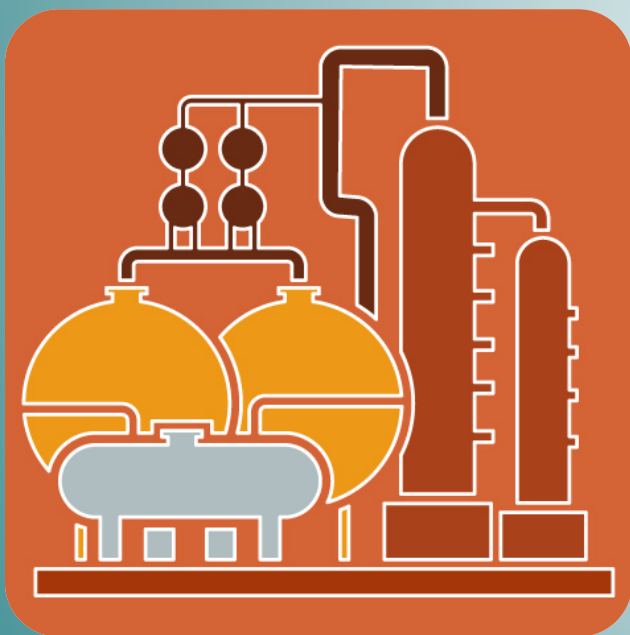


# Chemical Process Design / Diseño de Procesos Químicos

## Topic 5.6. Pumps



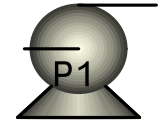
**Javier R. Viguri Fuente**  
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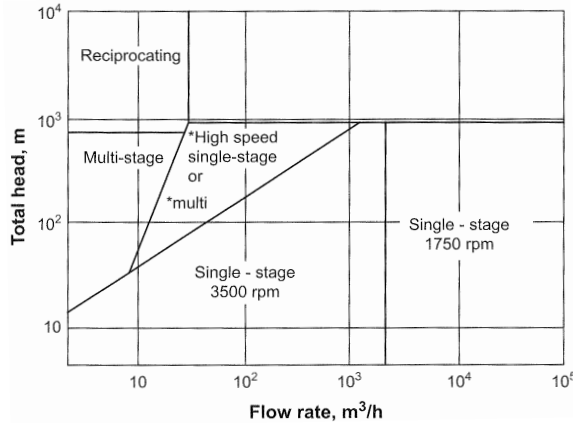
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# Shortcut for Pump Sizing



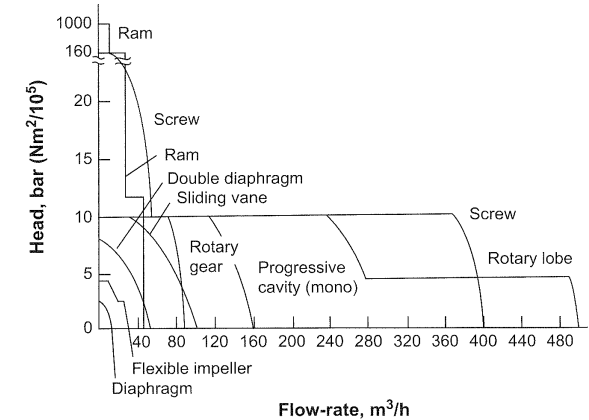
## Normal operating range of pumps



Centrifugal pumps selection guide.

(\*) Single-stage > 1750 rpm, multi-stage 1750 rpm.  
Sinnott, R. & Towler, G. (2009).

Type	Capacity Range (m <sup>3</sup> /h)	Typical Head (m of water)
Centrifugal	0.25 - 10 <sup>3</sup>	10 - 500 (multistage)
Reciprocating	0.5 - 500	50 - 200
Diaphragm	0.05 - 500	5 - 60
Rotary gear and similar	0.05 - 500	60 - 200
Rotary sliding vane or similar	0.25 - 500	7 - 70



Selection of positive displacement pumps.

(Sinnott, R. & Towler, G. (2009).

- **Centrifugal pumps** most common. **Assumptions:** Isothermal conditions.

- **Brake horsepower:** 
$$W_b = \mu \frac{(P_2 - P_1)}{\rho \eta_P \eta_M}$$

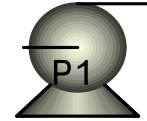
Pump:  $\eta_P = 0.5$  (less than  $\eta_C = 0.8$  because of frictional problems in L); Motor:  $\eta_M = 0.9$

$W_b \ll W_c \rightarrow \epsilon_b \ll \epsilon_c$  in 2 orders of magnitude  $\rightarrow$  Changing P in the pumps during heat integration in distillation columns does not greatly increase the cost.

Use electrical motors, not turbines as drivers in pumps.

# Guthrie Material and Pressure Factors for Centrifugal Pumps and Drivers

## Pumps




### Guthrie MPF for Centrifugal Pumps and Drivers

$$\text{MPF} = F_m \cdot F_o$$

<u>Material Type,</u>	<b>F<sub>m</sub></b>
Cast iron	1.00
Bronze	1.28
Stainless	1.93
Hastelloy C	2.89
Monel	3.23
Nickel	3.48
Titanium	8.98

<u>Operating Limits,</u>	<b>F<sub>o</sub></b>		
Max. Suction P (psig)	150	500	1000
Max. T (°F)	250	550	850
F <sub>o</sub>	1.0	1.5	2.9

# Pumps

Equipment Type	$C_0$ (\$10 <sup>3</sup> )	$S_0$	Range (S)	$\alpha$	MF2 / MF4 / MF6 / MF8 / MF10
 Centrifugal pumps <i>S = C/H factor (gpm x psi)</i>	0.39	10	10 - 2.10 <sup>3</sup>	0.17	3.38 / 3.28 / 3.24 / 3.23 / 3.20
	0.65	2.10 <sup>3</sup>	2.10 <sup>3</sup> - 2.10 <sup>4</sup>	0.36	3.38 / 3.28 / 3.24 / 3.23 / 3.20
	1.5	2.10 <sup>4</sup>	2.10 <sup>4</sup> - 2.10 <sup>5</sup>	0.64	3.38 / 3.28 / 3.24 / 3.23 / 3.20

**S**  $\equiv$  Pump Power = Flow rate Output (Gpm) · Pressure (psi)

$C = BC = C_0 (S / S_0)^\alpha$

**MF (Module Factor)**

- MF 2: If C < 200.000 \$
- MF 4: If C = 200.000 - 400.000 \$
- MF 6: If C = 400.000 - 600.000 \$
- MF 8: If C = 600.000 - 800.000 \$
- MF 10: If C = 800.000 - 1.000.000 \$

Materials and Pressure correction Factor (Vessels):  $MPF = F_m \cdot F_o$

Update Factor UF = Present Cost Index ( $CI_{actual}$ ) / Base Cost Index ( $CI_{base}$ )

Updated bare (simple) module cost:  $BMC = UF(BC) (MPF + MF - 1)$

# Pumps



## Specifications

- **Pump Type:** Centrifugal.
  - **Flow / P Specifications:**
    - Liquid Flow: 170.000 GPM.
    - Discharge P: 43.0 psi.
    - Inlet Size: 2.000 inch.
    - Discharge Size: 1.500 inch.
    - Media Temperature: 250 F.
  - **Power Specifications:**
    - Power Source AC.
    - 100/200 Single.
  - **Market Segment:**
    - General use.
    - Paper Industry.
- **Pump Type:** Centrifugal.
  - **Flow / P Specifications:**
    - Liquid Flow: 15400.000 GPM.
    - Discharge P: 212.0 psi.
    - Inlet Size: 16.000 inch.
    - Discharge Size: 16.000 inch.
    - Media Temperature: 572 F.
  - **Power Specifications:**
    - Power Source AC.
    - Electric Motor.
  - **Market Segment:**
    - General use.
    - Mining.
    - Chemical Industry.
- **Pump Type:** Centrifugal.
  - **Flow / P Specifications:**
    - Liquid Flow: 1541.003 GPM.
    - Discharge P: 507.6 psi.
    - Media Temperature: 662 F.
  - **Power Specifications:**
    - Power Source DC.
  - **Market Segment:**
    - General use.
    - Petrochemical or Hydrocarbon.
    - Chemical Industry.
  - **SULZER:** <https://www.sulzer.com/en>.