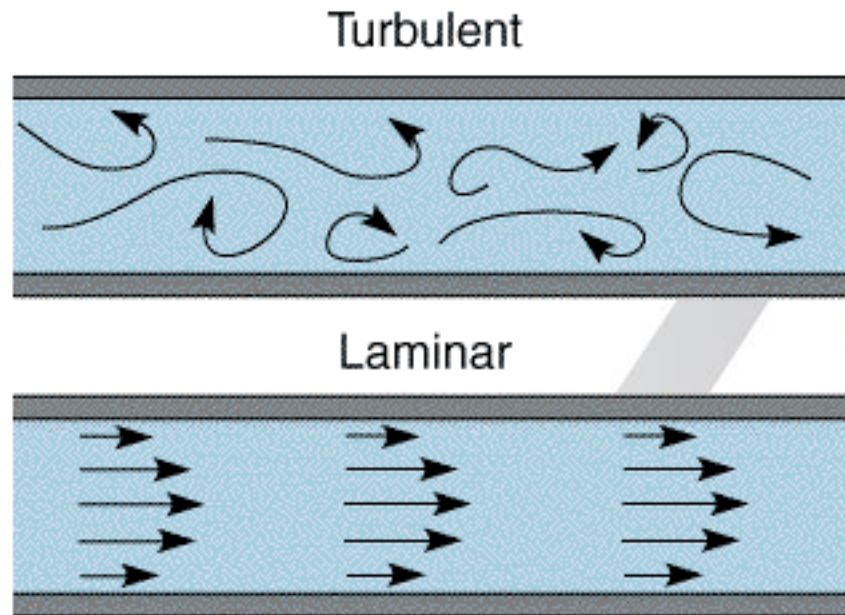
D= Pipe Diameter (ft)

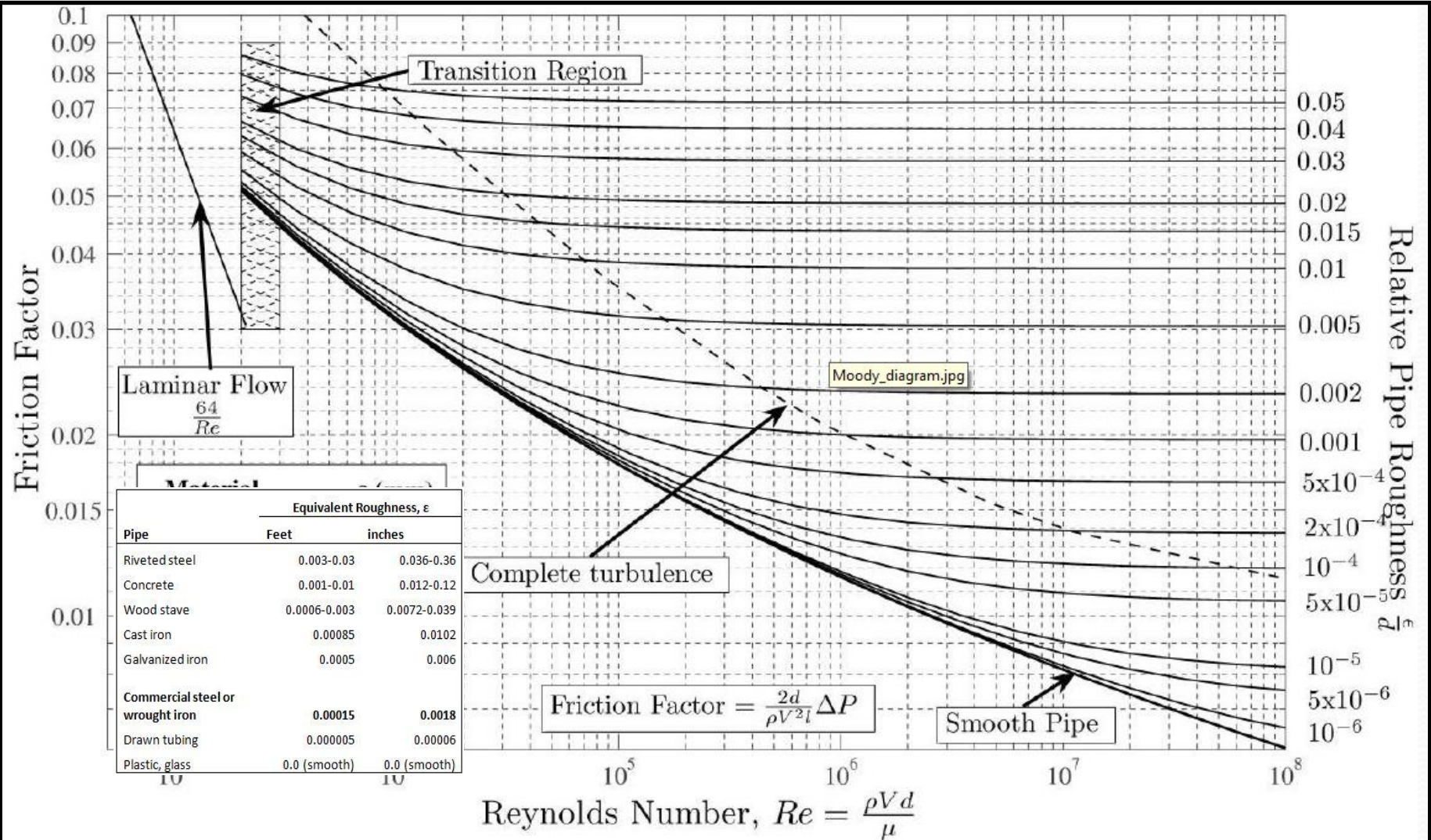
K= K Value for Flow Resistance (dimensionless)

v= Average Velocity (ft/sec)

g<sub>c</sub>= Acceleration of Gravity (32 ft/sec<sup>2</sup>)



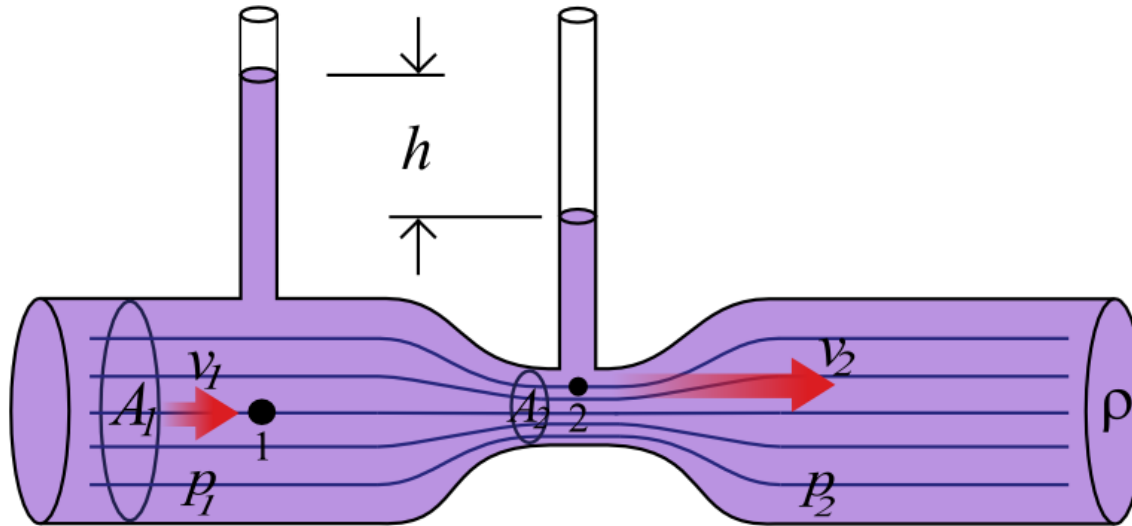




<i>Fitting, Hand Valve</i>	<i>K Value</i>
Short Radius 90 Deg. Elbow (r/d=1)	$20 F_t$
Long Radius 90 Deg. Elbow (r/d=1.5)	$14 F_t$
Tee Thru	$20 F_t$
Tee Branch	$60 F_t$
Pipe Entrance	0.5
Pipe Exit	1
Gate Valve	$8 F_t$
Ball Valve	$3 F_t$
Butterfly Valve	$45 F_t$
Globe Valve	$340 F_t$
Swing Check Valve	$50 F_t$

<i>Pipe Dia</i>	<i>F<sub>t</sub></i>
0.5 inch	0.027
0.75 inch	0.025
1 inch	0.023
2 inch	0.019
3 inch	0.018
4 inch	0.017
6 inch	0.015
8-10 inch	0.014
12-16 inch	0.013
18-24 inch	0.012
26-48 inch	0.011

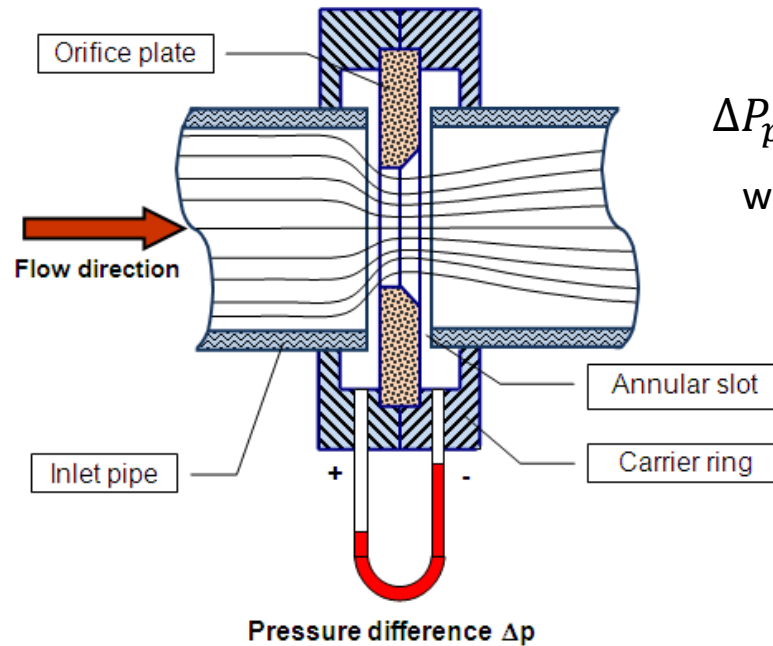




$$v_2 = \left( \frac{C_v}{\sqrt{1 - \left( \frac{A_2}{A_1} \right)^2}} \right) \sqrt{\frac{2g_c(p_1 - p_2)}{\rho}} \quad [U.S.]$$



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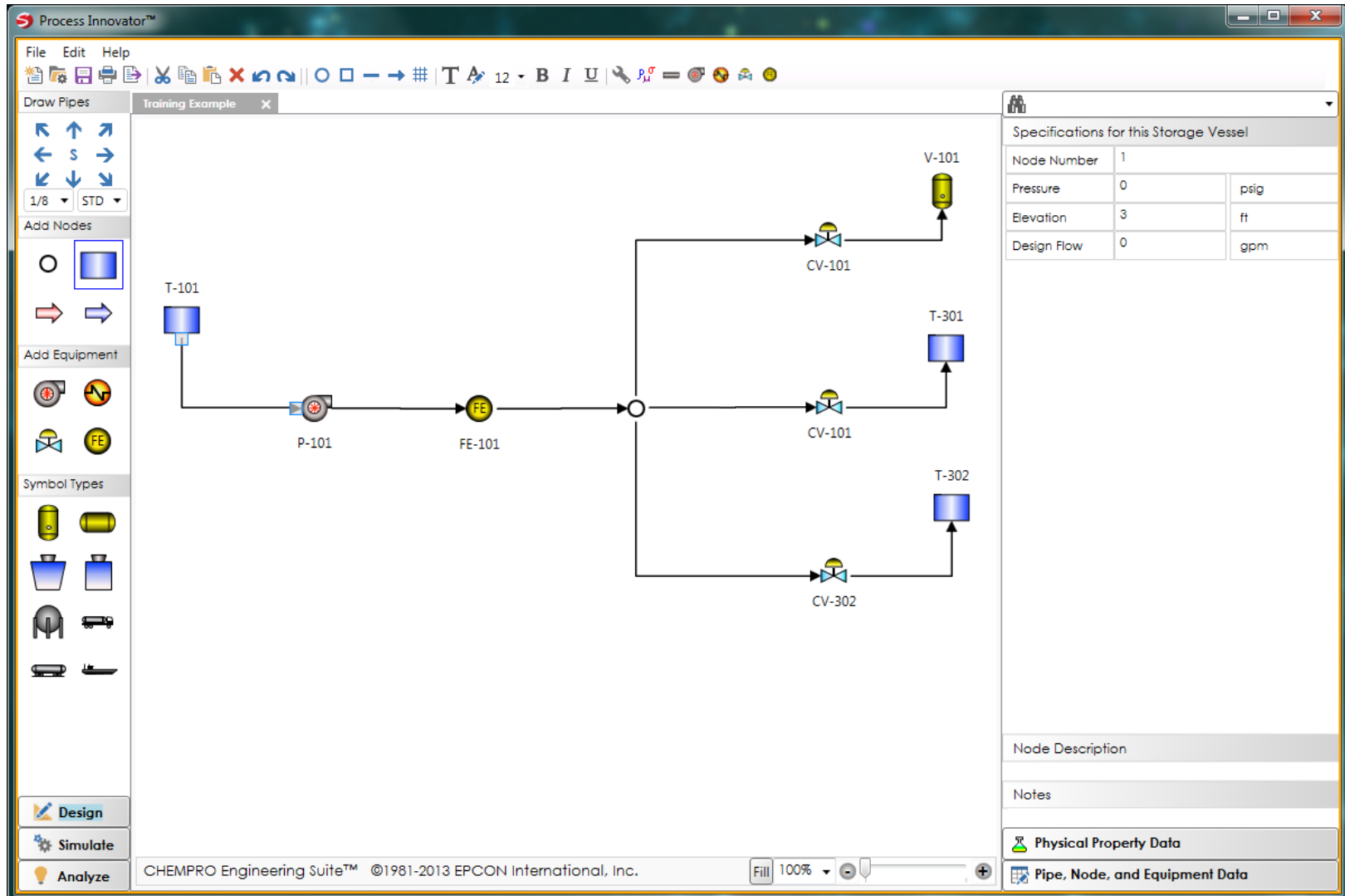


$$\Delta P_{perm} = [1 - \beta^2] * \Delta P_{actual}$$

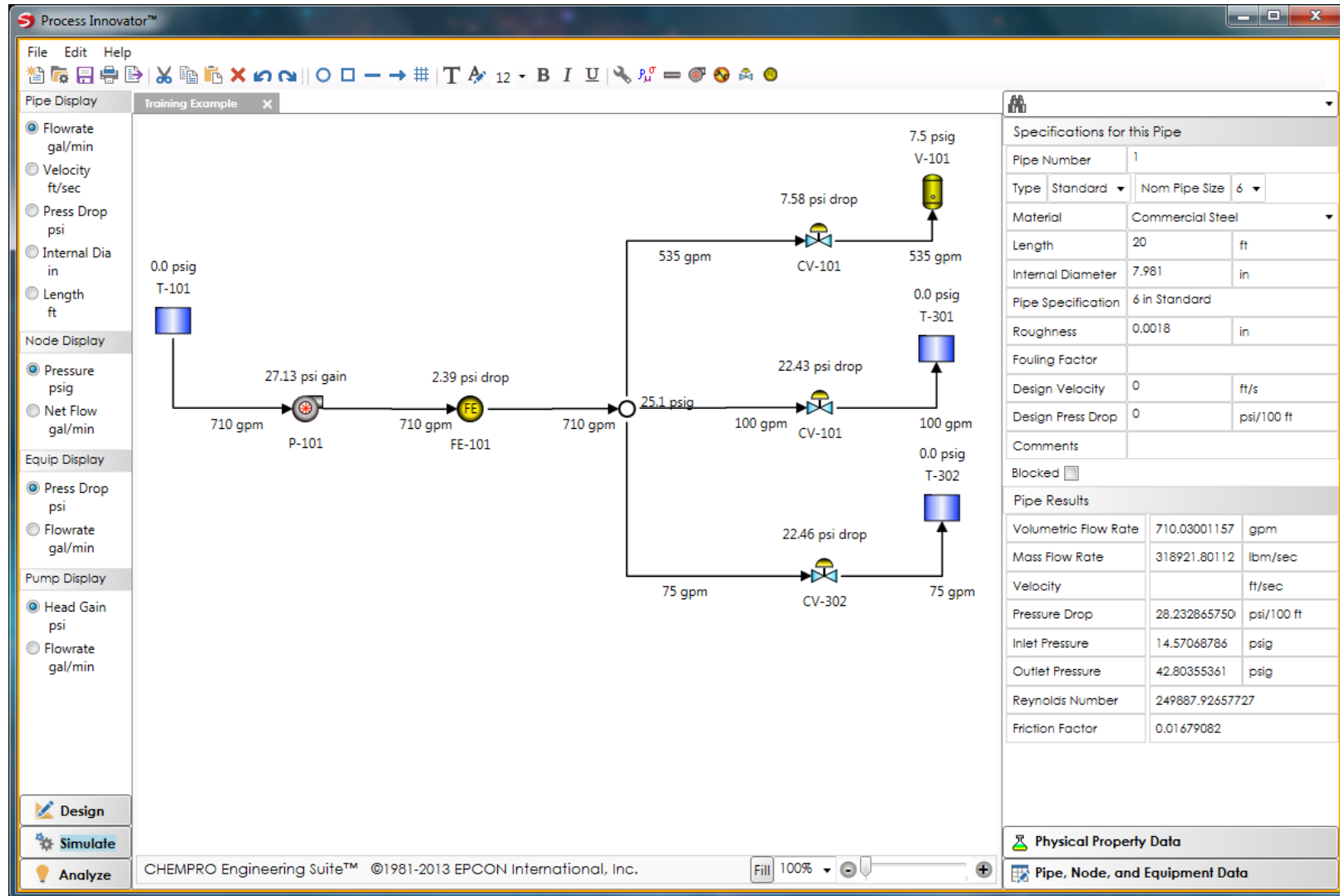
where  $\beta = \frac{D_{orifice}}{ID_{pipe}}$

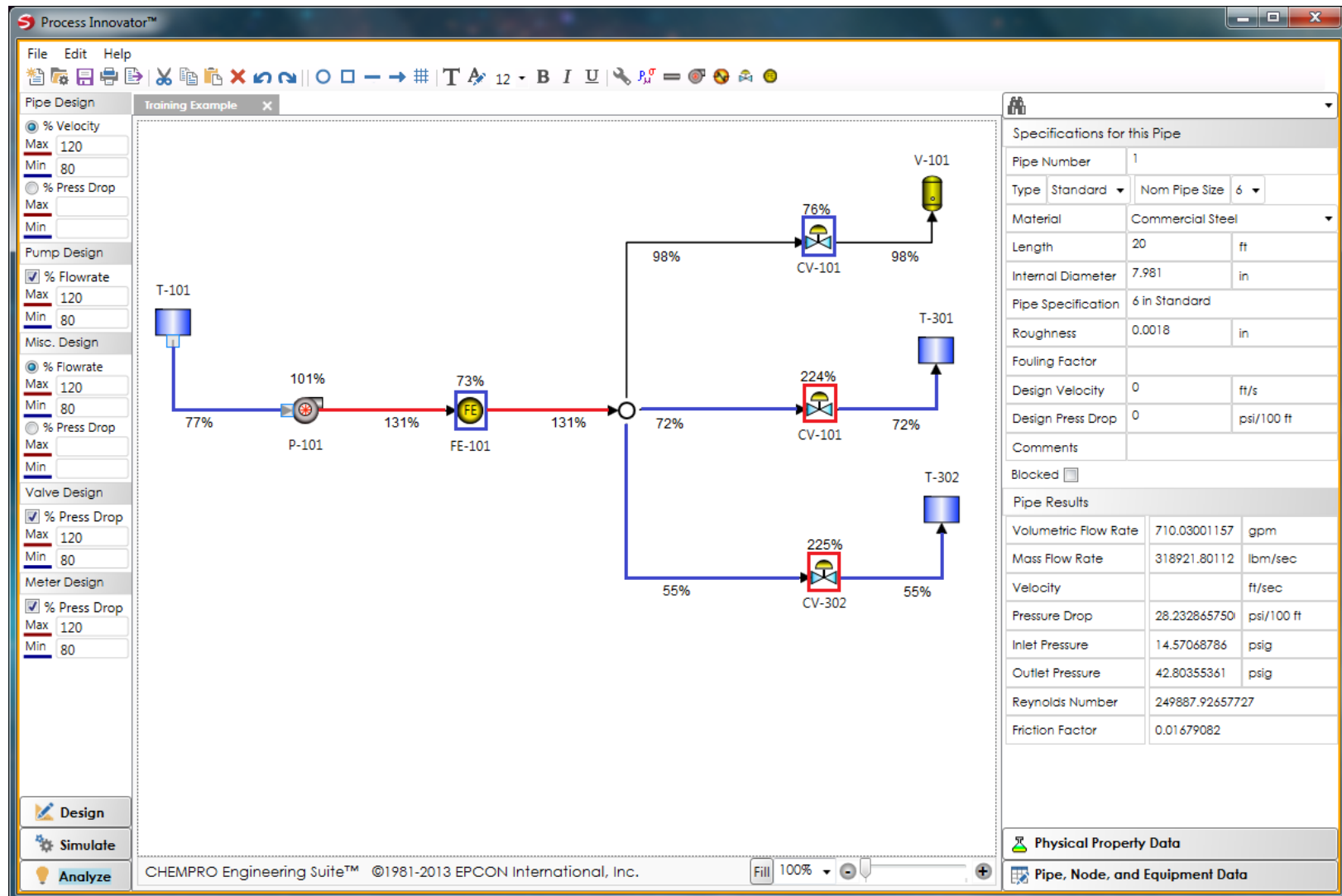
$$v_0 = \left( \frac{C_v}{\sqrt{1 - \left( \frac{C_c A_0}{A_1} \right)^2}} \right) \sqrt{\frac{2g_c(p_1 - p_2)}{\rho}} \quad [U.S.]$$

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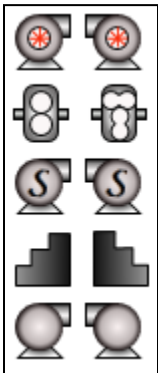
## Pumps/Blowers



**Default Symbol:**  
Pump

### Other Symbols:

Cent. Pump (R)  
Cent. Pump (L)  
Gear Pump  
Diaphragm Pump  
Screw Pump (R)  
Screw Pump (L)  
Recip. Pump (R)  
Recip. Pump (L)  
Blower (R)  
Blower (L)



## Misc. Equipment



**Default Symbol:**  
Exchanger

### Other Symbols:

Heater  
Cooler  
Burner Tubes  
Fin Fan Tubes  
Filter  
Drier  
In-line Mixer  
Miscellaneous



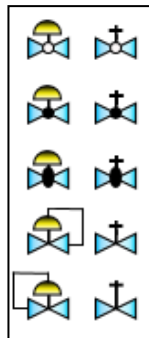
## Valves



**Default Symbol:**  
Control Valve

### Other Symbols:

Globe Control  
Globe Manual  
Ball Control  
Ball Manual  
Butterfly Control  
Butterfly Manual  
Let-Down  
Gate Manual  
Backpressure  
Post Indicating



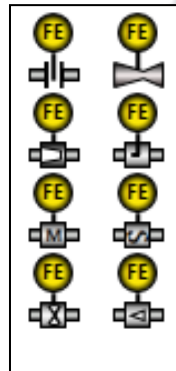
## Flow Meters



**Default Symbol:**  
Flow Meter

### Other Symbols:

Orifice  
Venturi  
Flow Nozzle  
Pitot Tube  
Magnetic  
Ultrasonic  
Turbine  
Vortex



## Storage Vessels



**Default Symbol:**  
Tank

### Other Symbols:

Press Vessel (V)  
Press Vessel (H)  
Cross Flow CWT  
Counter-Cur CWT  
Sphere  
Tanker Truck  
Railcar  
Ship



## Inlets



**Default Symbol:**  
Inlet Arrow

### Other Symbols:

Exchanger  
Furnace  
Compressor  
Turbine  
Boiler  
Let-Down Valve  
Reactor  
Column Side  
Column Top  
Column Bottom



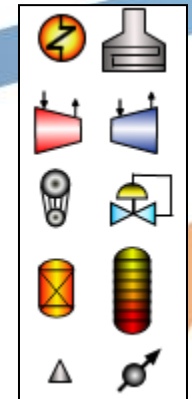
## Outlets



**Default Symbol:**  
Outlet Arrow

### Other Symbols:

Exchanger  
Furnace  
Compressor  
Turbine  
Boiler  
Let-Down Valve  
Reactor  
Column Feed  
Spray Nozzle  
Monitor/Hydrant



## EPCONSOFTWARE™

### Draw Pipes

Creates a pipe with the selected node or equipment in the desired direction

### Add Nodes

Junction, Vessel, Inlet, and Outlet

### Add Equipment

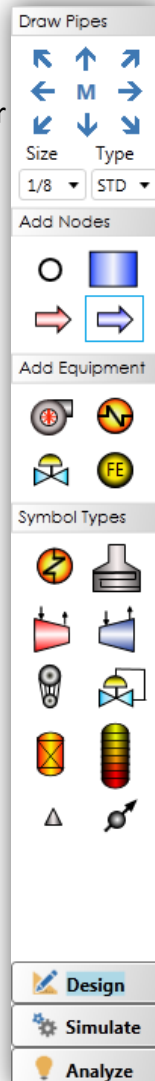
Pump/Blowers, Miscellaneous, Valves, and Flowmeters

### Symbol Types

Different options are shown based on the selected Node or Equipment class selected above

### Design, Simulate, Analyze

3 major program modes



**Draw Pipes**

Size: 1/8 Type: STD

**Add Nodes**

**Add Equipment**

**Symbol Types**

**Design** **Simulate** **Analyze**

### Pipe Fittings

Enter the quantity of the fittings depicted by the icon to calculate their k-value resistance

### Hand Valves

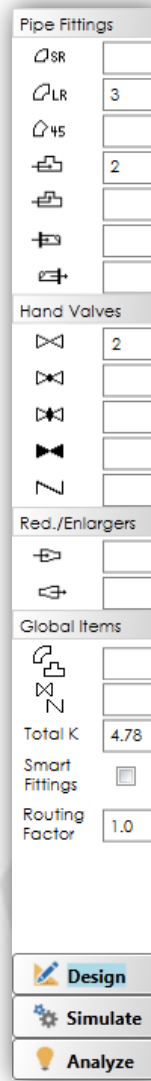
Enter the quantity of the hand valves to calculate their k-value resistances

### Red./Enlargers

Enter the specified diameter to calculate k-values

### Global Items

Enter or calculate misc. fittings and hand valve k-values and automate entry of pipe fittings, hand valves, and reducers/enlargers with Smart Fittings



**Pipe Fittings**

**Hand Valves**

**Red./Enlargers**

**Global Items**

Total K: 4.78

Smart Fittings: ☐

Routing Factor: 1.0

**Design** **Simulate** **Analyze**

### Specifications

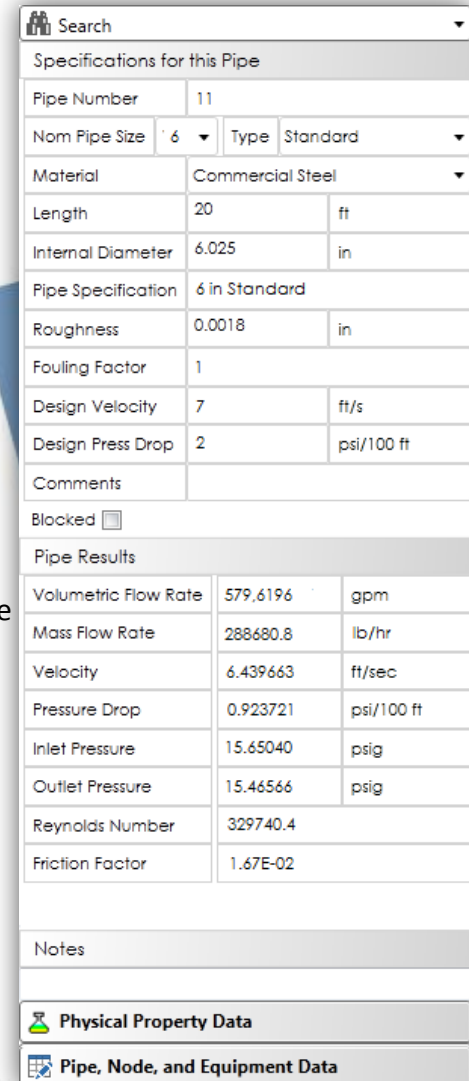
Enter the pipe, node or equipment specifications by clicking on that element or searching by its number

### Results

Results are displayed by selecting the Simulate button and clicking on the desired item or searching for any pipe, node or equipment

### Options

View physical property data or pipe, node and equipment data



**Search**

**Specifications for this Pipe**

Pipe Number	11	
Nom Pipe Size	6	Type: Standard
Material	Commercial Steel	
Length	20	ft
Internal Diameter	6.025	in
Pipe Specification	6 in Standard	
Roughness	0.0018	in
Fouling Factor	1	
Design Velocity	7	ft/s
Design Press Drop	2	psi/100 ft
Comments		
Blocked	<input type="checkbox"/>	


**Pipe Results**



Volumetric Flow Rate	579.6196	gpm
Mass Flow Rate	288680.8	lb/hr
Velocity	6.439663	ft/sec
Pressure Drop	0.923721	psi/100 ft
Inlet Pressure	15.65040	psig
Outlet Pressure	15.46566	psig
Reynolds Number	329740.4	
Friction Factor	1.67E-02	

**Notes**

**Physical Property Data**

**Pipe, Node, and Equipment Data**


File Edit

**Feed** Temperature-Pressure

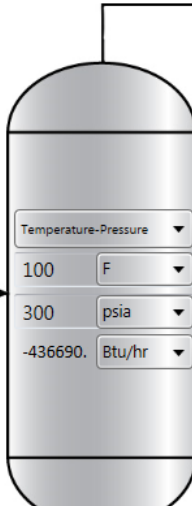
Temperature  F

Pressure  psia

Mole Flow  lb-mol/hr

☐ Copy Feed Conditions to Flash

Vapor/Feed 0.689




**Vapor** 41.66 mol %


Temperature  F


Pressure  psia

Flash Duty  Btu/hr





**Liquid** 58.34 mol %


 **View Binary Parameters**


 **Run Flash Calculations**


 **View Stream Properties**

Property Slate: API

Name	Feed	Vapor	Liquid 1	Liquid 2	K1	K2
 METHANE	0.33	0.6864	0.0812	0.0000	8.4519	0.0000
 PROPANE	0.33	0.2664	0.3811	0.0000	0.6991	0.0000
 n-PENTANE	0.33	0.0472	0.5377	0.0000	0.0878	0.0000
						

 **Add Pure Component**

 **Add Pseudocomponents**

 **Generate Pseudocomponents**

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Design. Analyze. Optimize. Implement.®

- Pick a passionate area that has been neglected
  - Fluid Flow is an excellent choice
  - If you are not sure, attend the PE Exam Review Course to learn from those passionate in thermodynamics, mass/energy balances, kinetics/reactions, separations, plant operations, etc.
  - No harm in pursuing multiple events!
- Pick the right coach and team
- Stick with it!
- Training camp begins in January, 2014 – next PE Exam Review course.
- Go for the Gold Medal in your Chemical Engineering Career!!