3. Tecnologia de Vácuo

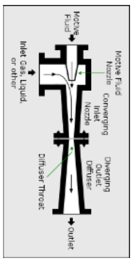
Prof. José Humberto Dias da Silva
Ciência e Tecnologia de Filmes Finos
POSMAT – Unesp/Bauru

O que vimos na aula passada ? [aula 06]

Resumo

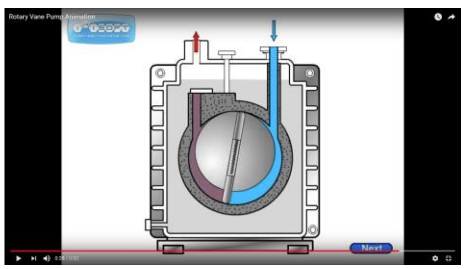
- Vácuo ≡ baixas pressões
- bombas de vácuo
- vedações

... do mais simples ...



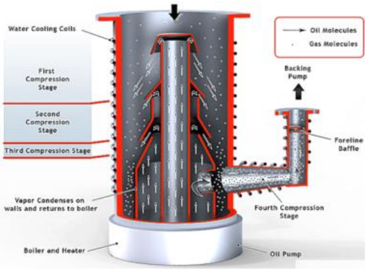
http://physics.kenyon.edu/EarlyApparatus/Pneumatics/Vacuum_Pump/Vacuuum_Pump.html

https://www.youtube.com/watch?v=AFHogF-9eGA



https://www.agilent.com/en/video/agilent-idp-dry-scroll-pump-family

Bomba scroll

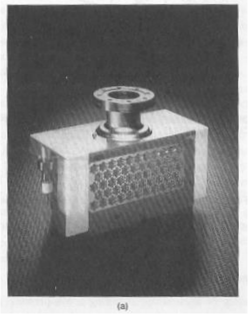


STP MAGNETICALLY LEVITATED TURBOMOLECULAR PUMPS

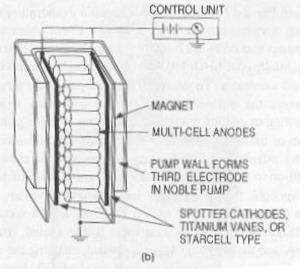
... ao mais sofisticado....

5-axis control The STP600, STP1000, STP2001 and all the high throughput pumps (H-C), utilise a full 5 active axis system with electromagnets for all bearings. This patented, fully active system allows an automatic balancing system to be used.

0



(a)



(b)

- **Bombas iônicas e de sublimação**

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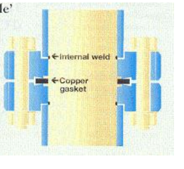
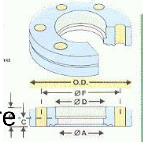
Ultra alto vácuo (UHV, p ~ $10^{-6} – 10^{-11}$ torr)





Selo metálico – Anéis de cobre
(CONFLAT)

Resumindo:

⇒ Há diferentes tecnologias disponíveis para gerar baixas pressões (“vácuo”)

⇒ Cada tipo de bomba é adequada para uma determinada faixa de pressões

⇒ Os sistemas de vácuo devem ser pensados pela pressão final e pela quantidade de fluido bombeado !

3.2 Tecnologia de Vácuo

[aula 07]

Prof. José Humberto Dias da Silva
Ciência e Tecnologia de Filmes Finos
POSMAT – Unesp/Bauru

- (a) Medidores de pressão
- (b) Analisadores de gases
- (c) Regimes de escoamento
- (d) Medidores de Fluxo
- (c)Exercícios – Caps. 2 e 3

- 3.3 (b) Vazão e veloc. de bombeamento

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- 3.2 (a) Medidores de pressão

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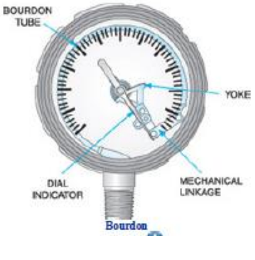
Pressões acima da atmosférica

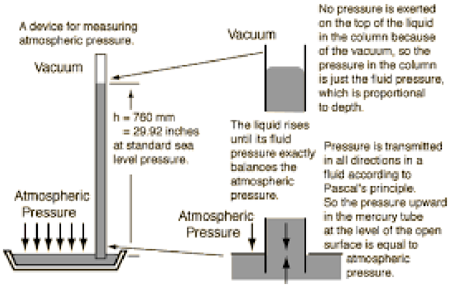
Manômetros tipo Bordon

P: Como esses medem a pressão?



KJL Tecninical notes (língua de sogra)

Pressão atmosférica



1ATM = 760 mm Hg = 1.01 x 10^5 Pa (N/m^2)

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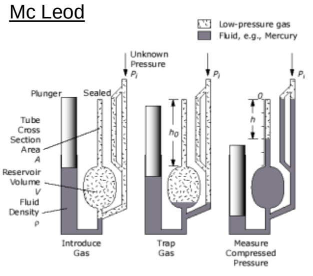
1 bar = 10^5 Pa (N/m^2) ~ 1 ATM

1 torr = 133 Pa = 1.33 mbar

1 psi (libra/polegada^2) = 7.000 Pa = 52 torr

Baixas pressões

Mc Leod



$$P_i = ah^2/V$$

https://www.youtube.com/watch?v=VxFsVV4a0Ag

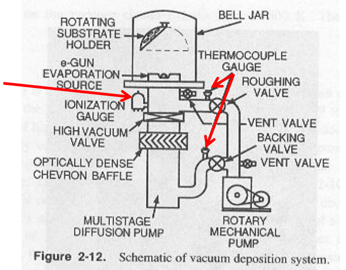
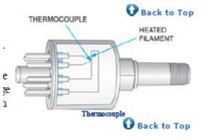
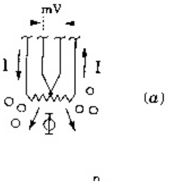


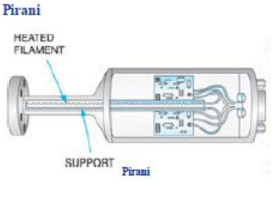
Figure 2-12. Schematic of vacuum deposition system.

termopar

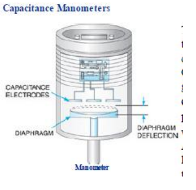


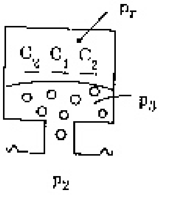


p_{ATM}- 10^{-2}torr



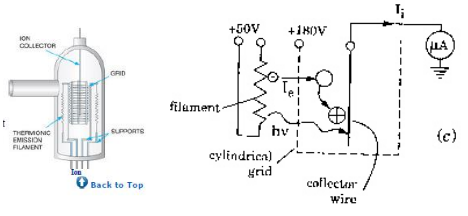
capacitância





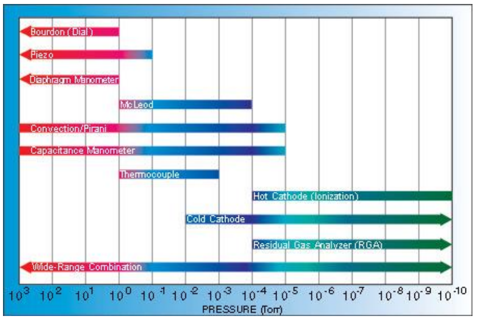
1 - 10^{-4}torr

Iônico / Hot filament



$10^{-3} – 10^{-11}$ torr

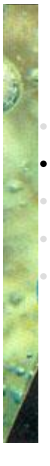
Range – medidores de pressão



Medidores de Pressão

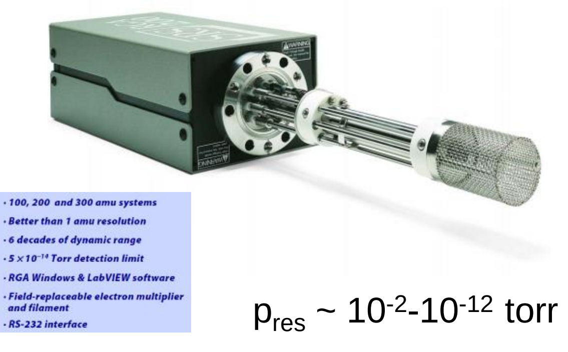
Conclusão:

* os medidores de pressão (vácuo) têm suas escalas típicas.



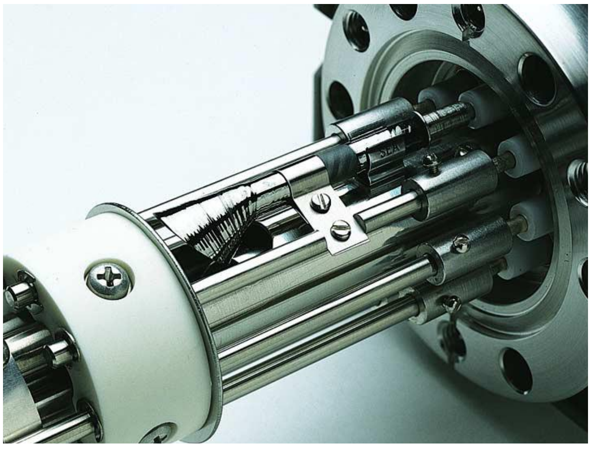
- Medidores de pressão
- 3.2 (b) Analisadores de gases
- Regimes de escoamento
- Medidores de Fluxo
- Exercícios – Cap. 3

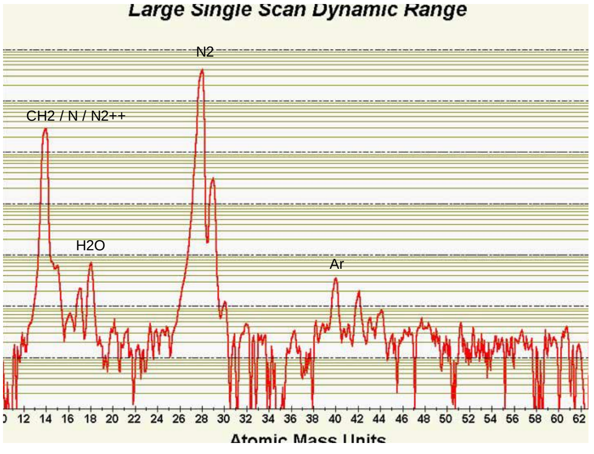
Analisador de gases residuais



$p_{res} \sim 10^{-2}$-10^{-12} torr

Analisador de gases residuais





Analisadores

Regimes de escoamento

- Medidores de pressão
- Analisadores de gases
- 3.2 (c) Regimes de escoamento
- Medidores de Fluxo
- Exercícios – Cap. 3

Regimes de Escoamento

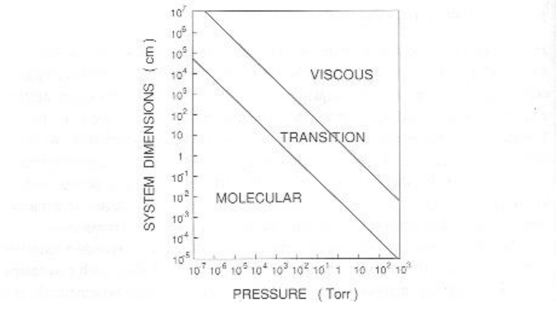
$$K_n = {}^{l}\!/_{L}$$

l = livre caminho médio

L=tamanho do sistema

Número de Knudsen:

- **Kn > 1 – alto vácuo, colisões molécula-paredes (molecular)**
- **Kn << 0,01 – fluxo de fluido, colisões molécula-molécula (fluido / viscoso)**
- **0.01<< Kn < 1 – regime intermediário**



Regimes de fluxo de gás dominantes em função das dimensões do sistema e pressão

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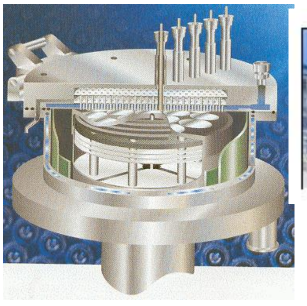
Reator CVD complexo (comercial)



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Fluxo de gás / Inomogeneidades

322 Chemical Vapor Deposition

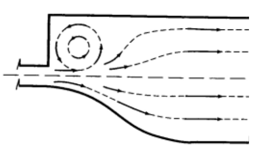

Figure 7.7 Two alternative reactor-entrance geometrie patterns (upper and lower halves). The upper patter avoided.

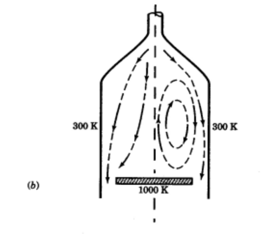

Figure 7.12 Typical free-convection roll cells: (a) horizontal rectangular-tube reactor (view along axis) with two alternate sidewall conditions, insulated (left) and cooled (right); (b) downflow axisymmetric reactor, showing two alternate flow patterns. In (b), the recirculating pattern (right) is to be avoided.

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Distribuição de velocidades nas proximidades do susceptor (porta substratos).

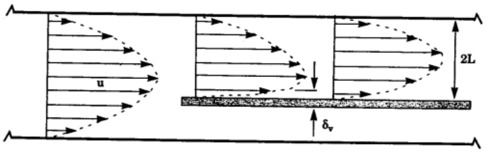

Figure 7.8 Velocity boundary layer of width δ_v forms at the susceptor leading edge in a tube reactor.

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Linhas de fluxo de gás / simetria axial

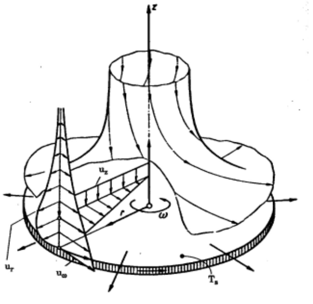

Figure 7.10 Axisymmetric flow pattern over a rotating disc. (Source: Reprinted from Ref. 7 by permission, © 1968 by McGraw-Hill Book Co.)

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3.3 Tecnologia de Vácuo

- Medidores de pressão
- Analisadores de gases
- Regimes de escoamento
- 3.3 (a) Controladores de Fluxo
- Vazão e velocidade de bombeamento
- Exercícios – Cap. 3

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