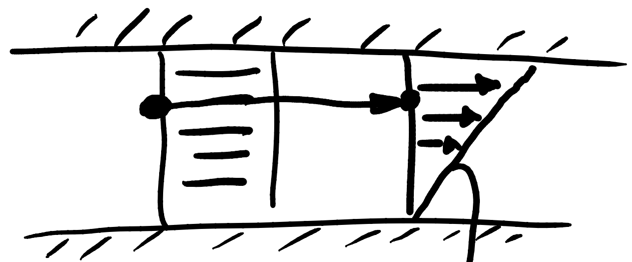
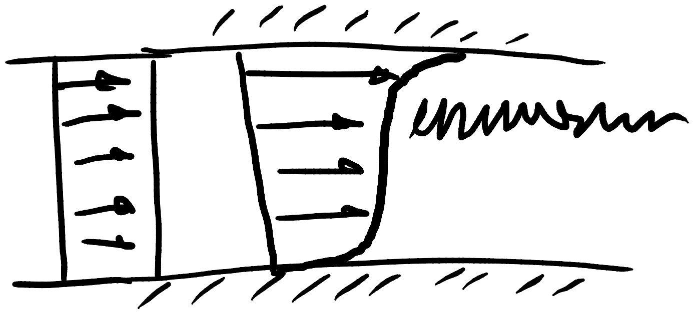
laminar

$\vec{u}$

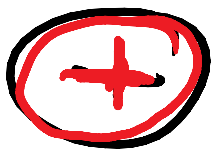


nichtlinear.

turbulent.

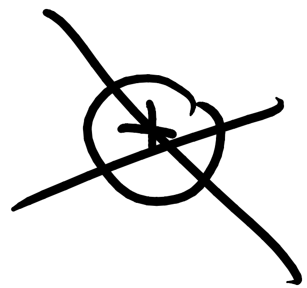


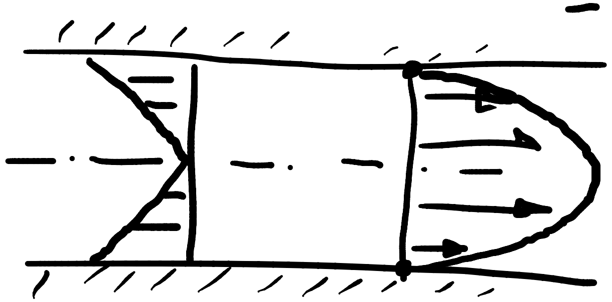
Schleppströmung

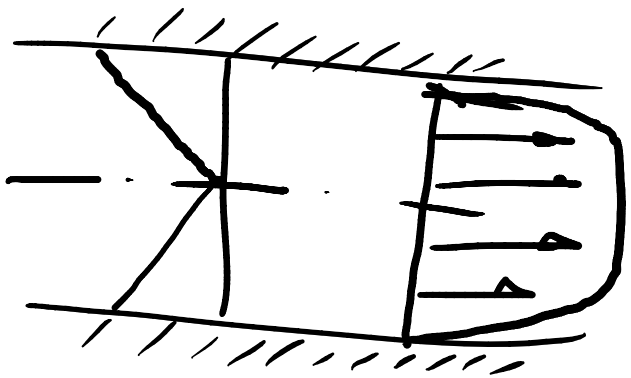


$$\underbrace{\rho \frac{D\vec{u}}{Dt}}_{\equiv 0} = \underbrace{-\nabla p + \eta \Delta \vec{u}}_{\text{linear.}}$$

$\equiv 0$, für quasistationäre, laminare Schichtenstr.







$$\nabla p = \eta \Delta \vec{u}$$

Druckstr.

↳ Superponieren.

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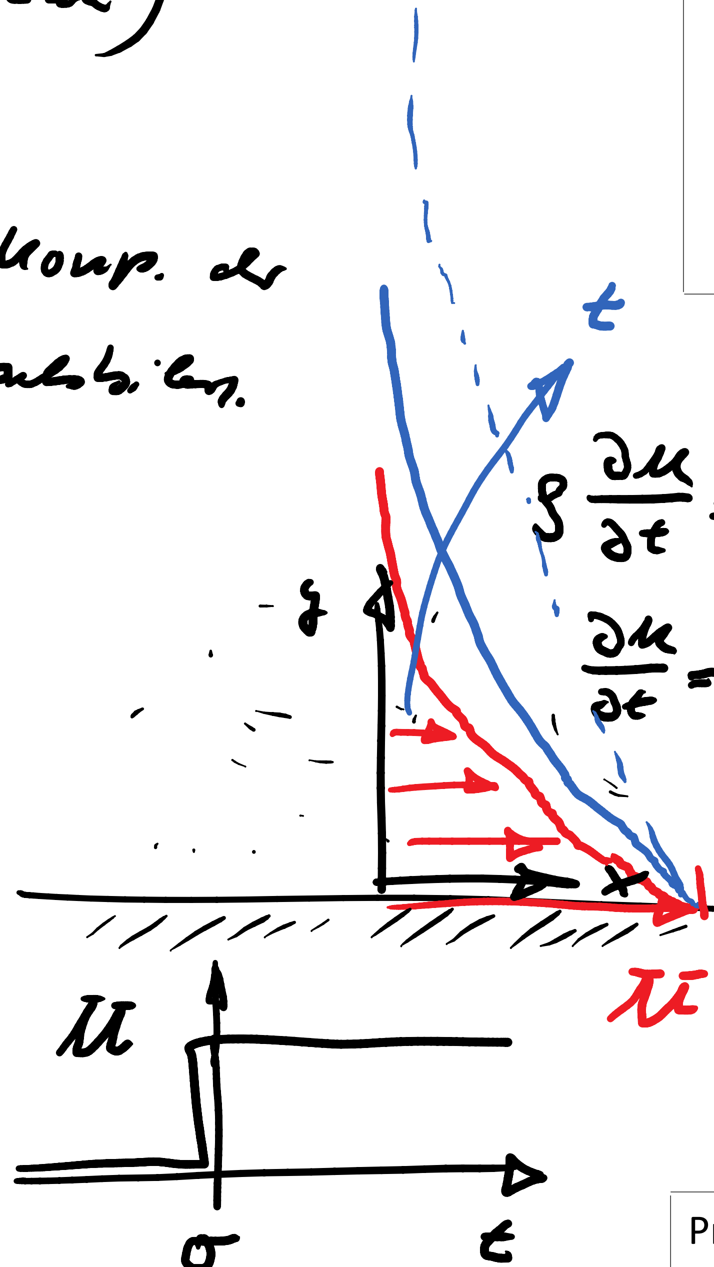
Instationäre Schichtenströmung (laminar)

$$\rho \frac{Du}{Dt} = -\frac{dp}{dx} + \eta \left(\frac{\partial^2 u}{\partial y^2} + \overbrace{\frac{\partial^2 u}{\partial x^2}}^{=0} \right)$$

x-Komp. der Impulsbilanz.

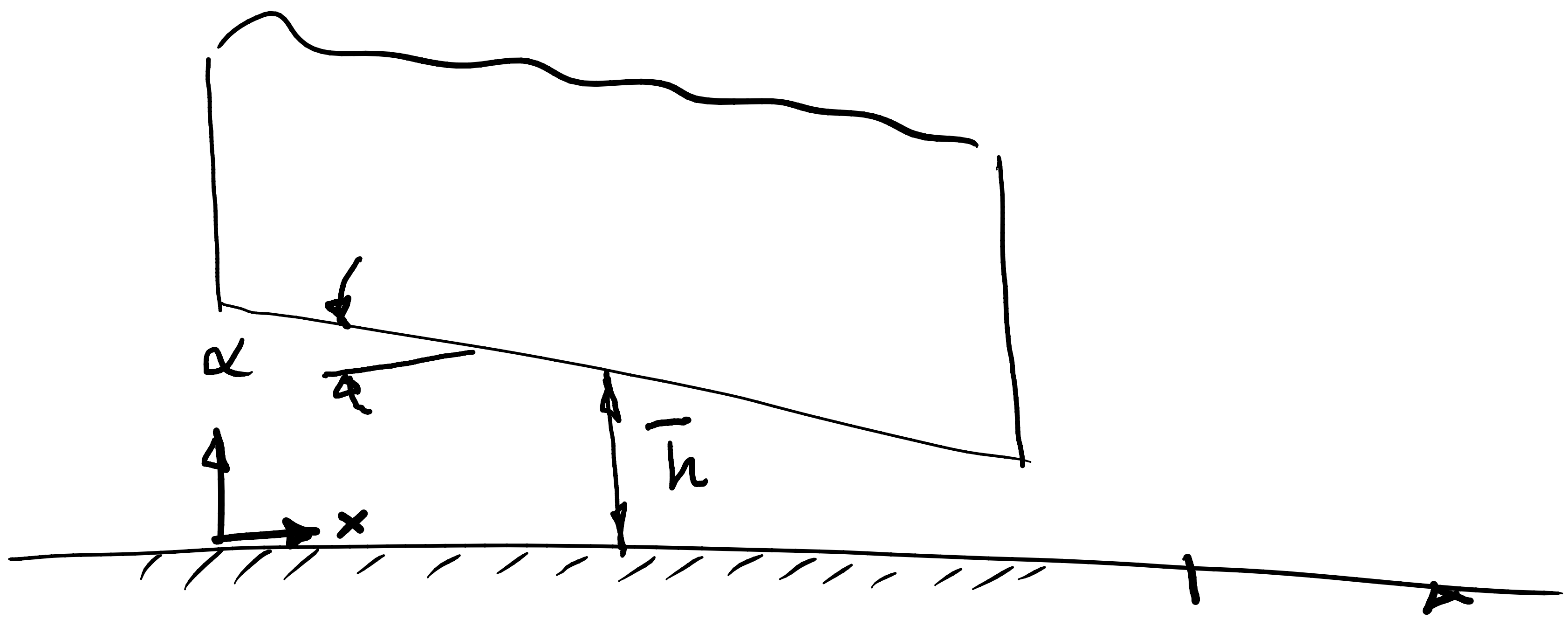
$$\rho \frac{\partial u}{\partial t} + \underbrace{\rho u \frac{\partial u}{\partial x}}_{=0} + \underbrace{\rho v \frac{\partial u}{\partial y}}_{=0} = \ldots\ldots$$

$$\hookrightarrow \quad \rho \frac{\partial u}{\partial t} = -\frac{dp}{dx} + \frac{\partial}{\partial y}(\tau)$$



$$\rho \frac{\partial u}{\partial t} = \eta \frac{\partial^2 u}{\partial y^2}$$

$$\frac{\partial u}{\partial t} = \nu \frac{\partial^2 u}{\partial y^2}$$



$\bar{h}$ mittlere Lagerspiel $\qquad U$

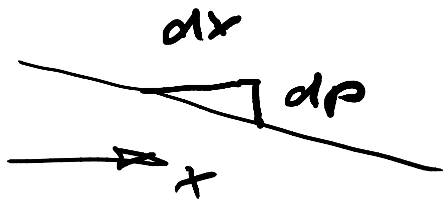
Wenn $\alpha \frac{U \bar{h}}{\nu} = \alpha Re \ll 1$, dann können die konvektiven Terme in der Bewegungsgleichung vernachlässigt werden.

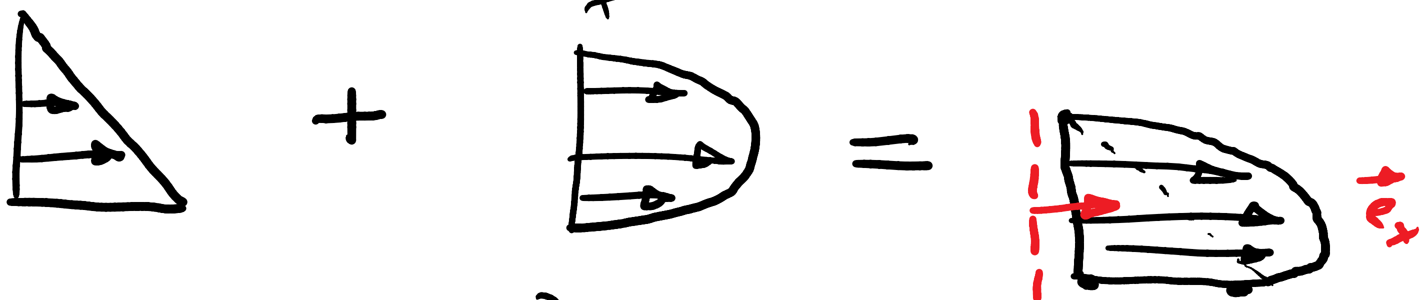
An jedem Ort x stellt sich eine

<u>Druck-Schlepp-Strömung ein.</u>

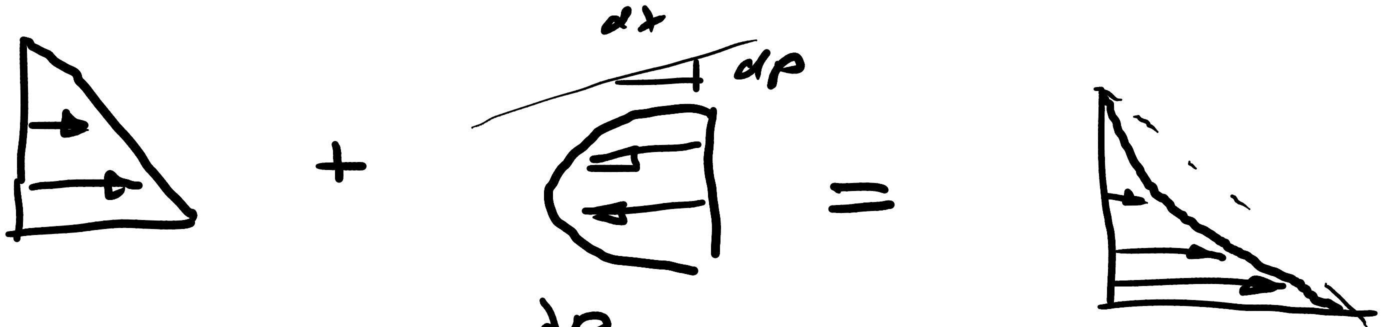
$$\frac{u}{U} = \underbrace{\frac{y}{h(x)}}_{\text{Schleppstr.}} - \frac{\partial p}{\partial x}\frac{h^2(x)}{2\eta U}\left(1-\frac{y}{h(x)}\right)\frac{y}{h(x)} \qquad = \dot V_x$$

?





$$\frac{\partial p}{\partial x} < 0$$



$$\frac{\partial p}{\partial x} > 0$$

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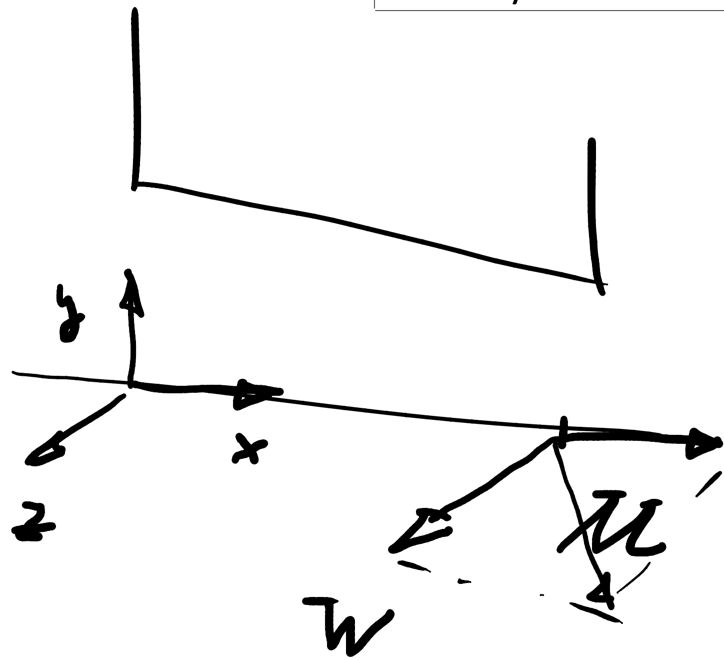
$$\dot V_x := \int_0^{h(x)} u\,dy = \frac{1}{2} U h - \frac{\partial p}{\partial x}\frac{h^3(x)}{12\eta}$$

$$\dot V_z = \frac{1}{2} W h - \frac{\partial p}{\partial z}\frac{h^3(x)}{12\eta}$$



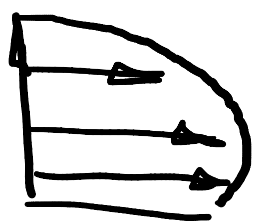
$$\vec{\dot V} = \dot V_x \vec e_x + \dot V_z \vec e_z$$

$$\frac{\partial \dot V_x}{\partial x} + \frac{\partial \dot V_z}{\partial z} \overset{!}{=} 0$$ aus Kontinuitätsbzg.

$$\frac{\partial}{\partial x}\left(\frac{h^3}{\eta}\frac{\partial p}{\partial x}\right) + \frac{\partial}{\partial z}\left(\frac{h^3}{\eta}\frac{\partial p}{\partial z}\right) = 6\left(\frac{\partial (hU)}{\partial x} + \frac{\partial (hW)}{\partial z} + 2\frac{\partial h}{\partial t}\right) \quad (*)$$

Reynoldsche Gleichung für die hydrodynamische Schmierung. } Poissongleichung für $p(x,z,t)$

↳ (+)

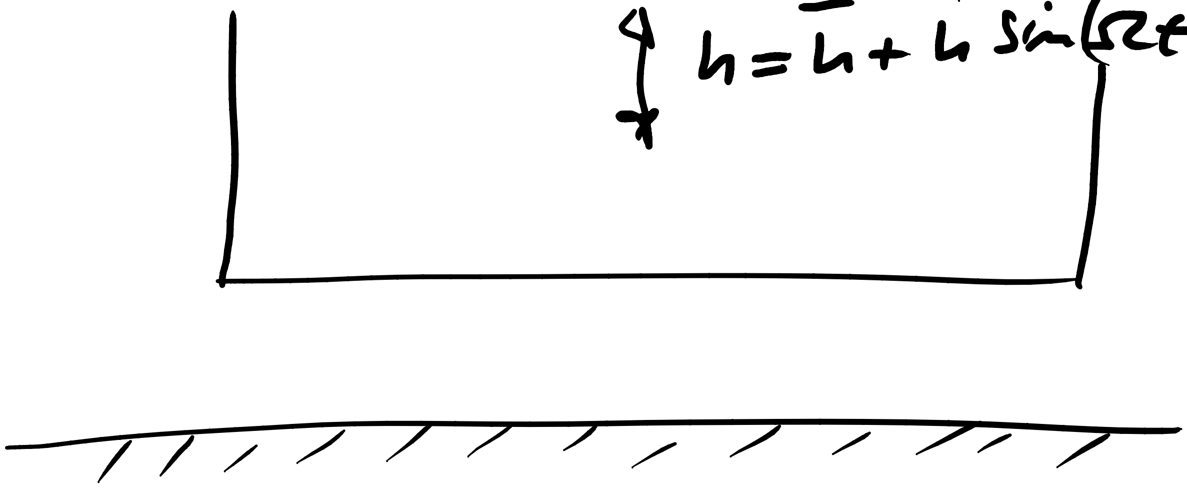


Die Information über das Geschwindigkeitsprofil ist in (*) enthalten.

(+) 3D → 2D Problem.

$h = \bar{h} + \hat{h}\sin(\Omega t).$

$\frac{\Omega \bar{h}^2}{\nu} \ll 1.$

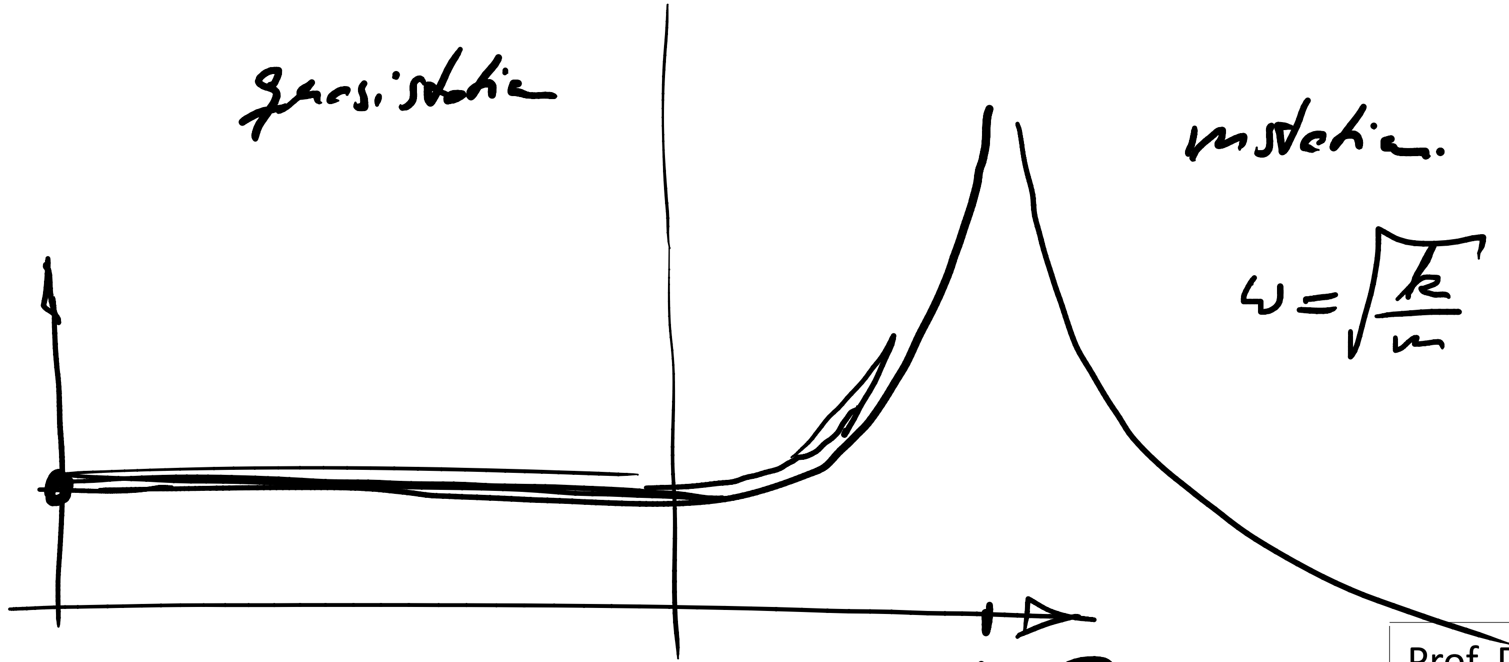


stationär

quasistatisch

instationär

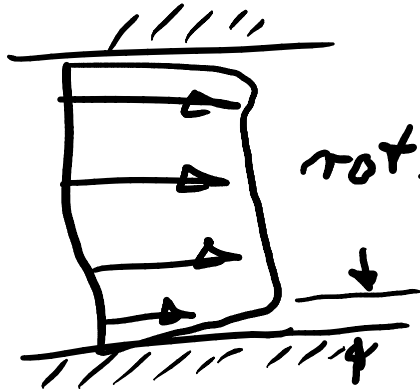
$\omega = \sqrt{\frac{k}{m}}$



$1 \quad \frac{\Omega}{\omega}$

$$\frac{\Omega \bar{h}^2}{\nu} \gg 1 \rightsquigarrow$$ Reibung hat kein Zeit sich im Spalt zu entwick.

$\rightsquigarrow$ Blockprofil



▼ Φ ist bekannt.

$$G = \frac{\partial \phi}{\partial t} + \frac{1}{2} \nabla\phi \cdot \nabla\phi + \frac{p}{\rho} + gz$$

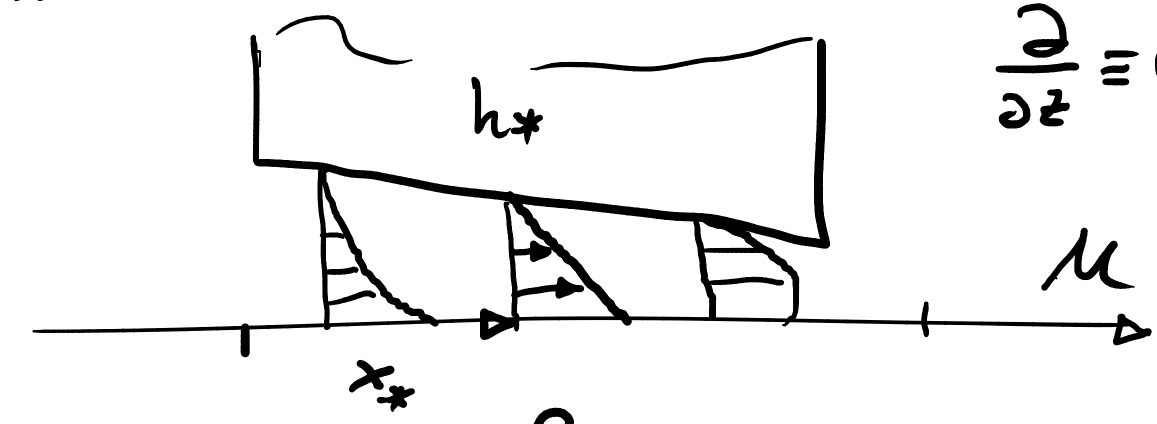
Bernoulli Gleichung für $\mathrm{rot}\,\vec{u} = 0$

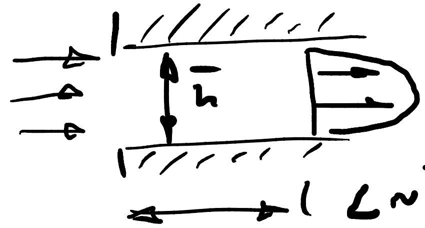
$\Rightarrow p(x,z,t)$.

$$\left.\begin{array}{l} \vec{u} = \nabla \Phi \\ \nabla \cdot \vec{u} = 0 \end{array}\right\} \Delta \phi = 0.$$

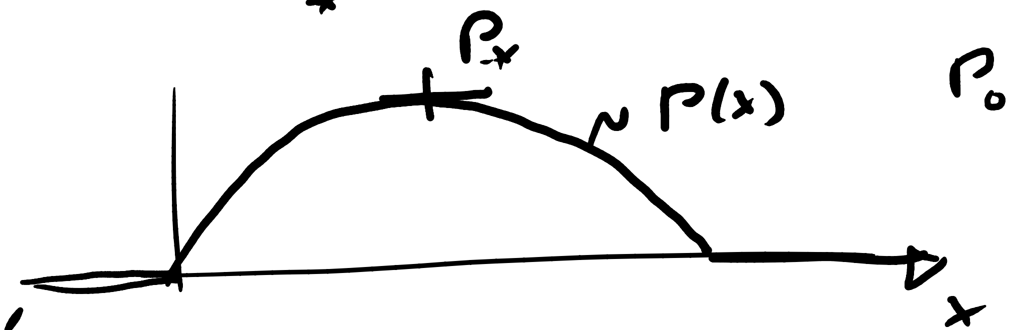
Keillager

$\frac{\partial}{\partial t} \equiv 0; \quad W \equiv 0; \quad \frac{\partial h}{\partial t} \equiv 0$

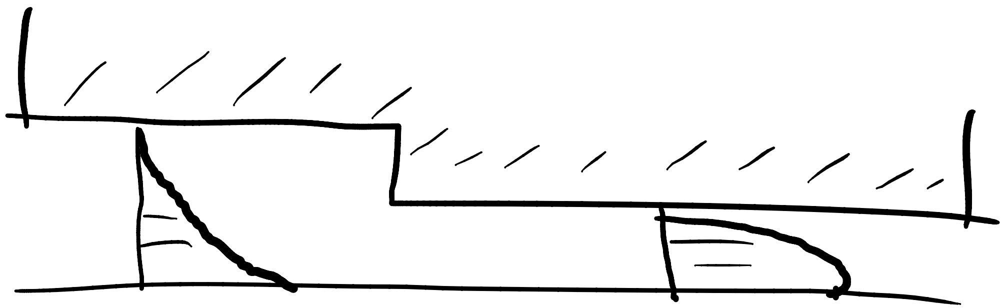


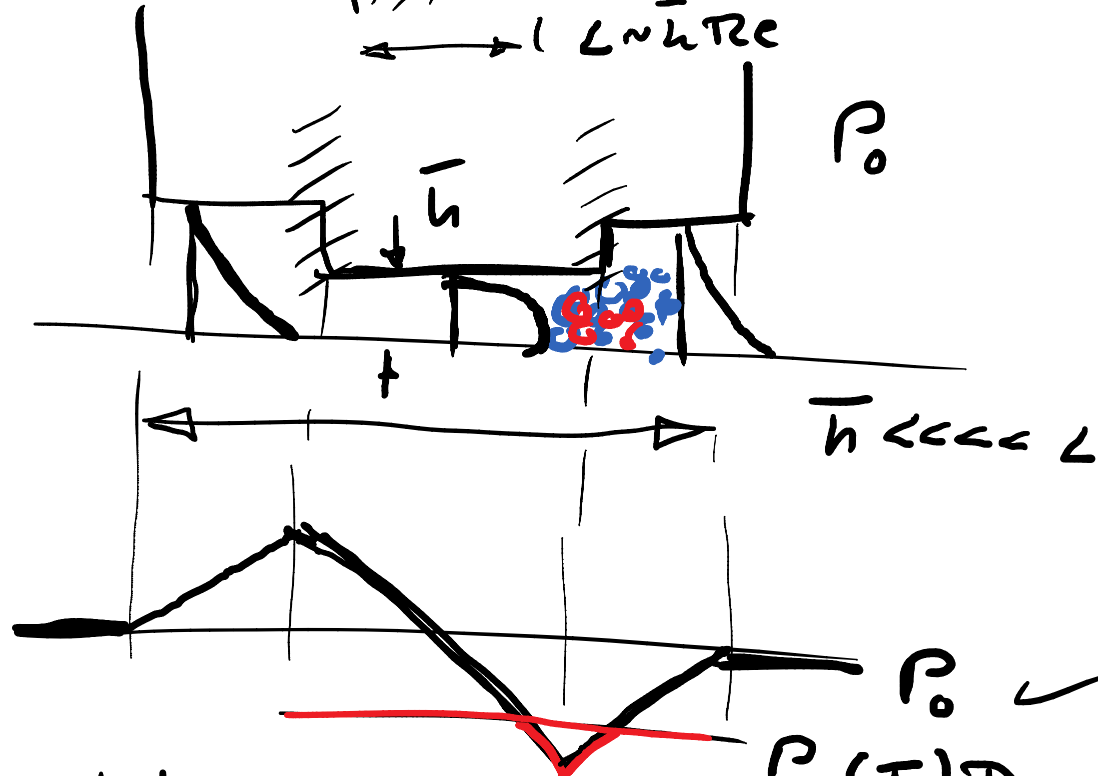


$L \sim \bar{h}\, Re$



Stufe





Kavitation
- o Dampfblasen
- o Gasblasen

pseudo Kav.

Lösungsgleichgewicht

$c = H\, p$

Konzentration an gelöstem CO_2

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Kavitation − Funktion wird gestört

− laut

− Materialschädig.

Kavitation + Medizin

+ Reinigen z.B.