Pressure Sensor Clusters

On the Way to 100 Pressure Sensors on a 1-Euro Coin

Sebastian Schreier & Christian Poelma
Faculty 3mE, Depts. M&TT & P&E
Spatial Distribution of Sloshing Pressures

- Example impacts at 80% filling
- Tank width 200 mm
- Sensor spacing 14.8 mm

What did we miss?
Idea: Very Small Pressure Sensors

- Tank width 200 mm
- > 100 pressure sensors per line?! 
- Sensor spacing < 2 mm
EPCOS Pressure Sensor C32 Industrial

- Dimensions: 1.65 x 1.65 x 1.5 mm³
- Absolute pressure sensor
- Vacuum reference cavity
- Suitable for wet (non-aggressive) media
- Measurement range 0..1.6 bar (10 bar)
- Distributed Wheatstone bridge
- Sensitivity (typ.) 22 mV/V @ 1.6 bar
- Non-linearity (typ.) 0.2%
- Operating temperature -20..85 deg C
  short time (< 15 min): 105 deg C
Engineering Considerations

- Air in cavity considered as bubble in water
  - Oscillation frequency 6.6 kHz (isothermal), 7.8 kHz (adiabatic)

- Pressure drop in channel due to surface tension
  - Water/air $\sigma=0.072 \text{ N/m} \rightarrow 700 \text{ Pa}$

- Cavity filled with water
  - Time for shock wave to run from opening to membrane and back: $1.5 \ \mu\text{s} \rightarrow 670 \text{ kHz}$

$\Rightarrow$ Conclusion: Cavity to be filled with water
Get Going

• Step 1 → get one to work (!)
Get Going

- Step 1 → get one to work (!)
- Step 2 → cluster many sensors

Current sensor d = 11 mm
→ 24 new sensors
Challenges

- Micro-electronics world
  - Gluing sensors to circuit board
  - Electric connections by wire bonding
  - Water proofing of assembly
  - High conductor density on circuit board

- Overcoming/using surface tension
Current Status

- 1st sensors are glued and bonded (16.10.2017)
Next steps

- Testing and evaluation of sensors in air
  - 1\textsuperscript{st} static testing
  - 2\textsuperscript{nd} dynamic behaviour
- Try applicability in water
- Testing and evaluation in water
- Proceed to sensor clusters
(Almost) 100 Sensors on a 1-EUR Coin
Acknowledgments

• Thanks to our colleagues at TU Delft
  • Henk van Zeijl, EWI/EKL for gluing and wire bonding
  • Frits Sterk, 3mE/SHS for electronics support
Thank You for Your Attention!

- What are your ideas for applications?