Journal of Zhejiang University-SCIENCE A (Applied Physics & Engineering)

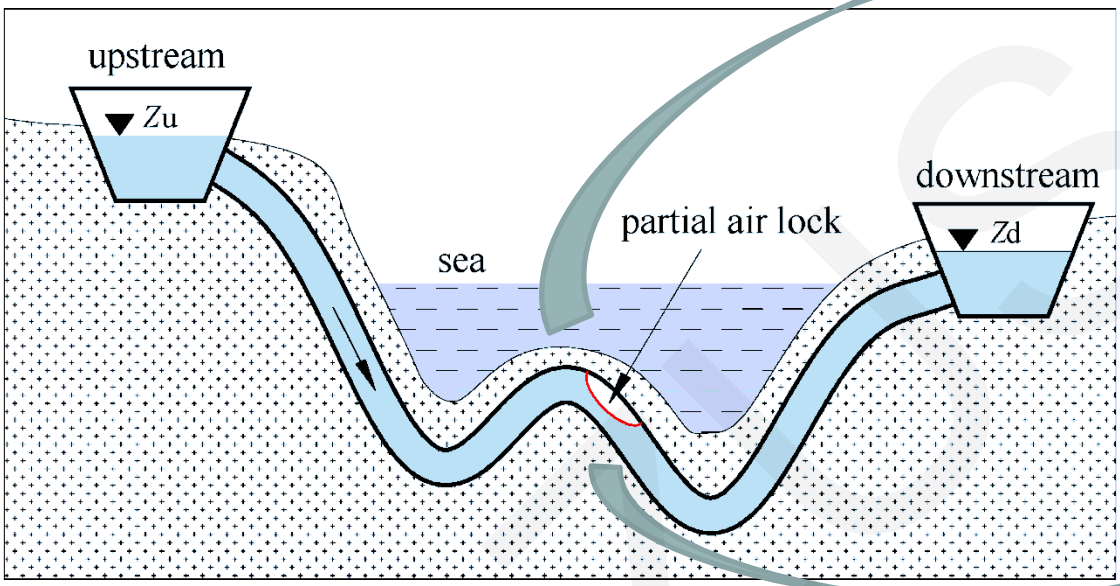
Investigation on critical equilibrium of trapped air pocket in water supply pipeline system

Wu-yi WAN, Chen-yu LI, Yun-qi YU

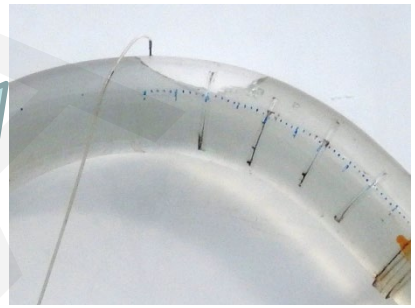
Cite this as: Wu-yi WAN, Chen-yu LI, Yun-qi YU, 2017. Investigation on critical equilibrium of trapped air pocket in water supply pipeline system. *Journal of Zhejiang University-SCIENCE A (Applied Physics & Engineering)*, 18(3):167-178.

http://dx.doi.org/10.1631/jzus.A1600325

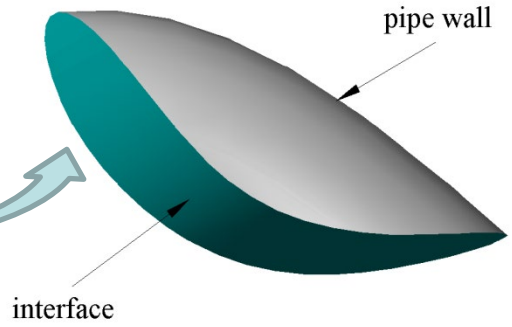
Profiles and model of an air lock



Schematics of partial air lock in submarine water supply system

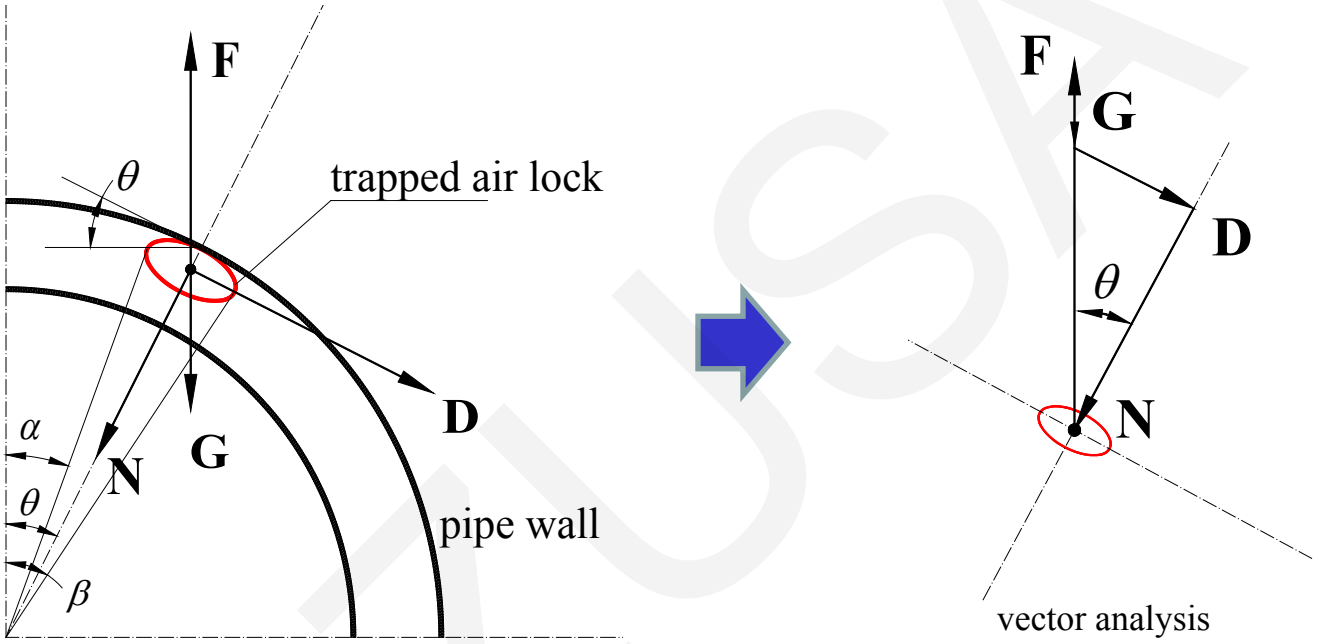


Experimental observation



Generalized model

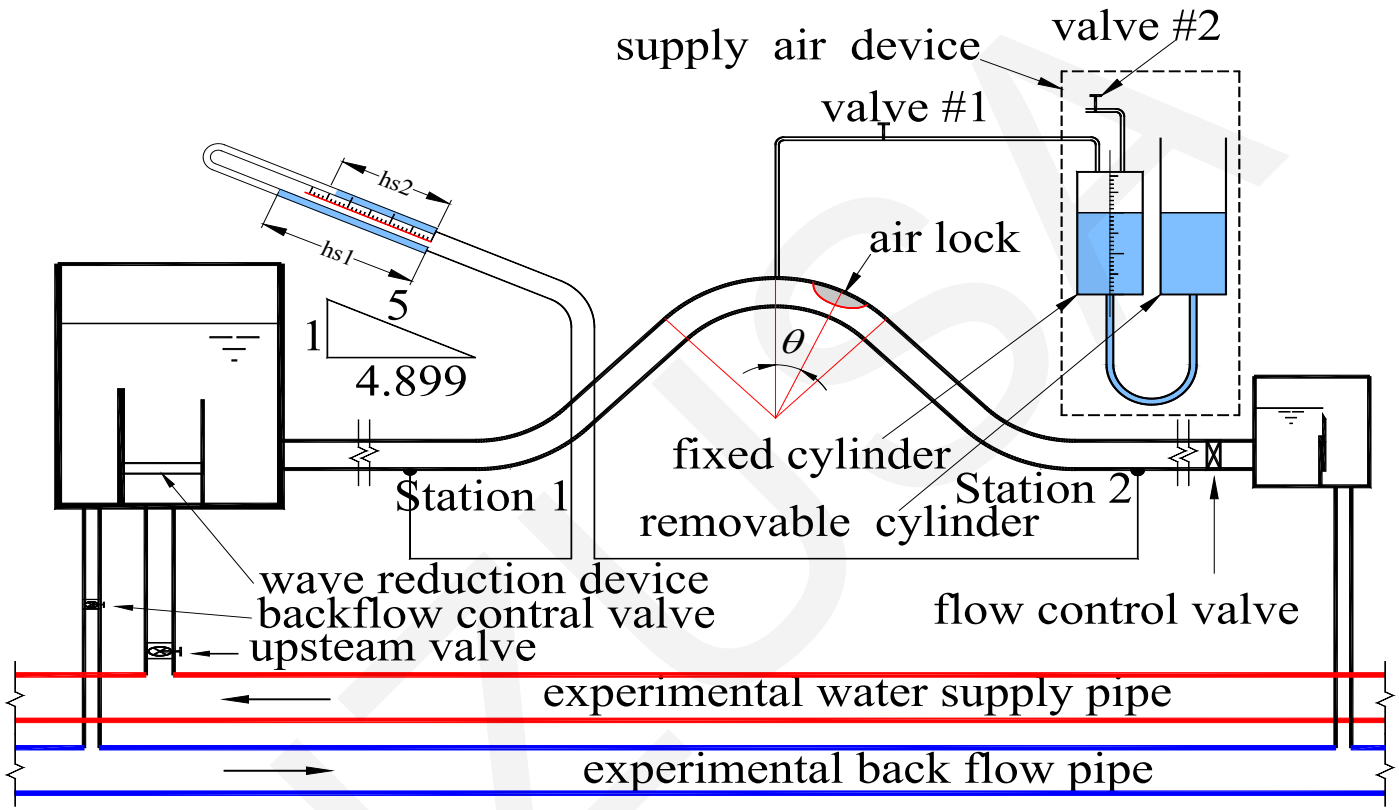
Force analysis of partial air lock in hump



In the vector analysis, through vector decomposition along the radial and tangential directions in the two dimensional plane, the equilibrium of the tangential component can be expressed as follows.

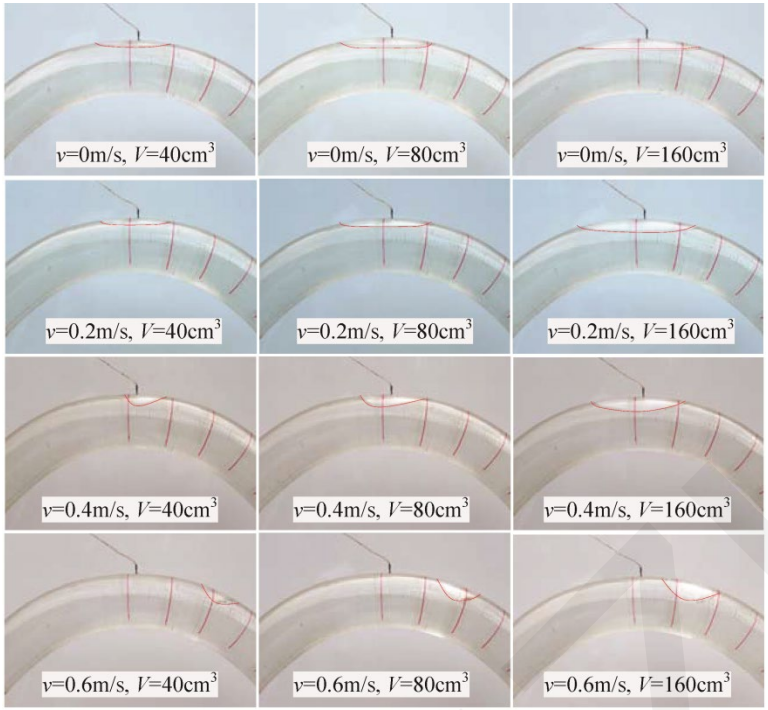
$$\left[\left|\mathbf{D}\right| \quad \left|\mathbf{N}\right|\right]^{\mathrm{T}} = \left[\left|\mathbf{F}+\mathbf{G}\right|\sin\theta \quad \left|\mathbf{F}+\mathbf{G}\right|\cos\theta\right]^{\mathrm{T}}$$

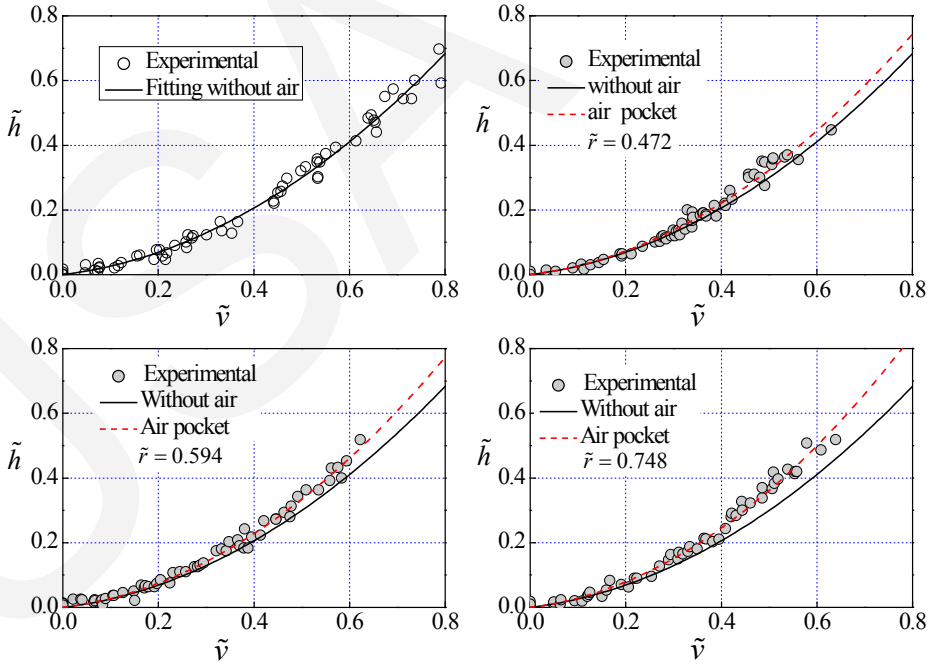
Experimental layout



Schematics of the experimental principle

Experimental analysis

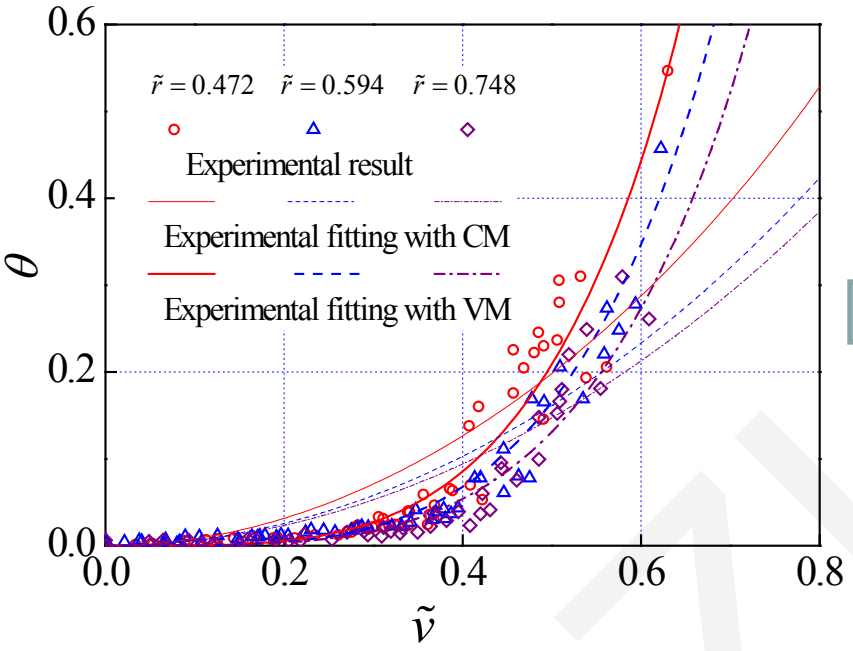


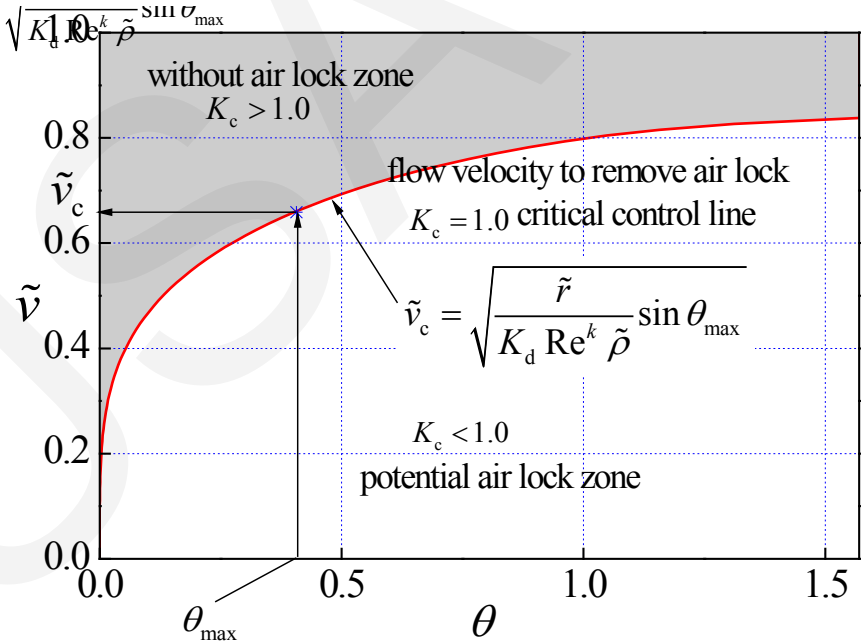


Air pockets change with the flow velocity and volume

Hydraulic head losses principle of air lock

Results





Influence of flow velocity on the location of air lock

Prevention and elimination of an air lock

Conclusions

- An air lock can cause extra head losses and decrease the local flow section, and the head losses increase with the pipe flow velocity and the volume of the air lock.
- The critical equilibrium angle increases and the air lock moves down-stream to a new equilibrium location with increasing pipe flow velocity.
- There are two approaches to pre-vent potential air locks. One is increasing the pipe flow velocity, and the other is decreasing the maxi-mum slope angle of the pipe.
- A criterion coefficient is proposed to evaluate the possibility of an air lock. According to this criterion, a greater flow velocity and less depression angle are advantageous to avoid the air lock hazard in a submarine water supply pipeline system.