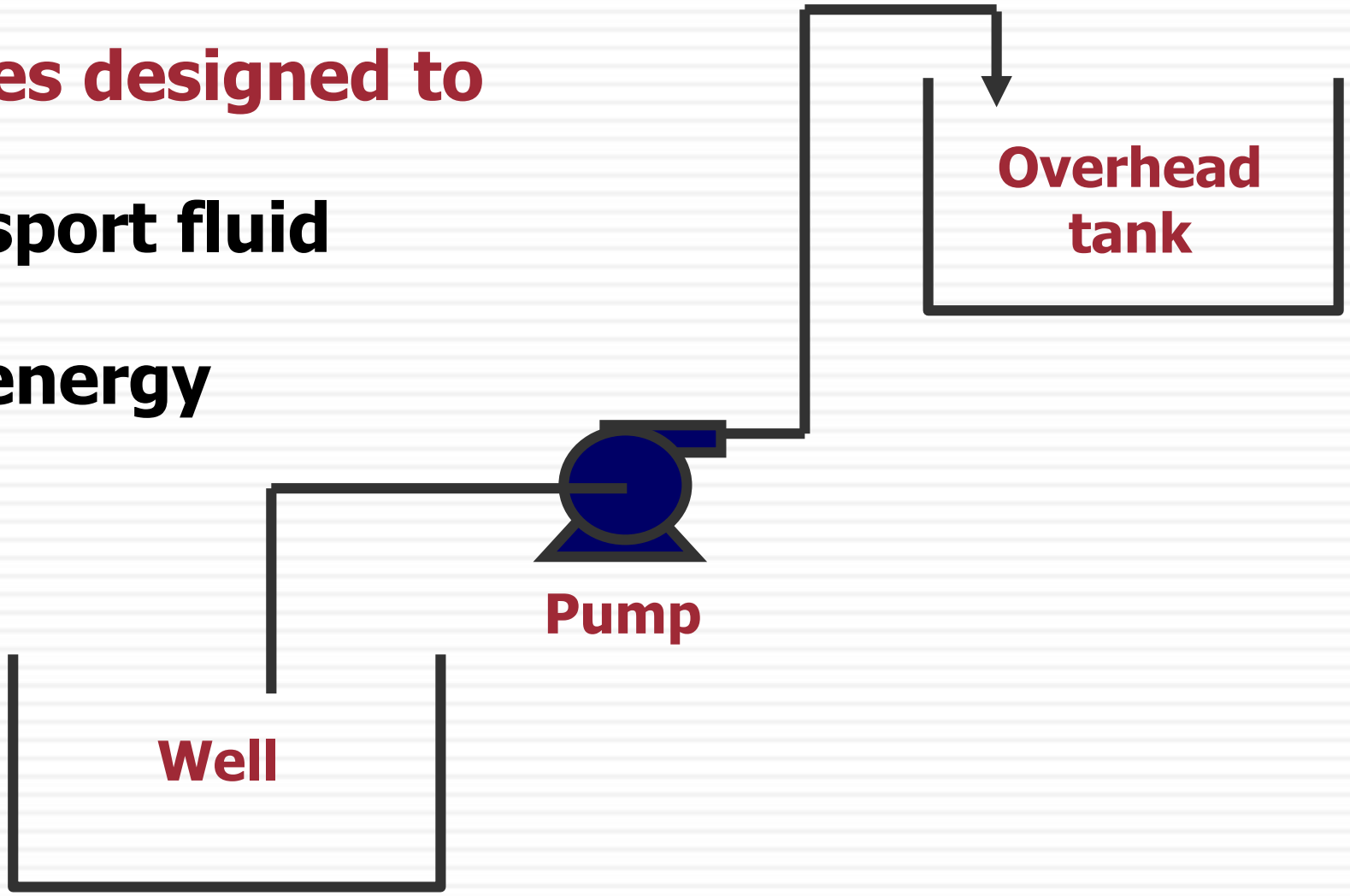
PUMPING SYSTEM

CONFEDERATION OF INDIAN INDUSTRY
CII – GODREJ GREEN BUSINESS CENTRE
HYDERABAD, INDIA

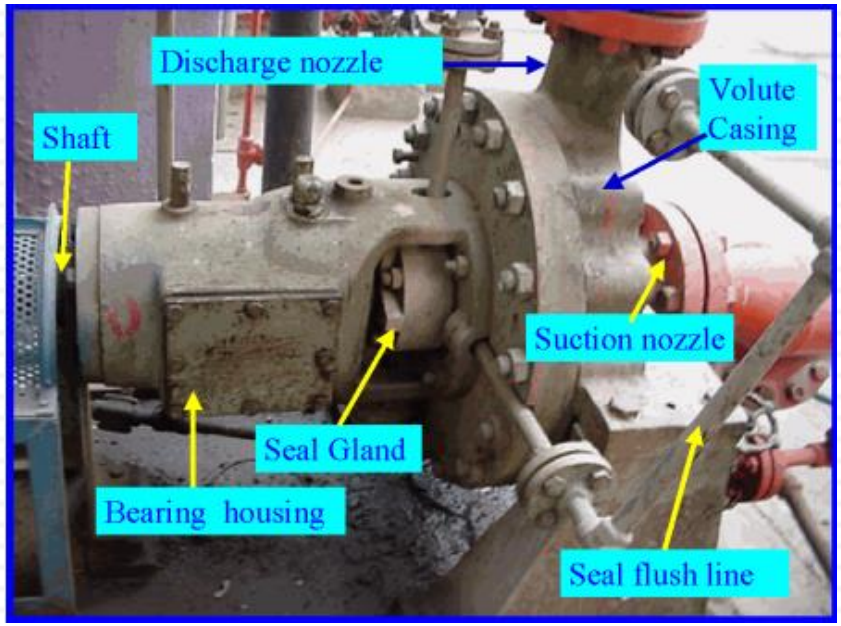
Pumps – Simple Definition

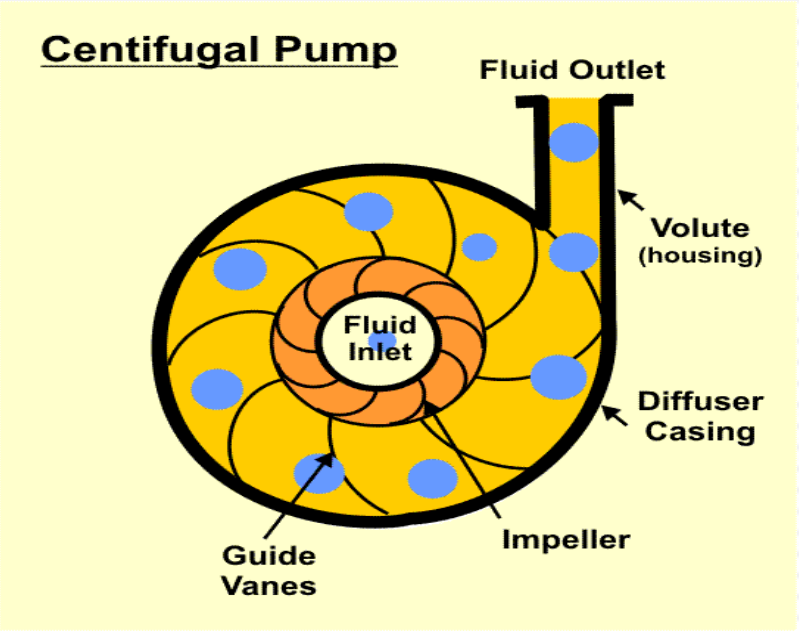
Machines designed to

- Transport fluid
- Add energy



Centrifugal Pumps

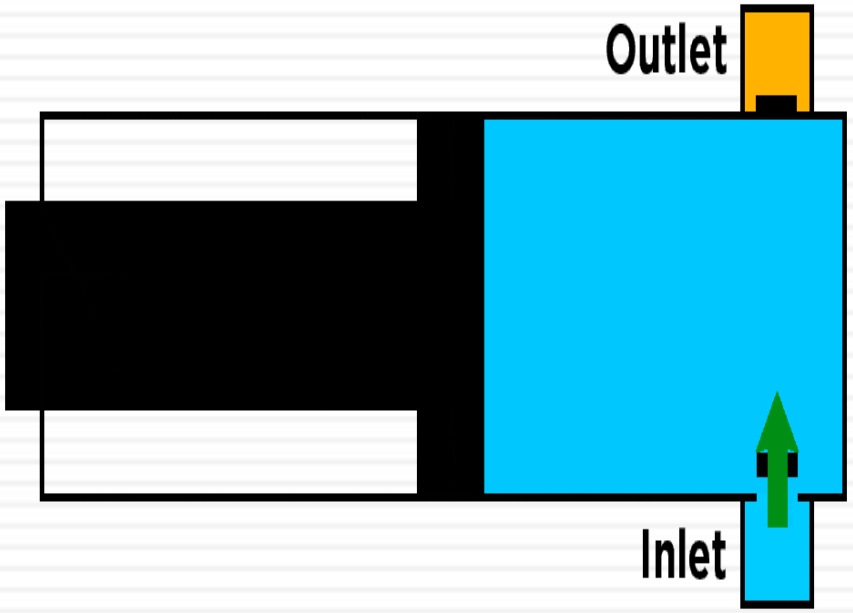


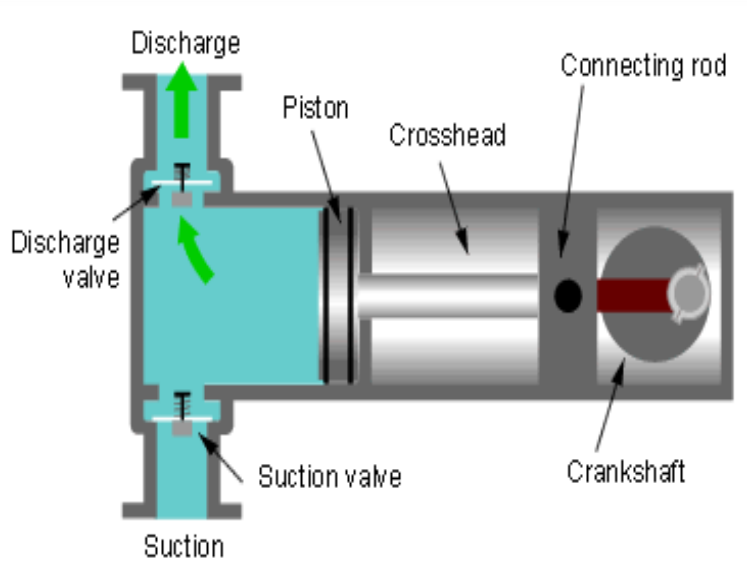


Centrifugal

- Moderate pressure (upto 6000 m WC)
- Moderate capacity (upto 10,000 m^3/h)
- General applications

Positive Displacement Pumps



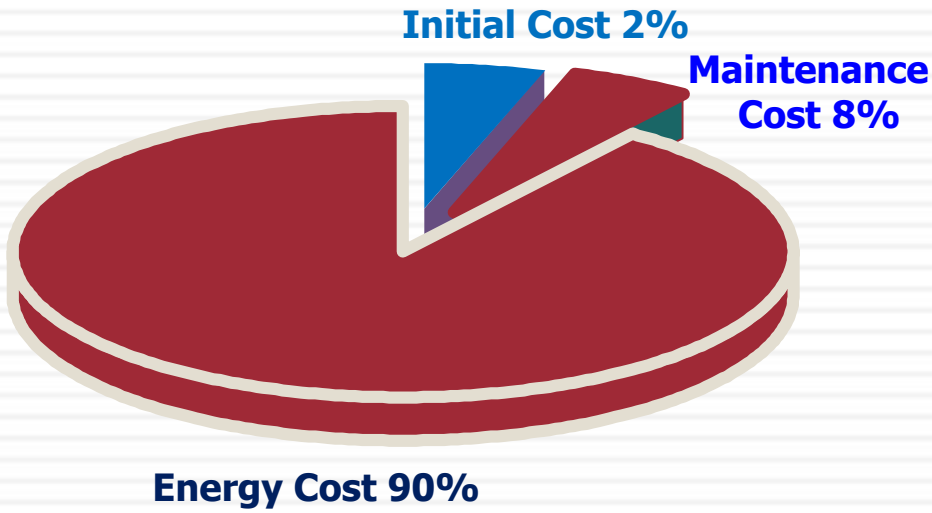


Reciprocating

- **High pressure - upto 10,000 m WC**
- **Low capacity - upto 1000 m^3/h**
- **Lubrication oil pumps**

Life Cycle cost for a Pump

- 30 kW pump
  - Initial cost: Rs 3,00,000/-
  - Operating hours: 8000/year
  - Power cost: Rs 5/unit
  - Lifetime: 15 years
  - Maintenance: Rs 30,000/-



Life Cycle Cost: Rs 187,50,000/-

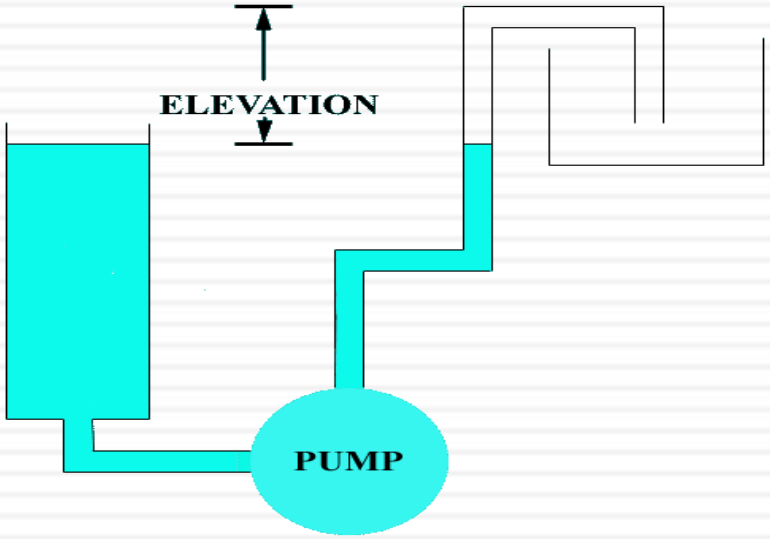
Energy Parameters

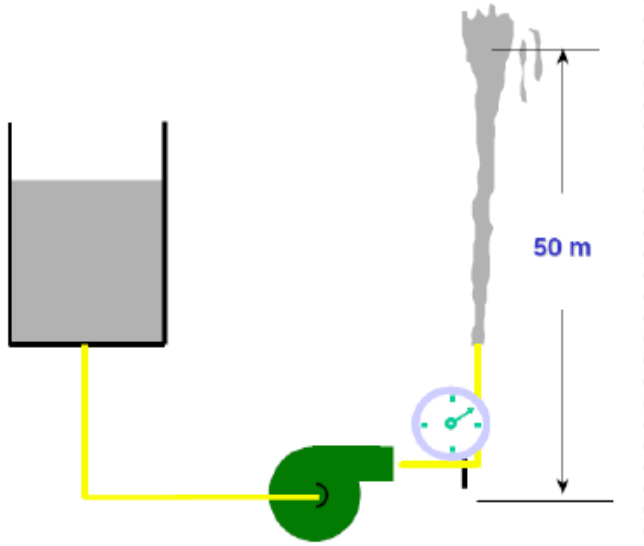
Capacity or Flow

Head or Pressure

Efficiency

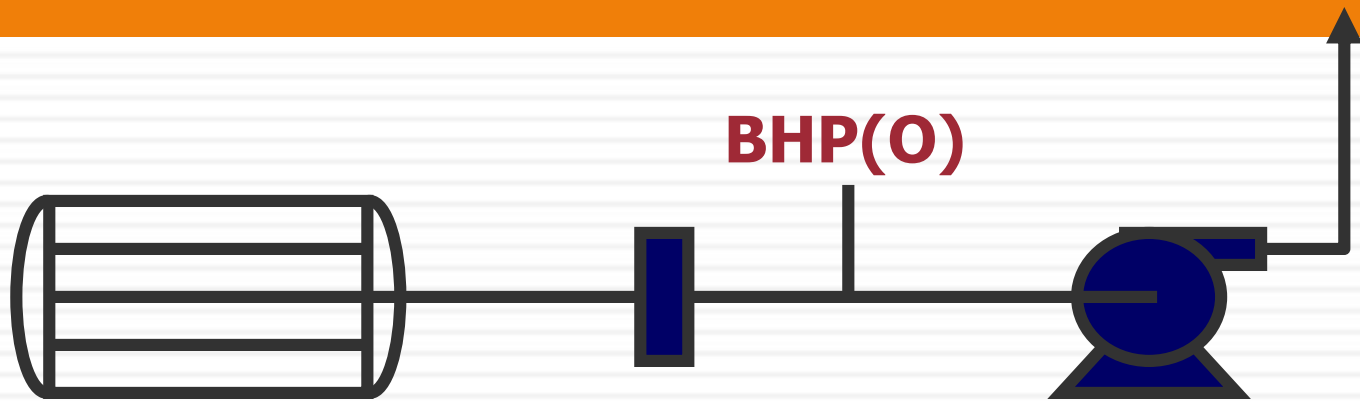
Head of Pump





- Head of a pump is an expression of how much height the pump can lift the liquid
  - Measured in terms of height of water column

Efficiency



$$\text{Pump } \eta\,(\%) = \frac{\text{Pump output}}{\text{Input to pump [BHP(O)]}}$$

$$\text{Pump } \eta\,(\%) = \frac{\text{Flow (lps) x Head (m) x Sp. Gr.}}{102 \times \eta\,(\text{motor}) \times \text{kW (I)}}$$

Pumps Formulae

- Capacity α (RPM)
- Head α $(RPM)^2$
- Power α (Capacity x Head)

  α $(RPM)^3$

Pumps Formulae

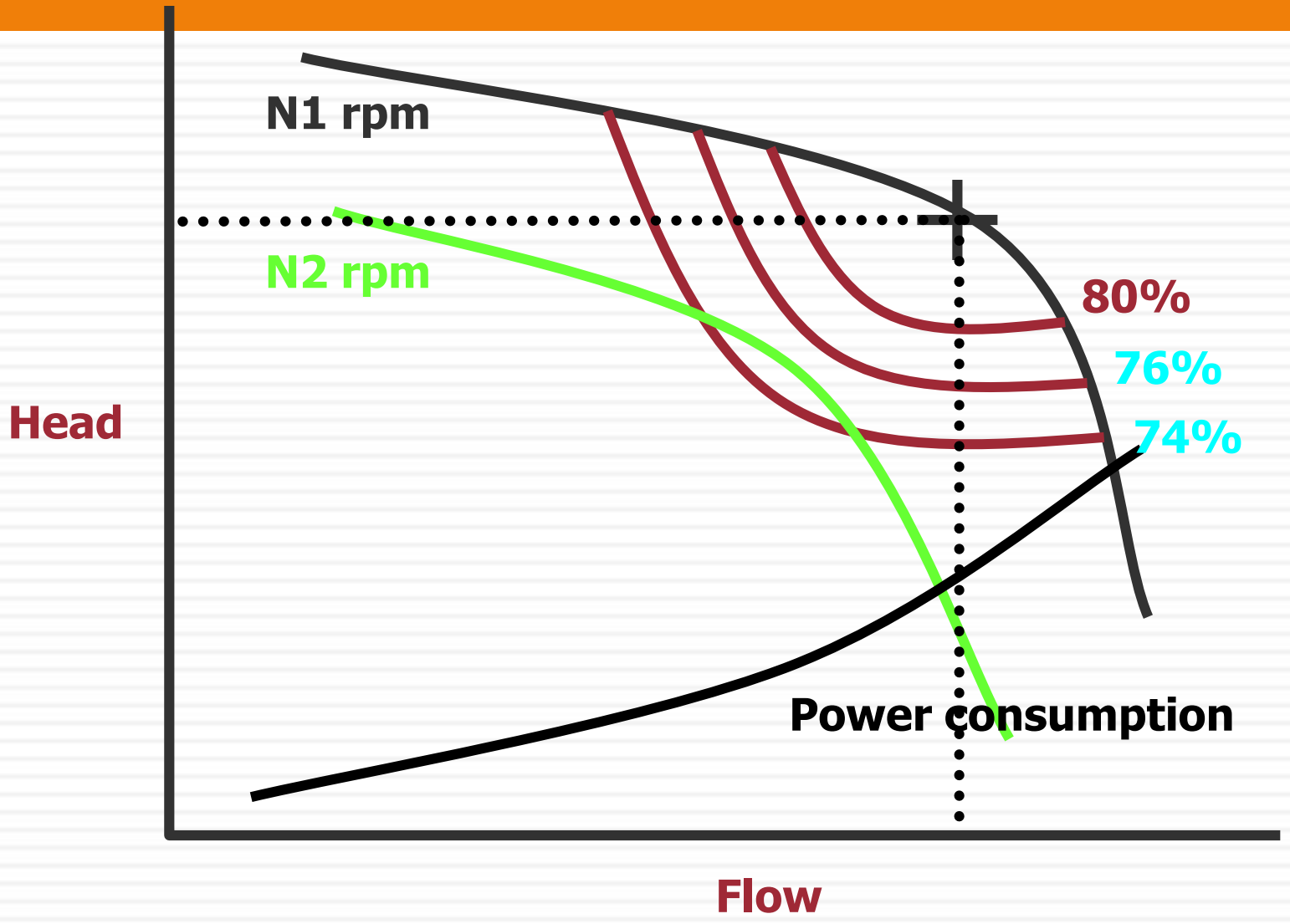
If the RPM is reduced by say 10%, what will happen to the

- **Capacity : reduces by 10%**
- **Head : reduces by 19%**
- **Power : reduces by 27%**

Other Affinity Laws

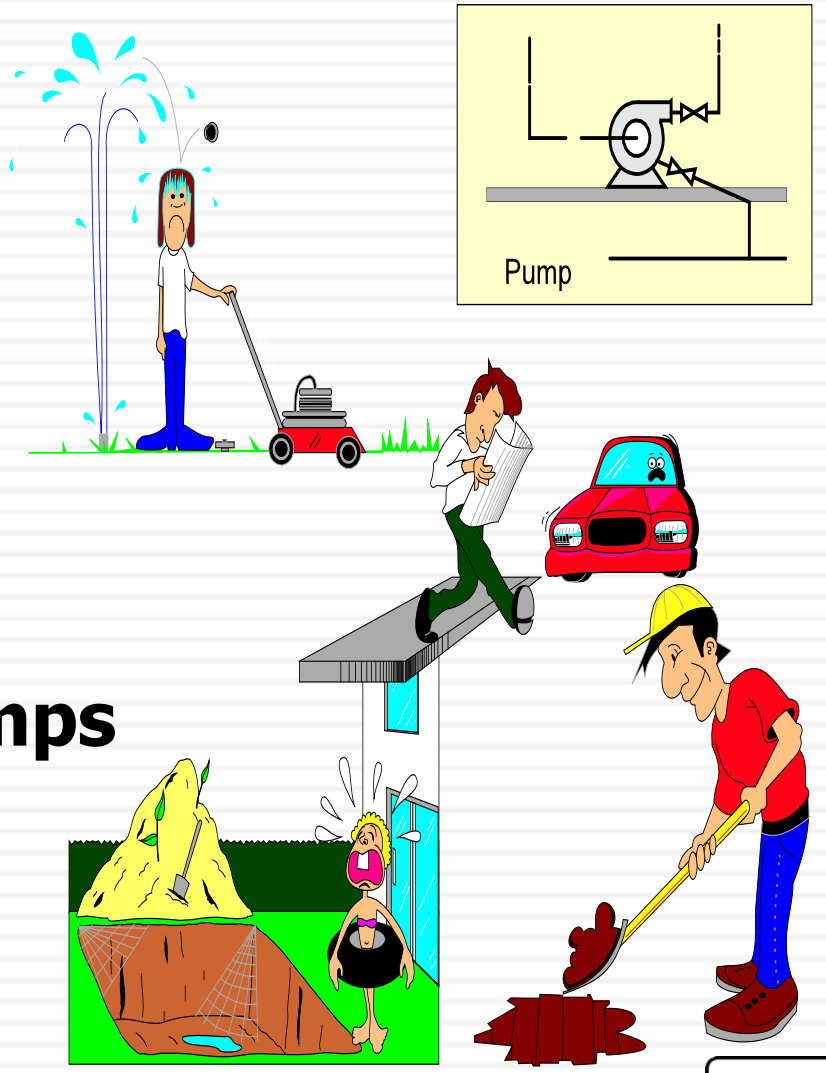
Formulas for Refiguring Pump Performance with Impeller Diameter or Speed Change		
Diameter Change Only	**Speed Change Only**	**Diameter and Speed Change**
$Q_2 = Q_1 \left(\frac{D_2}{D_1} \times \frac{N_2}{N_1}\right)$	$Q_2 = Q_1 \left(\frac{N_2}{N_1}\right)$	$Q_2 = Q_1 \left(\frac{D_2}{D_1}\right)$
$H_2 = H_1 \left(\frac{D_2}{D_1} \times \frac{N_2}{N_1}\right)^2$	$H_2 = H_1 \left(\frac{N_2}{N_1}\right)^2$	$H_2 = H_1 \left(\frac{D_2}{D_1}\right)^2$
$bhp_2 = bhp_1 \left(\frac{D_2}{D_1} \times \frac{N_2}{N_1}\right)^2$	$bhp_2 = bhp_1 \left(\frac{N_2}{N_1}\right)^2$	$bhp_2 = bhp_1 \left(\frac{D_2}{D_1}\right)^2$

Characteristic Curve of a Pump

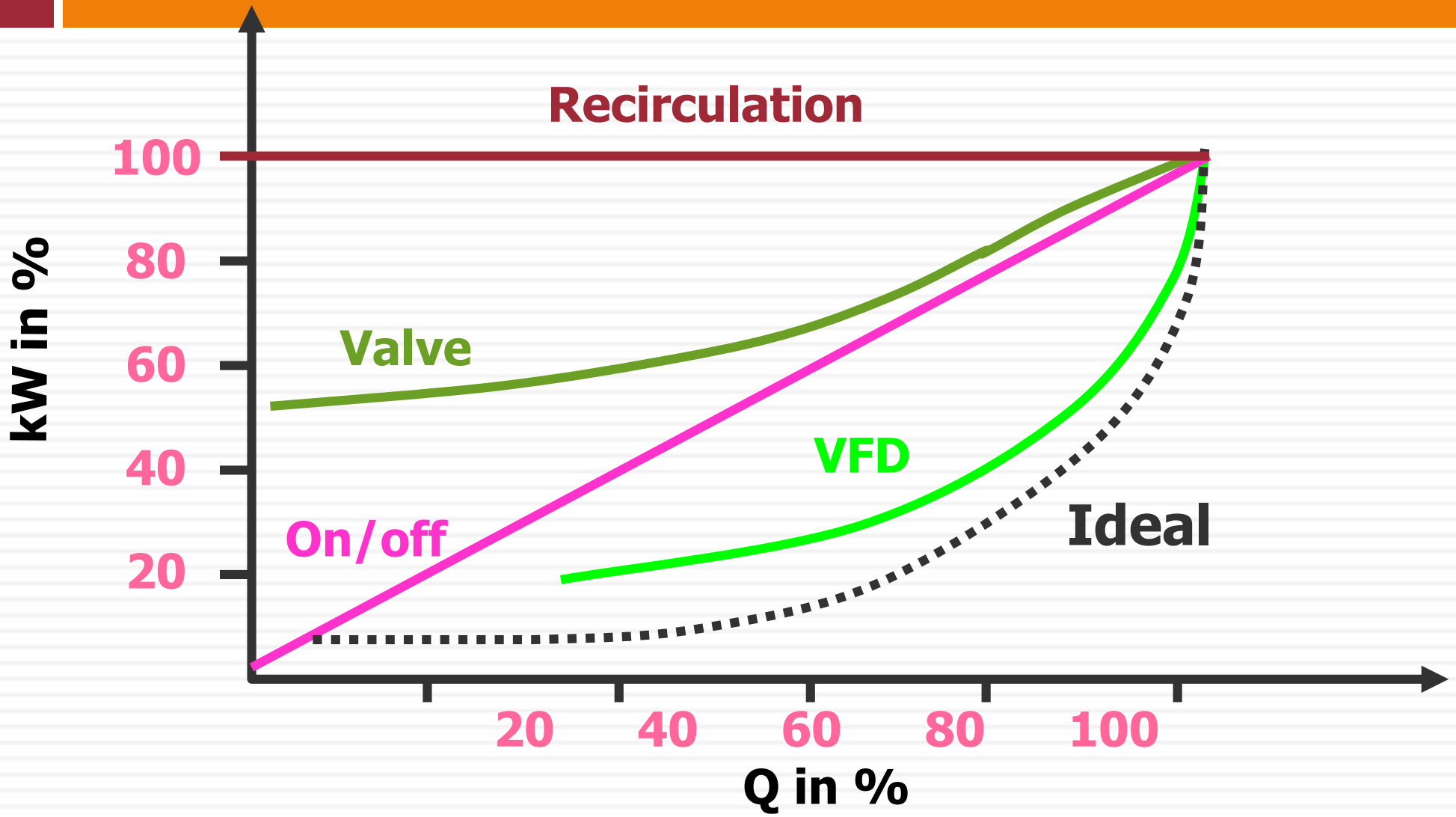


Reasons for excess power consumption

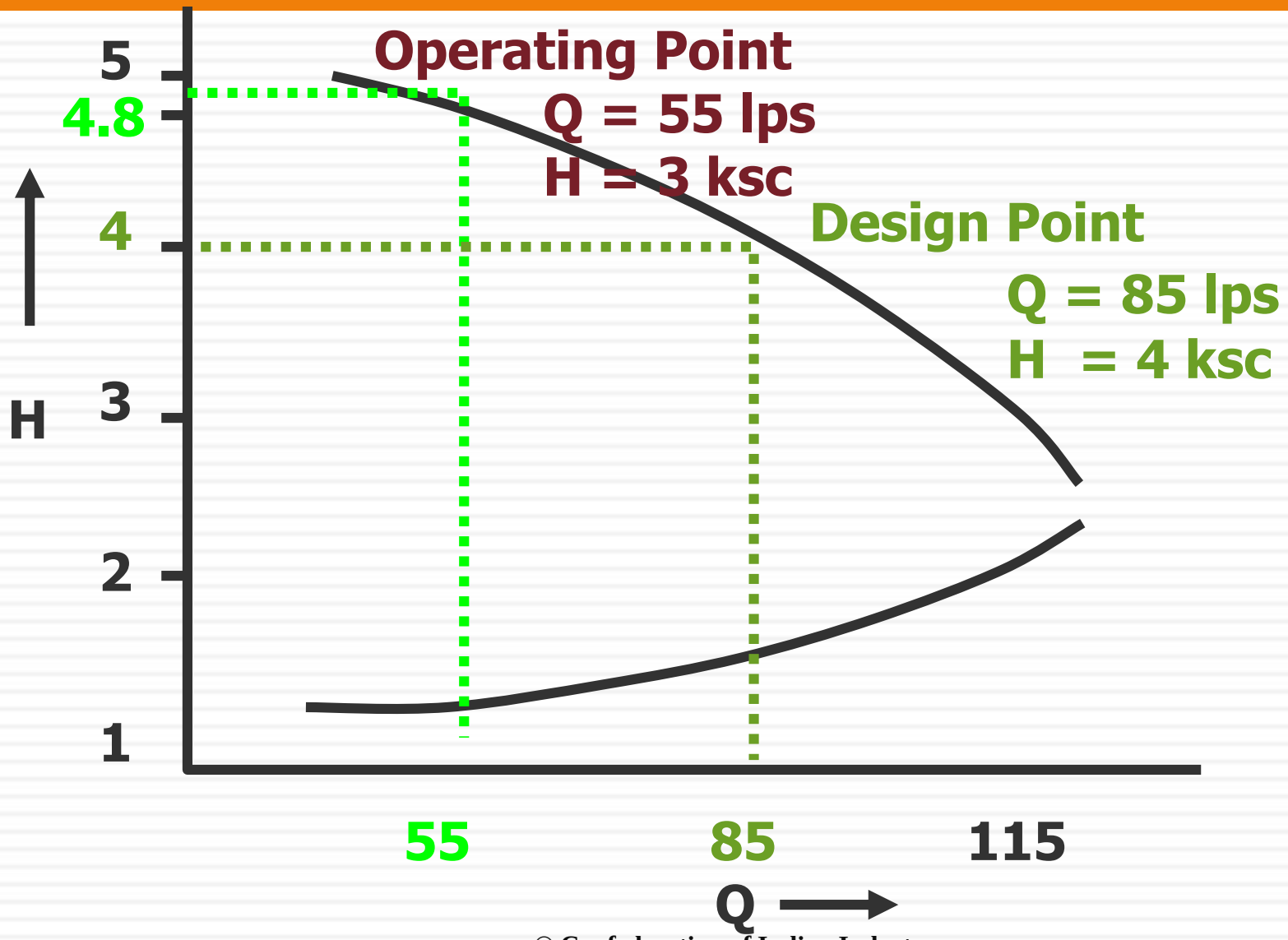
- Wrong Selection
- Over Design
- Improper Layout
- Old inefficient pumps
- Multiple smaller size pumps
- Ad-hoc decisions



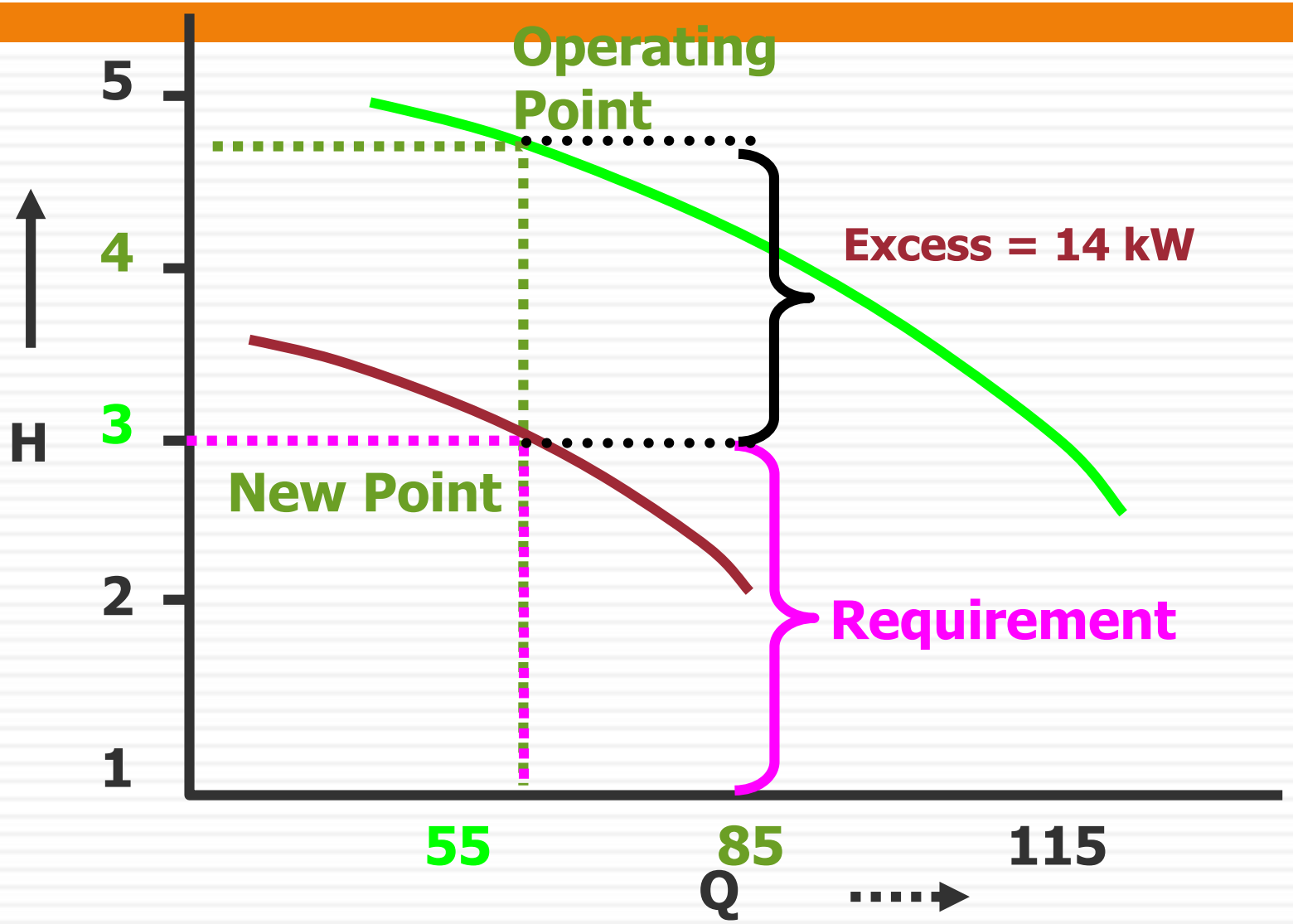
Effect of Various Capacity Controls



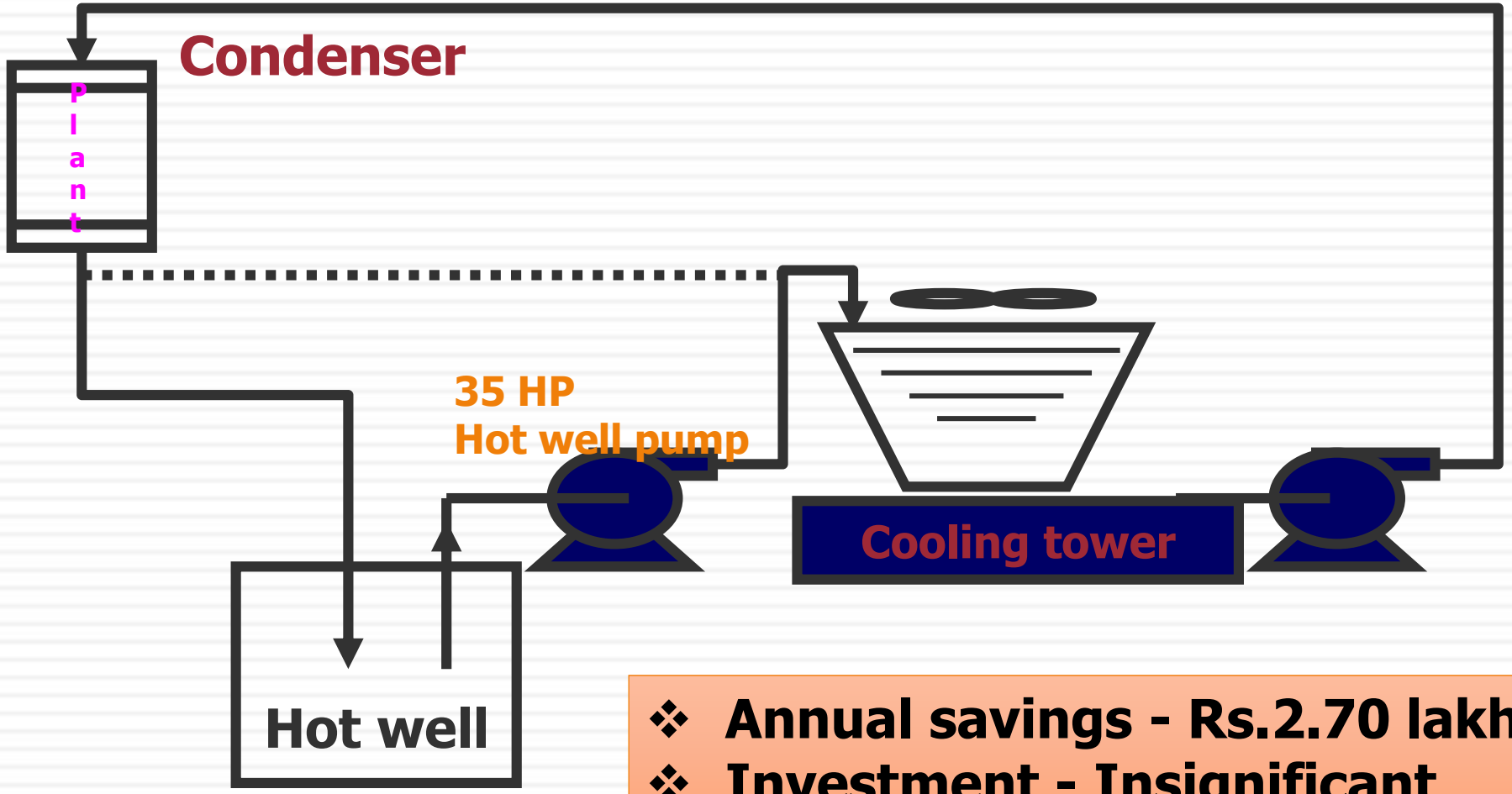
Operating Conditions of Pump



Operating Conditions of Pump



Use Gravity Flow as Much as Possible



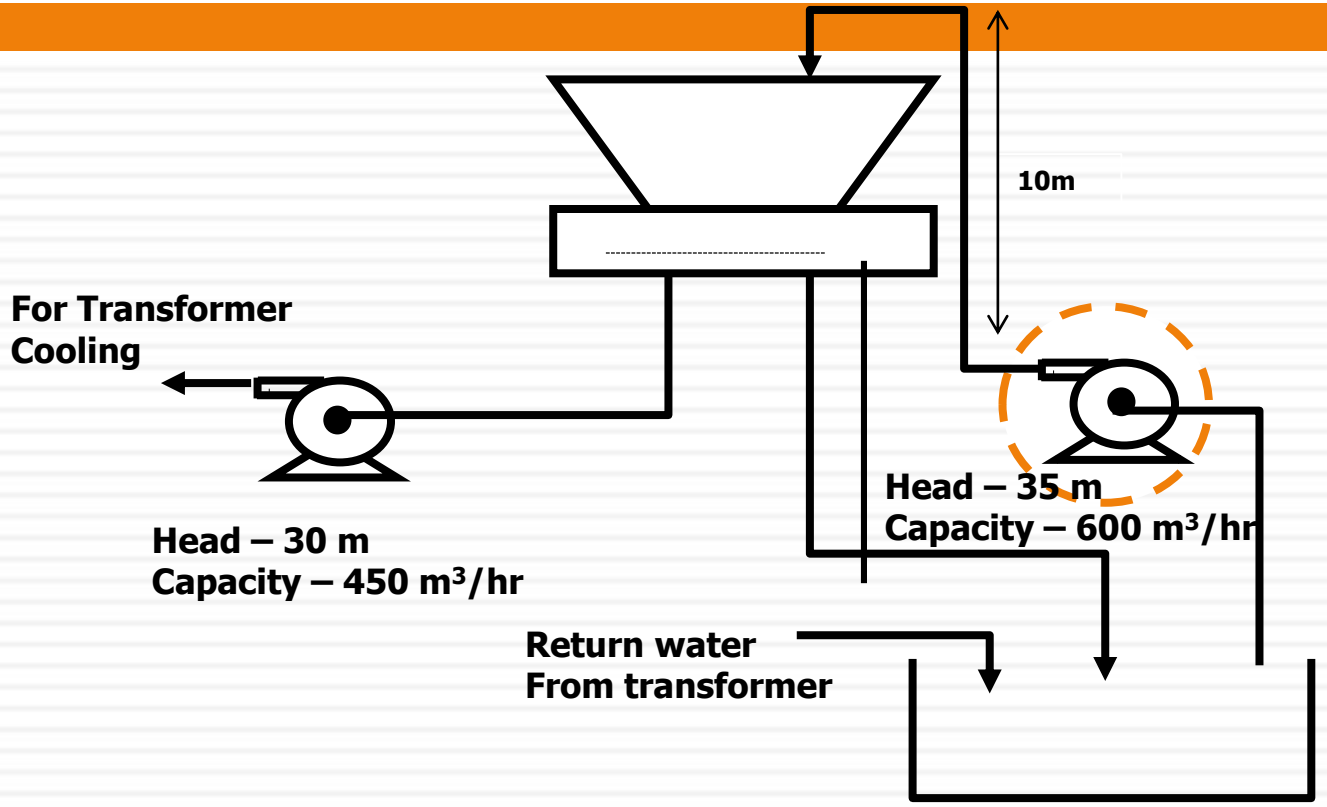
- Annual savings - Rs.2.70 lakhs
- Investment - Insignificant

Methodology of Pump Survey

- **Is the pump correctly Sized ?**
  - **Excess capacity due to uncertainty**
- **Leads to operation with valve throttling**
  - **Energy inefficient practice**

- **Impeller reduction**
- **Low capacity/head pump**
- **Installation of variable speed drive**

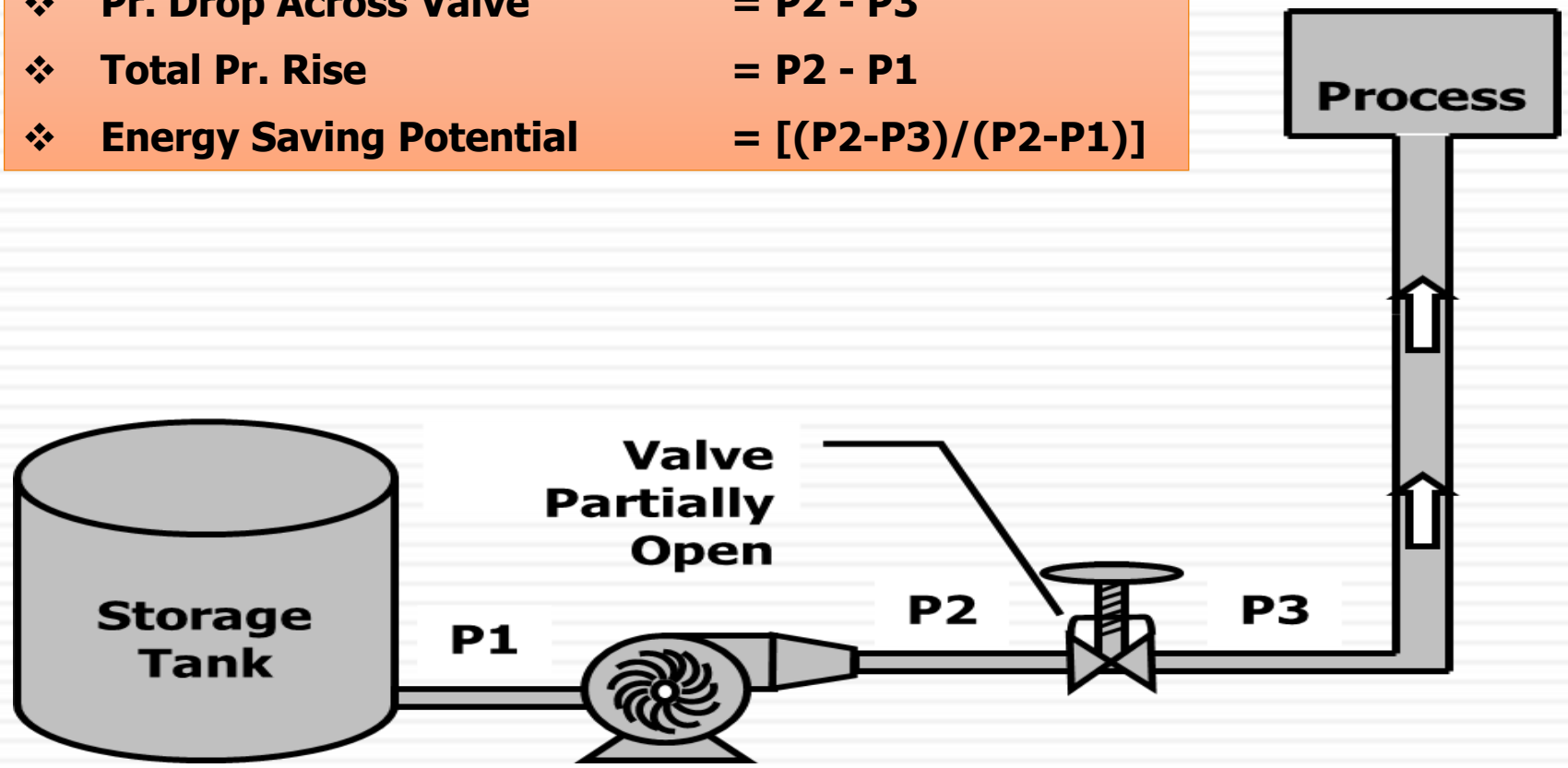
Installation of correct size pump



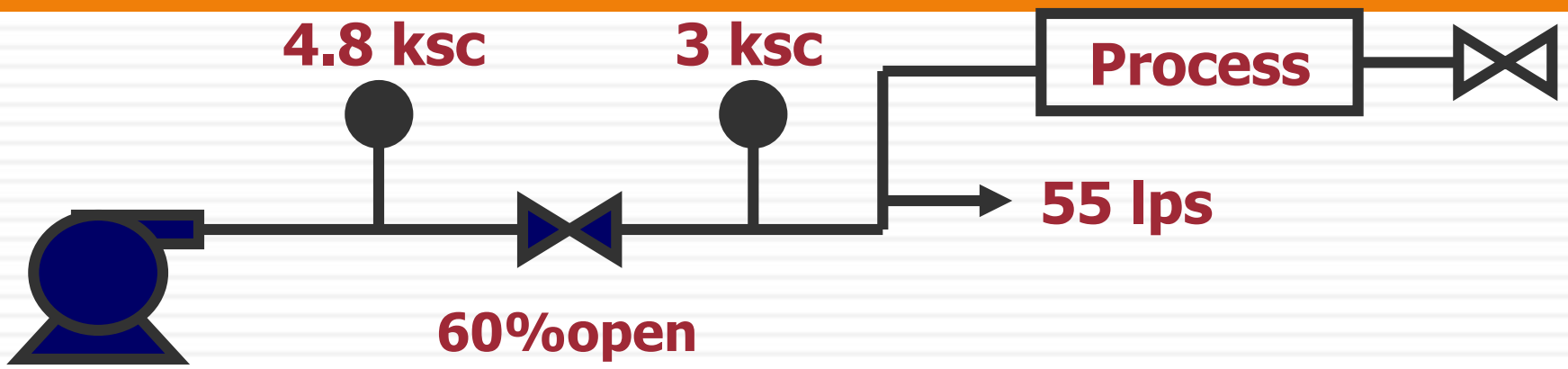
Annual savings	**-**	**Rs 7.29 Lakhs**
Investment	**-**	**Rs 3.00 Lakhs**
Payback period	**-**	**5 months**

Pressure Drop Across Valve

- Pr. Drop Across Valve = P2 - P3
- Total Pr. Rise = P2 - P1
- Energy Saving Potential = [(P2-P3)/(P2-P1)]



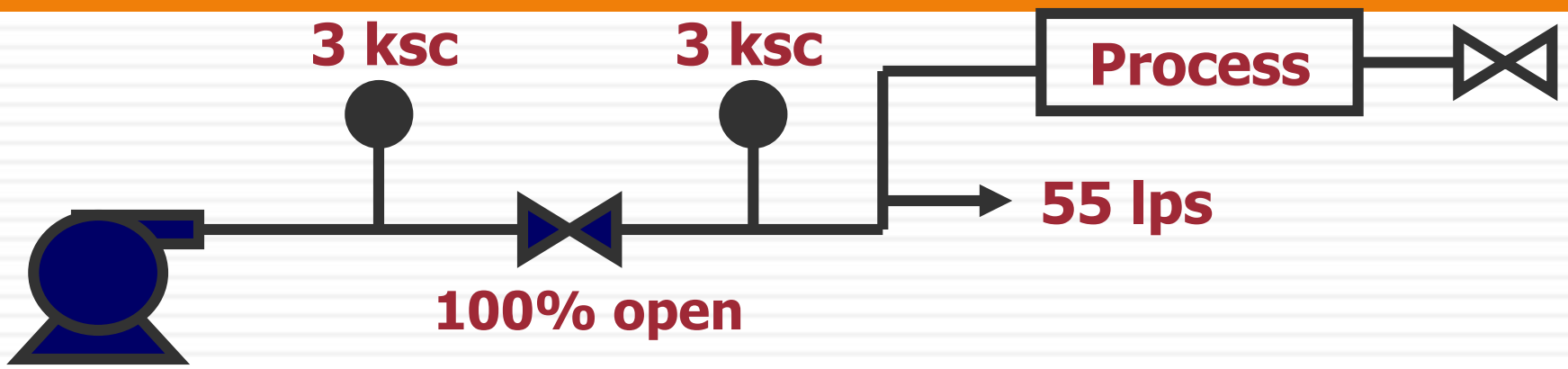
Effect of Valve Throttling



Design

Capacity	=	85 lps
Head	=	4 ksc
Existing	=	4.8 ksc
kW_{EX}	=	55 x 48/(102 x 0.7)
	=	37.0 kW

Effect of Valve Throttling



Modified

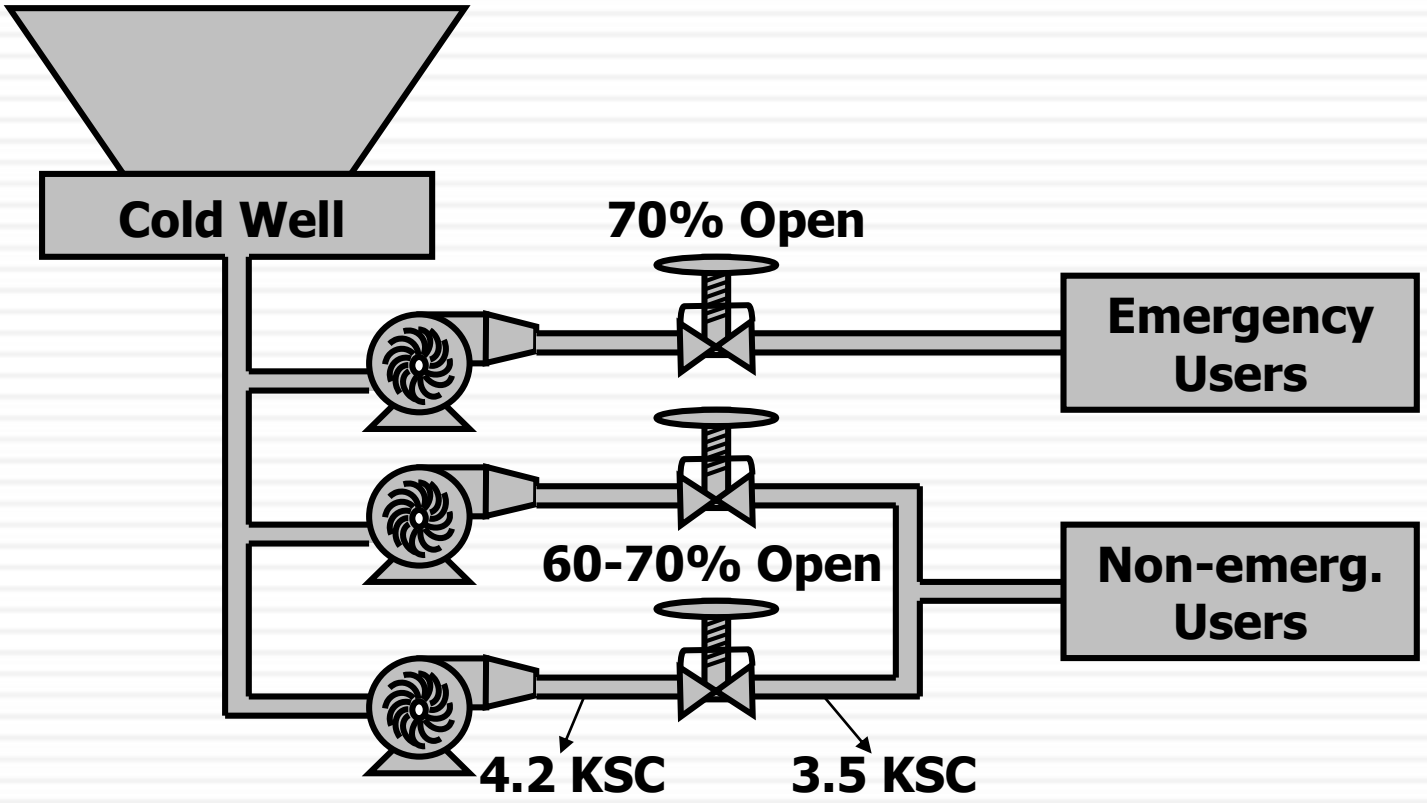
Proposed = 3.0 ksc

kW_P = 55 x 30/(102 x 0.7)

= 23.0 kW

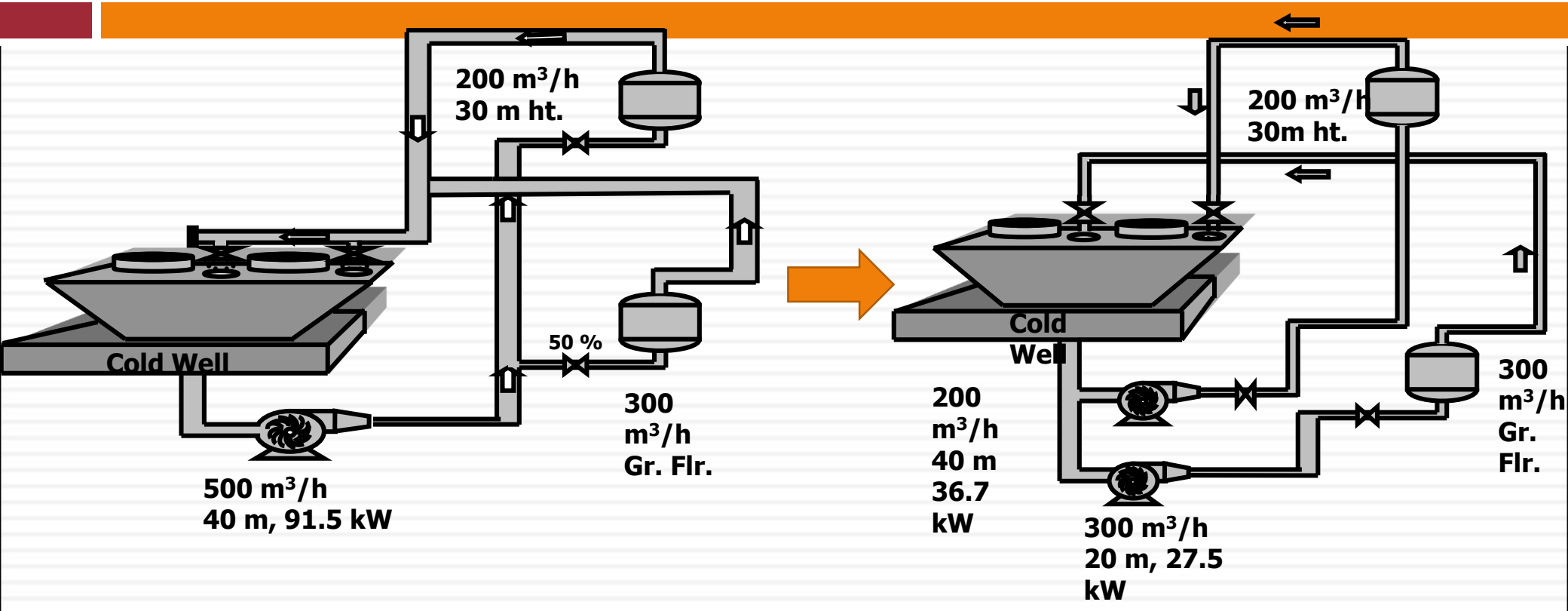
Savings = 14 kW

Installation of lower size impeller



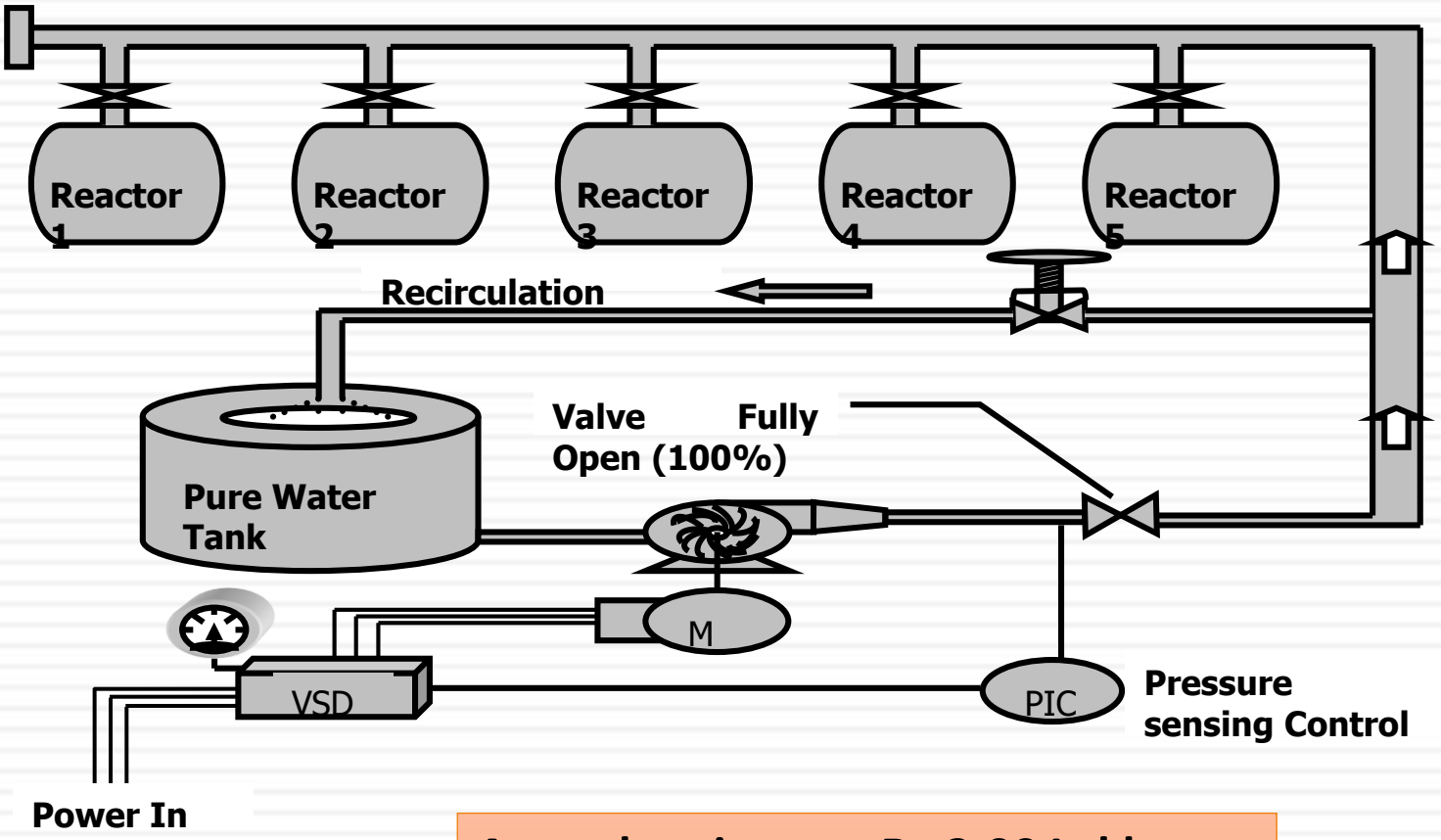
Annual savings	**= Rs.11.69 lakhs**
Investment	**= Rs.0.50 lakhs**
Payback period	**= 1 month**

Segregate high and low head users



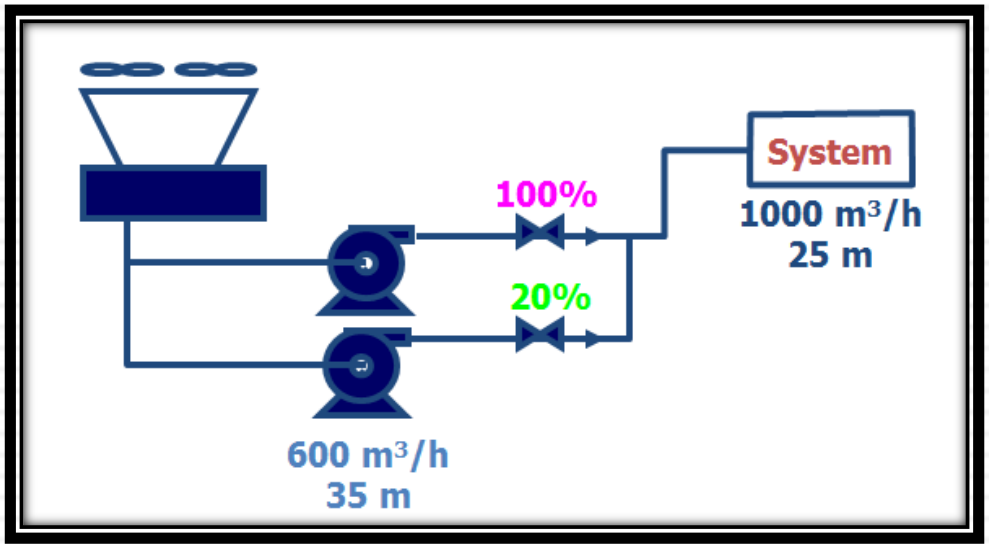
Annual Savings	= Rs. 4.80 Lakhs
Investment	= Rs. 6.00 Lakhs
Payback period	= 15 Months

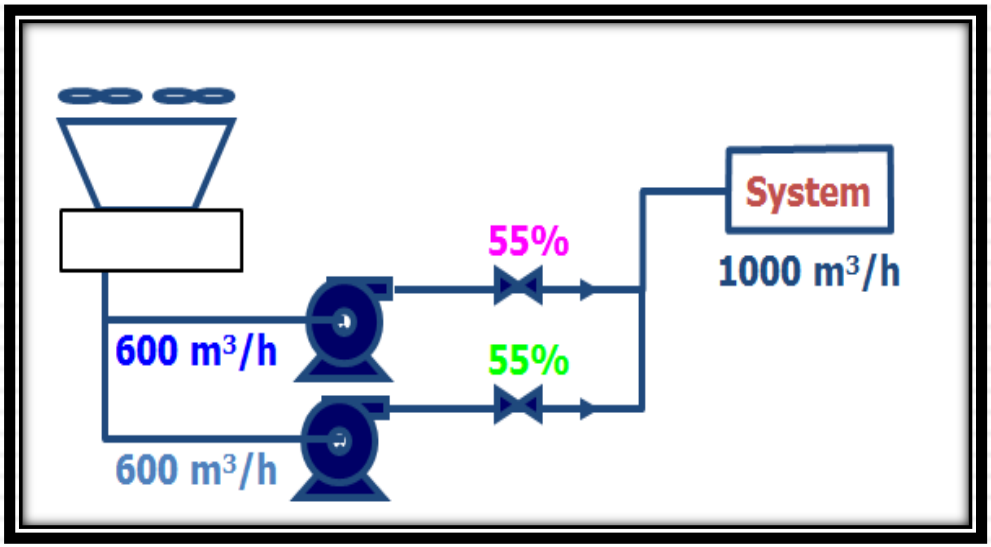
VFD for Pumping system



Annual savings	- Rs.3.00 Lakhs
Investment	- Rs.2.00 Lakhs
Payback period	- 8 Months

Parallel pumping

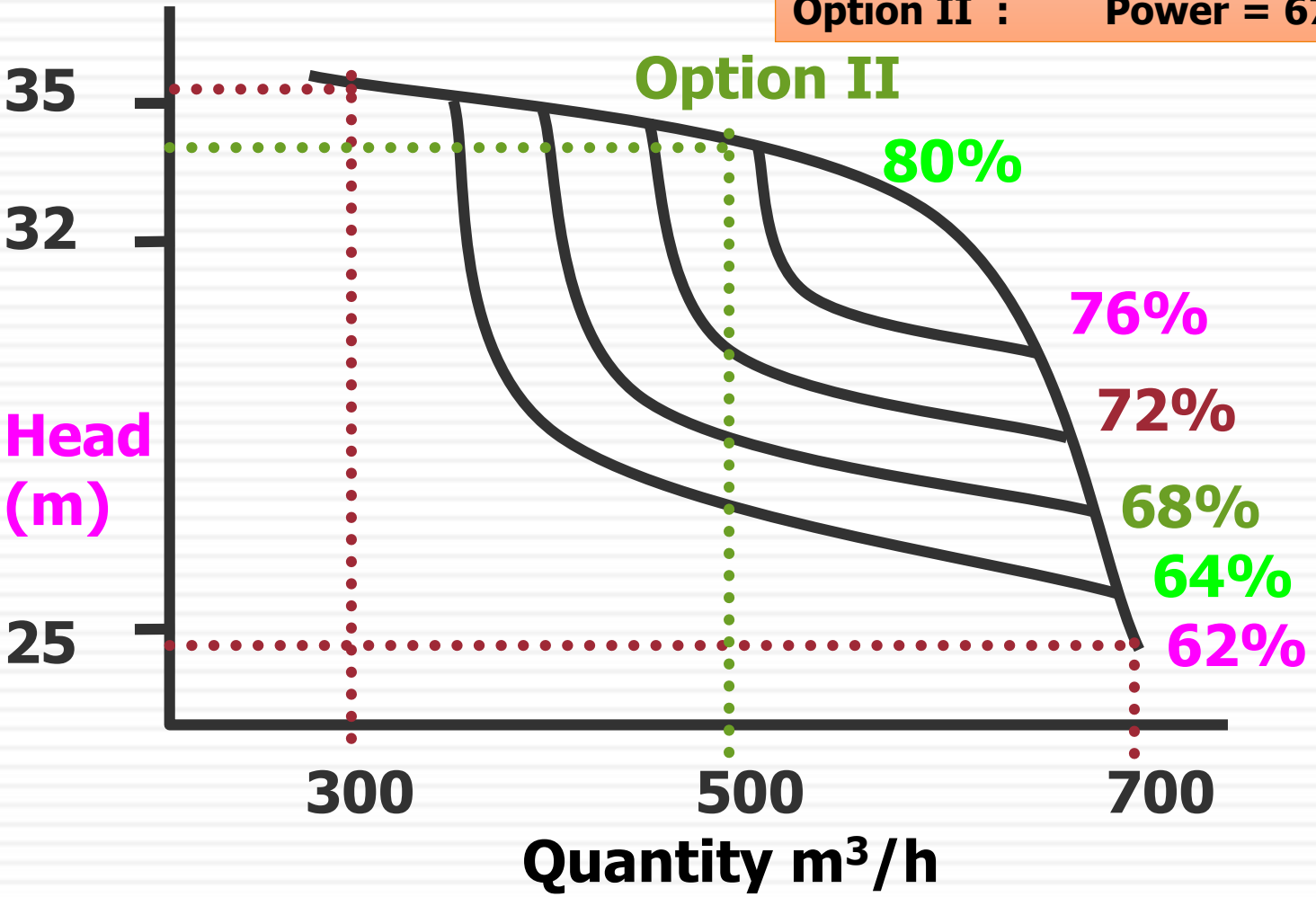




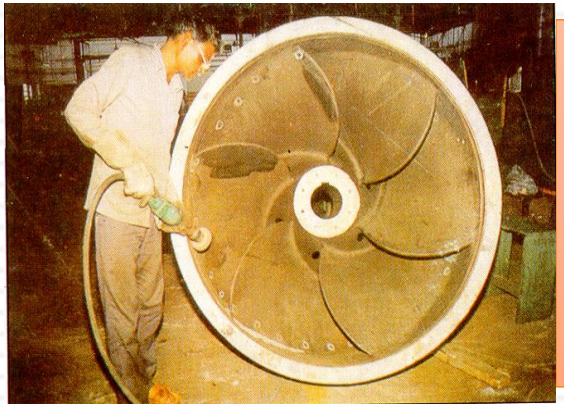
Which is the better option? Why?

Parallel pumping

Option I : Power = 106 kW + 47 kW = 153 kW
Option II : Power = 67 kW + 67 kW = 134 kW



Hydrophobic Coating

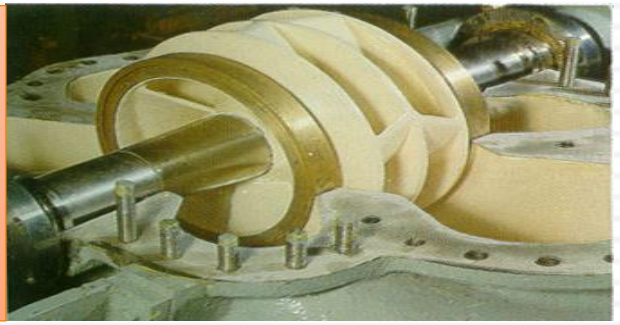


Earlier system

- Capacity : 120 m3/hr
- Head : 15 m
- Pump input power : 50 kW
- Best efficiency : 65%

Modified system

- Capacity : 120m3/hr
- Head : 15 m
- Pump input power : 48 kW
- Best efficiency : 67 %



Annual savings : Rs. 1.12 lakhs

Pump Maintenance Check List

Description	Comments	Maintenance Frequency			
		Daily	Weekly	Monthly	Annually
Pump use/sequencing	Turn off/sequence unnecessary pumps	X			
Overall visual inspection	Complete overall visual inspection to be sure all equipment is operating and safety systems are in place	X			
Check lubrication	Assure that all bearings are lubricated per the manufacture's recommendation			X	
Check packing	Check packing for wear and repack as necessary. Consider replacing packing with mechanical seals.			X	
Motor/pump alignment	Aligning the pump/motor coupling allows for efficient torque transfer to the pump			X	
Check mountings	Check and secure all pump mountings			X	
Check bearings	Inspect bearings and drive belts for wear. Adjust, repair, or replace as necessary.				X
Motor condition	Checking the condition of the motor through temperature or vibration analysis assures long life				X

TO SUM UP

Avoid P

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Instal

ect size pump

Thank you