Gas-liquid flow optimization with a Bubble Breaker device

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Introduction

• Bubble breaker was first presented by Shell engineers (Schrama and Fernandes, 2005):
  – Experimental and field tests

• Objective is to break the bubbles into smaller diameters, or change the flow pattern
Motivation

- Smaller bubbles reduce hydrostatic pressure drop and delay the transition to slug flow

(Guet et al., 2003)
Motivation

• Lower rise velocity $\rightarrow$ Greater void fraction $\rightarrow$ lower hydrostatic pressure gradient.

\[ \bar{\rho} = \rho_G \alpha + \rho_L (1 - \alpha) \]

\[ \alpha = \frac{Q_G}{A \cdot V_G} \]
Motivation

- Bubble rise velocity increases with bubble diameter.

=Celata et. al., 2007

(Parkinson et. al., 2008)

(Tomiyama et. al., 2002)

(Nguyen et. al., 1998)
Experiments

• This work presents experimental results to evaluate the device:

  – Pressure measurements:
    • At four locations along the pipe.
    • Ratio of Pressure Gradients before and after the bubble breaker.
      – \( R = \frac{\text{Press. Grad. After}}{\text{Press. Grad. Before}} \)

  – Detailed videos: high-speed camera.
Experimental facilities

- Air
- Water
- Bubble breaker device
- Pipe: ID=50mm, L=10.83m
- Rotameter
- Rotameter
- Water
• 3 different geometries: 1 plate with orifices and 2 Venturi
Test conditions

- Test conditions:
  - $Q_L = 6 - 21 \text{ L/min}$
  - $Q_G = 9 - 90 \text{ L/min}$
  - Air and water
Videos

- Dispersed bubbles
- One elongated bubble
- Slug flow
Pressure loss results

QL=6 L/min

QL=12 L/min

QL=16.8 L/min

QL=21 L/min
Values of R lower than 1 indicates that the Bubble Breaker is effective!
Results

• Bubble breaker is more effective at the Disperse Bubbles flow pattern (higher liquid flow rates).

• Geometry should be studied for each application.

• Reduction in the Pressure Gradients must be compared to local pressure drop.

• Next works: Different geometries to enhance bubble breaking while reducing local pressure drop.
References

1 – Schrama, E. and Fernandes, R. “The bubble breaker: breaking up slug flow into dispersed bubbly flow using a passive mechanical device”. BHR Group 2005 Multiphase Production Technology 12


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