Incorporating VSDs into Company Policy

IAC Lead Student Meeting

Kurt Hodges

TTU Lead Student

October 11, 2011

Schneider of Smyrna, TN

- Previously updated compressed air and lighting
- Installed demand shedding building automation system
- Seeking ISO 50001 certification
- Save Energy Now Leader
- Finished installation of 1MW Solar Field in July 2011
- Schneider's "Flagship" for energy efficiency

IAC Assessment

Assessment Date:
Sept. 27, 2010

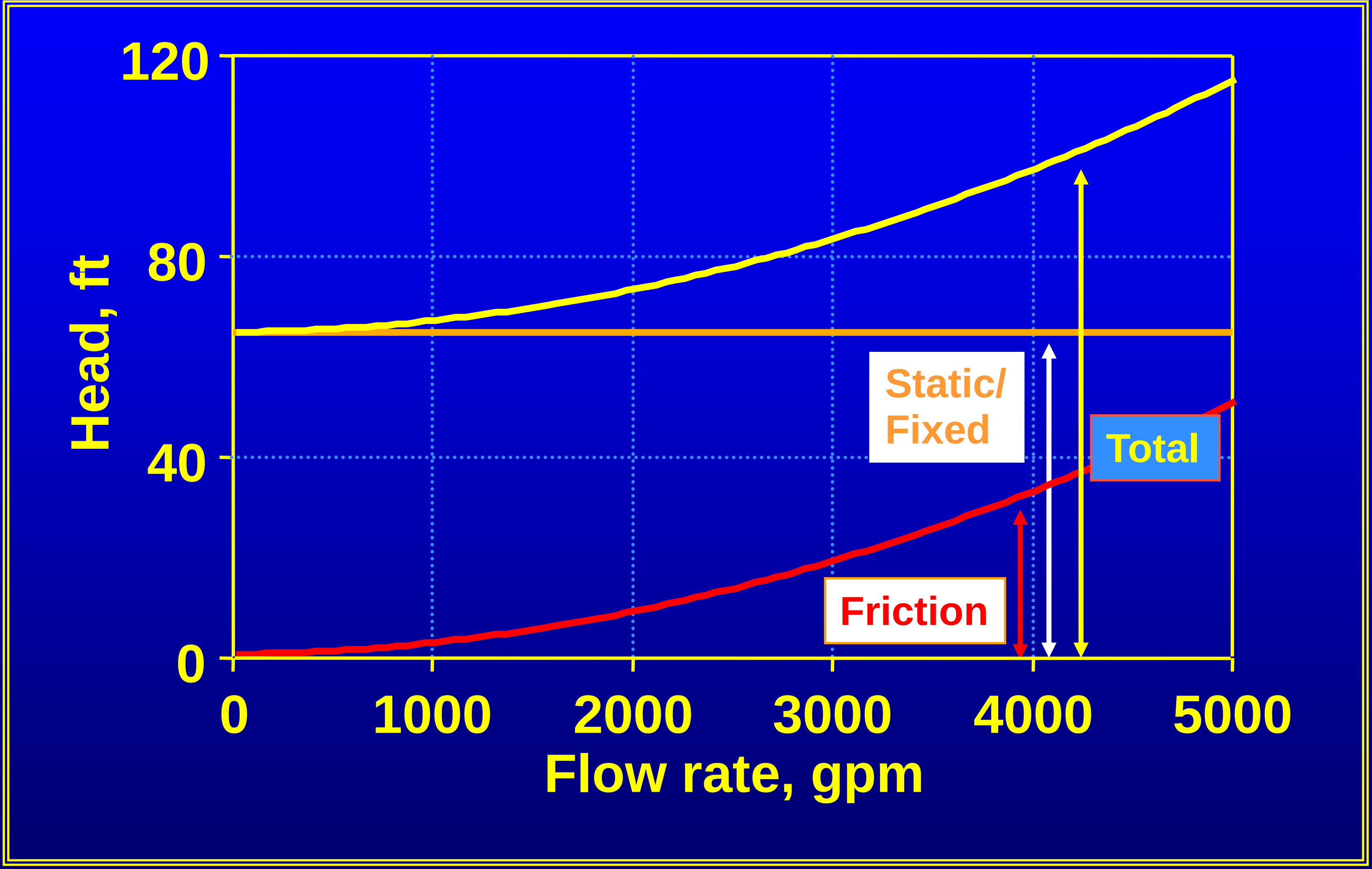
Led by Director, Dr. Glenn Cunningham, Assistant Director, Dr. Kenneth Currie, and Lead Student, Kurt Hodges

Other Students:
Anthony Griffith
Aditya Jayanthi
Seth Leedy

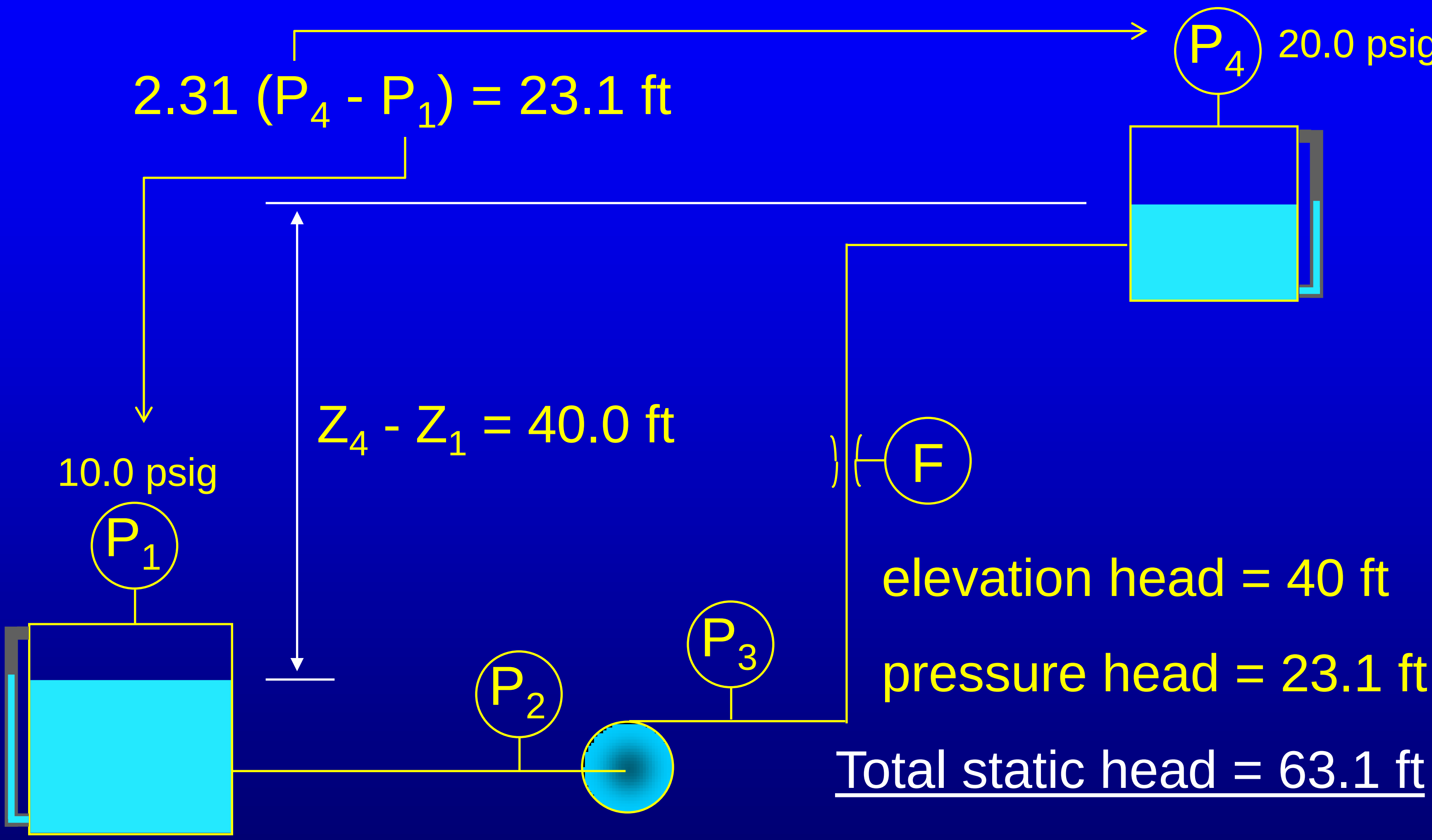
7 Parts Washer Pumps with Throttled Discharge

Butterfly Valve 35% to 40 % Open on Pump Discharge

System curves are made up of two fundamental components - the static head and the frictional head



Estimating the static head for a system

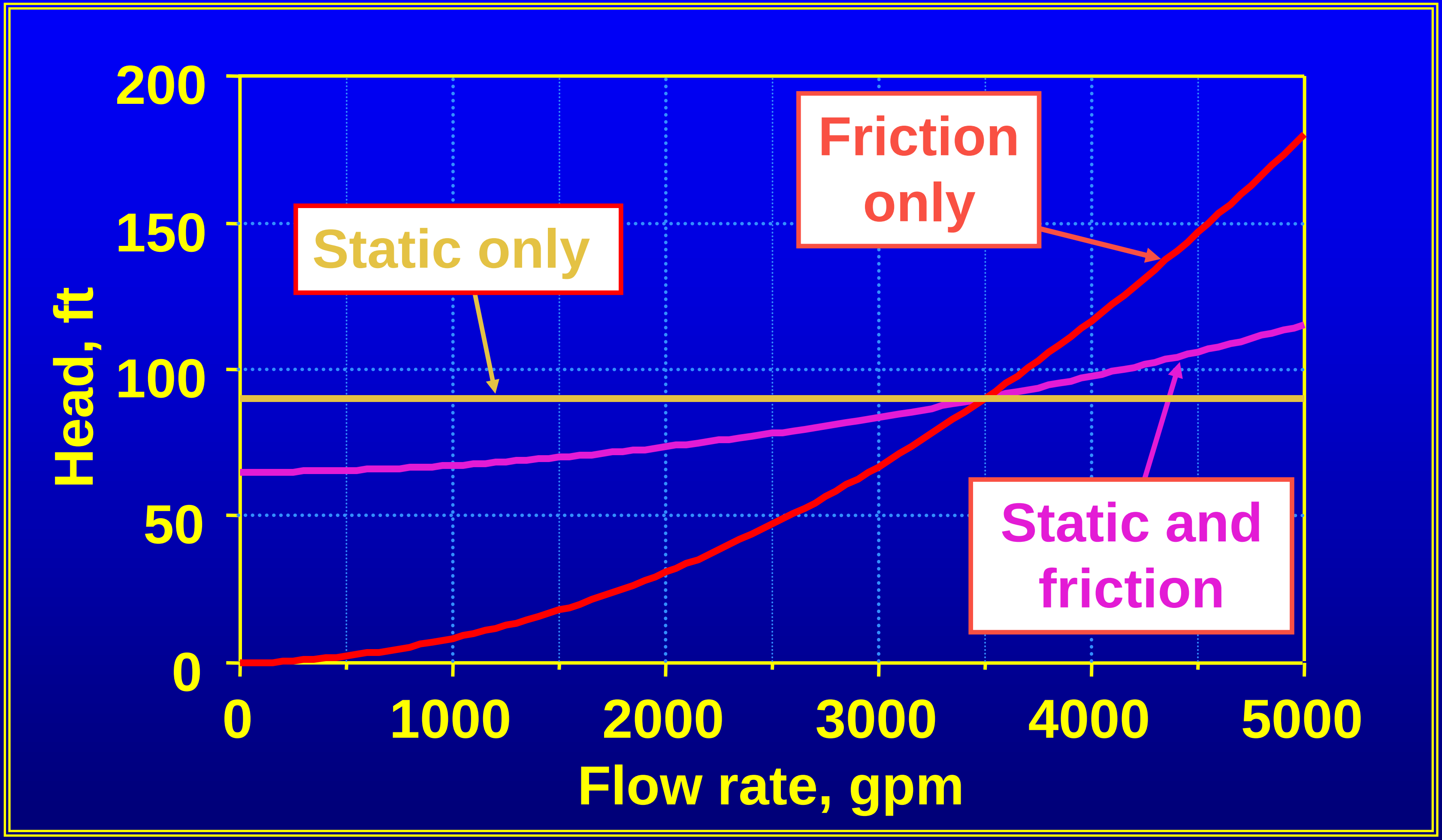


elevation head = 40 ft

pressure head = 23.1 ft

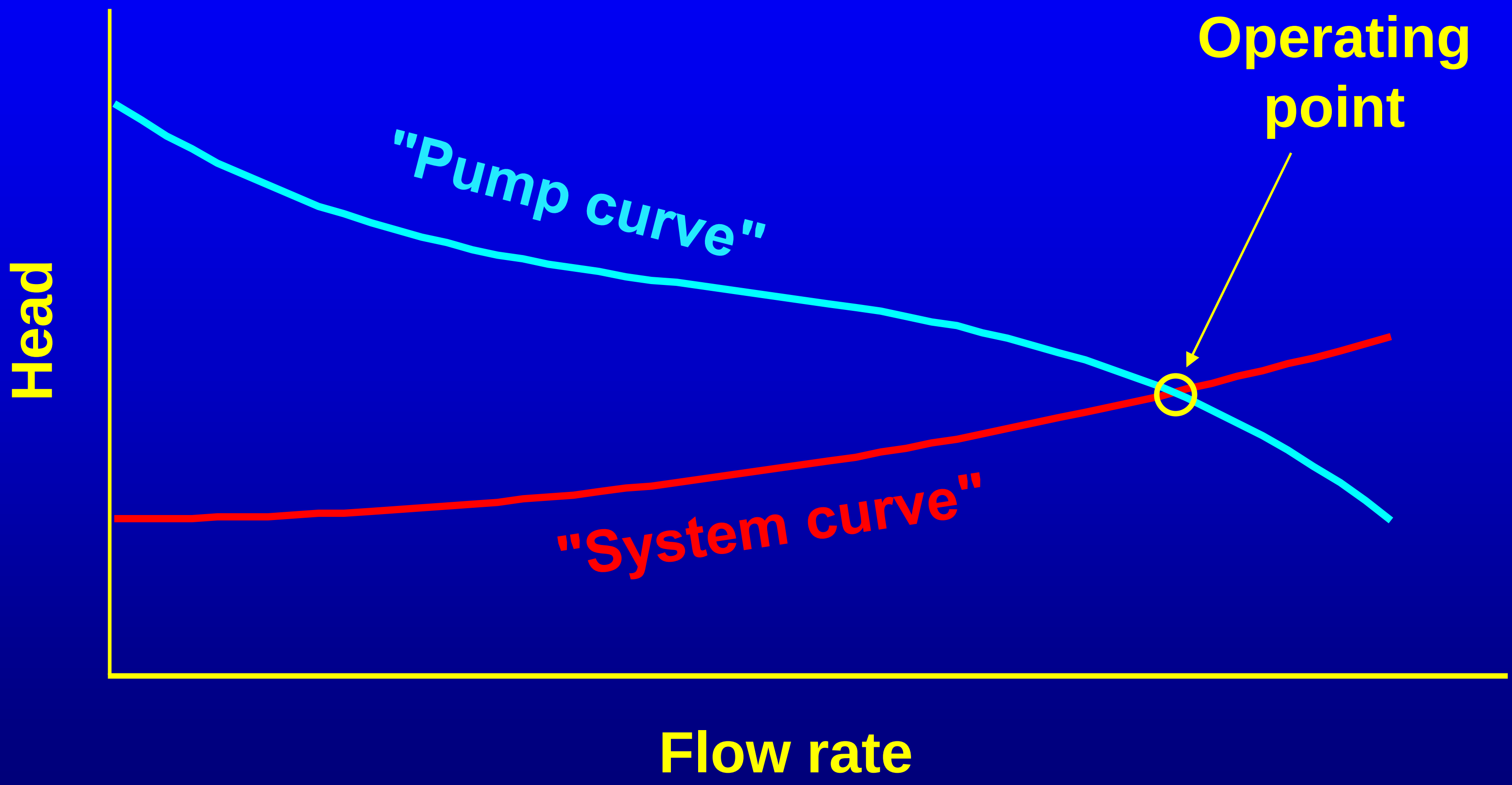
<u>Total static head = 63.1 ft</u>

System head curves for all frictional, all static, and combined static and frictional systems

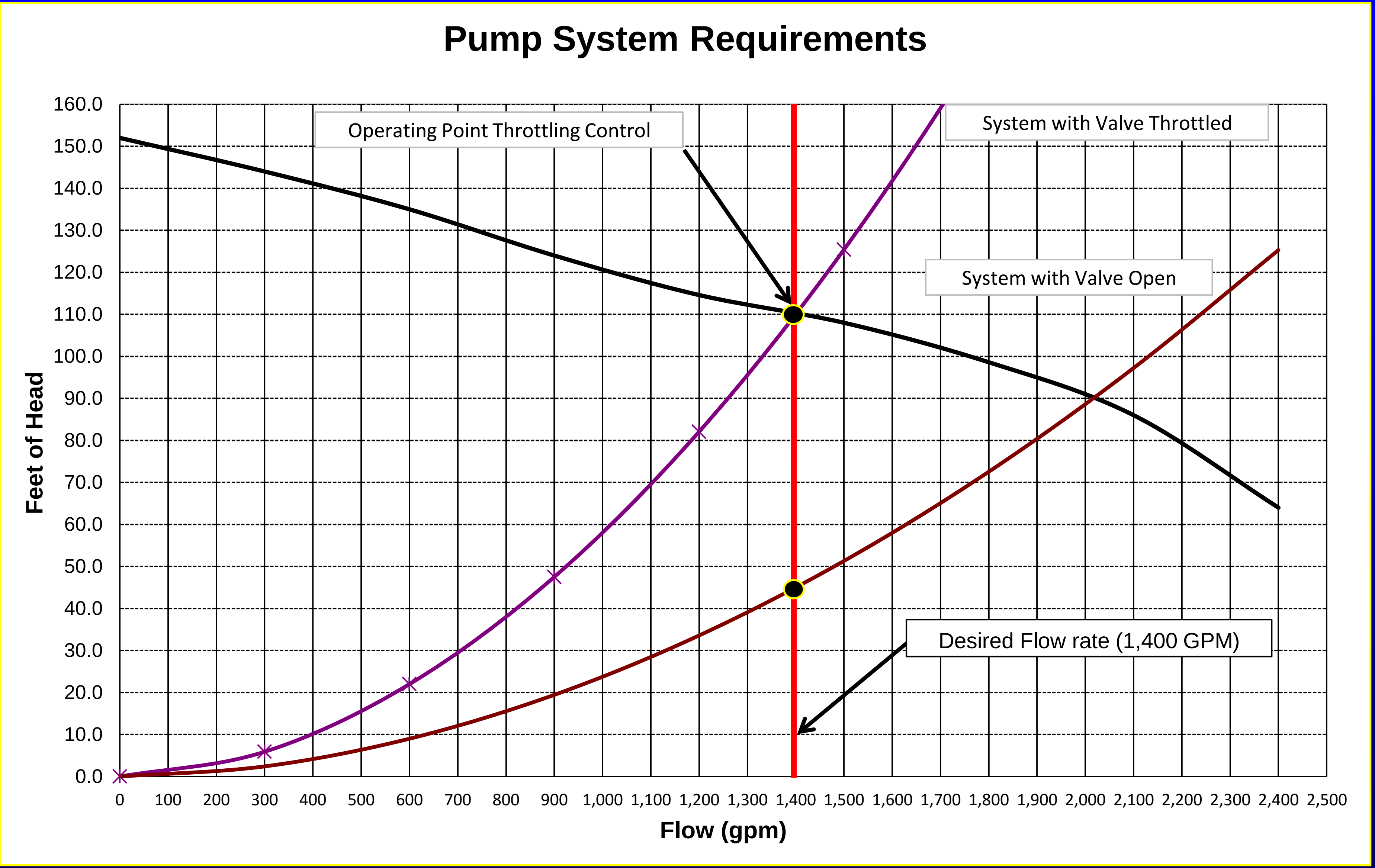


NOTE: These are three <u>different</u> systems

The system operating point is at the intersection of the pump and system head-capacity curves



Affect of Throttling Valve



Pump Horsepower Calculation

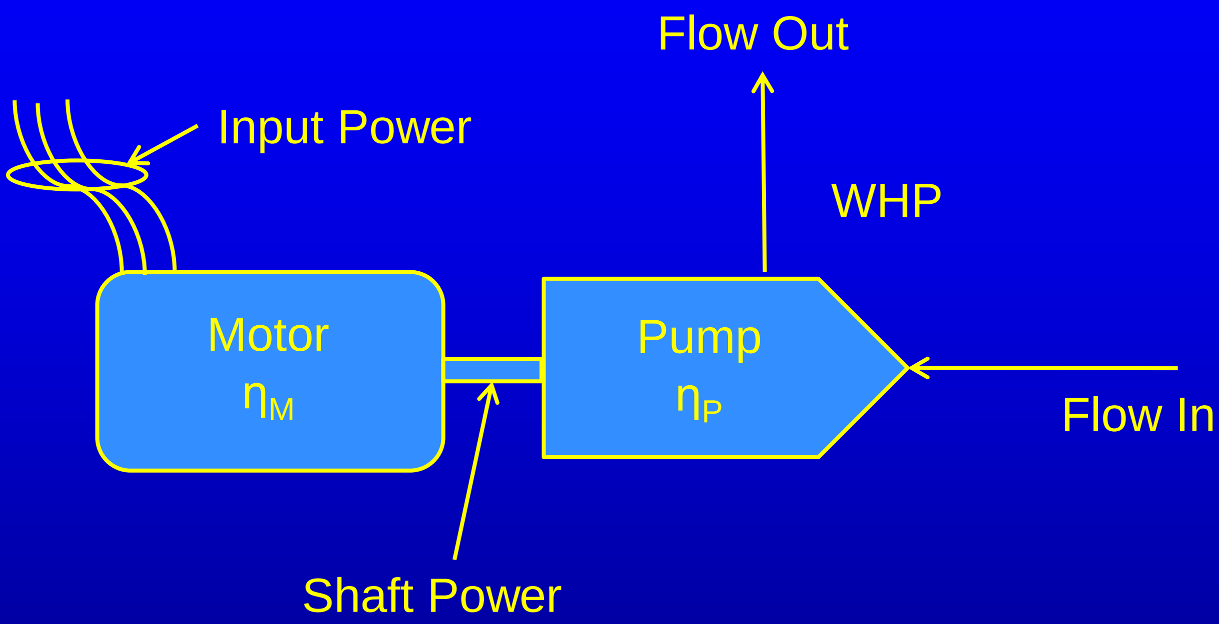
$$\text{Input Power (HP)} = (\text{WHP})/(\eta_M * \eta_P)$$

$$\text{WHP} = \frac{\text{Flow (GPM)} * \text{Head (Ft)} * \text{(S.G.)}}{3960}$$

η_M = motor efficiency and η_P = pump efficiency

S.G. = Specific Gravity (normally assumed as 1 for water)

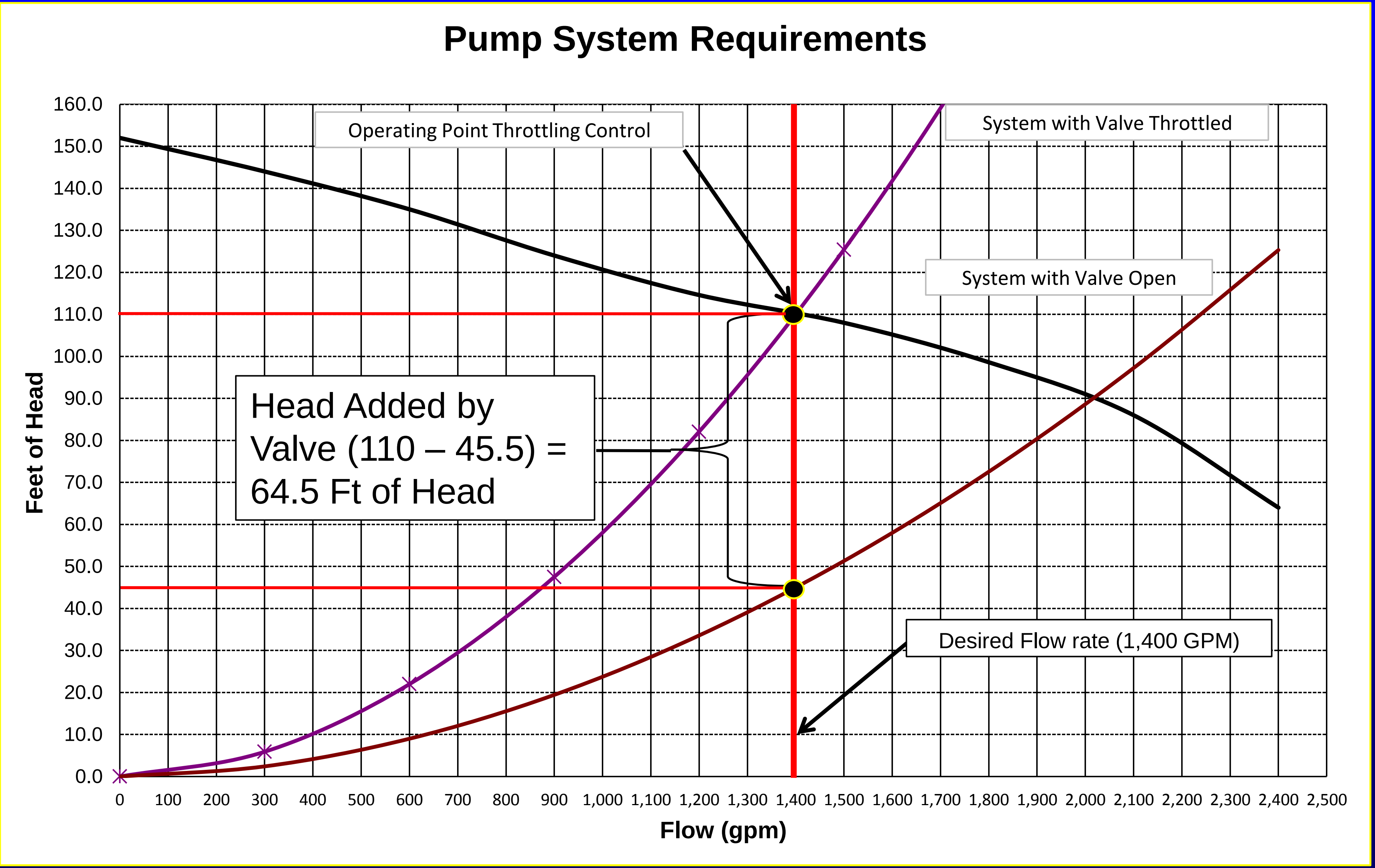
Pumping Power Diagram



Shaft Power = Input Power * (η_M)

WHP = Shaft Power * (η_P)

Affect of Throttling Valve



Pump Horsepower Calculation

Consider the preceding graph:

Assume: $\eta_M = 0.9$ and $\eta_P = 0.75$

Throttled Pump:

$$\text{Electric Consumption} = \frac{1400 * 110}{3960(0.9)(0.75)} = 57.61 \text{ HP} = 42.96 \text{ kW}$$

Slower Speed or Trimmed Impeller:

$$\text{Electric Consumption} = \frac{1400 * 45.5}{3960(0.9)(0.75)} = 23.83 \text{ HP} = 17.77 \text{ kW}$$

Throttle Valve Energy Waste = 33.78 HP or 25.19 kW

Pump affinity laws can be used to predict pump curves for different speeds and impeller diameters

<u>Speed</u>

$$\left(\frac{Q_1}{Q_2}\right) = \left(\frac{N_1}{N_2}\right)^1$$

$$\left(\frac{H_1}{H_2}\right) = \left(\frac{N_1}{N_2}\right)^2$$

$$\left(\frac{P_1}{P_2}\right) = \left(\frac{N_1}{N_2}\right)^3$$

<u>Diameter</u>

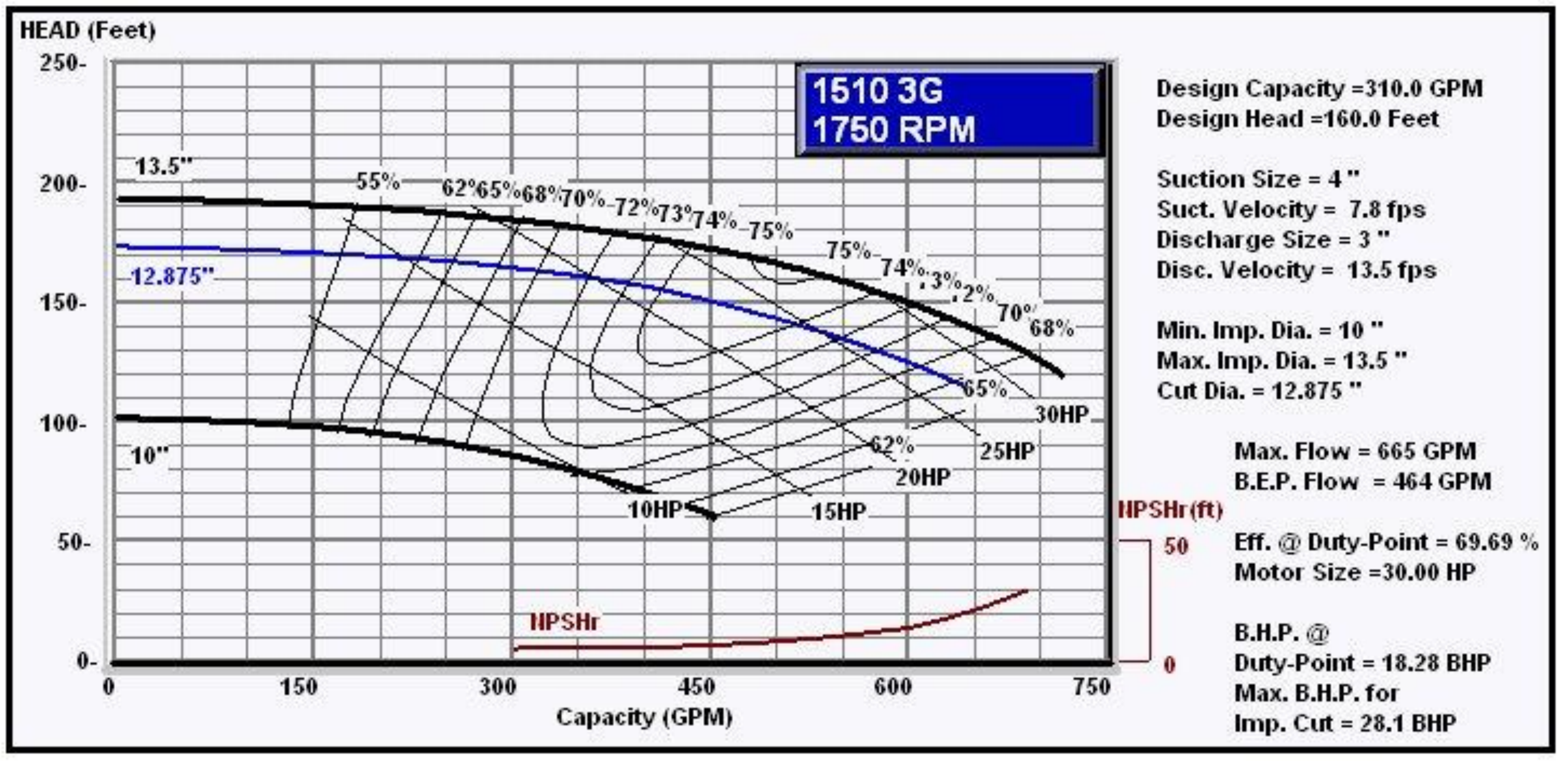
$$\left(\frac{Q_1}{Q_2}\right) = \left(\frac{D_1}{D_2}\right)^1$$

$$\left(\frac{H_1}{H_2}\right) = \left(\frac{D_1}{D_2}\right)^2$$

$$\left(\frac{P_1}{P_2}\right) = \left(\frac{D_1}{D_2}\right)^3$$

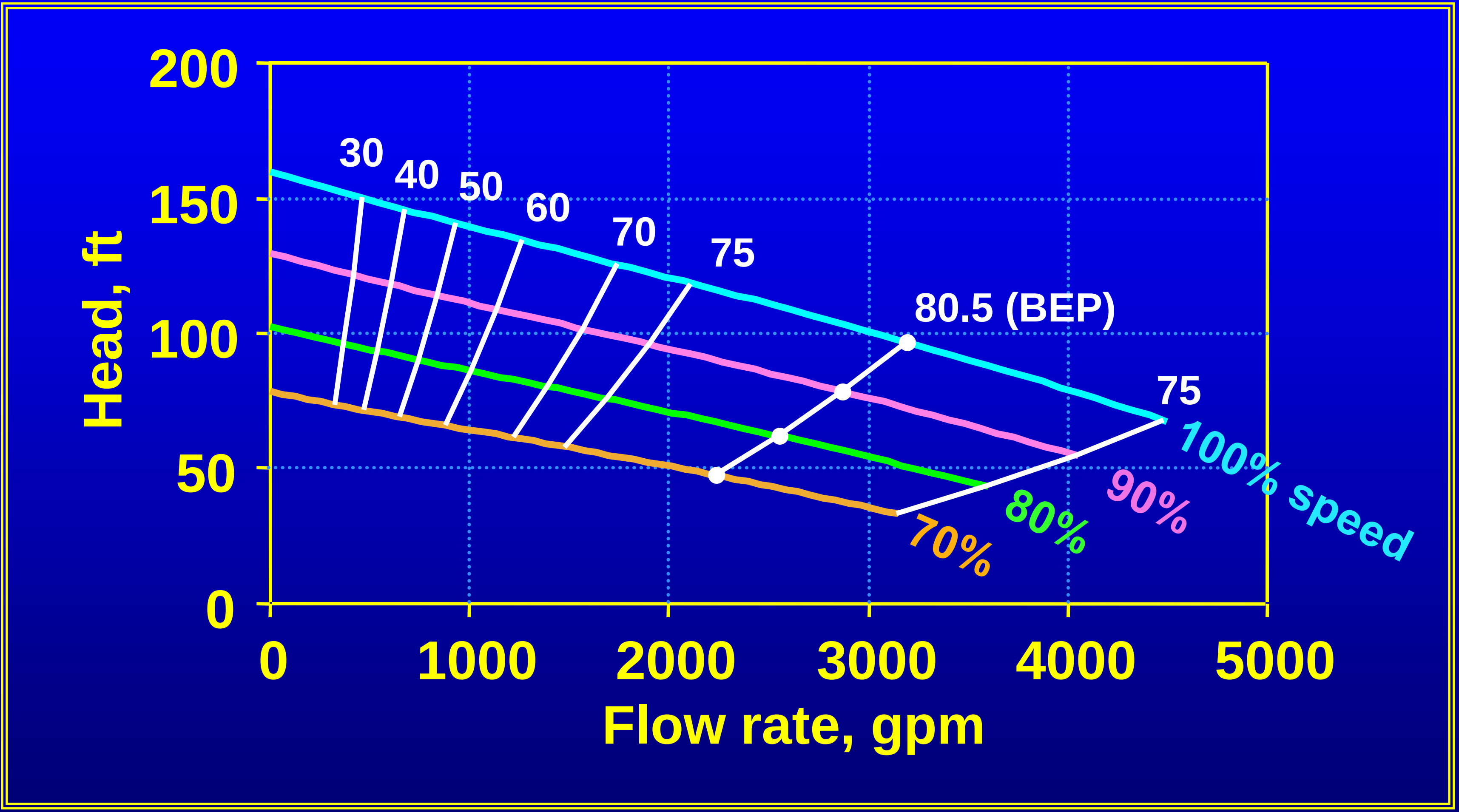
Q = flow rate   H = head   P = power   N = speed   D = diameter

The size of the Pump Curve decreases with smaller impellers



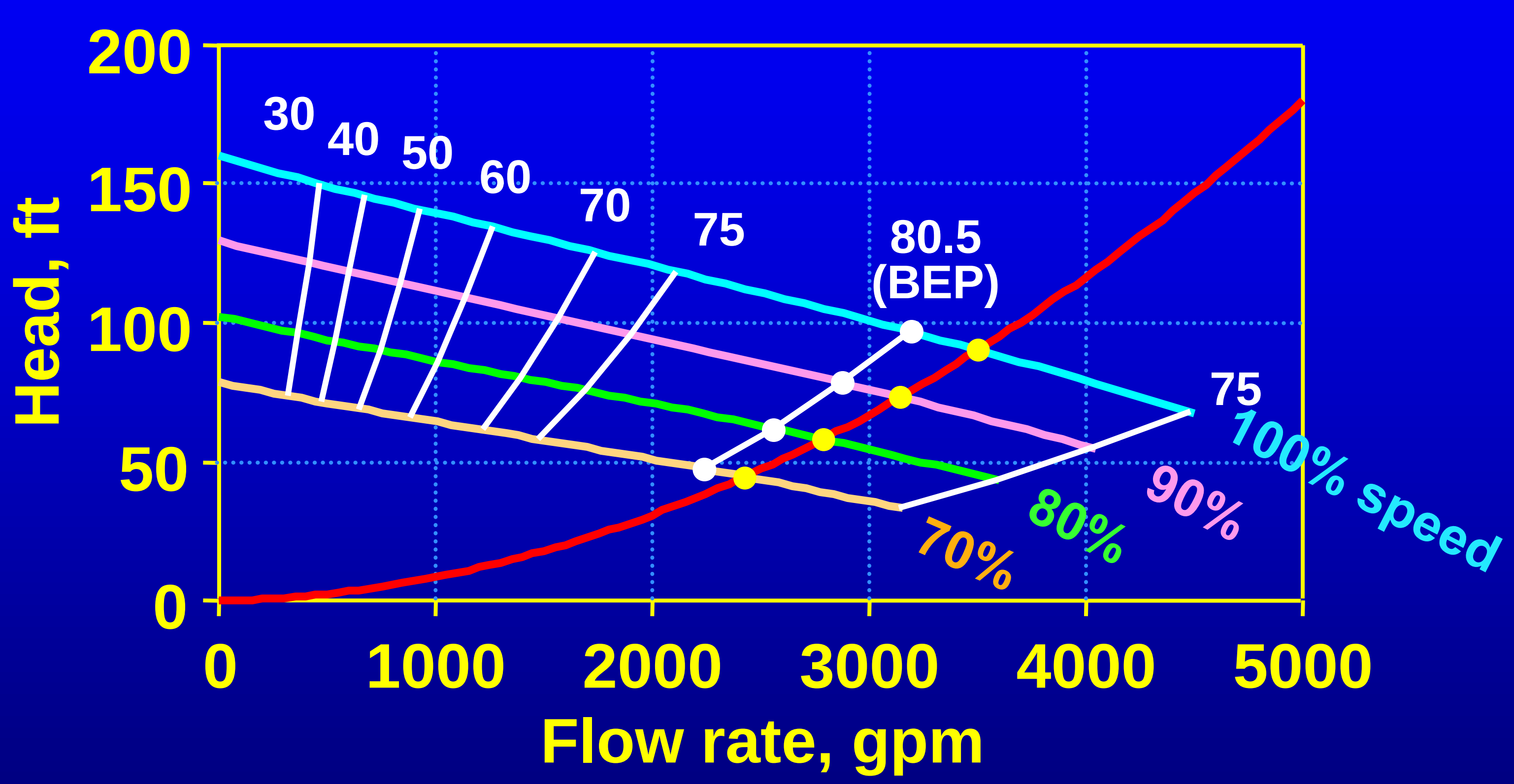
Variable speed drive performance characteristics

Speed is another matter - the affinity laws generally hold up very well with speed changes

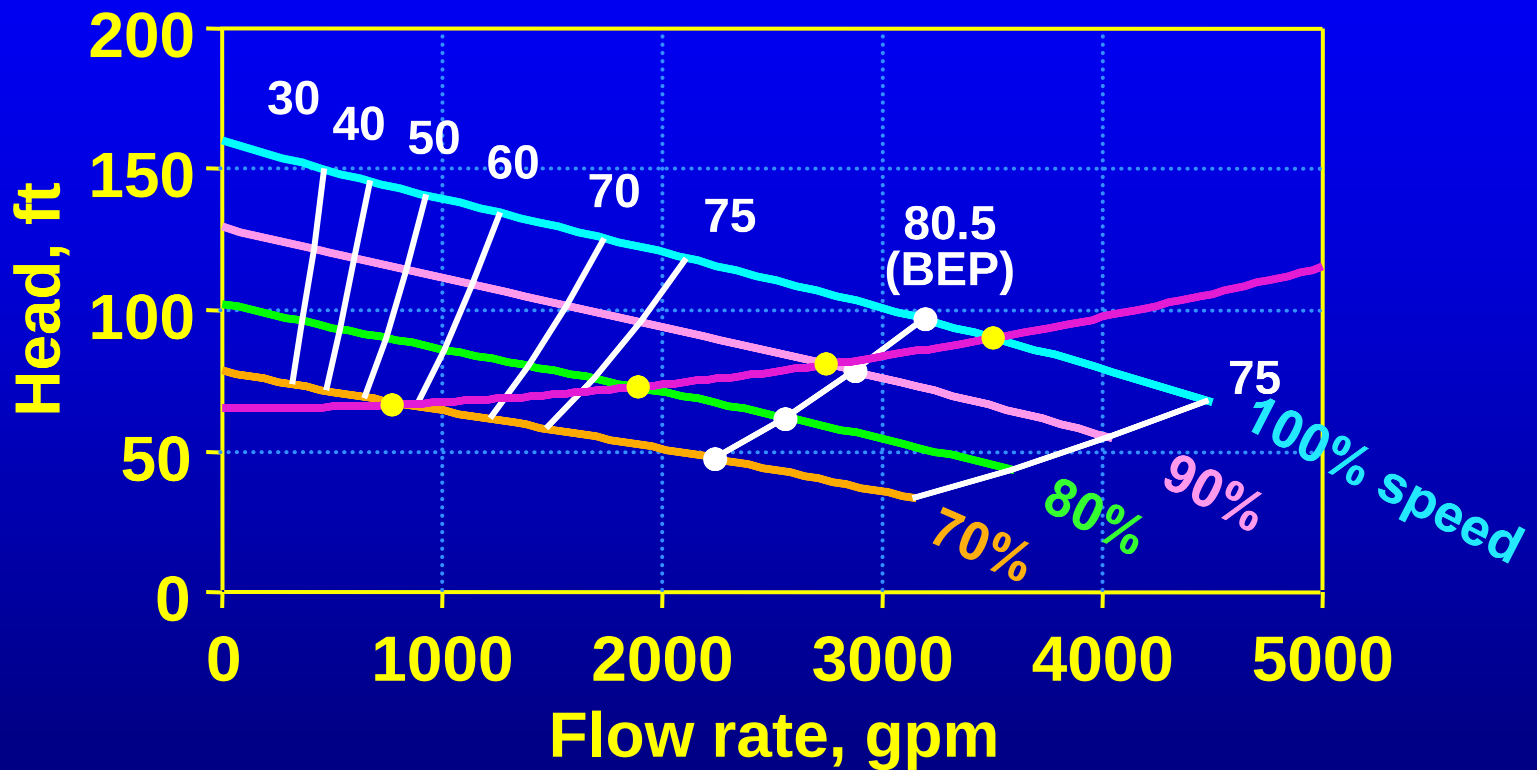


What happens if we reduce pump speed in the three systems types mentioned earlier?

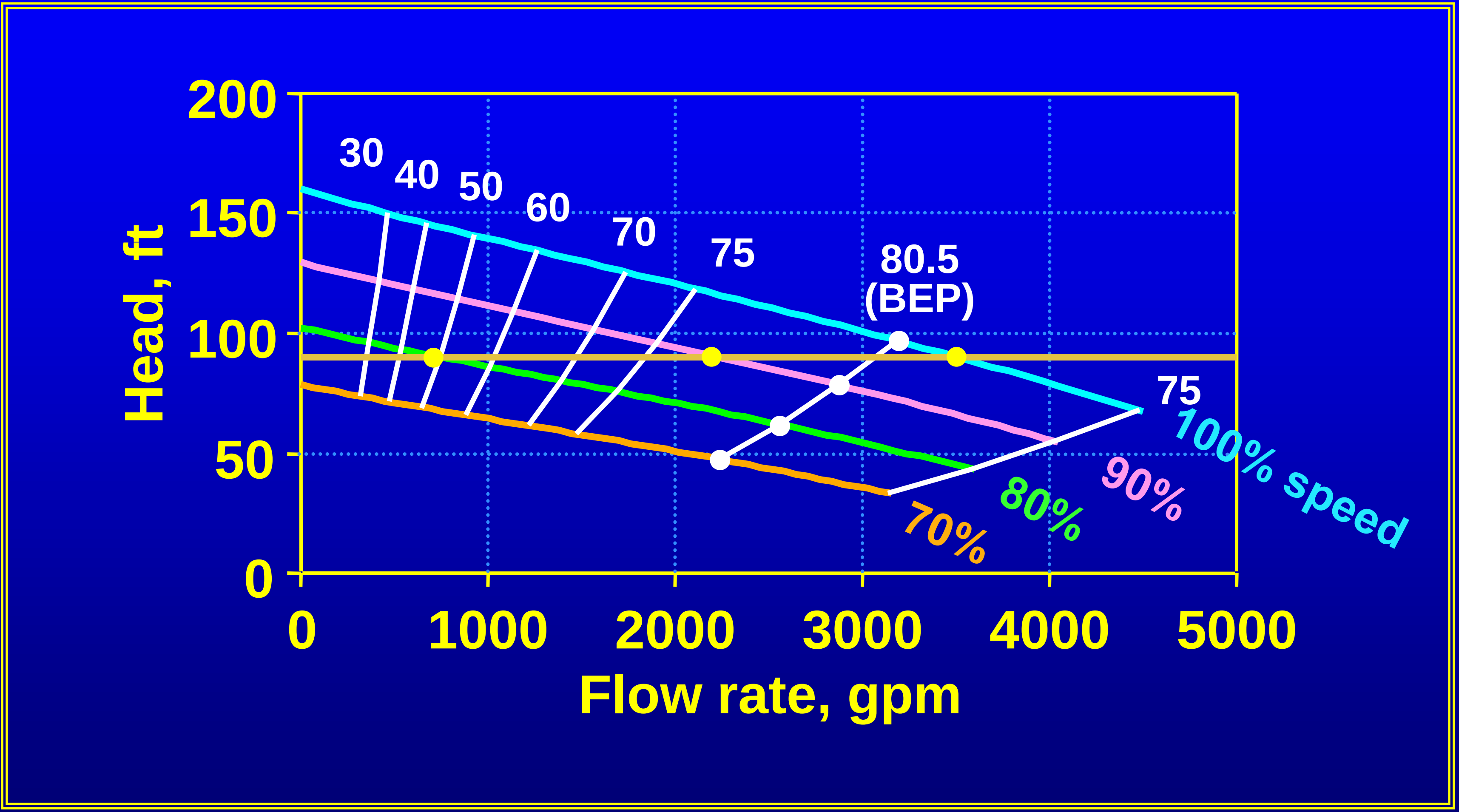
Change in speed for the all frictional system results in maintenance of constant pump efficiency



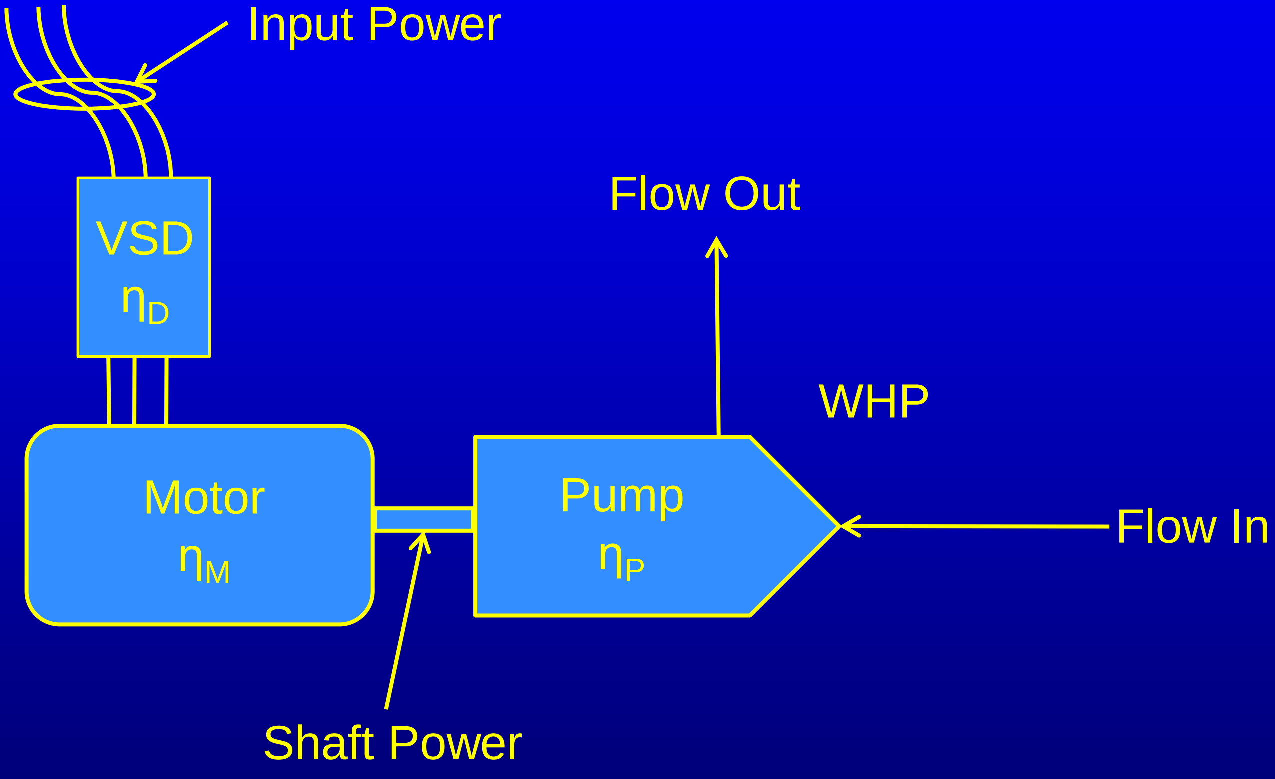
In a system with static head, pump efficiency does *not* remain fixed as speed changes



In a system with **ONLY** static head, the effect is even more dramatic

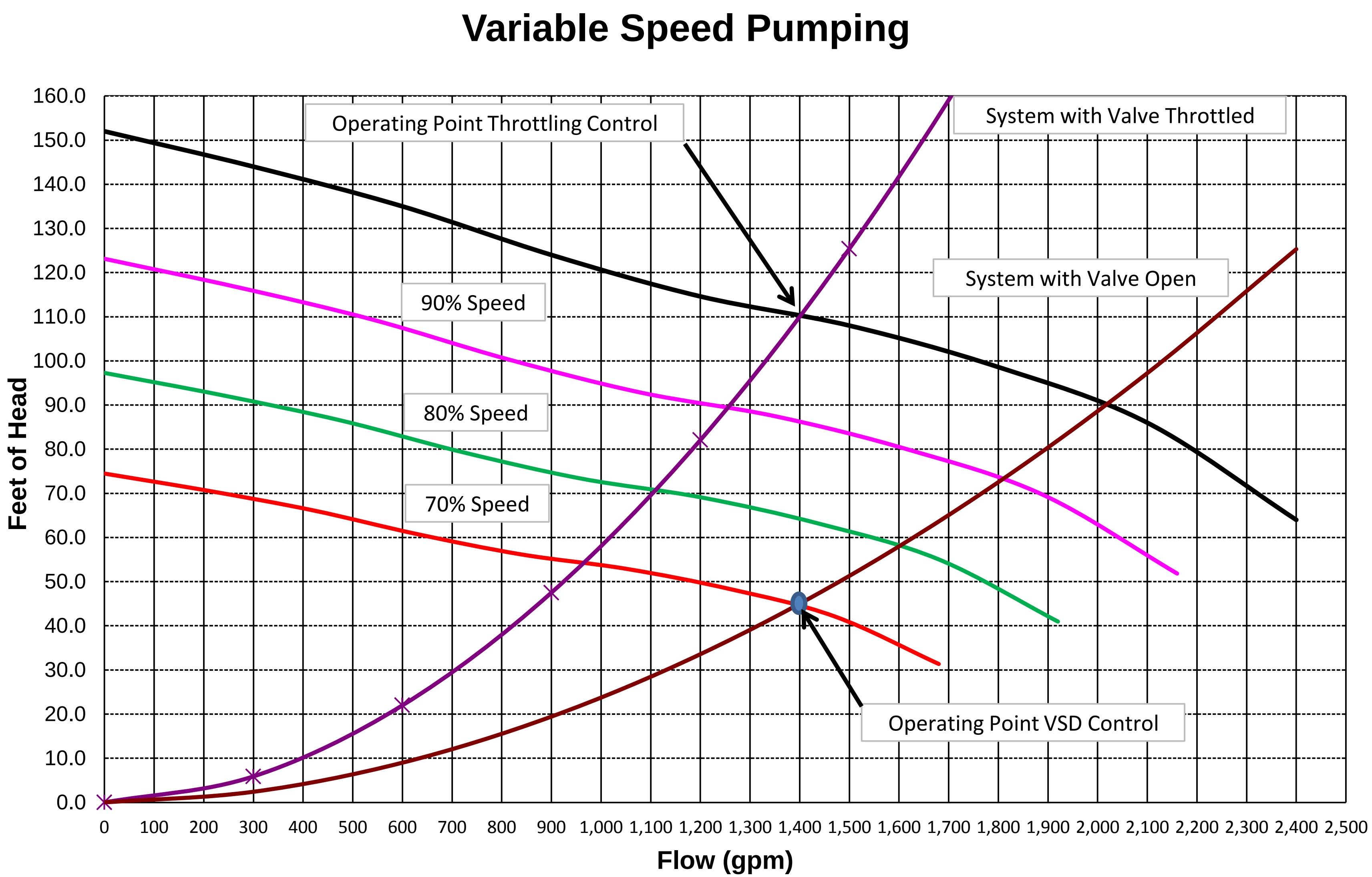


VSD on Pump Motor



Input Power = WHP/(η_D * η_M * η_P)

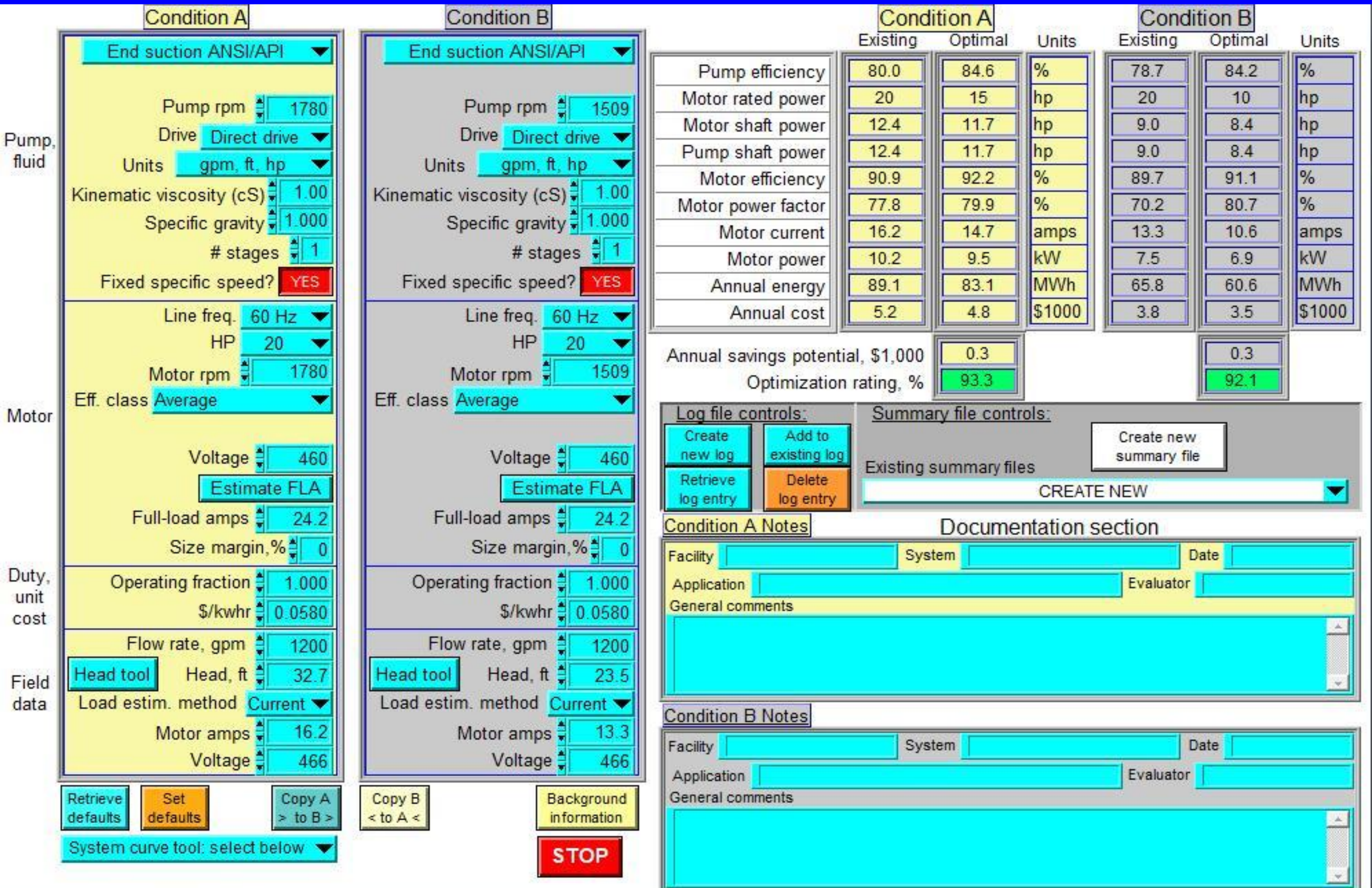
Actual Pump Data for VSD Operation



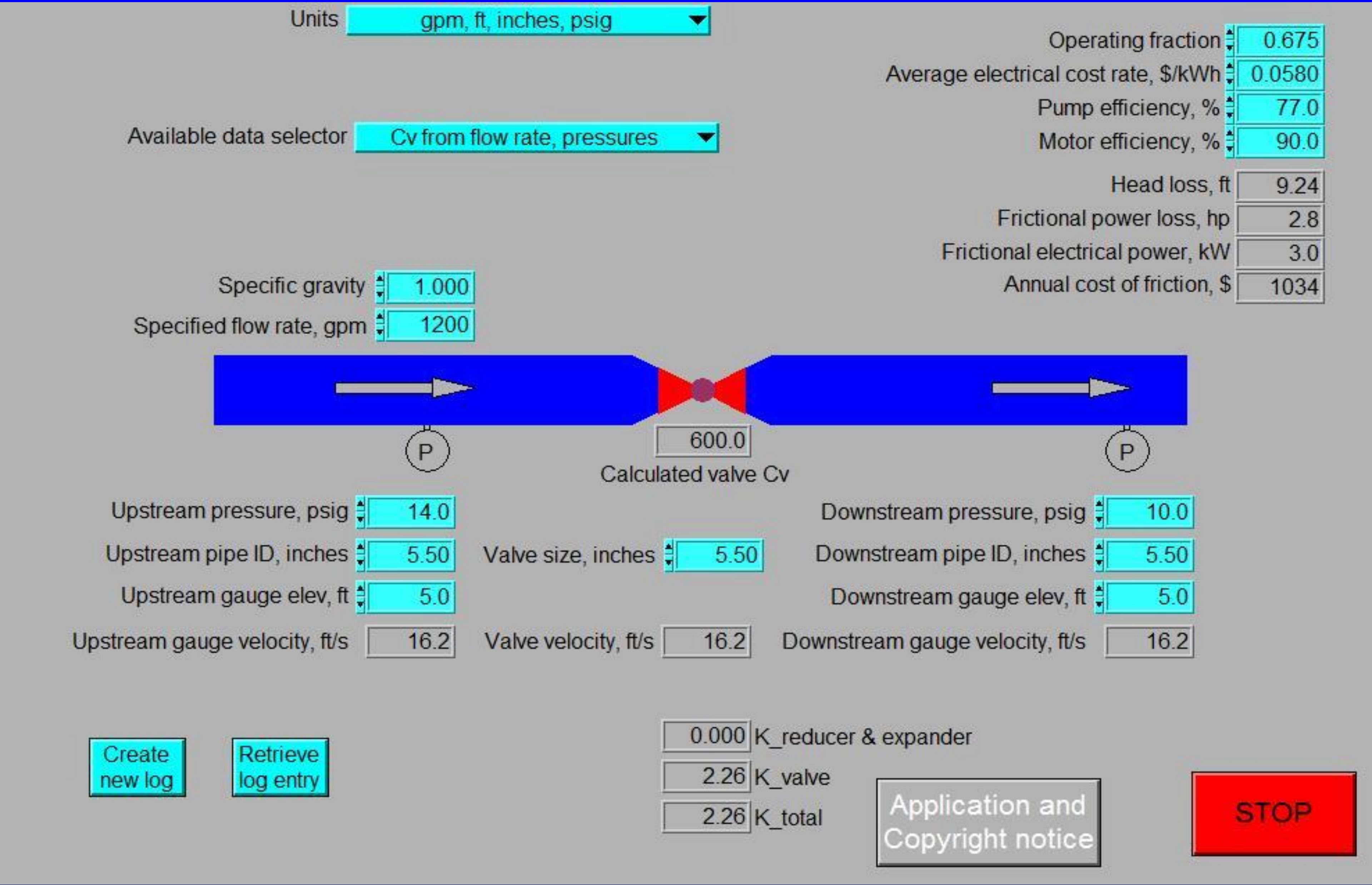
One of Schneider's Parts Washer Pumps with Throttled Discharge

Butterfly Valve 35% to 40 % Open on Pump Discharge

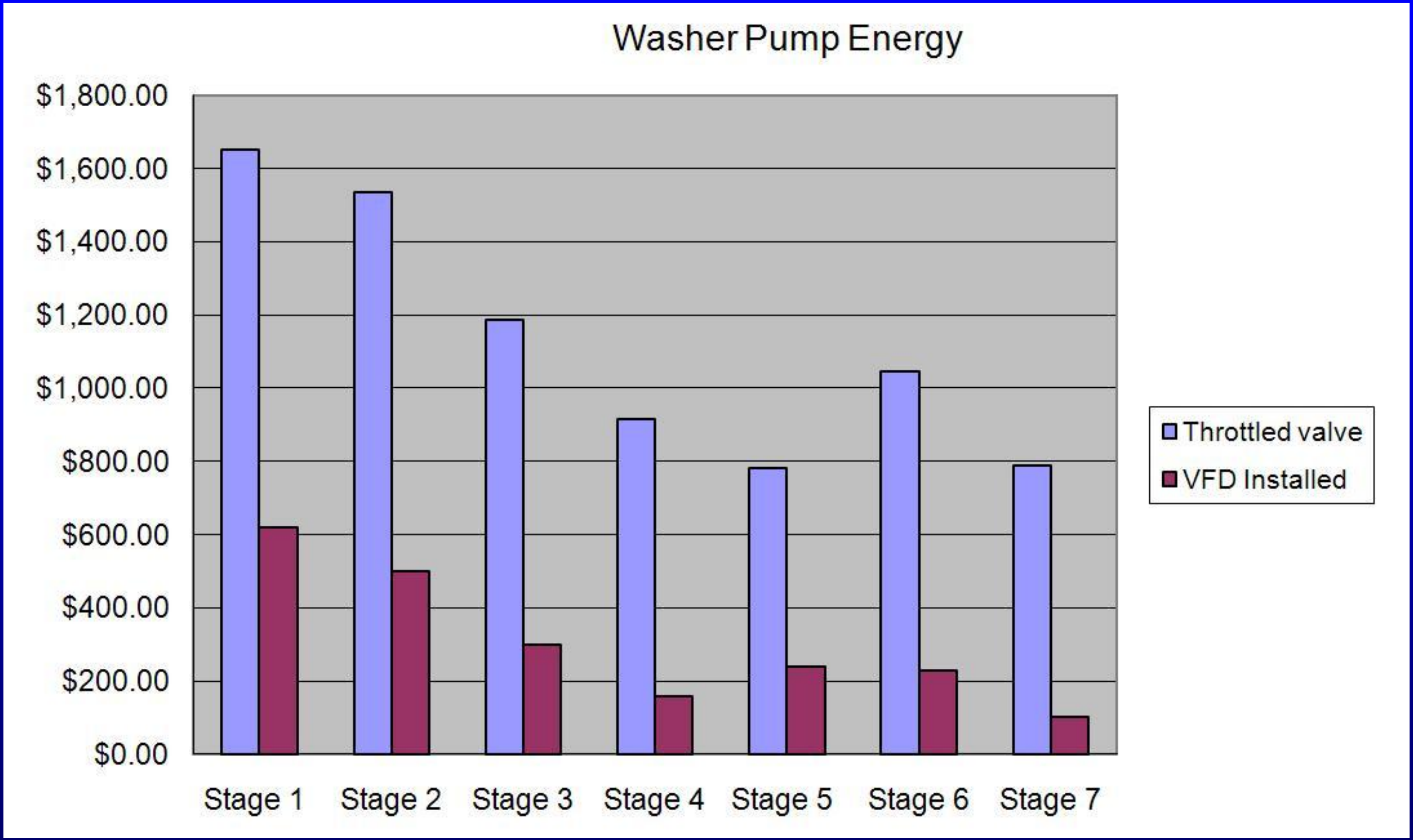
Pumping System Assessment Tool (PSAT)



Valve Tool


Units
gpm, ft, inches, psig
Operating fraction
0.675
Average electrical cost rate, $/kWh
0.0580
Pump efficiency, %
77.0
Motor efficiency, %
90.0
Available data selector
Cv from flow rate, pressures
Head loss, ft
9.24
Frictional power loss, hp
2.8
Frictional electrical power, kW
3.0
Annual cost of friction, $
1034
Specific gravity
1.000
Specified flow rate, gpm
1200
P
600.0
Calculated valve Cv
P
Upstream pressure, psig
14.0
Downstream pressure, psig
10.0
Upstream pipe ID, inches
5.50
Valve size, inches
5.50
Downstream pipe ID, inches
5.50
Upstream gauge elev, ft
5.0
Downstream gauge elev, ft
5.0
Upstream gauge velocity, ft/s
16.2
Valve velocity, ft/s
16.2
Downstream gauge velocity, ft/s
16.2
0.000 K_reducer & expander
2.26 K_valve
2.26 K_total
Create new log
Retrieve log entry
Application and Copyright notice
STOP

Washer Has 7 Throttled Pumps!



Washer Has 7 Throttled Pumps!

Pump	Description of original equipment	Total material cost	Yearly $ savings (from VFD installation sheet)	ROI in years
1	20hp pump w/ discharge closed @ 50%	$892.67	$1,034.13	0.86
2	20hp pump w/ discharge closed @ 50%	$892.67	$1,037.68	0.86
3	15hp pump w/ discharge closed @ 50%	$662.66	$885.91	0.75
4	10hp pump w/ discharge closed @ 50%	$624.14	$756.68	0.82
5	10hp pump w/ discharge closed @ 50%	$624.14	$540.12	1.16
6	10hp pump w/ discharge closed @ 50%	$624.14	$815.93	0.76
7	7.5hp pump w/ discharge closed @ 50%	$624.14	$689.93	0.90
Totals	**92.5hp**	**$4,944.60**	**$5,760.38**	**0.86**

Other Realized Advantages

- Replaced old corroded gauges with advantageously placed pressure and flow gauges
- Staff no longer had to open the washer to check flow from nozzles
- Improved Safety
- Minimizes downtime
- Better quality and process control
- Eliminating use of valve provides ergonomic assistance

VSDs Company-wide!

- VSDs implemented in Seneca, S.C., two plants in Mexico, and soon to be installed in Lexington, KY
- New Entry in Schneider’s Global Energy Best Practice Manual
- In addition to energy savings, also a potential marketing tool for VSD products

Advantages for TTU IAC

- Continued experience with VSD recommendations
- Learning tool for emerging student assessors
- Shared results from Schneider utilized as example of energy and cost savings for future assessments

Conclusion

What you are doing can have a GLOBAL IMPACT!

Thank You For Your Time

Questions?