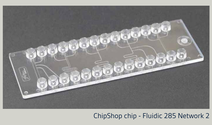
A novel method for validating Computational Fluid Dynamics (CFD) outcomes on microfluidic mixer devices: **a case study.**

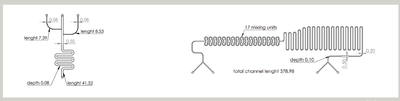
Daniel Blanco I Patrick Vlieger I Thijs Meewis I Koen Beyers I Tim Dieryckx

1. Materials and Methods

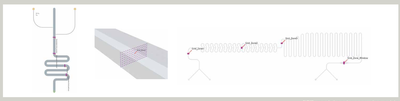


ChipShop chip - Fluidic 285 Network 2

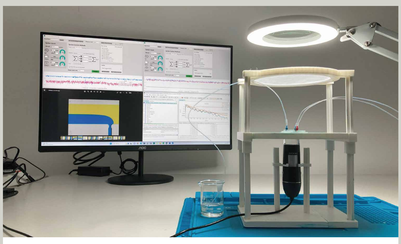
Adapted Coock chip



CAD model



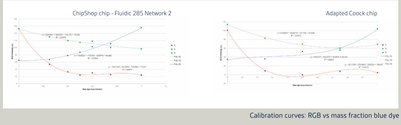
CFD model and measuring grids



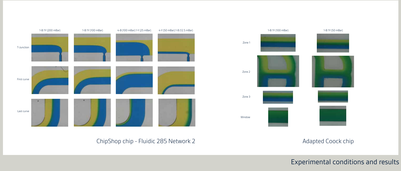
Test setup: pressure-driven flow, blue and yellow dye solutions, illumination and imaging

2. Results

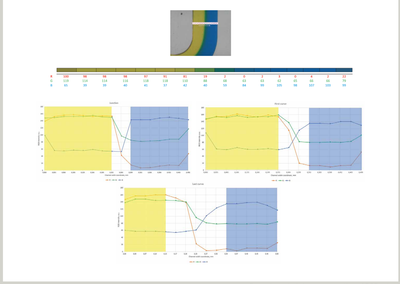
2.1 Experiments



Calibration curves: RGB vs mass fraction blue dye

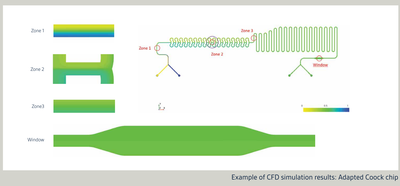


Experimental conditions and results

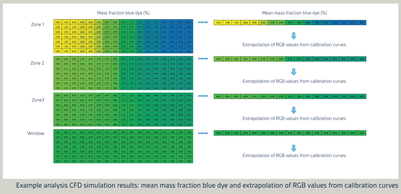


Example analysis image: extraction of RGB values

2.2 CFD Simulations

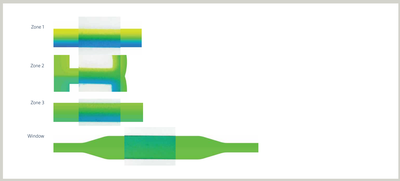


Example of CFD simulation results: Adapted Coock chip



Example analysis CFD simulation results: mean mass fraction blue dye and extrapolation of RGB values from calibration curves

3. Discussion



Example of comparison of real vs simulated images

Chip design	Experimental condition	Results		
Zone		T-junction	First curve	Last curve
ChipShop chip – Fluidic 285 Network 2	1-B:1-Y (100 mBar)	8±2	7±2	12±4
	1-B:4-Y (25:100 mBar)	13±2	12±1	13±1
	4-B:1-Y (50:12.5 mBar)	7±1	6±1	8±1
Zone		1	2	Window
Adapted Coock chip	1-B:1-Y (50mBar)	8±4	5±3	5±3
	1-B:1-Y (100mBar)	10±5	10±6	9±4

Summary of results: Relative diff % using G channel

Factors limiting the performance of the method

- Ability to ascertain significant differences in RGB values between mixing percentages (Image quality).
- Grid measuring points separation distance.
- CFD model assumptions.
- Pressure-driven flow control inaccuracy.

4. Conclusions

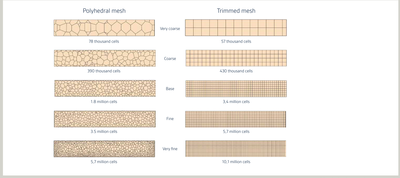
- A novel experimental method for evaluating the performance of mixing in microfluKidic devices and comparing experimental and simulation results has been developed and validated.**The predictive power of the CFD model is 15%±2 on average considering the results for the three channels.**

- This method can be used to:
  - Validate CFD models for micromixer devices and other microfluidic applications.
  - Compare micromixing structures.
  - Optimize the design of micromixer devices.
  - Evaluate full mixing and concentration gradients for downstream applications.

- Observed differences between real experiments and simulations could be improved with more iterations on the CFD model and more accurate equipment.

- The validity of the method is limited to the experimental conditions evaluated: 0,15 < Re < 4.

Supplementary material



Mesh independence study

visit us at **Booth 29**

voxdale faster forward together

Voxdale **Belgium** (HQ)

Bijkhoevelaan 32C - 2110 Wijnegem
Tel: +32 (0)3 226 83 10
E-mail: info@voxdale.be

Voxdale **Netherlands**

High Tech Campus 27 - 5656 AE Eindhoven
Tel: +31 (0)6 29701034
E-mail: info@voxdale.be

Voxdale **Germany**

c/o MotionLab - Bouchéstraße 12

Hall 20 - 12435 Berlin
Tel: +49 (0)160 273 86 34
E-mail: info@voxdale.de