

A.08.02 – Misturas Gás-Vapor e Condicionamento de Ar

Fenômenos de Saturação do Vapor no Ar

Prof. C. Naaktgeboren, PhD



<https://github.com/CNThermSci/ApplThermSci>

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1 Temperatura do Ponto de Orvalho

• Saturação Adiabática e Temperatura de Bulbo Úmido

- Saturação Adiabática
- Temperatura de Bulbo Úmido
- Psicrômetro Giratório

3 Referências e Tópicos de Leitura

Esta apresentação baseia-se nas referências [1], Seções 14-3 a 14-4 (tópicos de leitura) e [2].

Temperatura do Ponto de Orvalho, T_{po}

Definition

Temperatura de ponto de orvalho é definida como a temperatura na qual se dá o **início da condensação** quando o ar é resfriado à **pressão constante**.



Processo de resfriamento a pressão constante desde a temperatura inicial, T_1 , até a temperatura do ponto de orvalho, T_{po} . Diagrama em escala
Fonte: autoria própria

Temperatura do Ponto de Orvalho, T_{po}



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Temperatura do Ponto de Orvalho, T_{po}



www.liquidimageco.com



www.quora.com

Temperatura do Ponto de Orvalho, T_{po}



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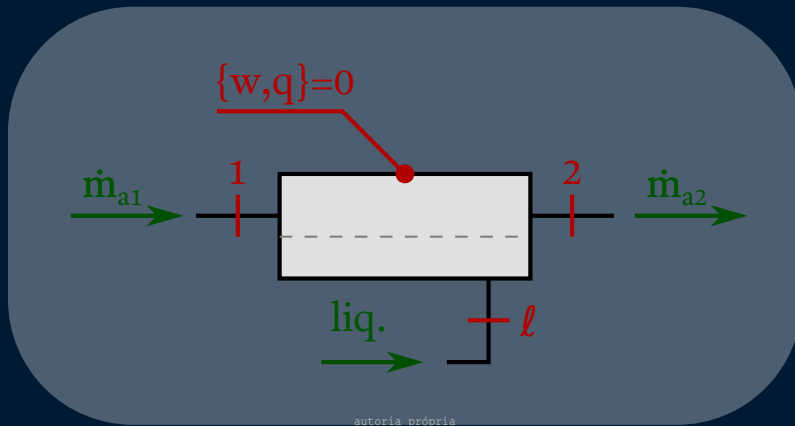
Saturação Adiabática

- Pressão parcial é um conceito de difícil medição direta;
- É desejável relacionar as umidades a grandezas de fácil medição;

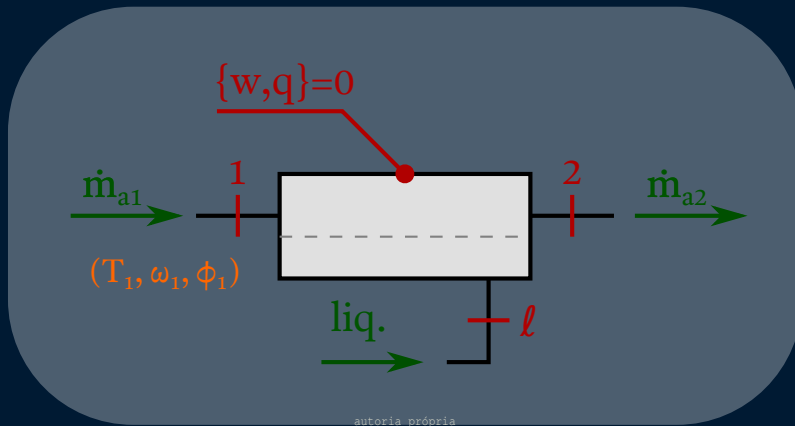
Saturação Adiabática

- Pressão parcial é um conceito de difícil medição direta;
- É desejável relacionar as umidades a grandezas de fácil medição;
- A medição da temperatura de orvalho, T_{po} , não é muito prática;

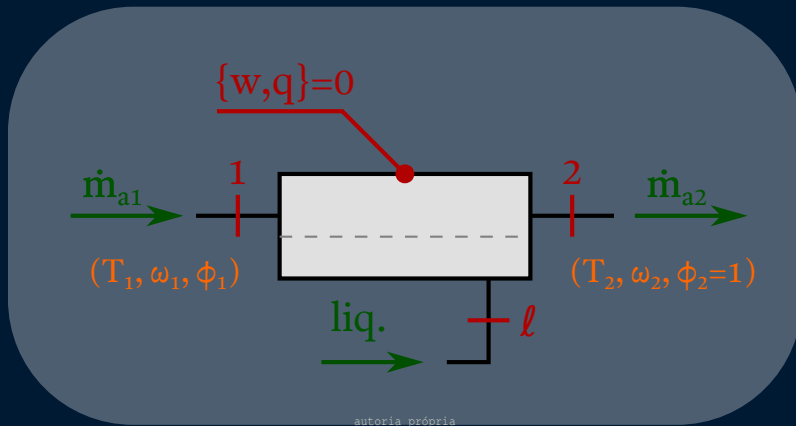
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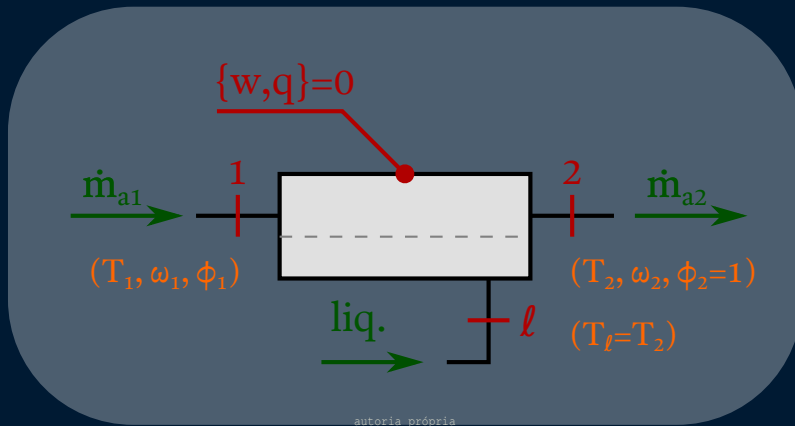
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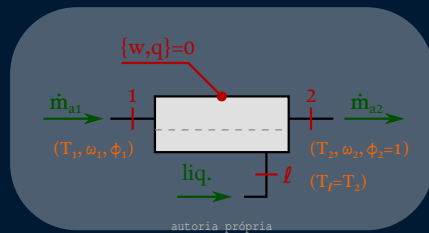


Saturação Adiabática



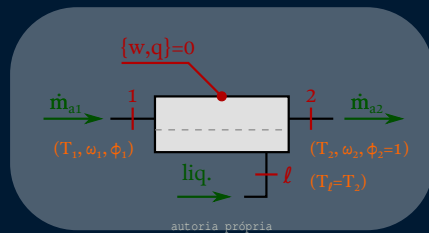
Balanco de Massa

$$\dot{m}_{a1} = \dot{m}_{a2}$$



Balanco de Massa

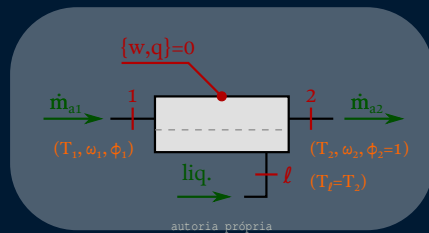
$$\dot{m}_{a1} = \dot{m}_{a2} = \dot{m}_a \quad (\text{ar seco})$$



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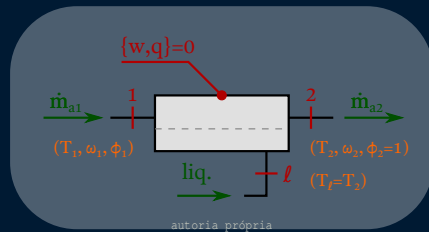
$$\dot{m}_{w1} + \dot{m}_l = \dot{m}_{w2}$$



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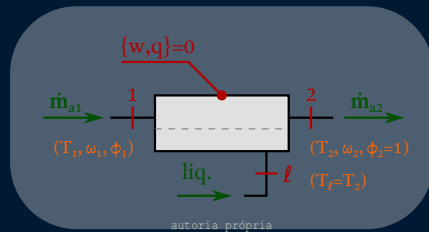


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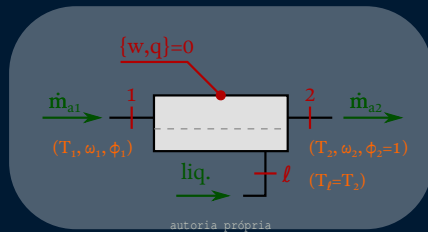


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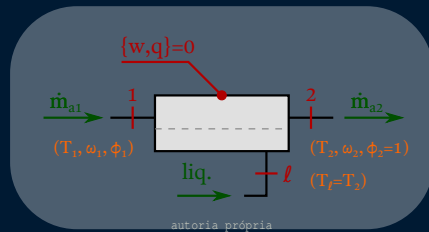
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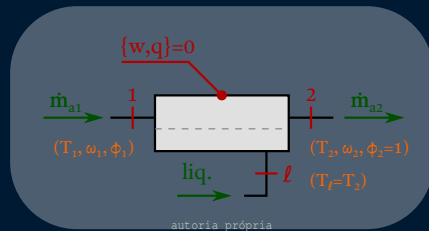
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$$\dot{m}_\ell = \dot{m}_a (\omega_2 - \omega_1).$$



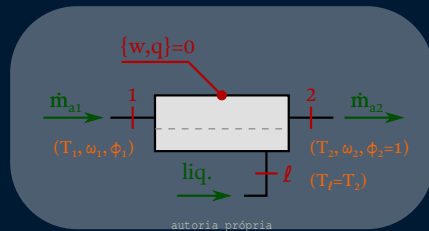
Balanco de Energia (com $Q = W = 0$)

$$\dot{E}_{ent} = \dot{E}_{sai}$$



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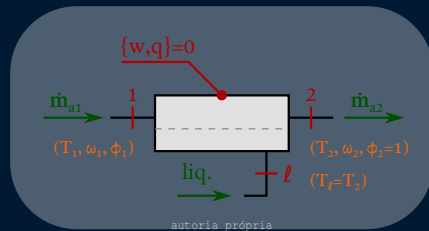
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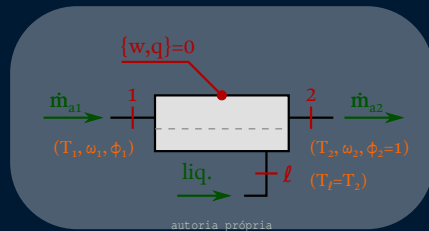
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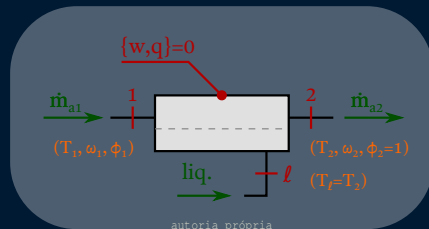


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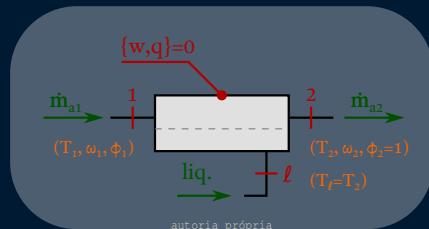


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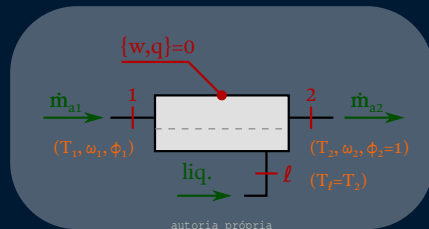
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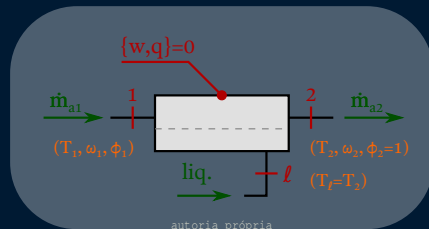
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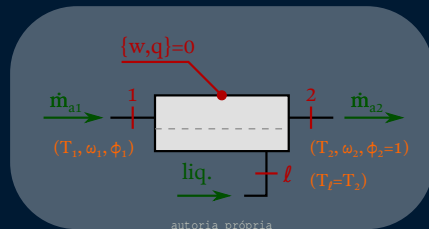
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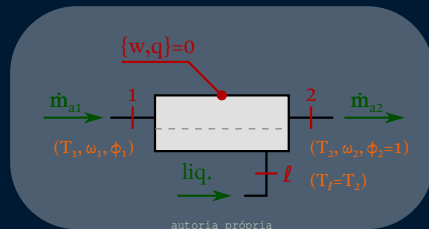
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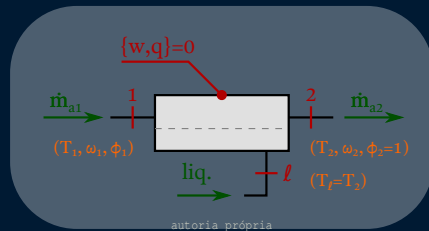
$$(c_P T_1 + \omega_1 h_{v1}) + (\omega_2 - \omega_1) h_\ell = (c_P T_2 + \omega_2 h_{g2})$$

$$\omega_2 = \frac{0,622 P_{g2}}{P - P_{g2}}; \quad \omega_1 = \frac{c_P (T_2 - T_1) + \omega_2 h_{lg2}}{h_{v1} - h_\ell}.$$



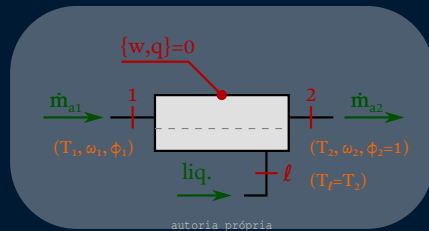
Exemplo: Ar entrando com $\phi_1 = 100\%$

$$\dot{m}_\ell = \dot{m}_a(\omega_2 - \omega_1) = 0 \text{ kg/s} \quad (\text{sat.})$$



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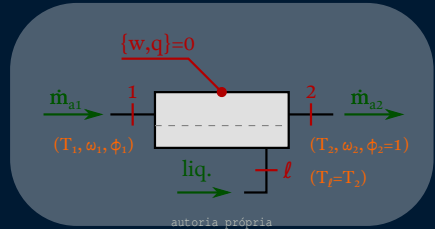
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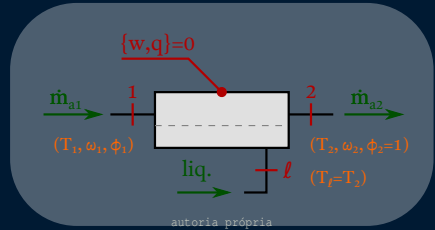
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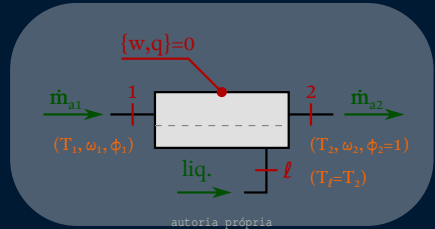


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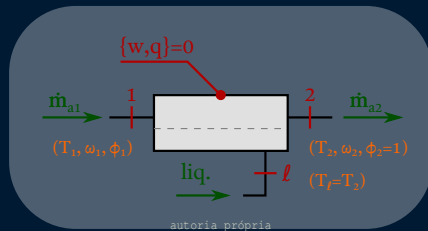


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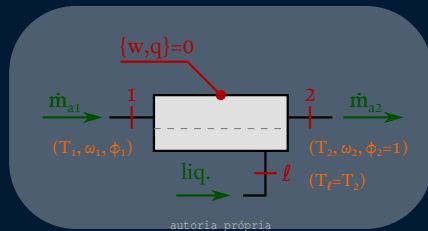
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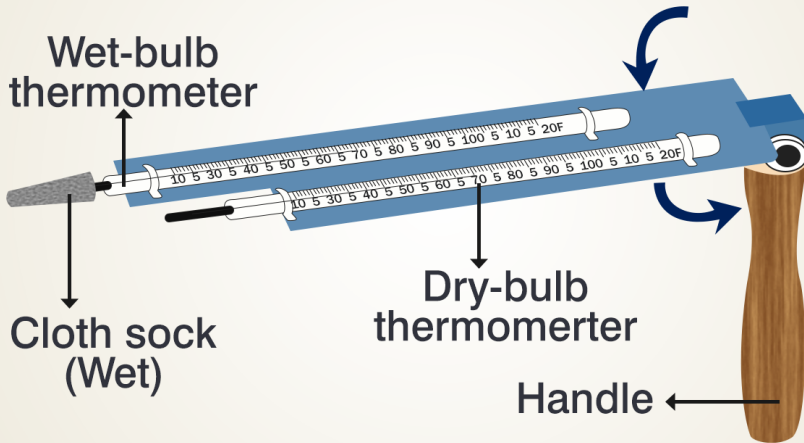
$$\omega_1 = \omega_2 \quad \rightarrow$$

$$h_1 = h_2 \quad \rightarrow$$

$$T_1 = T_2.$$



Sling Psychrometer



Referências – I

- [1] Y. A. Çengel and M. A. Boles.
Termodinâmica.
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- [2] D. L. Fenton.
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<https://www.pexels.com/photo/mountains-under-dark-clouds-in-evening-5592630/>