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Effect of interactions between spray jets on liquid distribution in a fluidized bed

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EFFECT OF INTERACTIONS BETWEEN SPRAY JETS ON LIQUID DISTRIBUTION IN A FLUIDIZED BED

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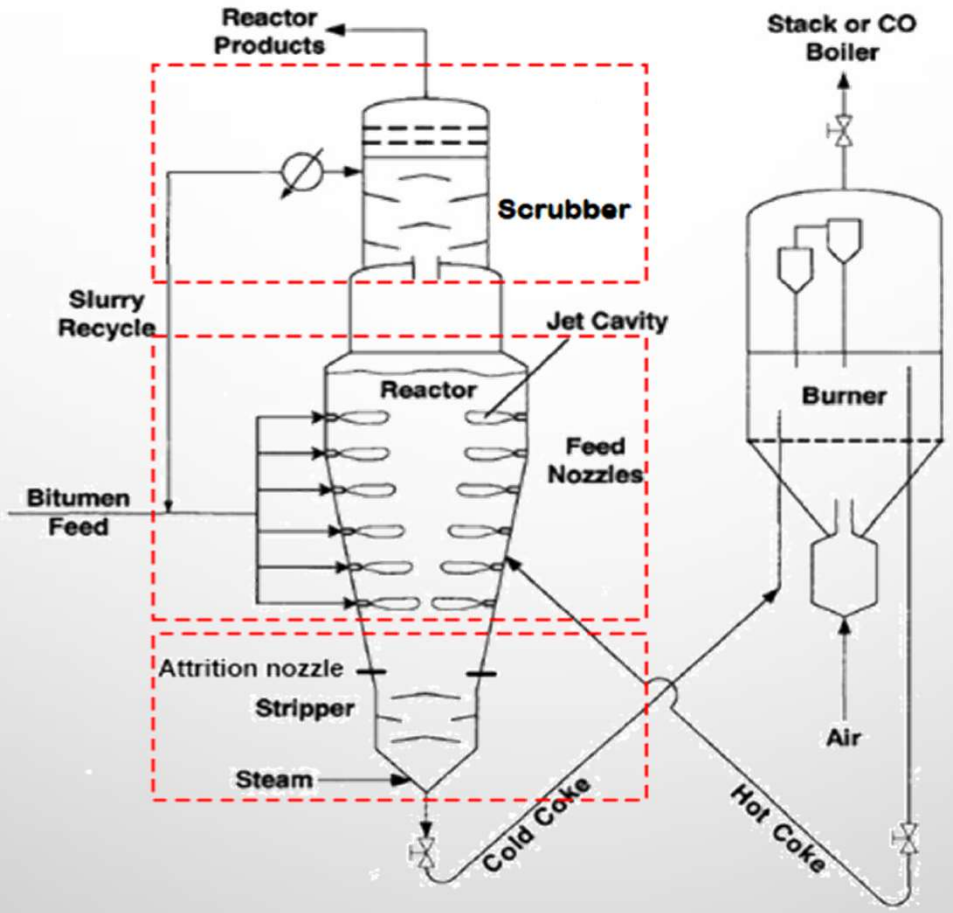
THE FLUID COKING PROCESS



In Fluid Coking, good contact between injected liquid and hot coke particles ensures high yields of valuable liquids and good operability

OBJECTIVE OF THE RESEARCH

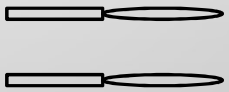
Investigate the impact of interacting spray jets on liquid distribution by studying:

- **bed conductance**
- **agglomeration with a binder solution**

with interacting jets:

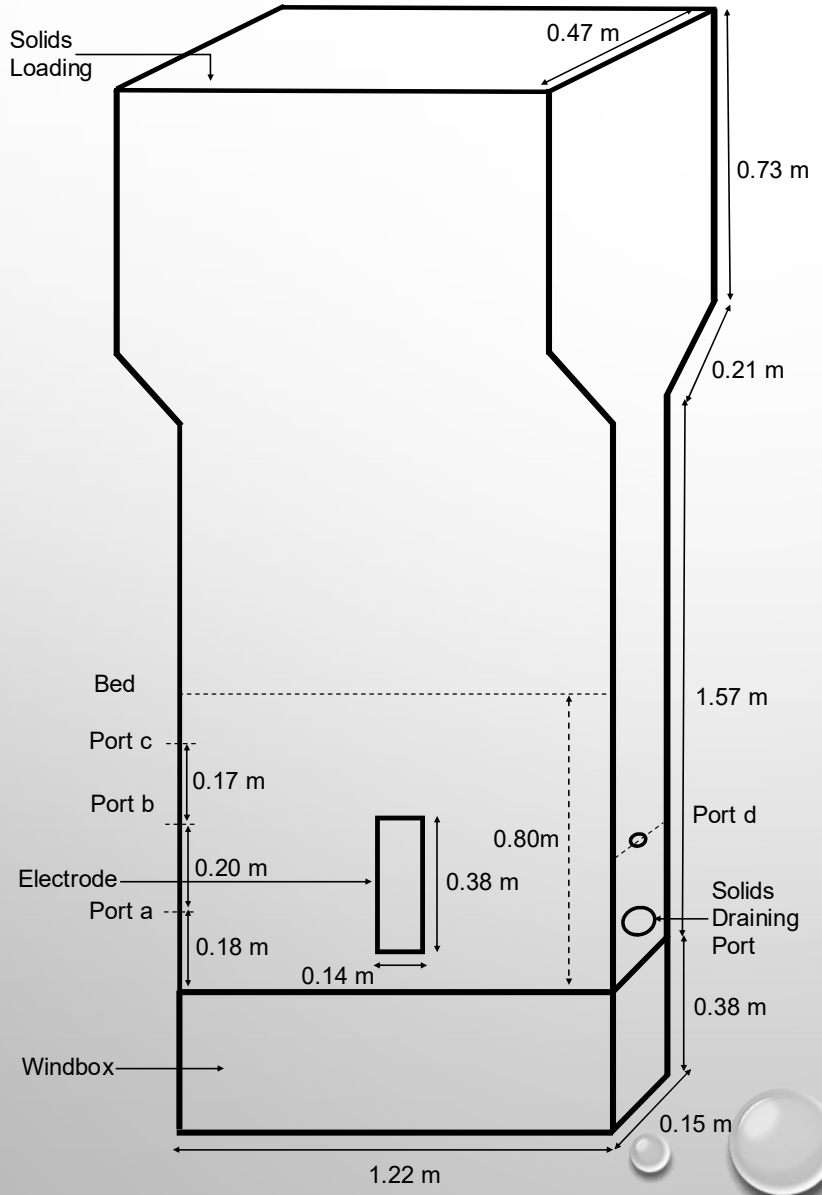
1. **Horizontally opposing**

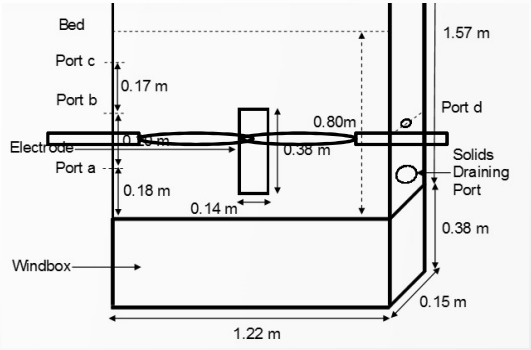
2. **Vertically separated**

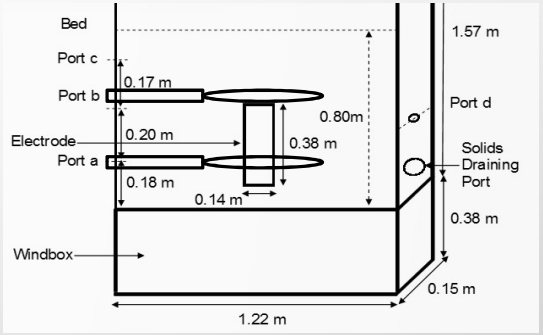


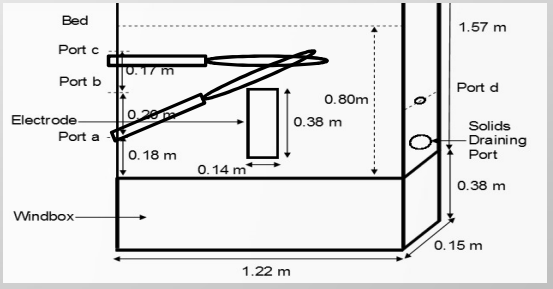
3. **Inclined**

EXPERIMENTAL SETUP





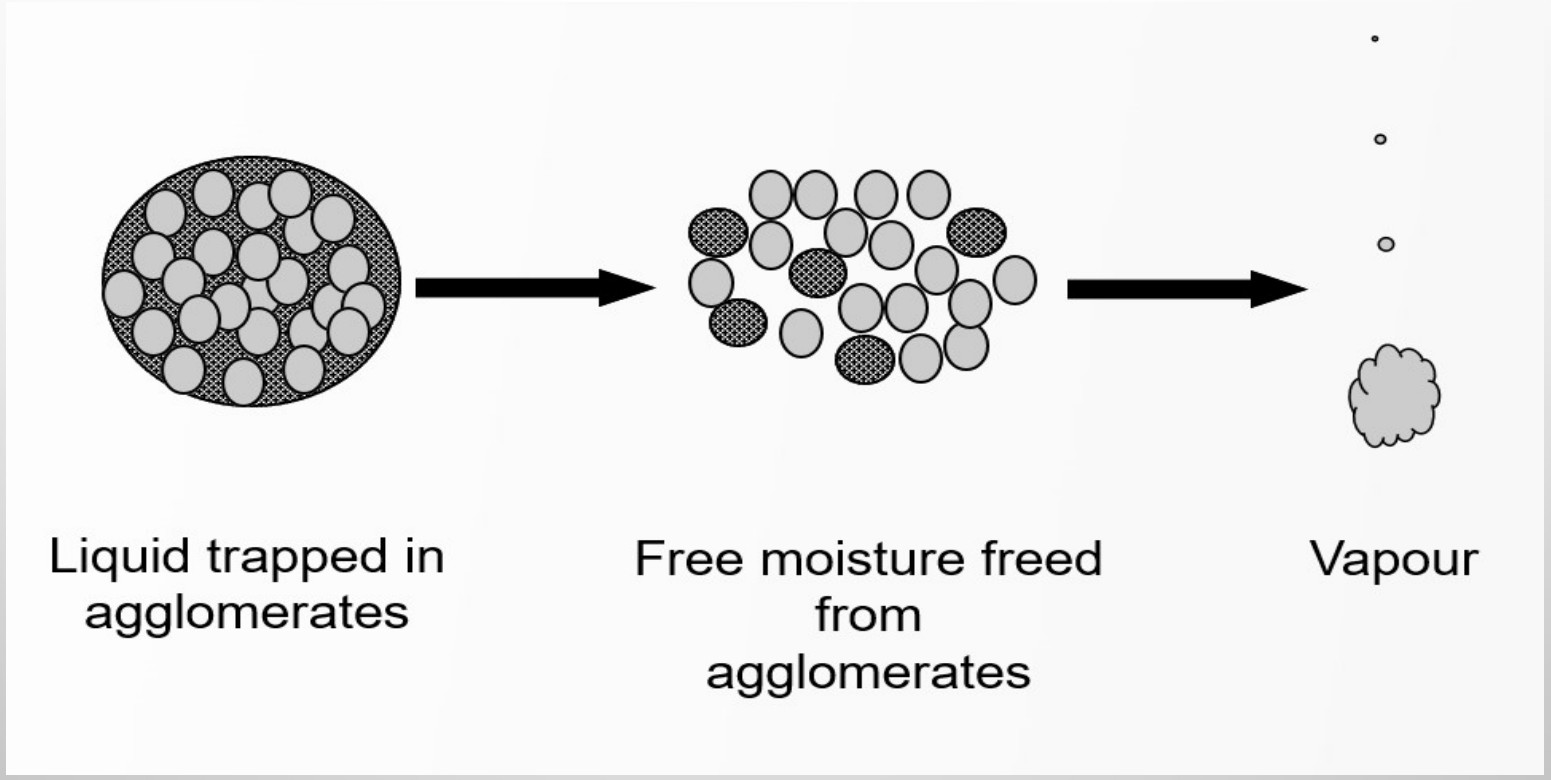




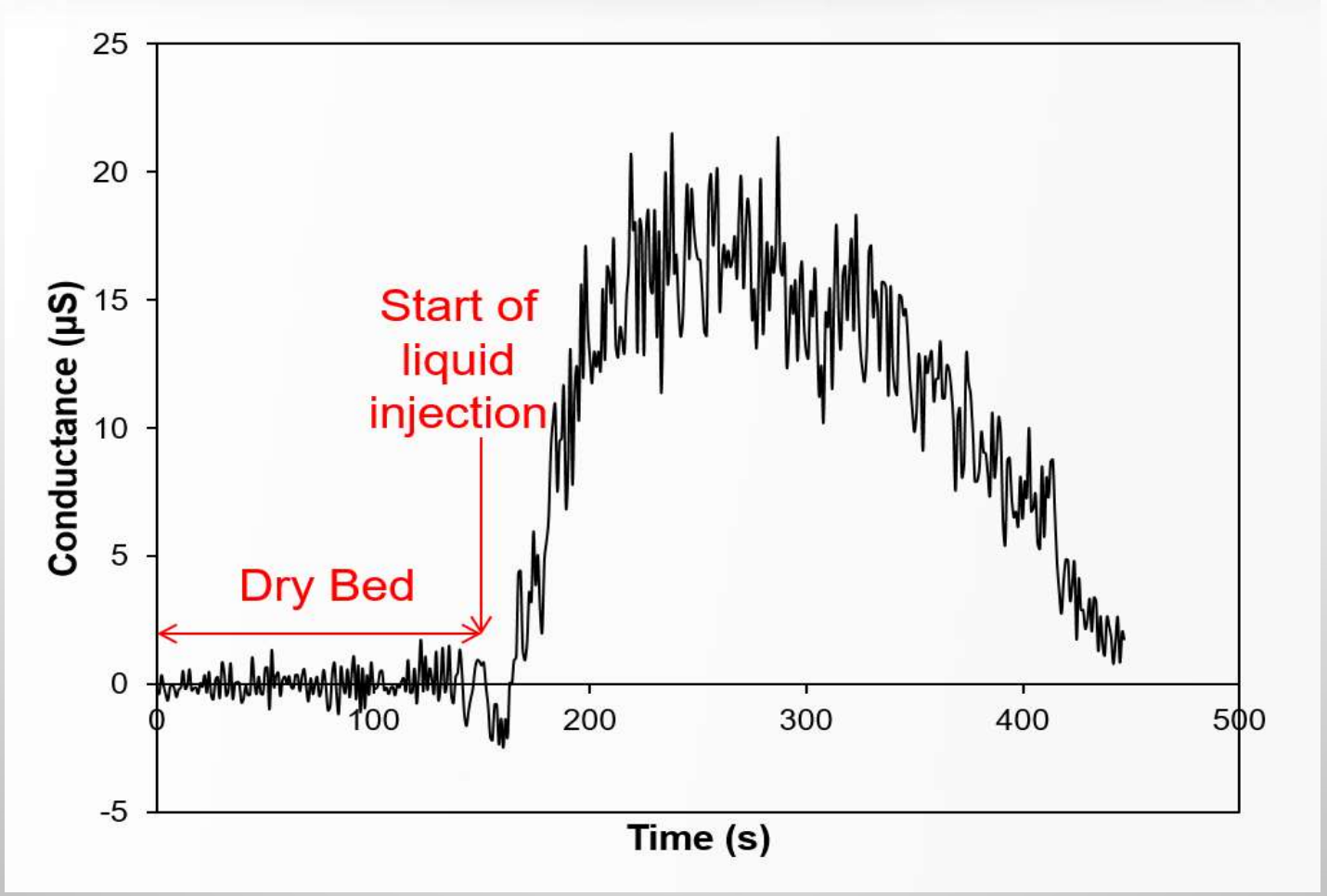
EXPERIMENTAL CONDITIONS

- 150 kg silica sand bed
- 300 g water sprayed (150 g through each nozzle)
- Water flowrate: 30 g/s through each nozzle
- Gas to Liquid Ratio (GLR): 2 wt%
- Fluidization velocity: 0.30 m/s
- Bed temperature at start of injection: 25 °C

CONDUCTANCE METHOD



CONDUCTANCE METHOD



CONDUCTANCE METHOD

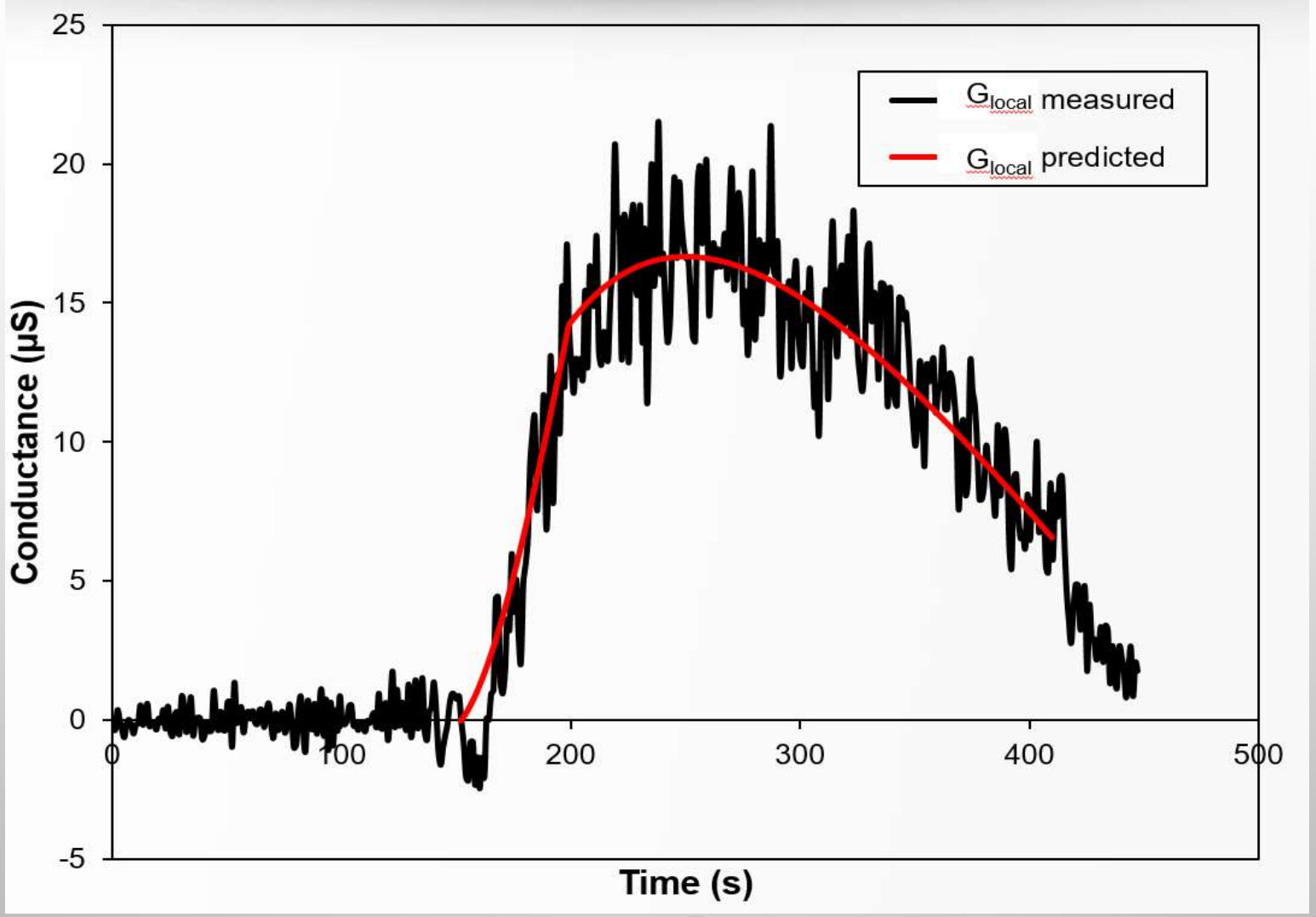
$$G = \beta\left[1-(1-\gamma_0)e^{\frac{-t}{\tau}} - \frac{t}{t_{ek}}\right]$$

G	Dry conductance subtracted from actual conductance
β	Constant
γ_0	Fraction of injected liquid initially as free moisture
τ	Agglomerate breakup time constant
t	Time
t_{ek}	Evaporation time

τ = time required to release 62.5% of the liquid from agglomerates

The smaller the τ value, the faster is the agglomerates breakup

CONDUCTANCE METHOD

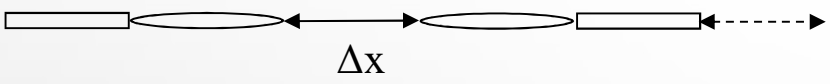


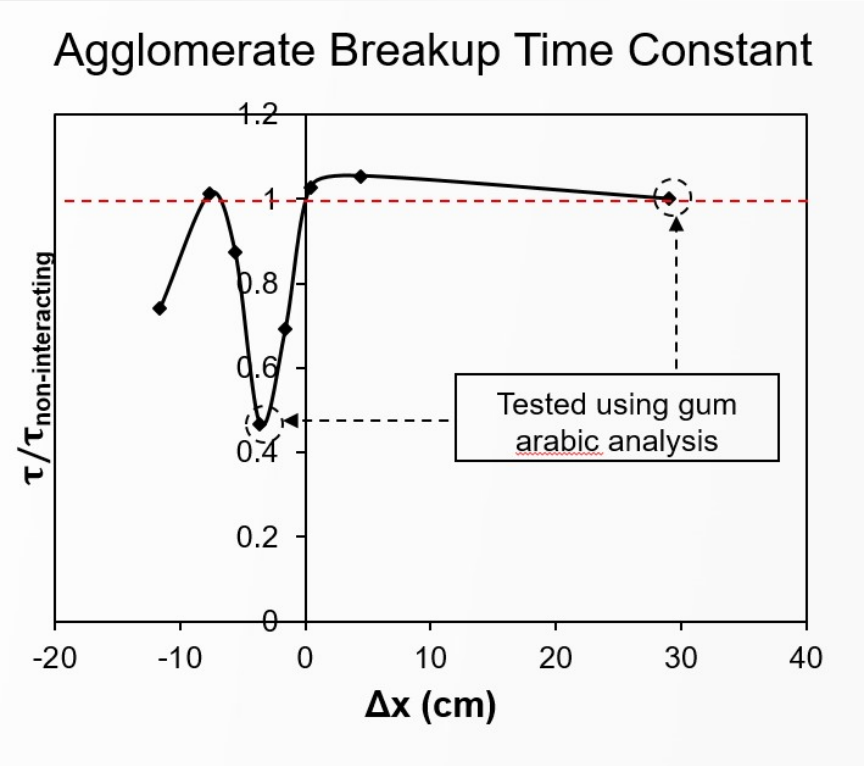
AGGLOMERATE FORMATION METHOD

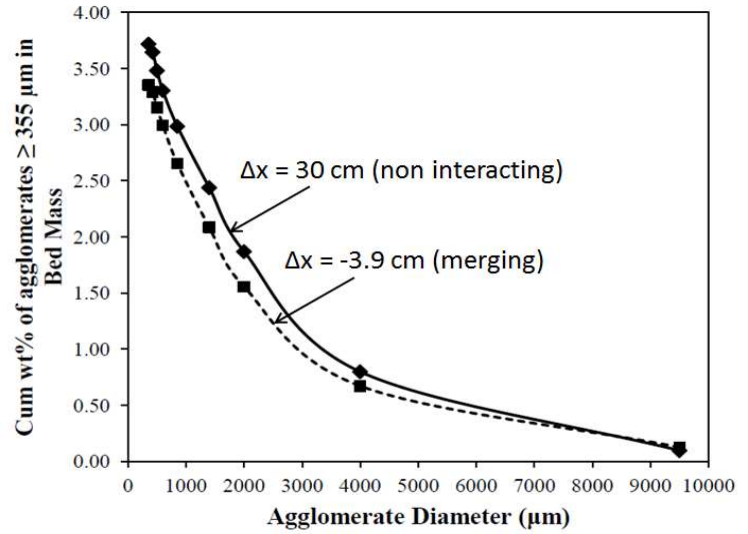
- Binder solution:
  - Water
  - 6 wt% gum arabic
  - Dye
- 1200 g of binder solution
  - 600 g through each nozzle
- Liquid flowrate: 30 g/s through each nozzle
- Initial bed temperature: 130 °C

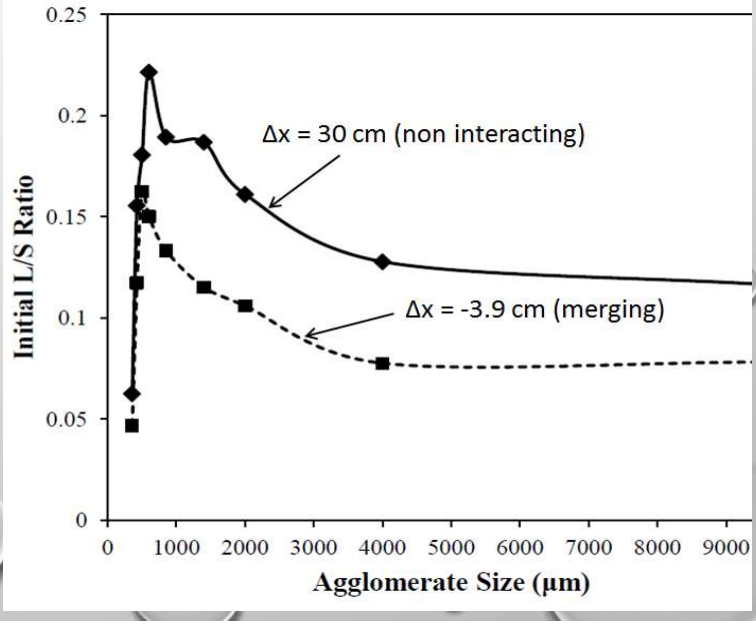
- Utilized for improved cases
- From agglomerates
  - Size distribution
  - Initial Liquid to Solid ratio (L/S)

EFFECT OF HORIZONTAL SPRAY JET INTERACTIONS ON THE LIQUID DISTRIBUTION

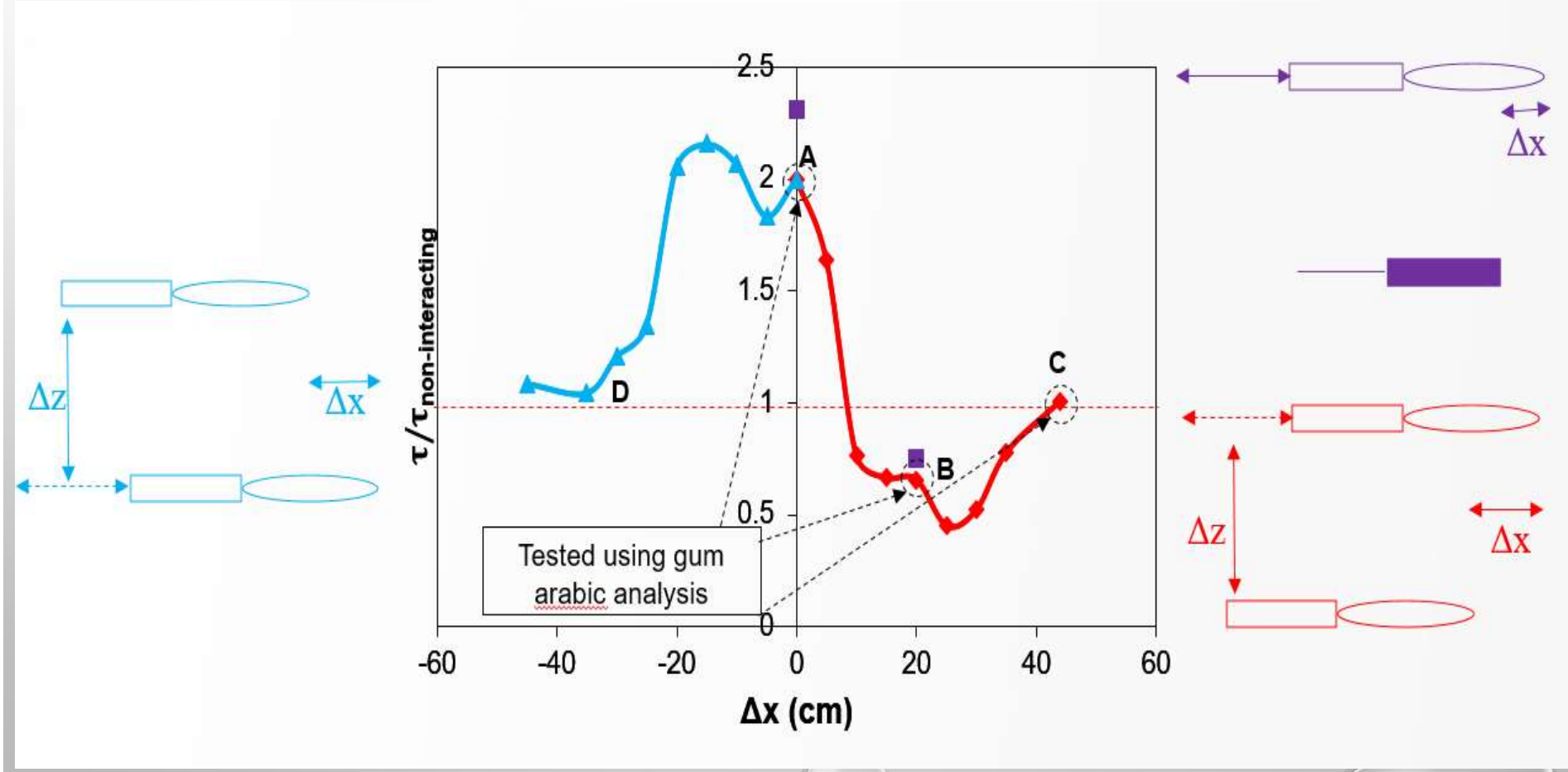




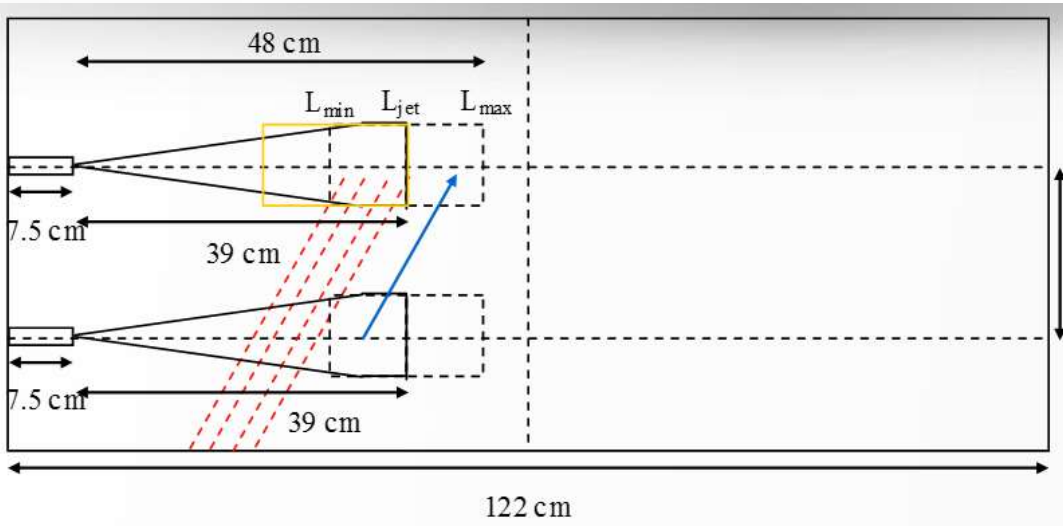




EFFECT OF VERTICAL SEPARATION BETWEEN SPRAY JETS ON THE LIQUID DISTRIBUTION



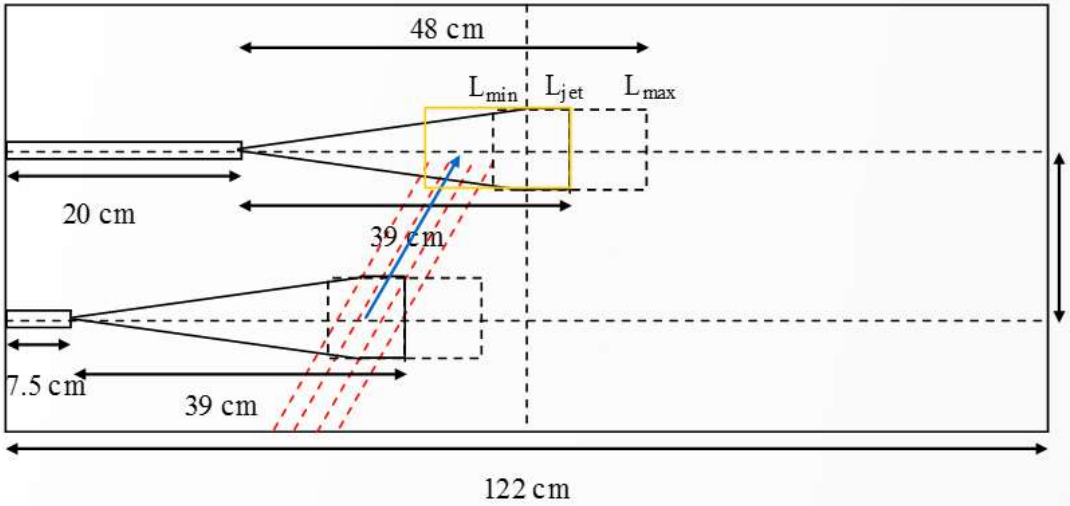
EXPLANATION



Bed bubble migration
Released bubble migration
Bubble capture area

A

$\tau/\tau_{non\text{-}interacting}$: **2.0**

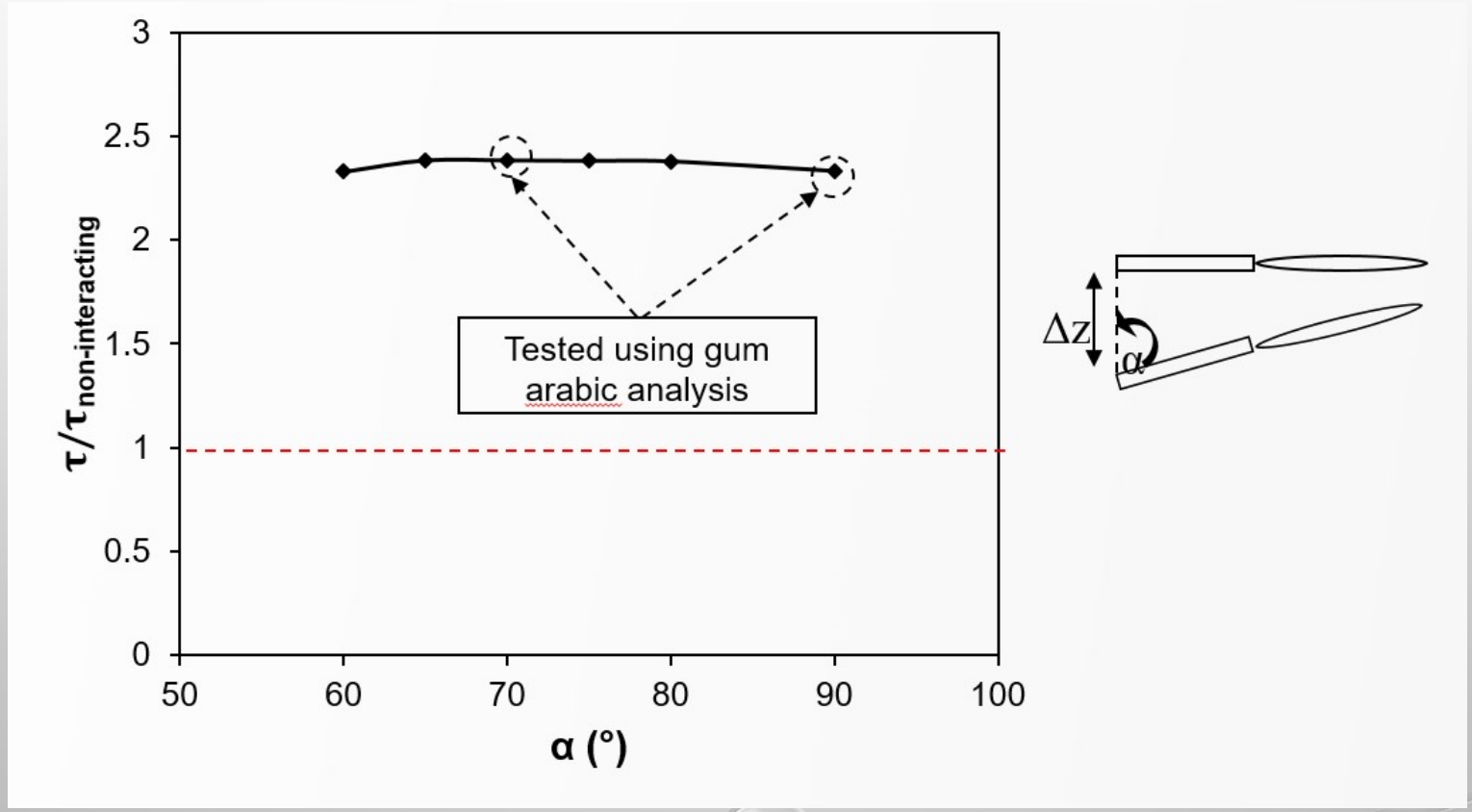


Bed bubble migration
Released bubble migration
Bubble capture area

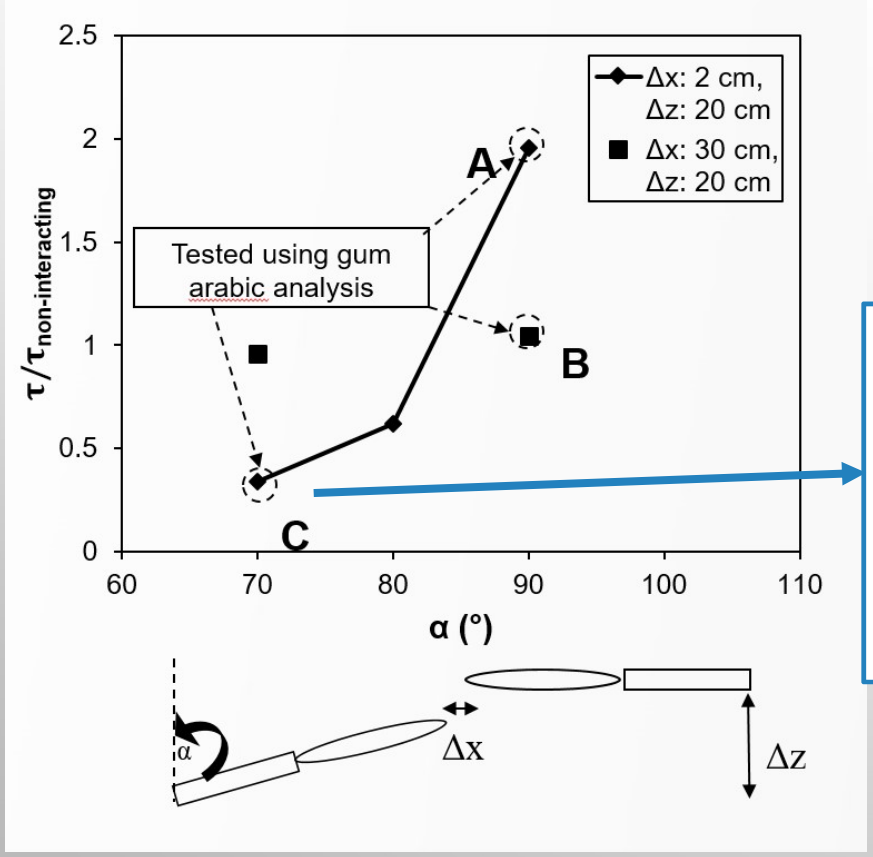
B

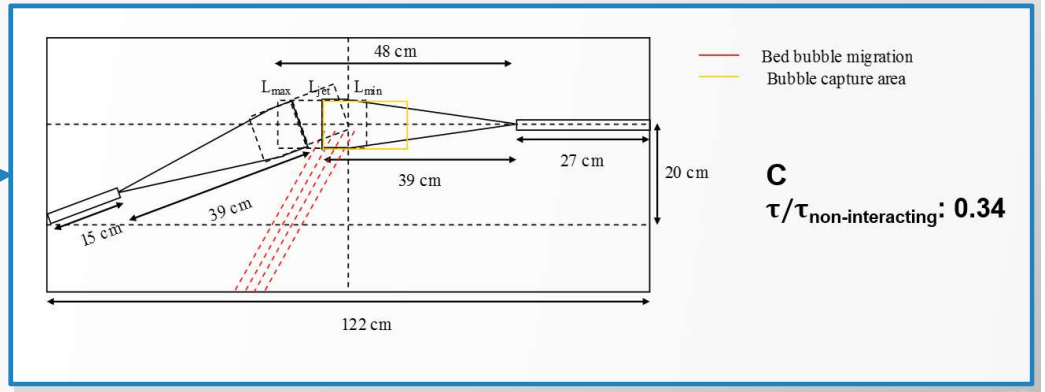
$\tau/\tau_{non\text{-}interacting}$: **0.66**

EFFECT OF INTERACTIONS OF INCLINED SPRAY JETS ON THE LIQUID DISTRIBUTION



EFFECT OF INTERACTIONS OF INCLINED SPRAY JETS ON THE LIQUID DISTRIBUTION





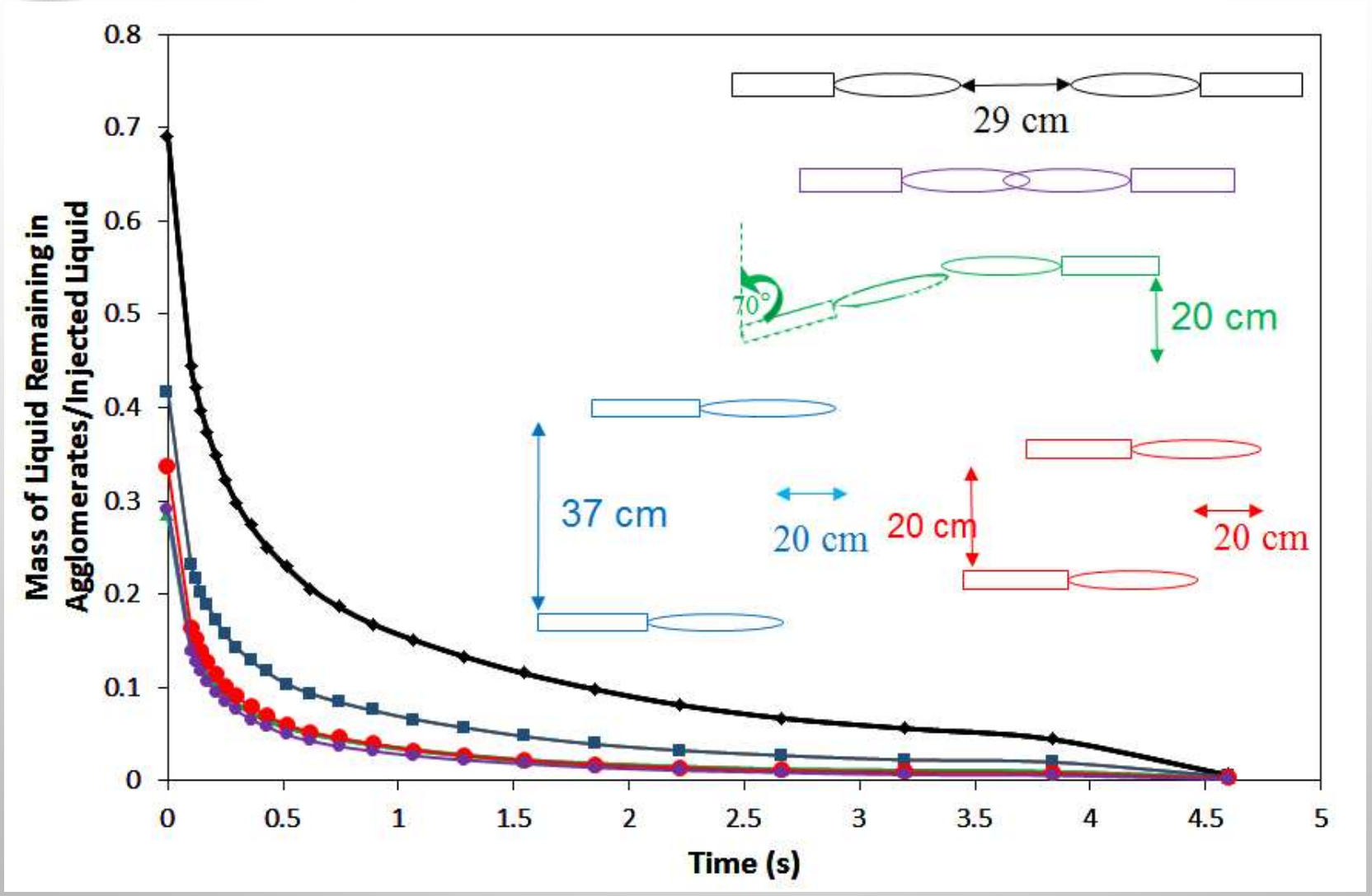
CONCLUSIONS

3 mechanisms can affect interacting jets at different vertical and horizontal positions:

1. **Bottom jet may shield bubble flow and starve top jet of bed bubbles**
2. **Bottom jet can release bubbles that are captured by the top jet reducing expansion cycles and enhancing agglomerates breakup and liquid dispersion**
3. **Bubbles released from the bottom jet can cause fewer agglomerates to be produced due to enhanced turbulence**

The combination of these mechanisms determines the effectiveness of each configuration

CONCLUSIONS



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