Study of the generation and emission of water drops in cooling towers

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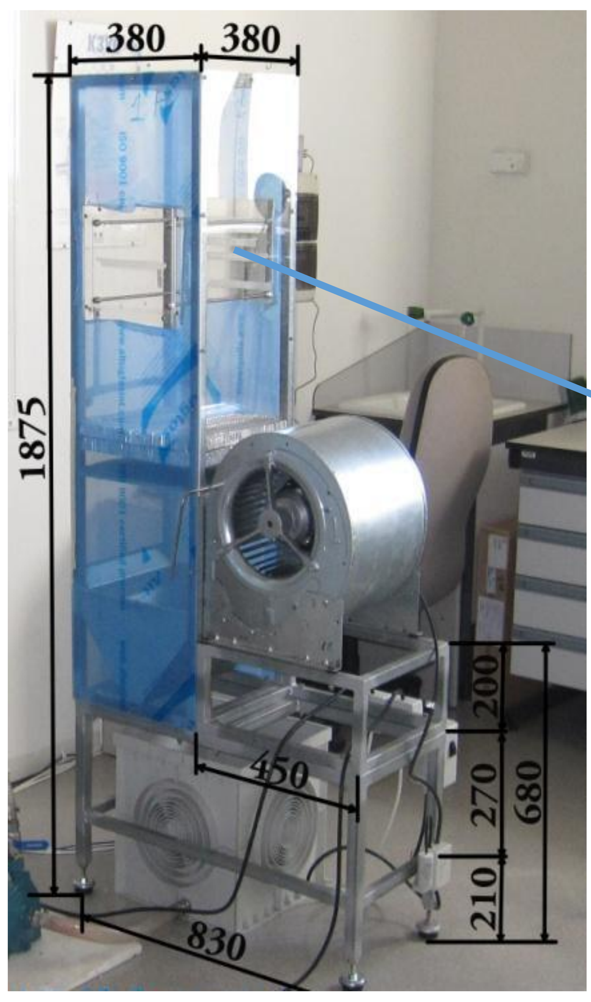
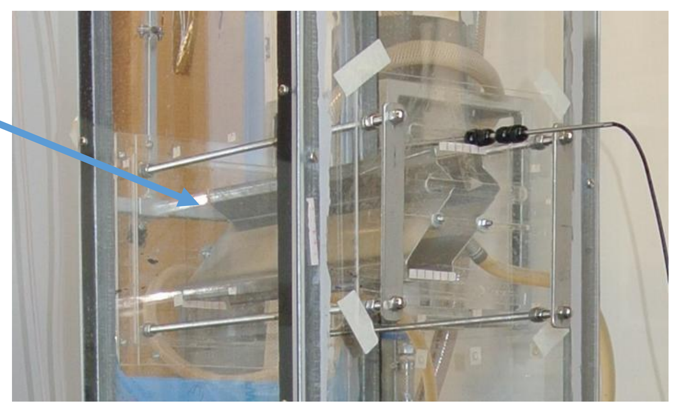
Background and objectives





An experimental prototype of a mechanical draft cooling tower has been set up to study the interaction of air and water in a drift eliminators. It consists on a prismatic structure; an airstream is introduced from the bottom of the tower; and a water circuit injects water inside the tower, through one of the plates of the drift eliminator, forming a water film simulating the films formed by the atomization of water in real towers.
2D and 3D numerical models have been developed in order to simulate the behavior of air and water inside the cooling tower and compare these results with experimental data.

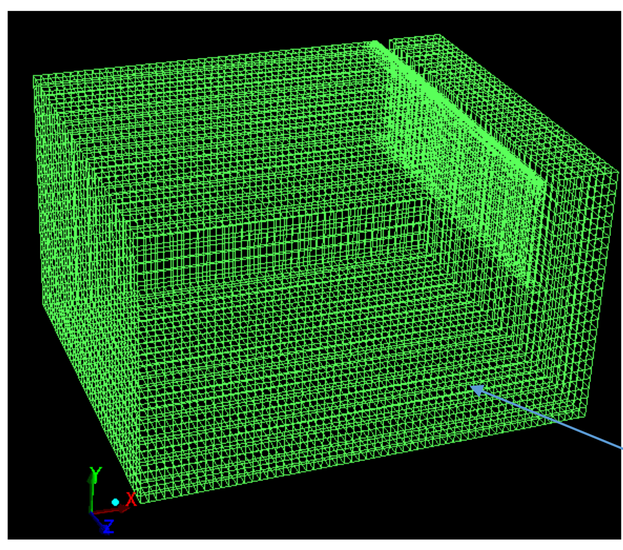
The main objective of this work is to describe the interaction between the water film and the air flow on the plates of the drift eliminator and to determine the operating conditions for the drift eliminator to act itself as a droplet generator. This means to determine the critical values for the air flow to make water droplets, originated from the eliminator plates, to be drifted by the airstream to outside "breakthrough".

Numerical Model

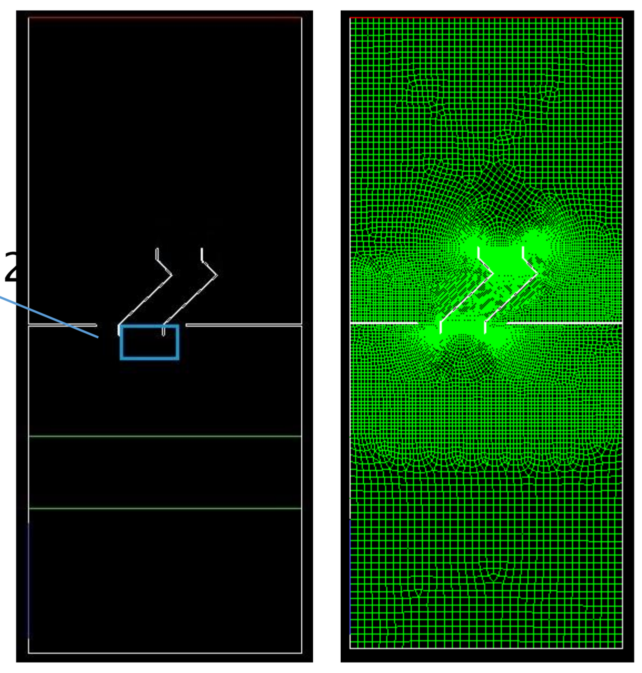
- 2D structured mesh: 140000 initial elements.
- 3D structured mesh: 50000 initial elements.
- Multiphase simulation (air and liquid water)
- Steady calculations without water / Unsteady calculations with water.
- k-epsilon turbulent model
- Volume of Fluid (VOF) model
- Dynamic Adaptive Mesh Refinement (AMR) in elements with more than 30% of water
- Pressure outlet boundary condition at top of the tower.
- Velocity inlet for water and air entrances.

COMPUTATIONAL DOMAIN AND MESHING

3D



2D



Controlled variables: Water flow rate and air velocity.

TEST PLAN

Tests are carried out for:

V1=2 m/s	Q1=0,14 l/min
V2=4 m/s	Q2=0,28 l/min
V3=6 m/s	Q3=0,69 l/min
V4=8 m/s	Q4=2,91 l/min

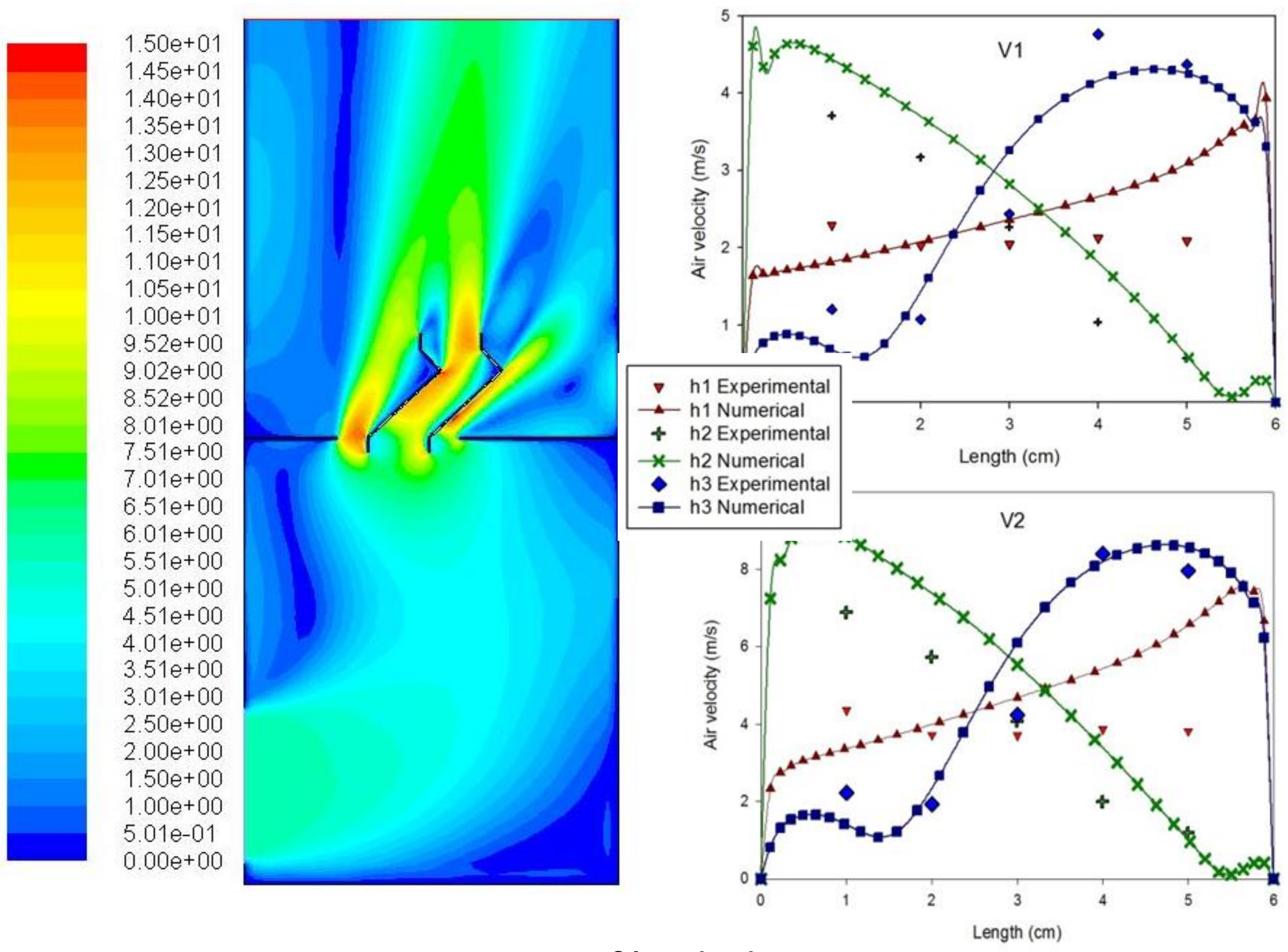
Two types of test:

1. Tests to analyze water and air interaction Each water flow is tested with each air velocity. Film thickness and detachment of drops are determined.

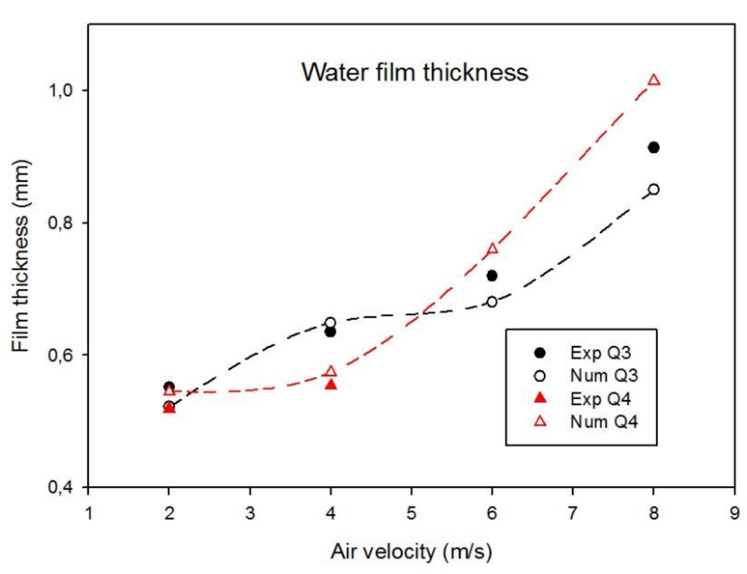
2, Tests to determine air velocity limits in which breakthrough occurs. VL1 and VL2 are determined. (VL1, when drops are drifted from the lower zone of the eliminator; VL2, when drops are drifted from the upper zone).

Experimental Validation and results

Air velocities in the channel between eliminators

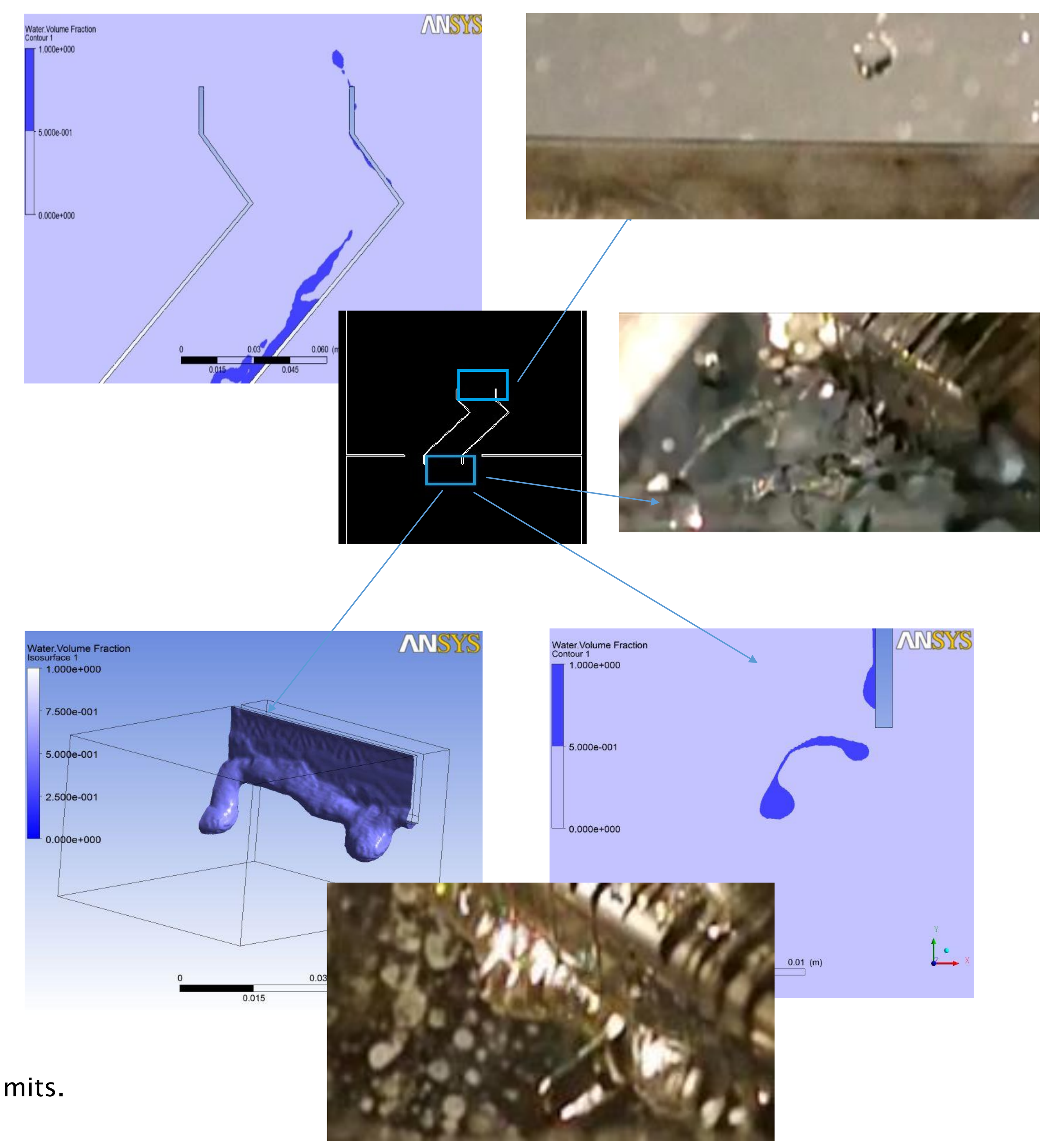


Water film thickness.



	VL1 (m/s)		VL2 (m/s)	
Q1	4.55		13.71	
Q2	4.36		12.98	
Q3	4.34	4,75*	11.30	10,73*
Q4	4.34	4,88*	12.50	12,63*

Experimental and numerical(*) air velocity limits.



3D, 2D and experimental drop separation.

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