CHEMICAL ENGINEERING DESIGN & SAFETY

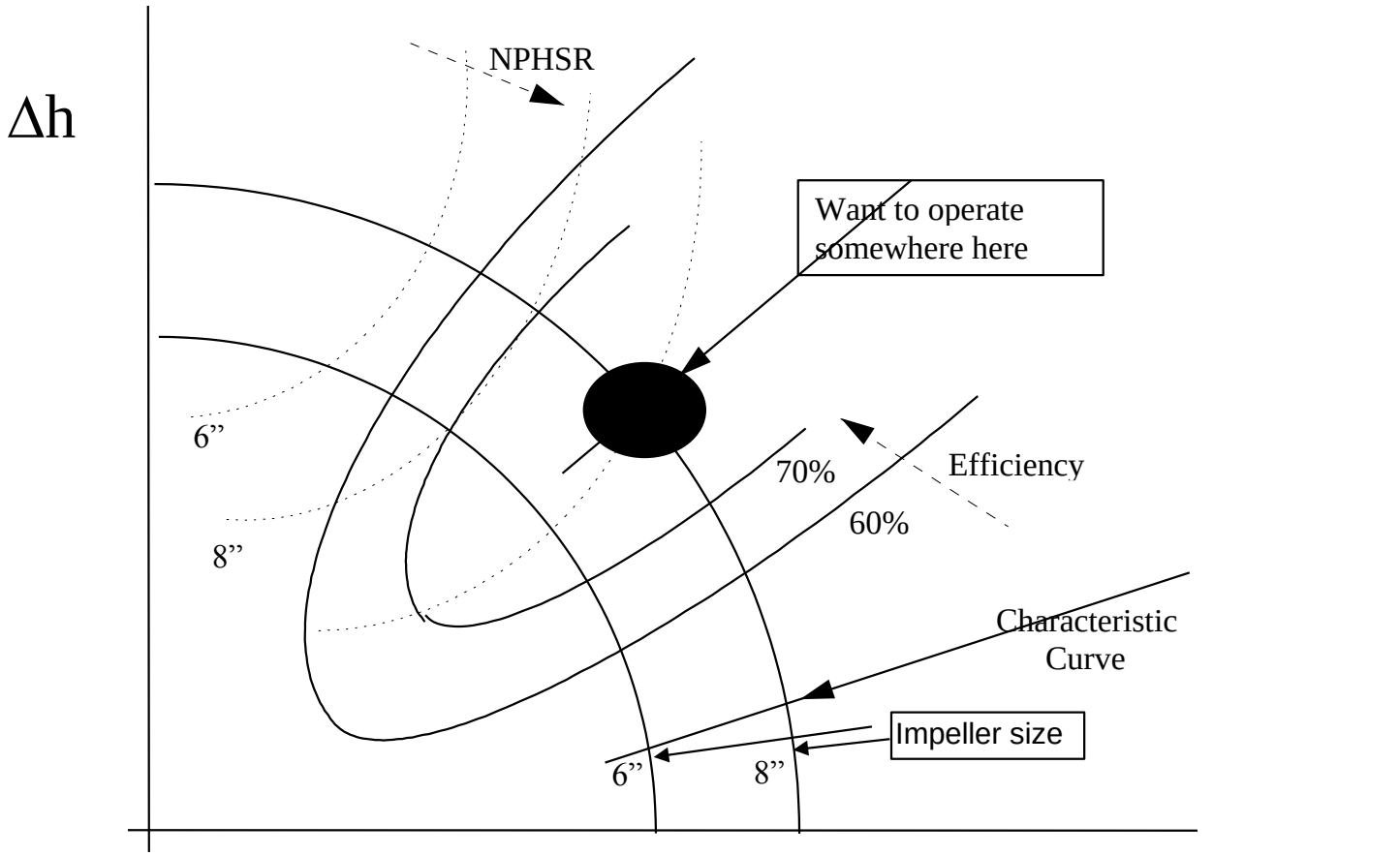
CHE 4253

Prof. Miguel Bagajewicz

Control Valve Sizing

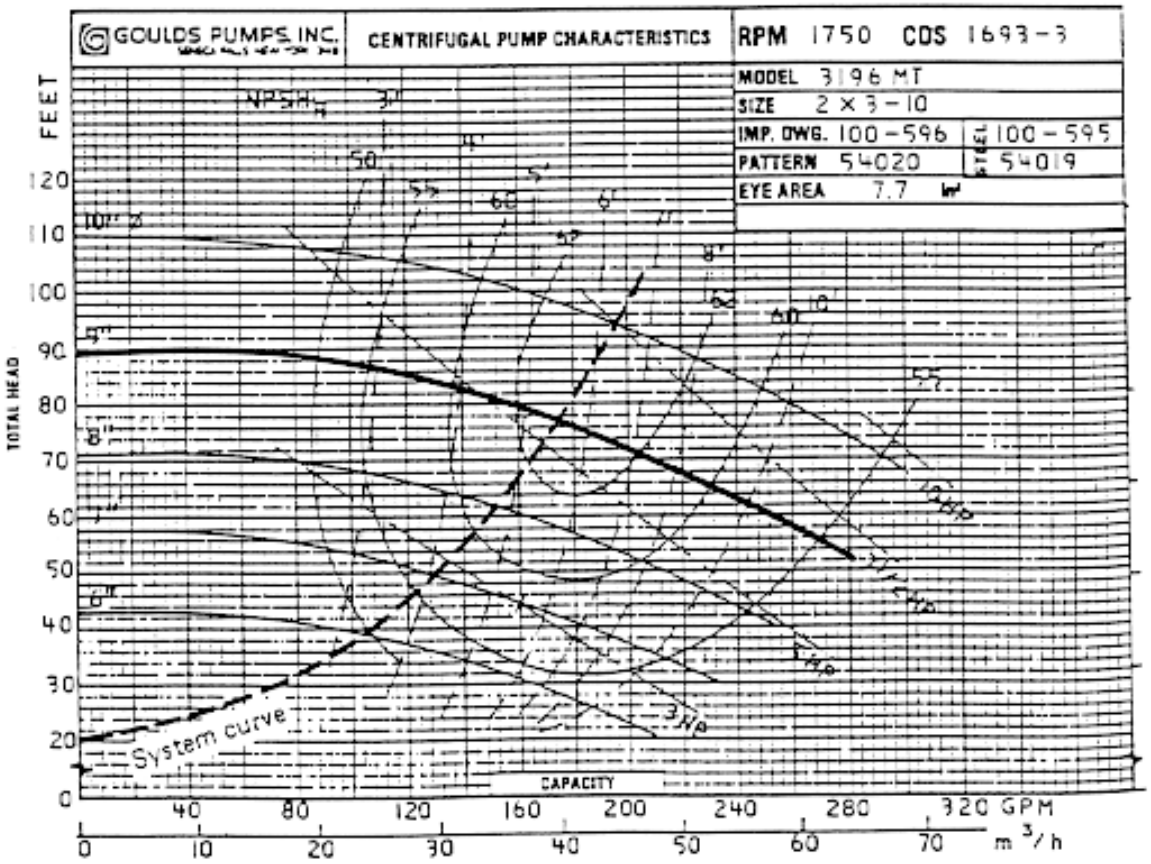
Fluid Flow - Pumps

Centrifugal Pump Performance Curves

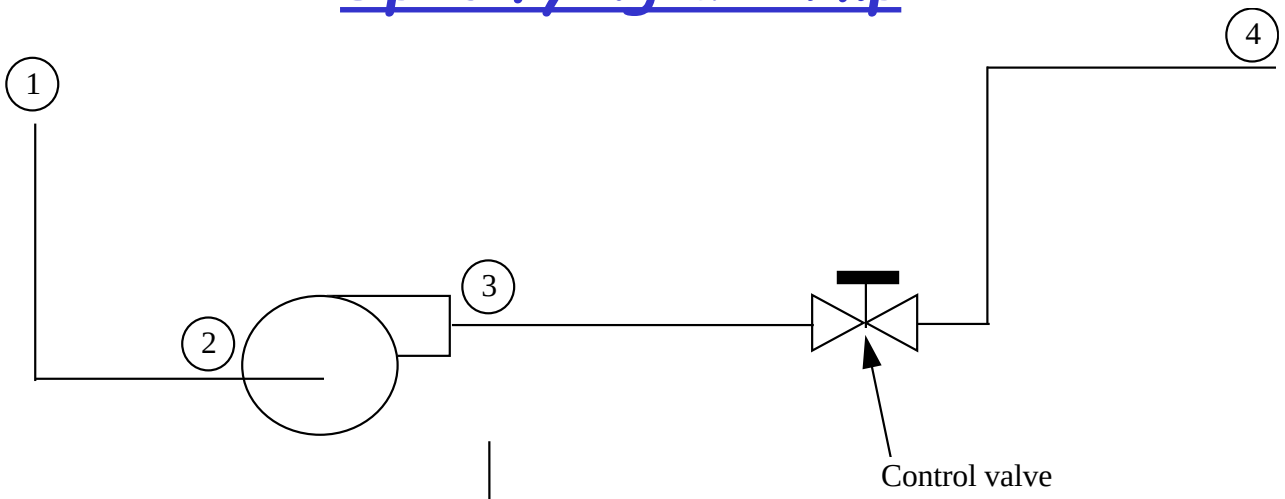


Specifying a Pump

Parameters you can control when selecting the pump: impeller diameter, speed (not very common), the model
Things to look for: Maximum efficiency, NPSHA > NPSHR

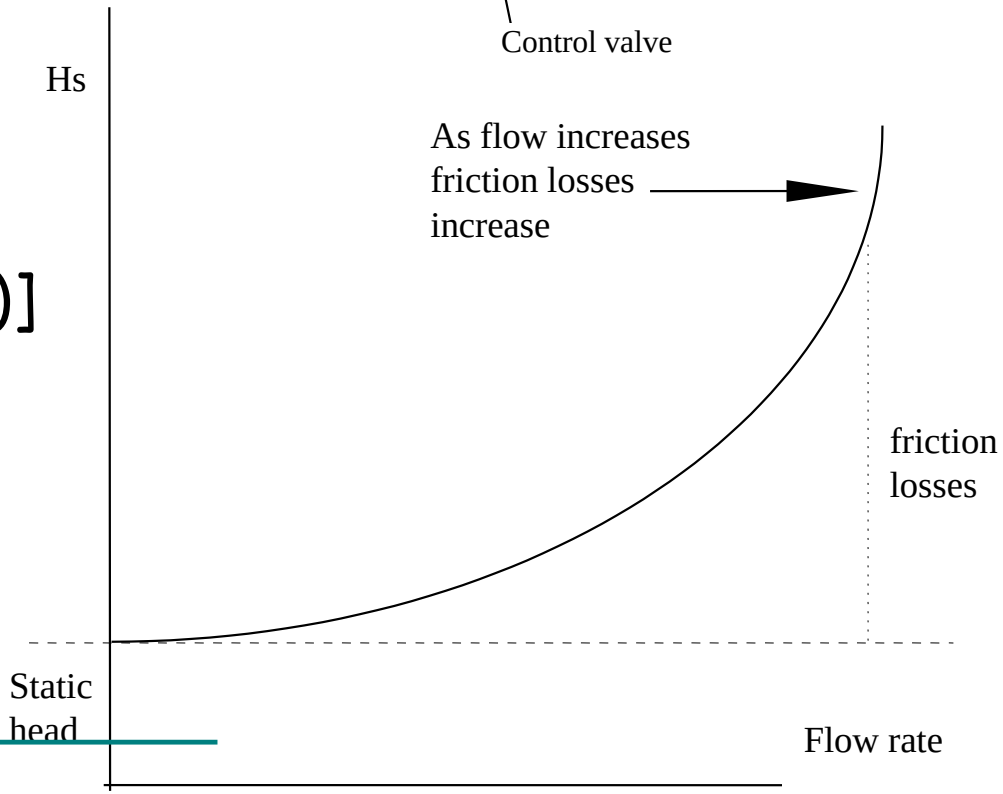


Specifying a Pump

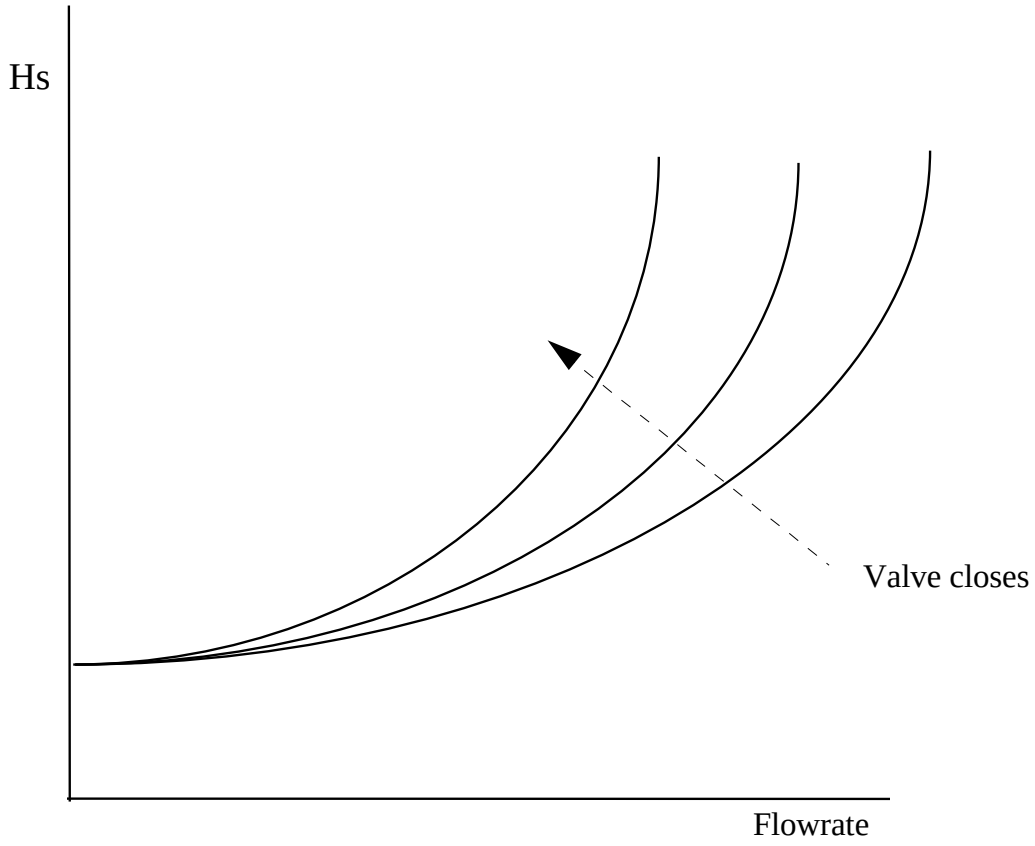


Need to calculate:
System head
$H_S = -[(P_4-P_3)+(P_2-P_1)]$
Pump head: Hp

But: **Hp = Hs**



Specifying a Pump



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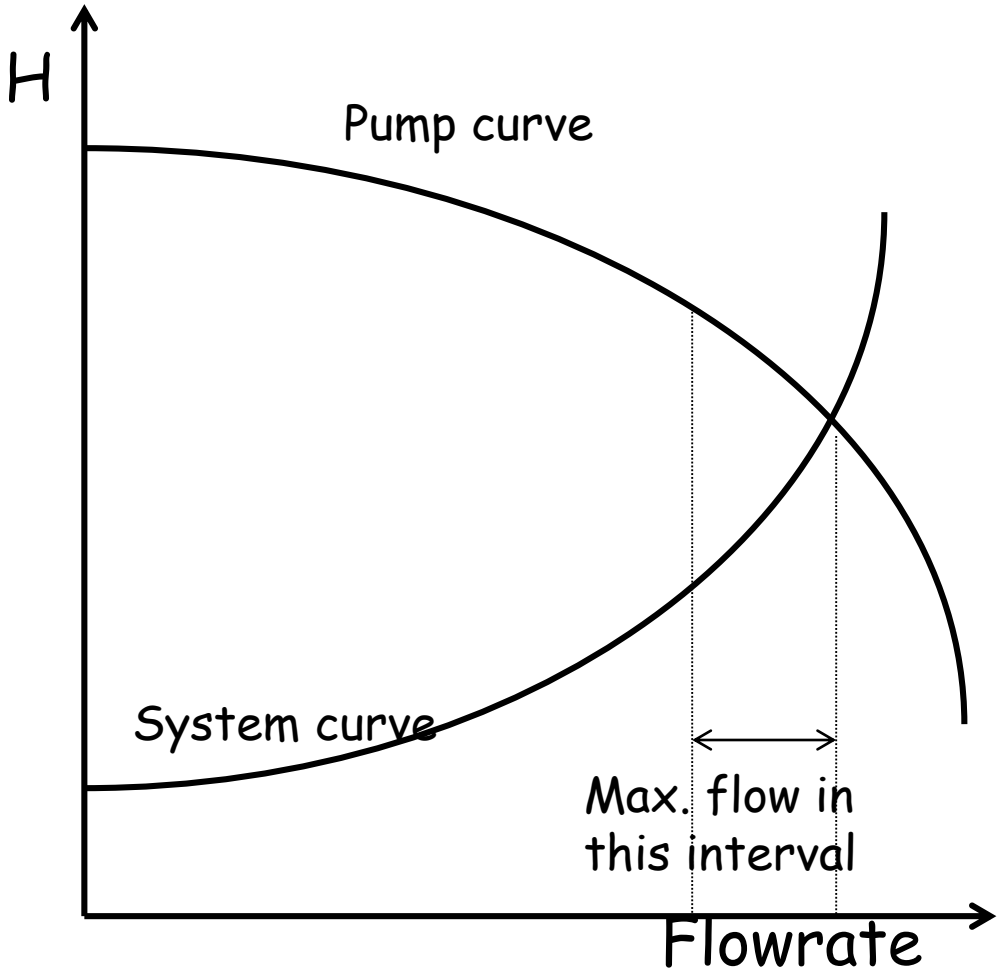
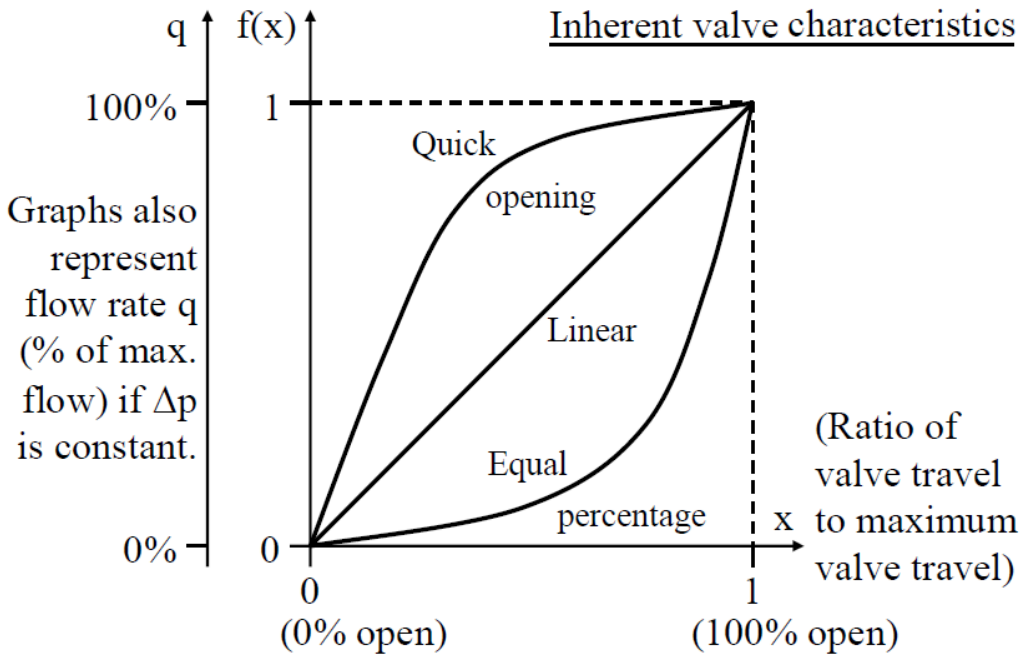
Specifying a Pump

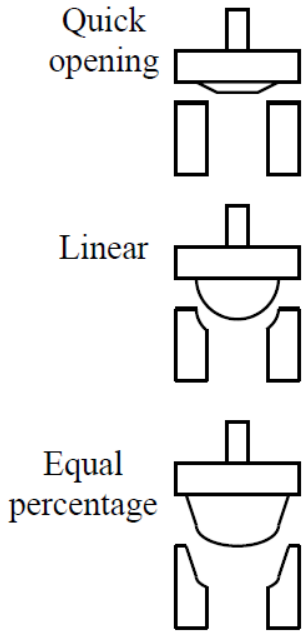


Since Hs = Hp , pick the Hs curve close to 80% open, at maximum flow

CONTROL VALVES

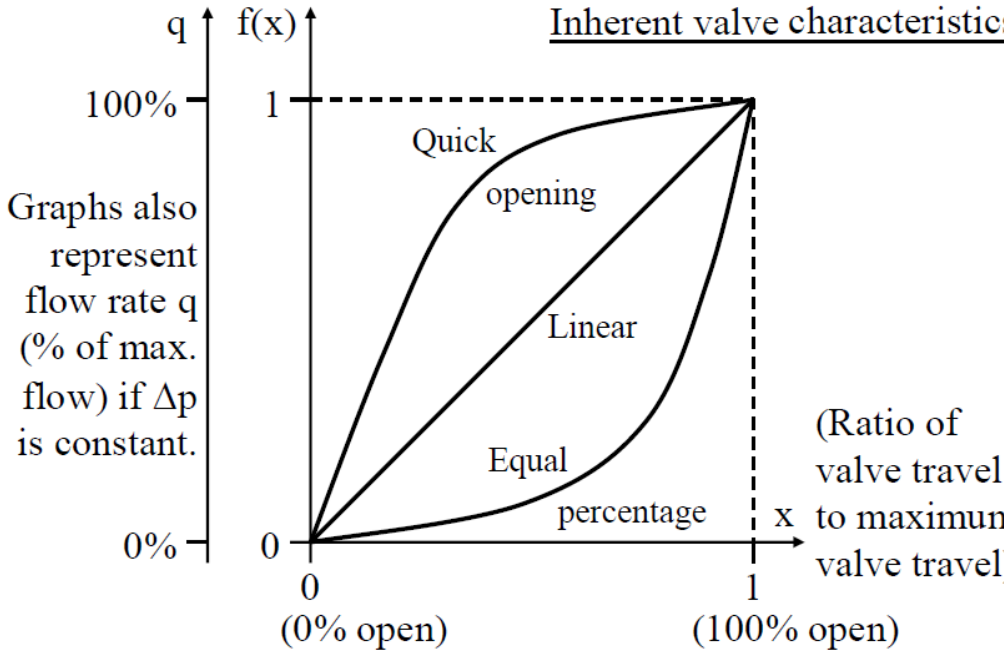
Inherent Flow Characteristics

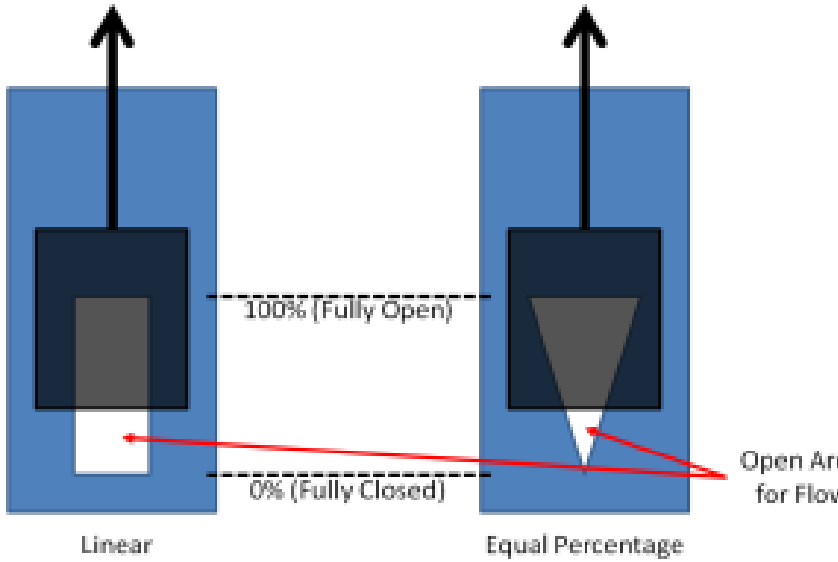




CONTROL VALVES

Inherent Flow Characteristics





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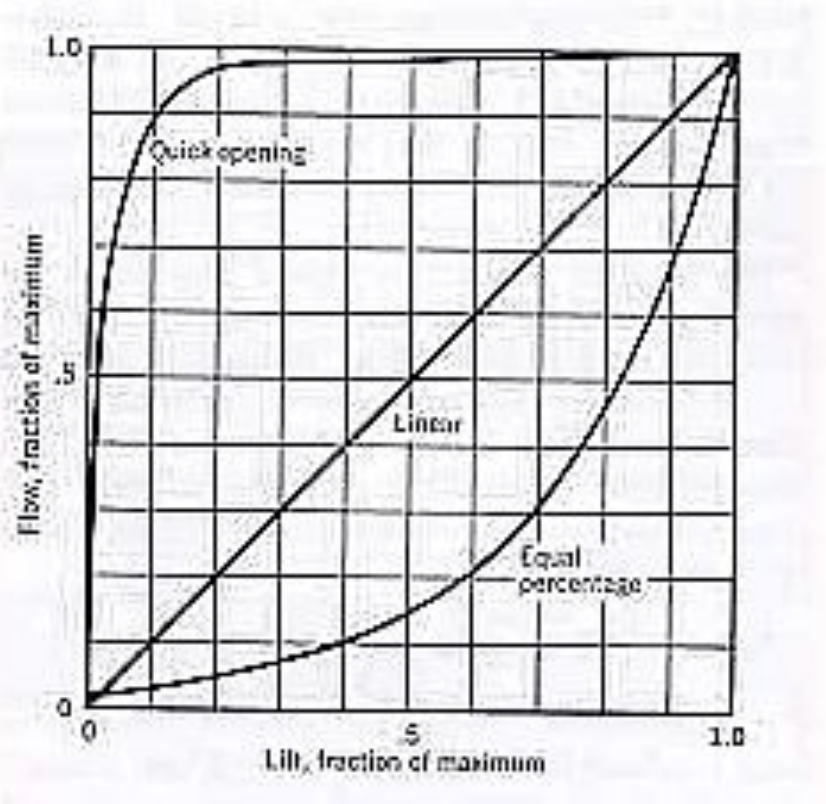
Inherent Flow Characteristics



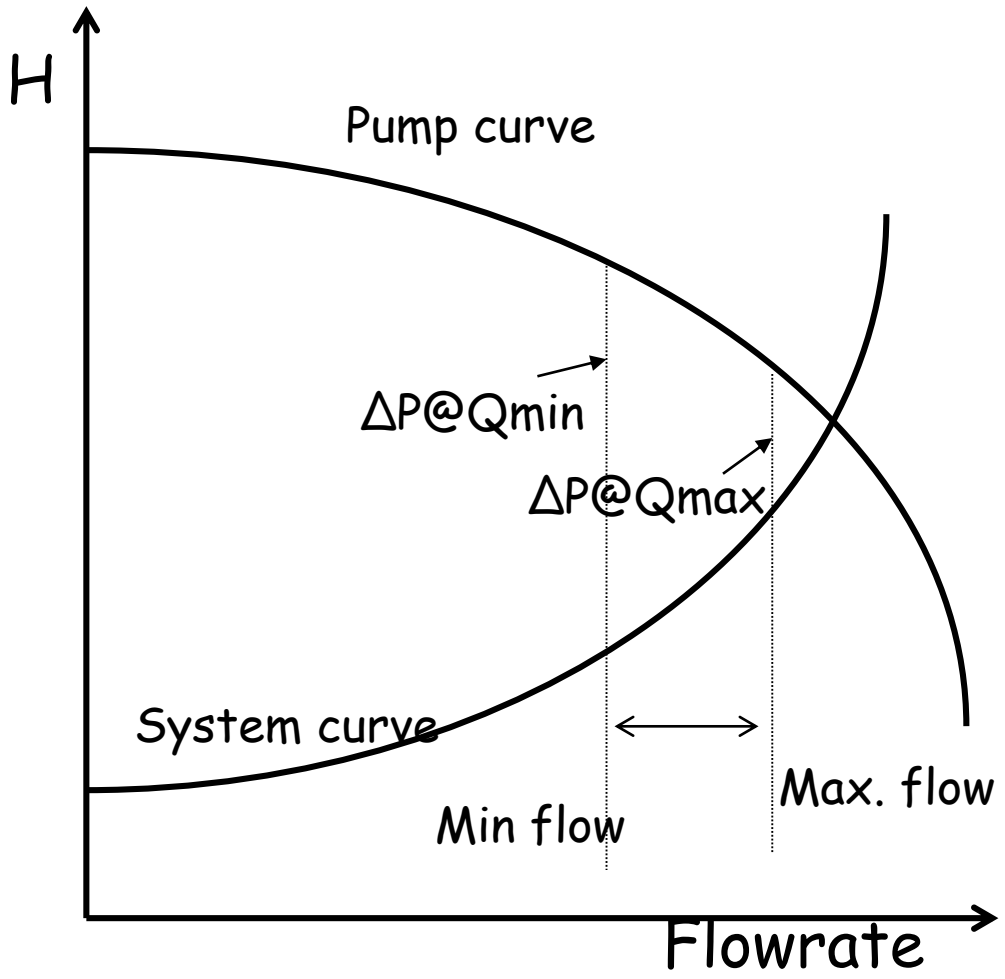
$Cv = Q(gpm)/Sqrt(\Delta P)$

Inherent Cv for each valve size (1", 2", …)

$Cvalve = Q/Sqrt(\Delta P = 1psi)$

$Cvalve/Qmax = exp(a[x-1])$

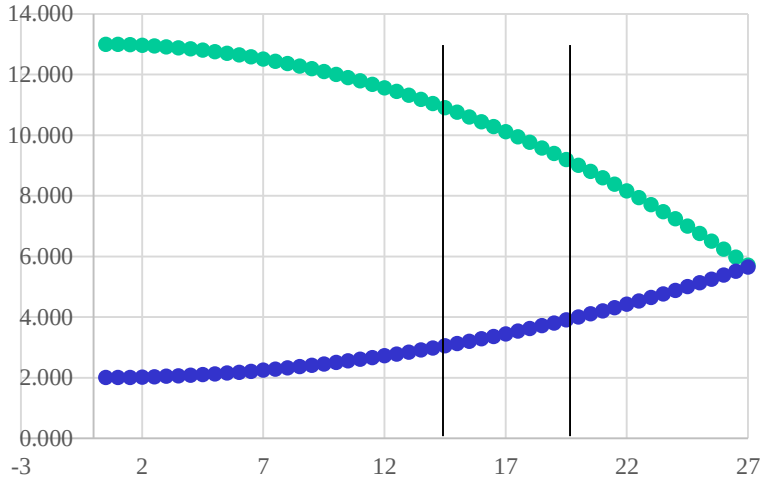
Specifying a Pump



Cv=Qmax/sqrt(ΔP@Qmax)

Control Valve Selection

Q	ΔP pump	ΔP sys	ΔPv	x
15	10.750	3.125	7.625	
15.5	10.598	3.201	7.396	
16	10.440	3.280	7.160	0.753936
16.5	10.278	3.361	6.916	0.765959
17	10.110	3.445	6.665	0.778047
17.5	9.938	3.531	6.406	0.790244
18	9.760	3.620	6.140	0.802593
18.5	9.578	3.711	5.866	0.815144
19	9.390	3.805	5.585	0.827952
19.5	9.198	3.901	5.296	0.841082
20	9.000	4.000	5.000	0.854606
20.5	8.798	4.101	4.696	0.868614
21	8.590	4.205	4.385	0.88321
21.5	8.378	4.311	4.066	0.898526
22	8.160	4.420	3.740	0.914728
22.5	7.938	4.531	3.406	0.93203
23	7.710	4.645	3.065	0.95072
23.5	7.478	4.761	2.716	0.971196
24	7.240	4.880	2.360	0.994034
24.5	6.998	5.001	1.996	
25	6.750	5.125	1.625	



Qmin=16 Qmax=22

Calculate Cv:

85% of Cv @ Qmax_calc=1.15*22

Cvmax=0.85*25/Sqrt(1.625)=16.66

Search for a valve of the calculated Cv (16.66).

Cv Valve found = 16

Typical Cv values (Globe valves)

Size	1/4	3/8	1/2	3/4	1	1.25	1.5	2
Cv	0.9	1.5	3.2	5.8	11.5	15.2	20.9	38.3

Control Valve Selection

Q	ΔP pump	ΔP sys	ΔPv	x
15	10.750	3.125	7.625	
15.5	10.598	3.201	7.396	
16	10.440	3.280	7.160	0.743831
16.5	10.278	3.361	6.916	0.755853
17	10.110	3.445	6.665	0.767942
17.5	9.938	3.531	6.406	0.780138
18	9.760	3.620	6.140	0.792487
18.5	9.578	3.711	5.866	0.805038
19	9.390	3.805	5.585	0.817847
19.5	9.198	3.901	5.296	0.830976
20	9.000	4.000	5.000	0.844501
20.5	8.798	4.101	4.696	0.858508
21	8.590	4.205	4.385	0.873104
21.5	8.378	4.311	4.066	0.88842
22	8.160	4.420	3.740	0.904622
22.5	7.938	4.531	3.406	0.921925
23	7.710	4.645	3.065	0.940615
23.5	7.478	4.761	2.716	0.961091
24	7.240	4.880	2.360	0.983928
24.5	6.998	5.001	1.996	
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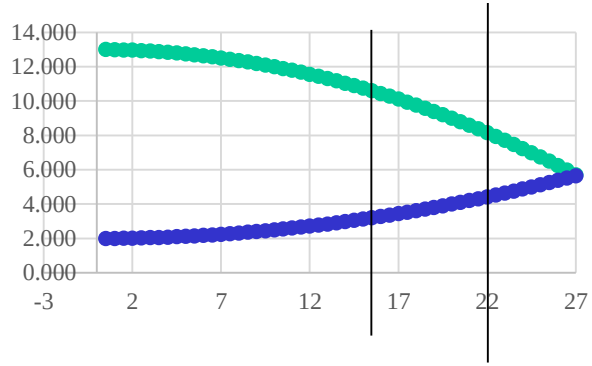
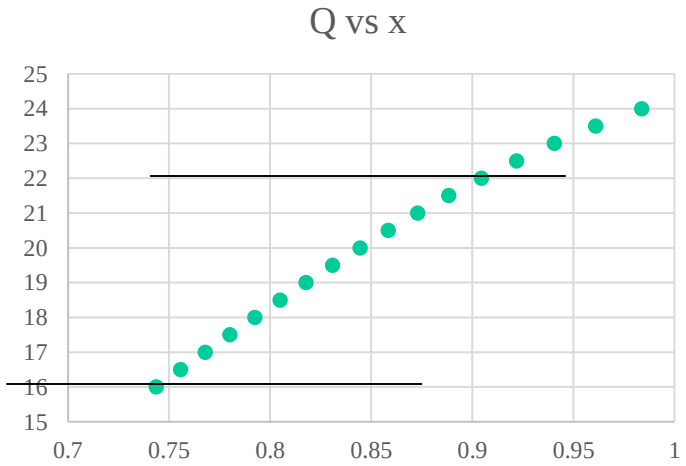


Qmin=16 Qmax=22

Cvalve=16

$x=1+\ln(Q/[\sqrt{(\Delta Pv)}*Cvalve])/a$



Control Valve Selection

Q	ΔP pump	ΔP sys	ΔPv	x
15	10.750	3.125	7.625	
15.5	10.598	3.201	7.396	
16	10.440	3.280	7.160	0.743831
16.5	10.278	3.361	6.916	0.755853
17	10.110	3.445	6.665	0.767942
17.5	9.938	3.531	6.406	0.780138
18	9.760	3.620	6.140	0.792487
18.5	9.578	3.711	5.866	0.805038
19	9.390	3.805	5.585	0.817847
19.5	9.198	3.901	5.296	0.830976
20	9.000	4.000	5.000	0.844501
20.5	8.798	4.101	4.696	0.858508
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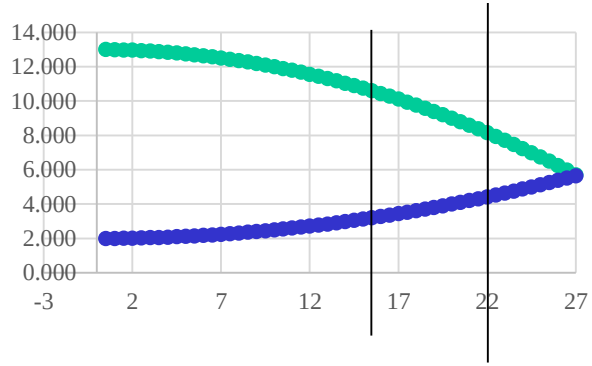

Qmin=16 Qmax=22

Recipe:

1) Cvalve=0.85*Qmax*1.15/ sqrt(ΔP@1.15Qmax)

2) Calculate x @ Qmin, Qmax and (Qmin+Qmax)/2 (x=1+ln(Q/[sqrt(ΔPv)*Cvalve])/a)

3) Verify linearity