

Internal Pump Coating – When They Save Money and When They Don't

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EEMODS

Sign of the Times!



Lifecycle Cost (LCC)

Acquisition Cost
Installation Cost
Operating Cost
 - Energy
 - Maintenance
Repairs
Downtime

Total LCC

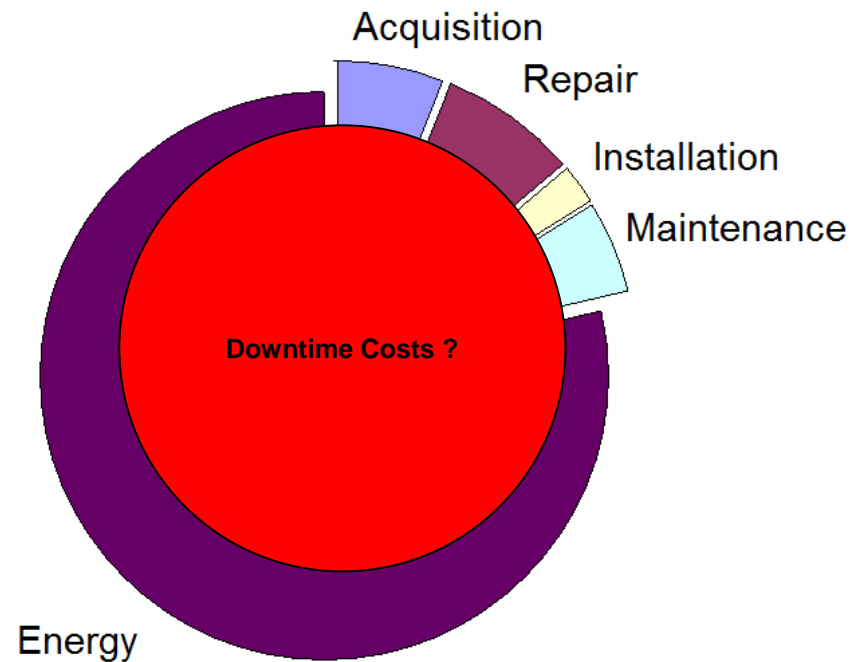
Think like an MBA

Act like an Engineer

Live like a King

30 hp Pump, 6000 hr/yr, 8 years

30 hp Pump	
- 8 yr life cycle	
- 6000 hr/yr	
- \$0.10/Kwhr	
Acquisition	\$8,500
Installation	\$3,200
Engery	\$107,424
Maintenance	\$7,200
Repair	\$10,500



Internal Coatings – Wet End

Benefits include

- Resistance to abrasives in the pumpage
- Corrosion resistance
- Reduced friction improving efficiency

A few prominent product suppliers include

- | | | |
|-----------|--------------|--|
| ■ Belzona | ■ Chesterton | ■ Vendor support |
| ■ Devcon | ■ Dupont | <input type="checkbox"/> Application Engineering |
| ■ Duromar | | <input type="checkbox"/> Training |

Abrasion & Corrosion Examples



Cavitation Damage



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Coating to Improve Pump Efficiency

□ Improving efficiency saves energy

- 750 gpm @ 175 ft head @ 70% efficiency = 50 HP
- Operated 5000 hr/yr @ \$0.10/kWhr = \$17,660 /yr
- Improve efficiency to 75% = 45 HP / \$16,483 /yr

■ Saving:	<hr/> \$ 1,177 /yr
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□ Application cost

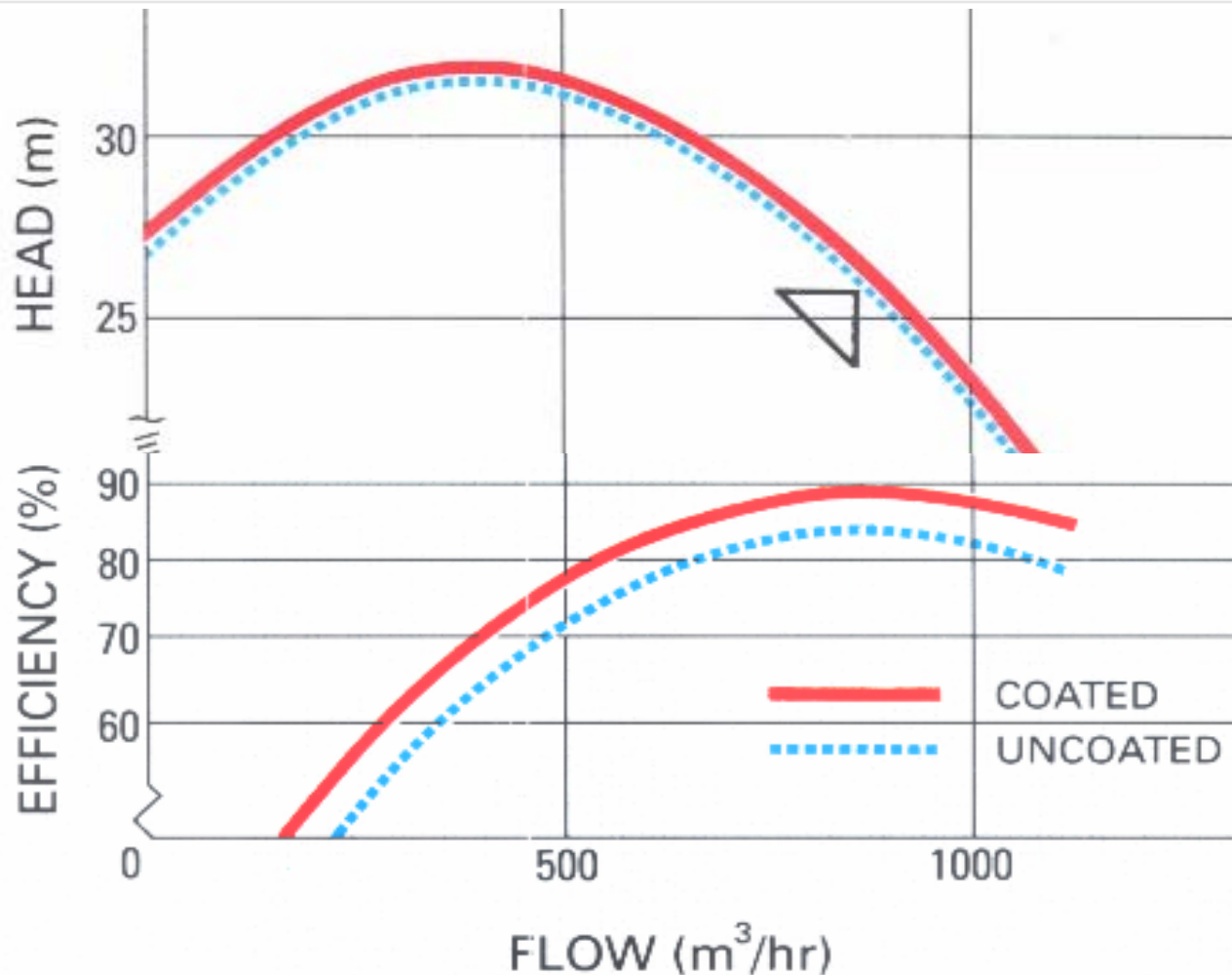
- | | |
|-------------------------------|--------|
| ■ Brushable resilient coating | \$ 275 |
| ■ 1 hr. application labor | \$ 125 |

■ Total Cost:	<hr/> \$ 400
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Repair Time is an Upgrade Opportunity

- Coatings cost is a small incremental cost
- Investment yields significant payback
 - Short ROI payoff
 - Energy usage reduction
 - Extended mean time between repairs

Quantifying Potential Improvement



At BEP
875 m³/hr, 26.5 m

75.5 KW, 83.5% η
Improved to
70.4 KW, 89.5% η

Equals an efficiency
Improvement of
6 percentage points

Independent Laboratory Test – U.K., N.E.L., 1989

Quantifying Potential Improvement

- Documented Results: 6%
- End user reported: 5% - 10%
- Vendor Claims 10% - 15%

- Further Study is underway
 - By application
 - By pump type
 - By N_s

Indirect Energy Savings

- Energy efficiency has been identified as a benefit from improved Pump Reliability
 - Erosion, Corrosion and Cavitation damage impeller & volute surfaces, increasing friction
 - Outages disrupt process operation, requiring process startup energy
 - Spillage wastes process energy
- Coatings improve reliability and extend mean time between service

Surface Conditions

□ Pump surface \approx Pipe surface:

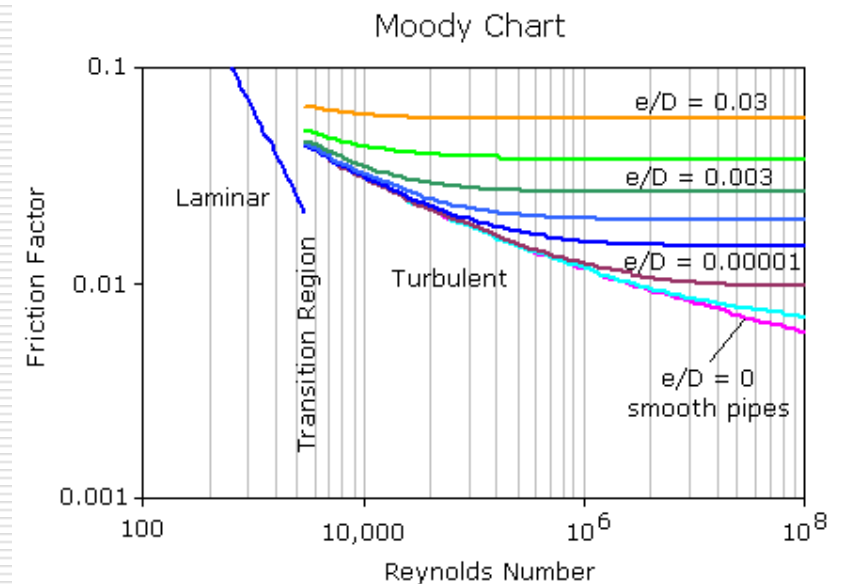
- Absolute Roughness (e)
- Relative Roughness (e/D , D =pipe diam.)

□ Machined Pump Surfaces

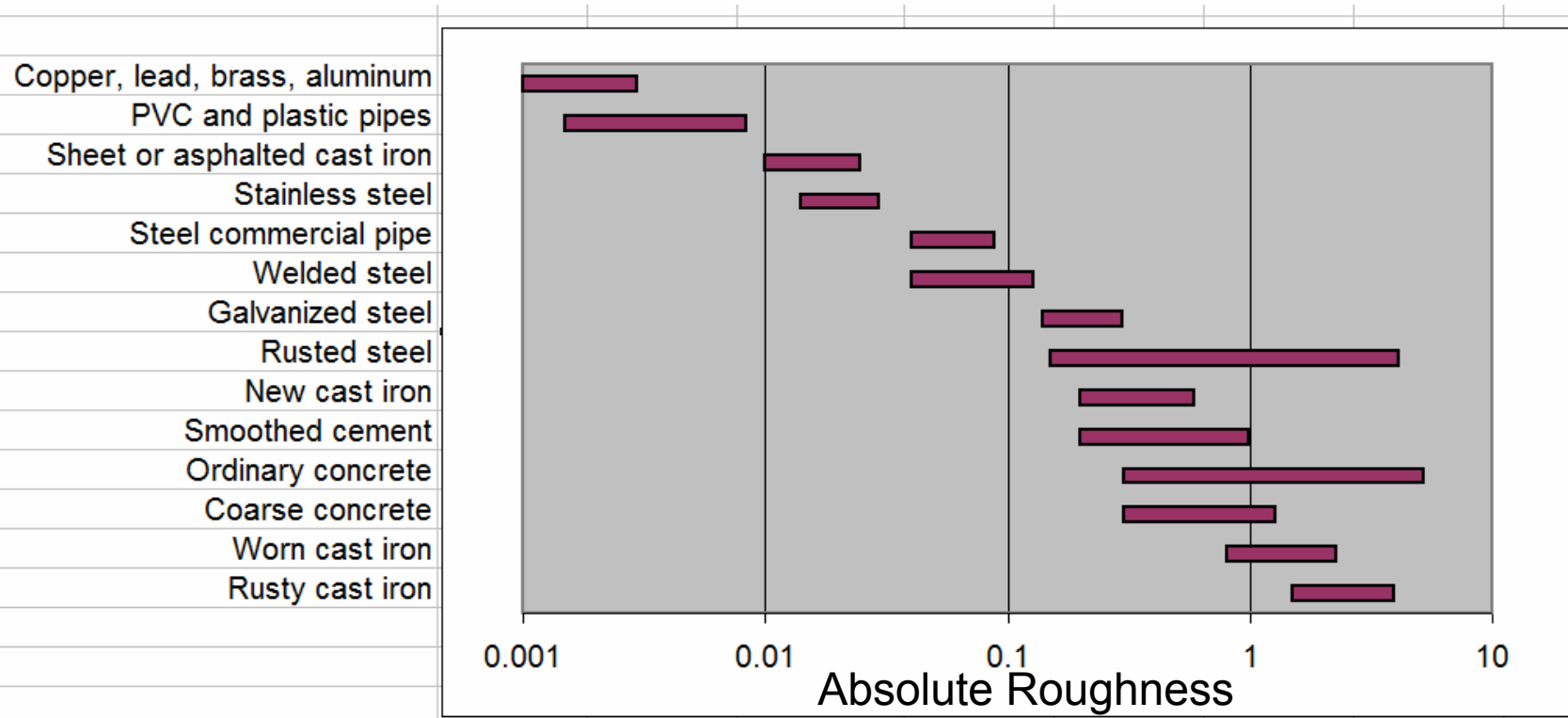
- Ra (roughness average)

□ Coated Surface

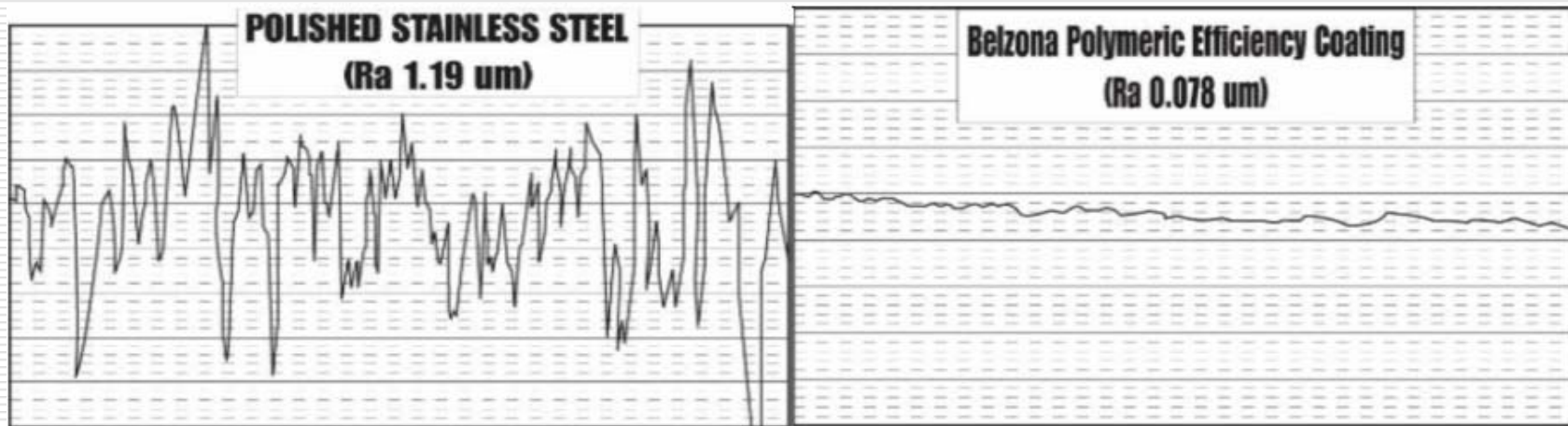
- Ra (roughness average)
- Diffusion / reflectivity



Original Surface Roughness



Coating Surface Roughness



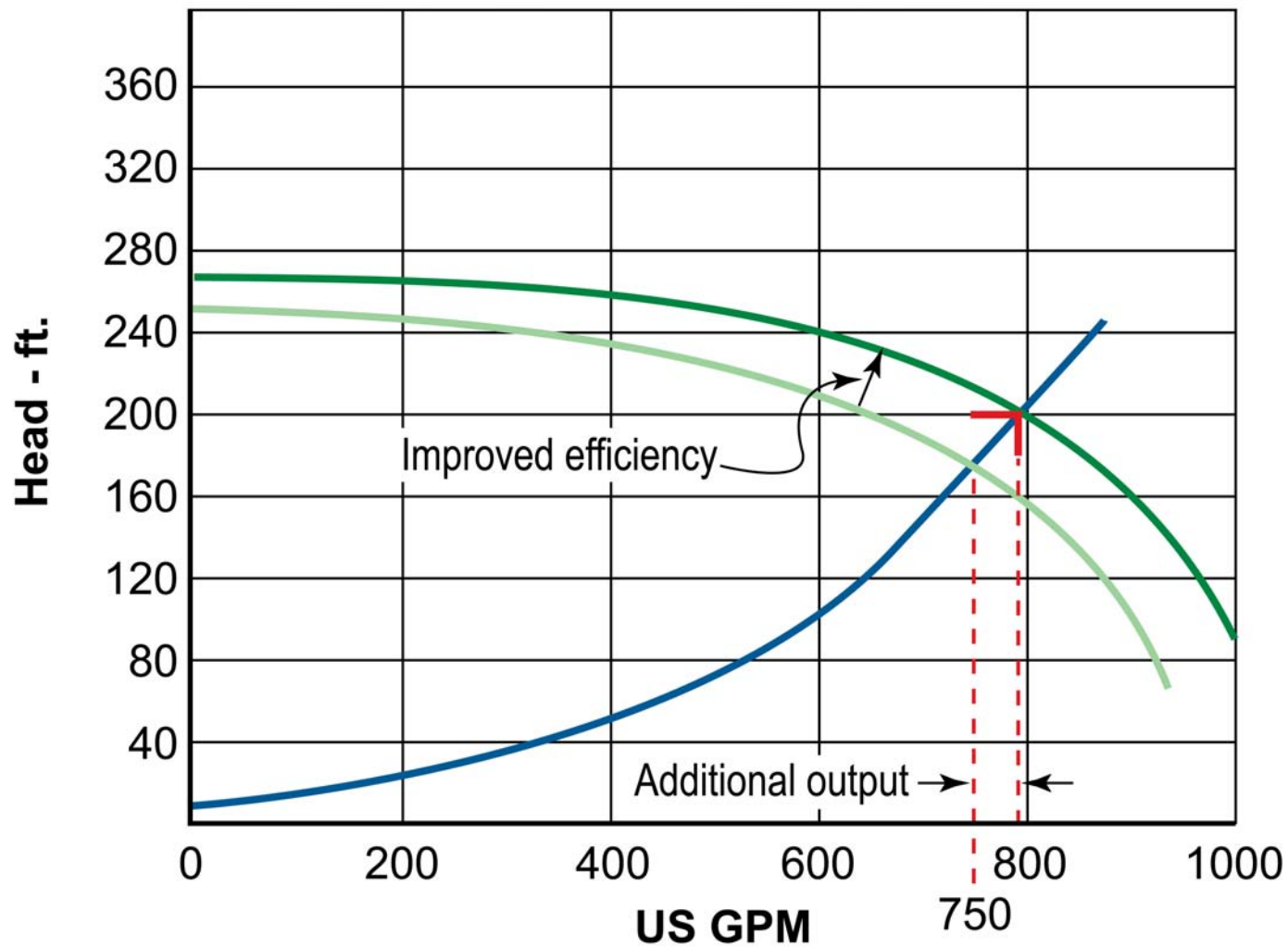
Surface \approx Efficiency

- New Cast Iron \approx 100:1 \approx Coated Surface
- In-service surface condition
 - Corrosion roughness x 10
 - Erosion roughness x 10
 - Organic matter roughness x 20
- Coatings resist corrosion, erosion & organic matter adhesion

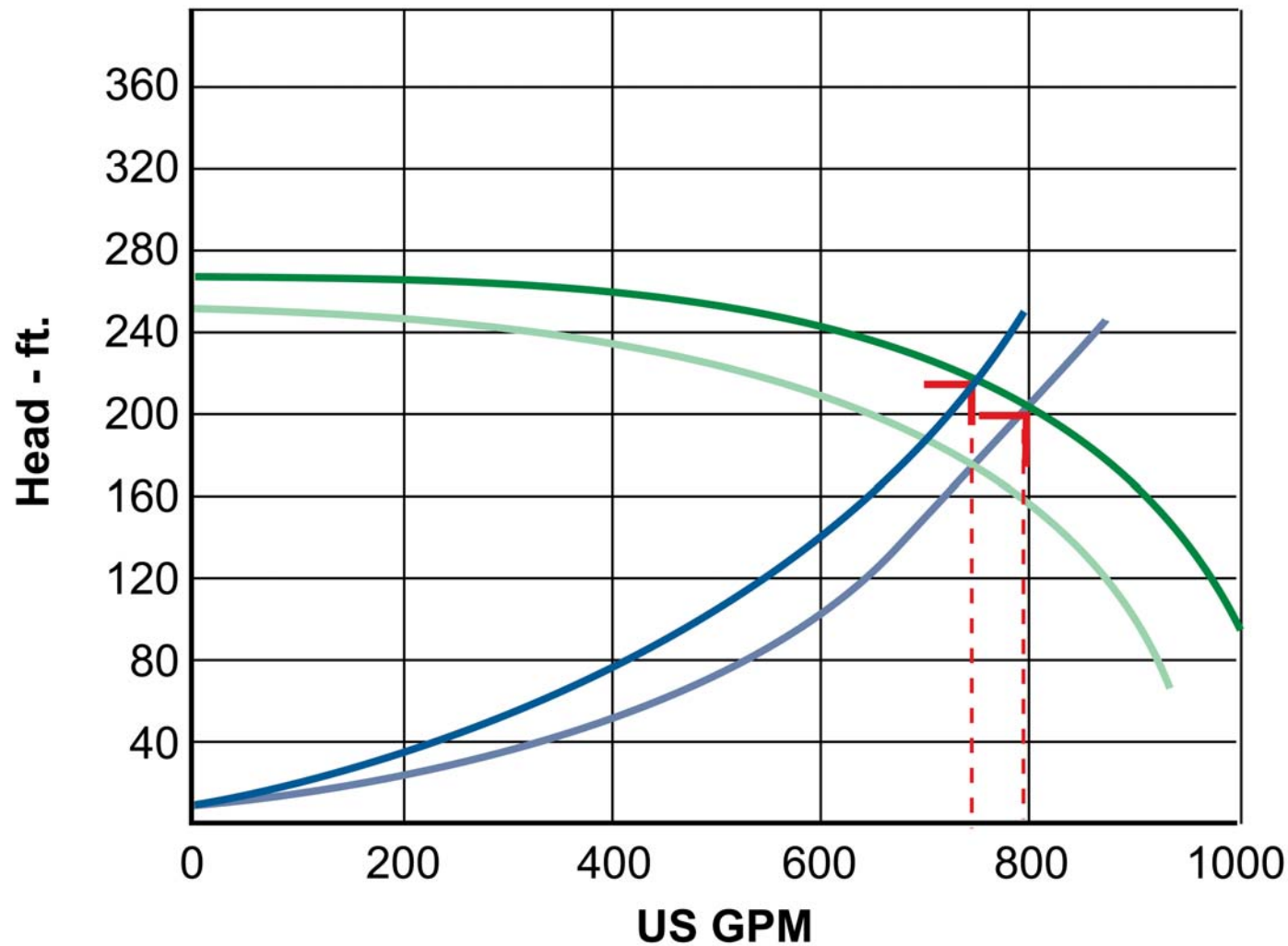
When does it pay off?

- Implement
 - at service outages
 - at initial purchase
- High volume pumps without discharge throttling
- The Pump Curve tells the story!

Affect of Efficiency on the Curve







Throttling efficiency back out



No Energy Savings on Throttled Pumps

- ❑ Systems controlled by throttle valves will compensate for increased flow – negating savings
- ❑ Flow controlled with pump speed – Lower speed equates to lower energy usage = savings
- ❑ Flow controlled by cycling – Shorter run times reduces energy usage = savings

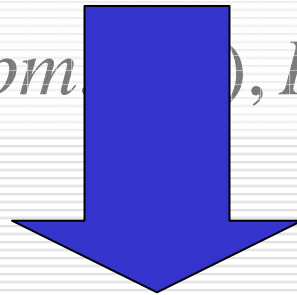
Flow Control Methods

	Method	Coating Benefits
1	Discharge Throttle	
2	Variable Speed Drive	
3	Accumulator	
4	Bypass	

Specific Speed

$$\text{Specific Speed, } N_s = \text{RPM} \times \frac{Q^{1/2}}{H^{3/4}},$$

where $Q = \text{Flow}(m^3 / h, \text{gpm})$, $H = \text{Head}(m, \text{ft})$

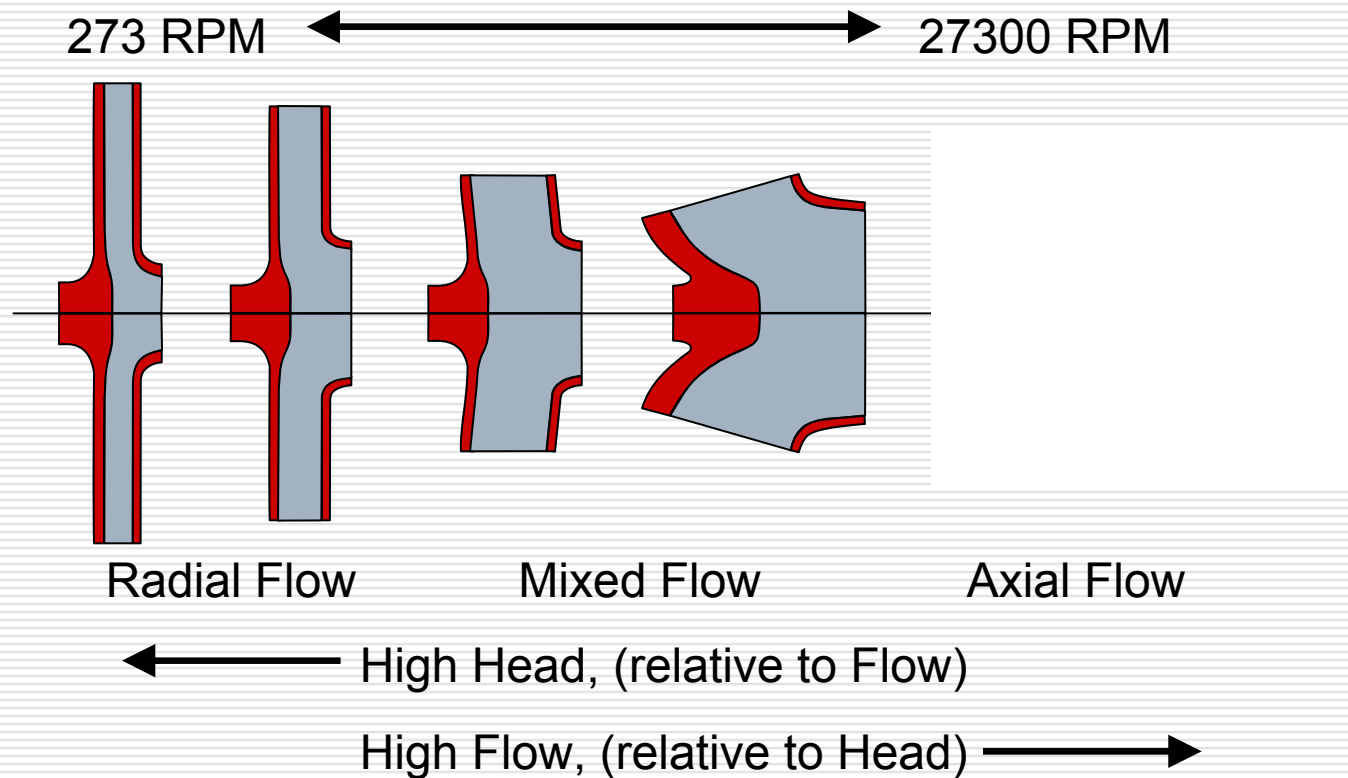


$$P_I = \frac{Q \times H \times \text{s.g.}}{k \times \eta}$$

$\frac{Q}{H}$	<i>Flow</i>
	<i>Head</i>

Impeller Specific Speed

□ Specific Speed is a ratio of Flow to Head



Efficiency Losses

- Power in (P_I)
- Mechanical losses (P_M)
- Volumetric losses (P_V)
- Hydraulic losses
 - Recirculation (P_R)
(turbulence)
 - Friction losses
 - Impeller
 - Disk friction (P_{DF})
 - Channel (P_{CF})
 - Casing
 - Volute (P_{VF})
 - Diffuser (P_{VF})

$$P_I = \frac{Q \times H \times s.g.}{k \times \eta}$$

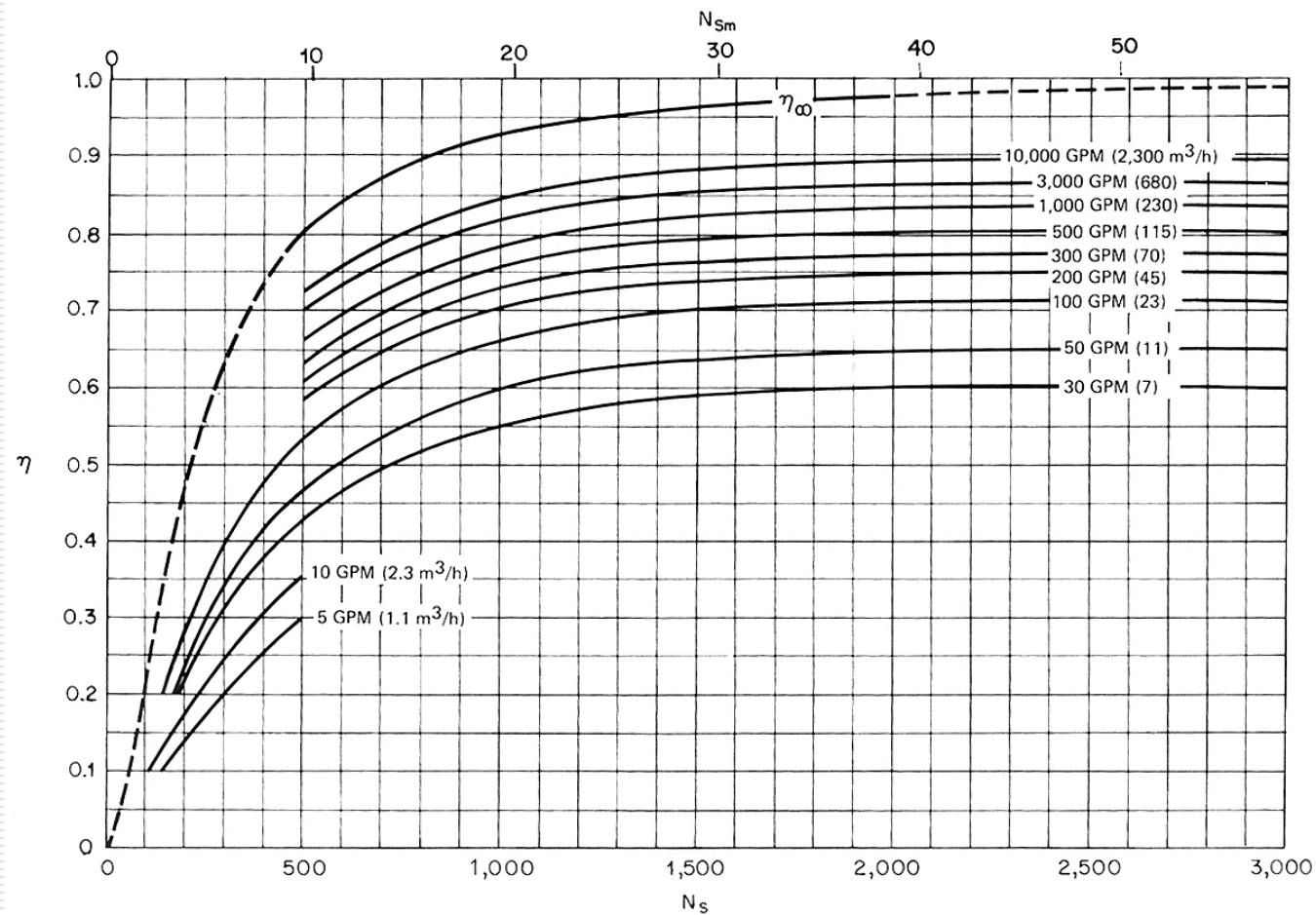
$$\eta = \frac{P_I - P_M - P_V - P_R - P_{DF} - P_{CF} - P_{VF}}{P_I}$$

Specific Speed - N_s

For Closed Centrifugal Impellers

- *Low N_s – radial flow*
 - *High disk friction component +*
 - *Coating limits impeller discharge area –*
 - *Lower Flow to Power ratio –*
- *Higher N_s – Mixed flow*
 - *Negligible effect on impeller discharge +*
 - *Higher Flow to Power ratio +*

Wislicenus Chart – η vs. N_S vs. Q



Pump Selection - Summary

- Flow control: variable speed or accumulator
- Size: smaller pumps have good potential saving on a per KW (HP) basis
- Specific speed:
 - All pumps have potential saving; further testing may indicate the extent to which N_s is a factor

Applying Coatings

Adherence to substrate

■ Mechanical

- requires grit blasting

■ Chemical

- requires absence of any surface contamination or corrosion
- Corrosion forms within hours of exposure to ambient air

Applying Coating

- Consistency (viscosity)
 - Sprayable: epoxy paint
 - Brushable: most specialized polymer coatings
 - Trowelable: certain specialized products
- Coating thickness must be controlled
 - Affects cross sectional area at impeller discharge (low N_s impellers)
 - Affects mass imbalance of the impeller

Applying Coatings

- Coatings are two part products
 - Require accurate proportions by volume or weight
 - Will cure at 20°C (70°F), 8–12 hr. typical
 - Increased temperature reduces cure time
 - Special formulated products cure at lower temperature

-
- Application Requirements suggest applying coatings
 - At purchase
 - Include in purchase specification
 - Incremental purchase cost – capital budget
 - At service opportunities
 - Include in service specification
 - Incremental service cost – MRO budget

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- Coating offer an inexpensive opportunity to improve pump efficiency
 - Proper selection of candidate pumps
 - Specified at purchase
 - Specified at repair/overhaul
 - Bolstered by indirect savings
 - Improved reliability
 - Extended Mean Time Between Repair