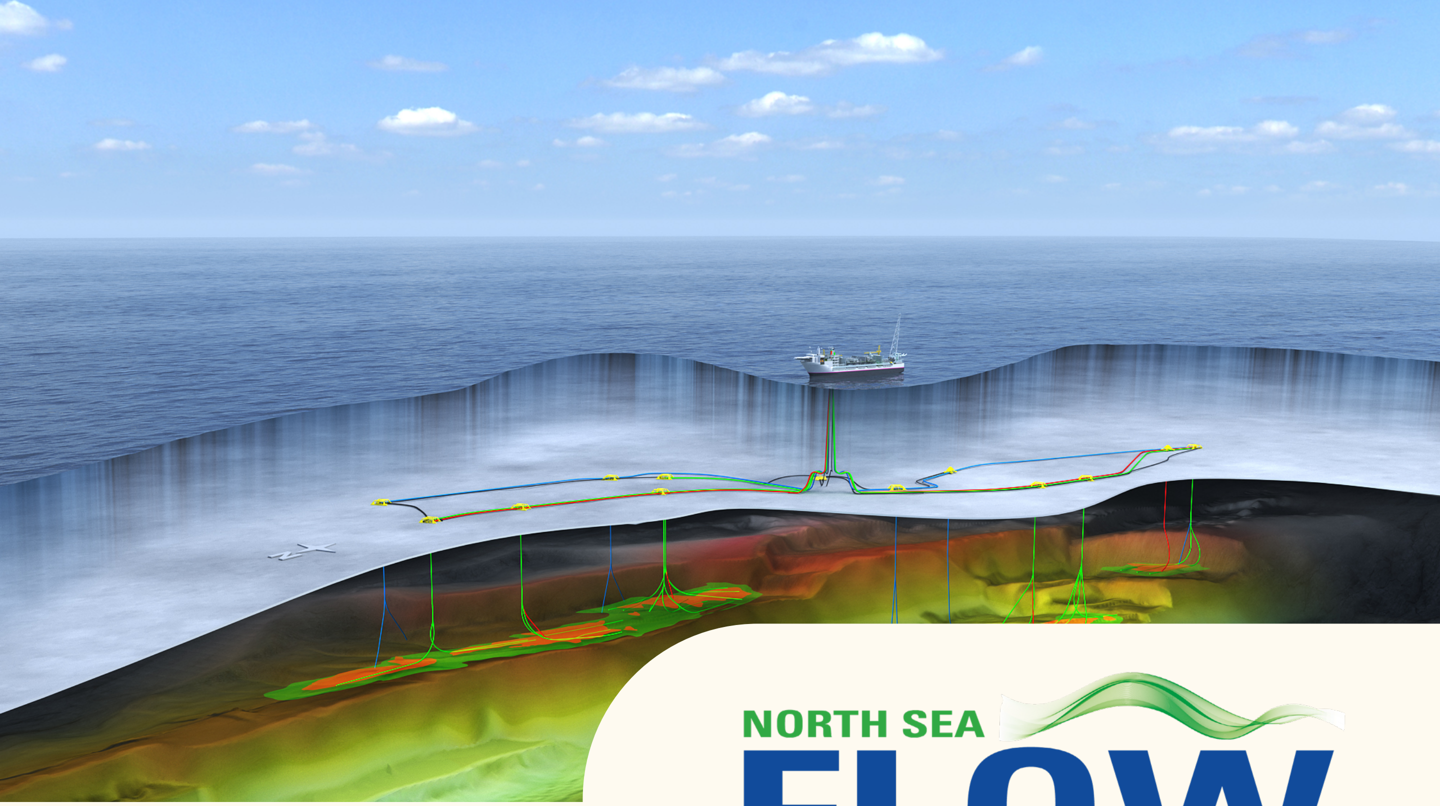

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MEASUREMENT WORKSHOP

measuring for the energy transition

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NORTH SEA FLOW MEASUREMENT WORKSHOP
measuring for the energy transition

A new geometrical approach to measure two-phase flow by means of differential pressure measurement with a V-Cone

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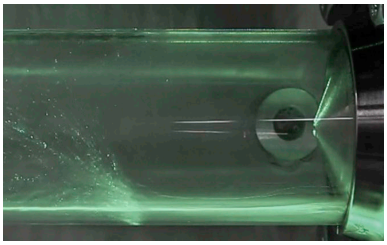
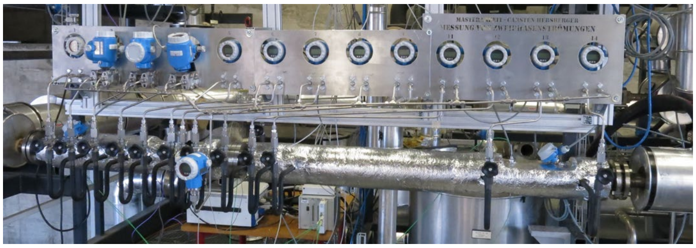




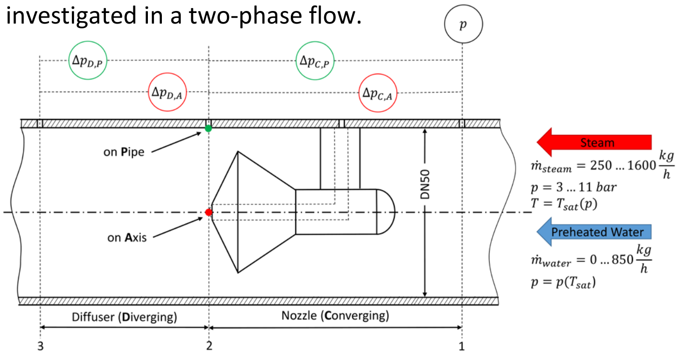
Flow measurements of two-phase flows by means of differential pressure measurement via a flow resistance, e.g. a V-Cone, are state of the art. By using two differential pressure measurements, which responds independent on the liquid phase, both phases can be computed. In this work, various geometric approaches to measure the differential pressure of a V-Cone were investigated experimentally. With a suitable choice of the pressure tap positions, the length of the device can be reduced and the gas mass flow can be determined independently of the liquid phase.

Theoretical Background

The theoretical mass flow can be determined based on the pressure variation through the change in the flow velocity. In the real single-phase case, flow losses occur as a function of the Reynolds number, the geometry and compressibility effects. In a two-phase flow, additional losses occur due to the liquid phase. In the following, all losses are combined into a calibration factor $K_{m,n}$, which allows a direct calculation of the gas mass flow $\dot{m}_g$.

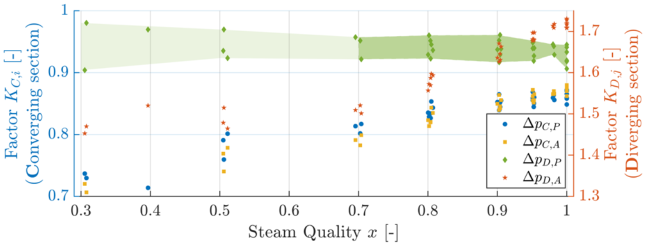
Experimental Setup

The static pressure distribution along the pipe wall was investigated in a two-phase flow.



Analysis

Depending on the position of the pressure taps for differential pressure measurement, the calibration factor K responds differently to the liquid phase. The differential pressure $\Delta p_{D,P}$, measured over the diffusor, appears to be independent of the steam quality.



With experimental data, $\gamma(x)$ and $K_{m,n}(\gamma(x))$ are determined and fitted by polynomial model functions.

$$\gamma(x) = \sqrt{\frac{\Delta p_{C,P}}{\Delta p_{C,A}}}; \dot{m}_g = K_{m,n}(\gamma(x)) \frac{A_2}{\sqrt{1 - \left(\frac{A_2}{A_{1,3}}\right)^4}} \cdot \sqrt{2 \cdot \rho_g \cdot \Delta p}$$

These models $\gamma(x)$ and $K_{m,n}(\gamma(x))$ allow for a direct calculation of steam quality x and gas mass flow $\dot{m}_g$.

Result

For the tested steam two-phase flow with a steam quality of 0.7 to 1, the following results have been achieved:

- *Compact design with the ratio γ*
  The model was able to calculate the gas mass flow with a standard deviation of 0.8%.
- *Gas phase independent of the liquid phase with $\Delta p_{D,P}$*
  The gas mass flow of the model data can be determined with a standard deviation of 1.3%.

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