

# Fluidummechanica

## Controlevolumes

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# Inhoud

- 1 Inleiding
- 2 Controle massa's
- 3 Controlevolumes
- 4 Stationair controlevolume met één in- en uitstroming

# Voorbeeld



Bron: <http://www.nasa.gov/>

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# Mechanica en Thermodynamica

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Behoud van massa

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Behoud van energie

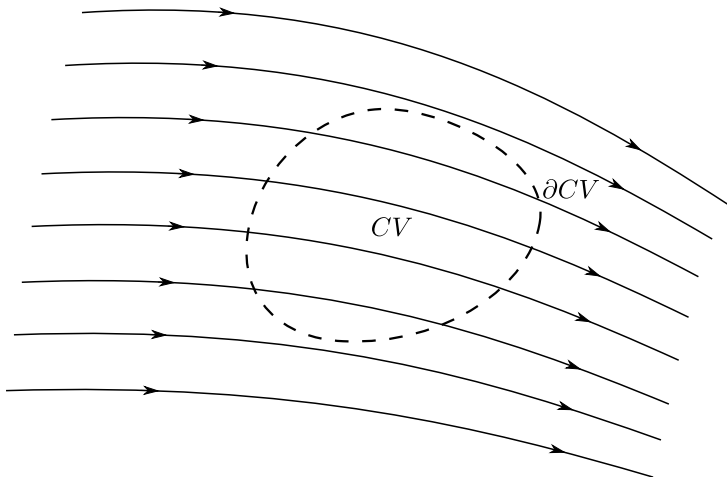
$$\frac{dE}{dt} = \dot{Q} - \dot{W} \quad (3)$$



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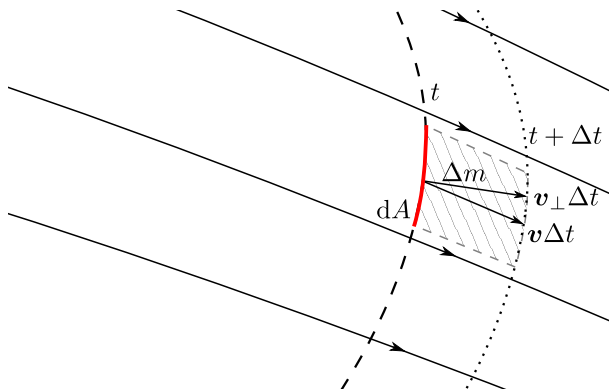
# Controlevolume



# Behoud van massa

$$\begin{bmatrix} \text{De verandering} \\ \text{van massa in} \\ \text{het controlevolume} \end{bmatrix} + \begin{bmatrix} \text{De netto} \\ \text{massastroom uit} \\ \text{het controlevolume} \end{bmatrix} = 0$$

# Massastroom



# Behoud van massa

$$\left[ \begin{array}{c} \text{De verandering} \\ \text{van massa in} \\ \text{het controlevolume} \end{array} \right] + \left[ \begin{array}{c} \text{De netto} \\ \text{massastroom uit} \\ \text{het controlevolume} \end{array} \right] = 0$$

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$$\frac{dm_{CV}}{dt} + \dot{m}_{\partial CV} = 0 \quad (4)$$

# Behoud van impuls

$$\begin{bmatrix} \text{De verandering} \\ \text{van impuls} \\ \text{in het} \\ \text{controlevolume} \end{bmatrix} + \begin{bmatrix} \text{De netto} \\ \text{impulsstroom} \\ \text{uit het} \\ \text{controlevolume} \end{bmatrix} = \begin{bmatrix} \text{De totale} \\ \text{kracht} \\ \text{op het} \\ \text{controlevolume} \end{bmatrix}$$

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$$\frac{d\mathbf{P}_{CV}}{dt} + \dot{\mathbf{P}}_{\partial CV} = \mathbf{F} \quad (5)$$



# Behoud van energie

$$\left[ \begin{array}{c} \text{De verandering} \\ \text{van energie} \\ \text{in het} \\ \text{controlevolume} \end{array} \right] + \left[ \begin{array}{c} \text{De netto} \\ \text{energiestroom} \\ \text{uit het} \\ \text{controlevolume} \end{array} \right] = \left[ \begin{array}{c} \text{De warmtesroom} \\ \text{toegevoegd en} \\ \text{arbeidsstroom} \\ \text{onttrokken aan} \\ \text{het controlevolume} \end{array} \right]$$

# Behoud van energie

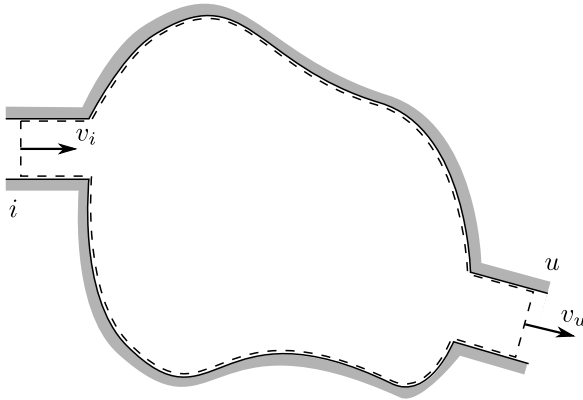
$$\left[ \begin{array}{c} \text{De verandering} \\ \text{van energie} \\ \text{in het} \\ \text{controlevolume} \end{array} \right] + \left[ \begin{array}{c} \text{De netto} \\ \text{energiestroom} \\ \text{uit het} \\ \text{controlevolume} \end{array} \right] = \left[ \begin{array}{c} \text{De warmtesroom} \\ \text{toegevoegd en} \\ \text{arbeidsstroom} \\ \text{onttrokken aan} \\ \text{het controlevolume} \end{array} \right]$$

$$\frac{dE_{CV}}{dt} + \dot{E}_{\partial CV} = \dot{Q} - \dot{W} \quad (6)$$

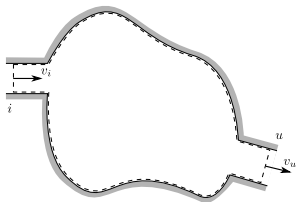
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# Stationair controlevolume met één in- en uitstroming



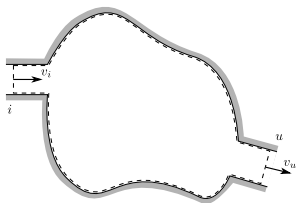
# Stationair controlevolume met één in- en uitstroming



$$\rho_i v_i A_i = \rho_u v_u A_u$$

(7)

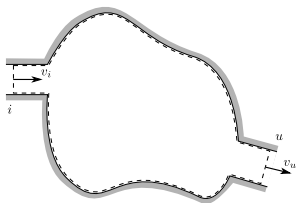
# Stationair controlevolume met één in- en uitstroming



$$\rho_i v_i A_i = \rho_u v_u A_u \quad (7)$$

$$\begin{aligned} F_{x,R} &= p_u A_u n_{x,u} + p_i A_i n_{x,i} + \dot{m}(v_{x,u} - v_{x,i}) \\ F_{y,R} &= p_u A_u n_{y,u} + p_i A_i n_{y,i} + \dot{m}(v_{y,u} - v_{y,i}) \\ F_{z,R} &= p_u A_u n_{z,u} + p_i A_i n_{z,i} + \dot{m}(v_{z,u} - v_{z,i}) \end{aligned} \quad (8)$$

# Stationair controlevolume met één in- en uitstroming



$$\rho_i v_i A_i = \rho_u v_u A_u \quad (7)$$

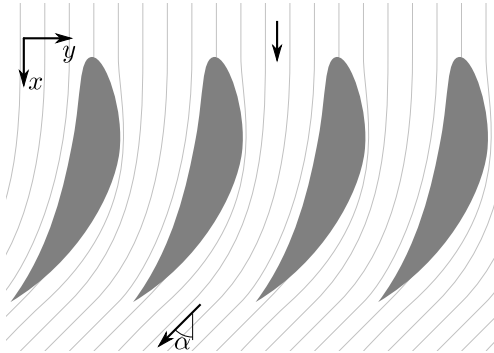
$$F_{x,R} = p_u A_u n_{x,u} + p_i A_i n_{x,i} + \dot{m}(v_{x,u} - v_{x,i})$$

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$$F_{z,R} = p_u A_u n_{z,u} + p_i A_i n_{z,i} + \dot{m}(v_{z,u} - v_{z,i})$$

$$\dot{m}\left(u_u + \frac{p_u}{\rho_u} + \frac{1}{2}v_u^2 + gz_u\right) - \dot{m}\left(u_i + \frac{p_i}{\rho_i} + \frac{1}{2}v_i^2 + gz_i\right) = \dot{Q} - \dot{W}_a \quad (9)$$

# Toepassing



Bepaal de horizontale en verticale kracht op één schoep, veronderstel isotherme stroming zonder warmteoverdracht