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Removal of Dye Contaminates in Water by a Plasma Liquid Interface

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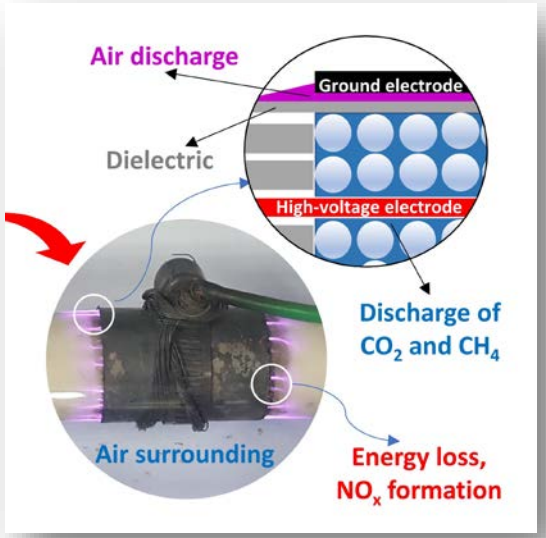
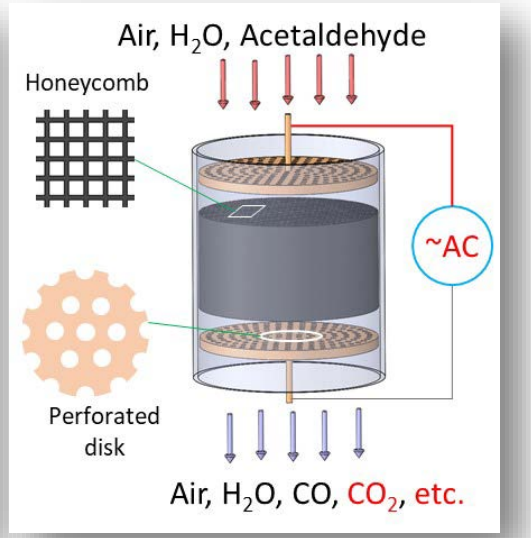
My Research Topics

Conventional topics

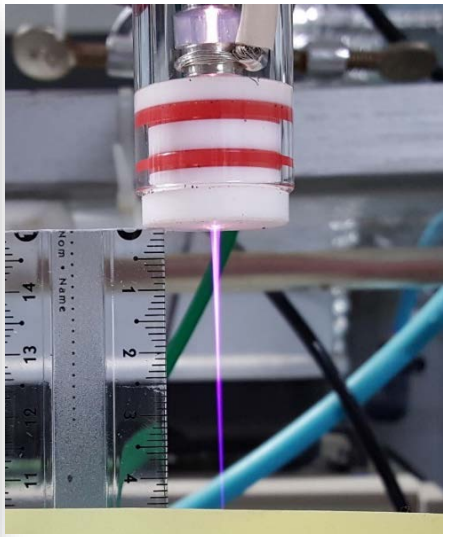
Plasma catalyst: gas conversion



Plasma catalyst: Gas treatment



Plasma jet: bioapplications



Recently topics

Energy from Plasma: generation & storage

- NH_3
- NO_x
- H_2

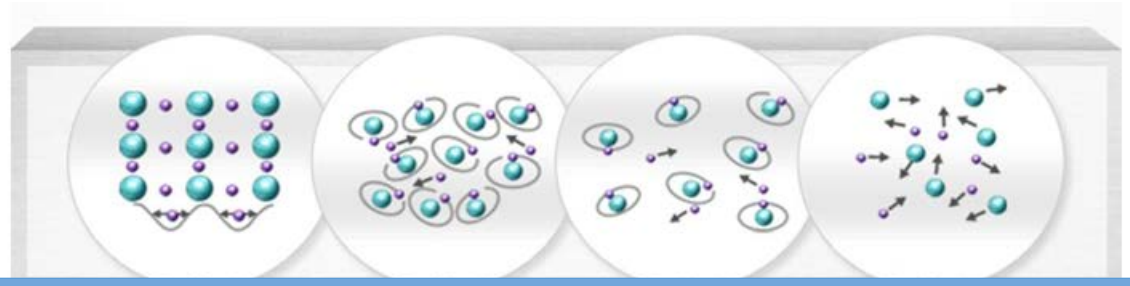
Plasma liquid interaction

- Water treatment

Outlines

- ❑ Introduction of Plasma Liquid Interaction
- ❑ Removal of methylene blue by a plasma jet
- ❑ **Future work**

1.1. What is Plasma?

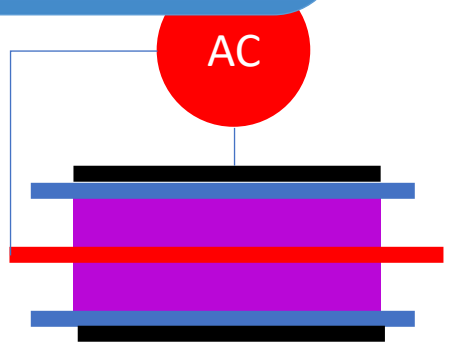


Pla

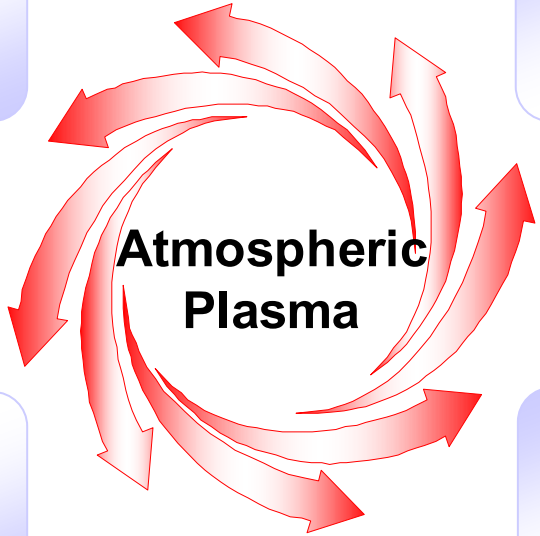
Non-thermal plasma or Atmospheric Pressure Plasma

Common and simple plasma reactor:

A dielectric barrier discharge (DBD) reactor used to generation of plasma



1.2. Applications of Atmospheric Plasma



Processing
- Surface processing
- Emitter arrays

Switches
- Electric power
- Pulsed power

Flat
- Panel Displays
- Plasma displays

Energy Converters
- MHD converters
- Thermionic energy

Volume Processing
- Flue gas treatment
- Metal recovery
- Waste treatment

Light Sources
- High intensity discharge lamps
- Low pressure lamps
- Specialty sources

Radiation Processing
- Water purification
- Plant growth

Surface Treatment
- Ion implantation
- Hardening beam sources
- Welding, Cutting, Drilling

Chemical Synthesis
- Plasma spraying
- Diamond film deposition
- Ceramic powders

Environmental technology
- Processing of combustion gases
- Treatment of greenhouse gases
- Reforming of fuel gases

1.3 Plasma Liquid interactions

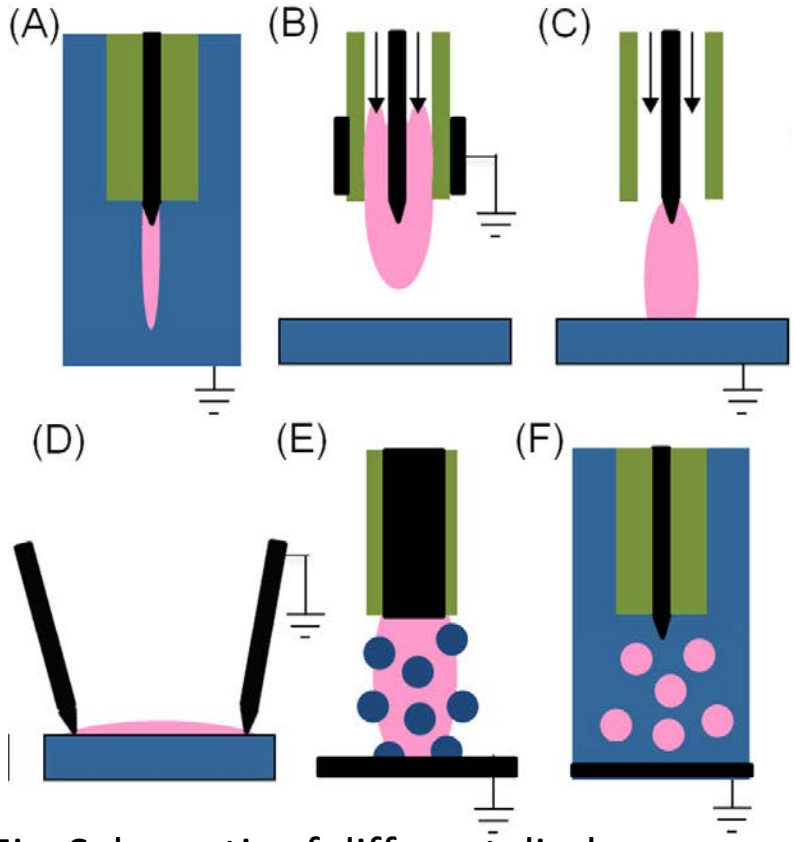


Fig. Schematic of different discharges used in plasma–liquid interactions, adopted from Bruggeman et al.

P J Bruggeman et al 2016 Plasma Sources Sci. Technol. 25 053002

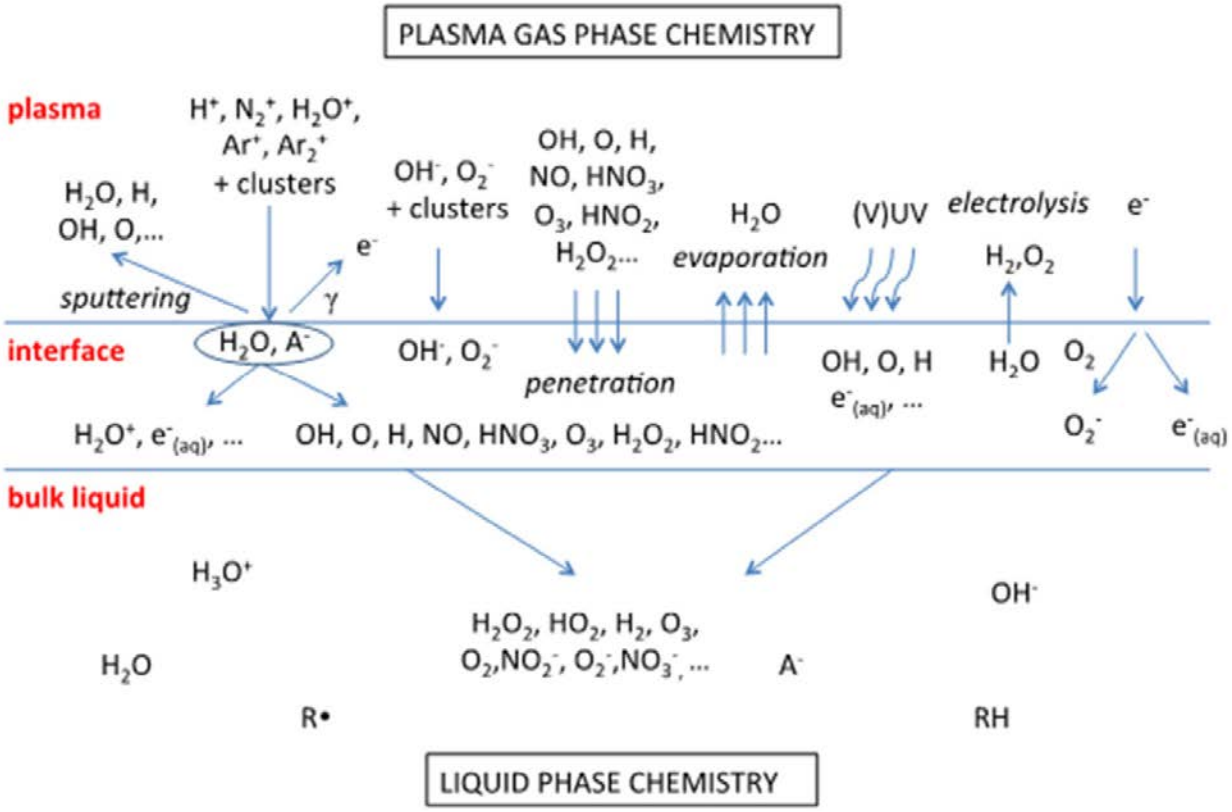


Fig. Schematic diagram of some of the most important species in plasma–liquid interactions, adopted from Samukawa et al.

Seiji Samukawa et al 2012 J. Phys. D: Appl. Phys. 45 253001

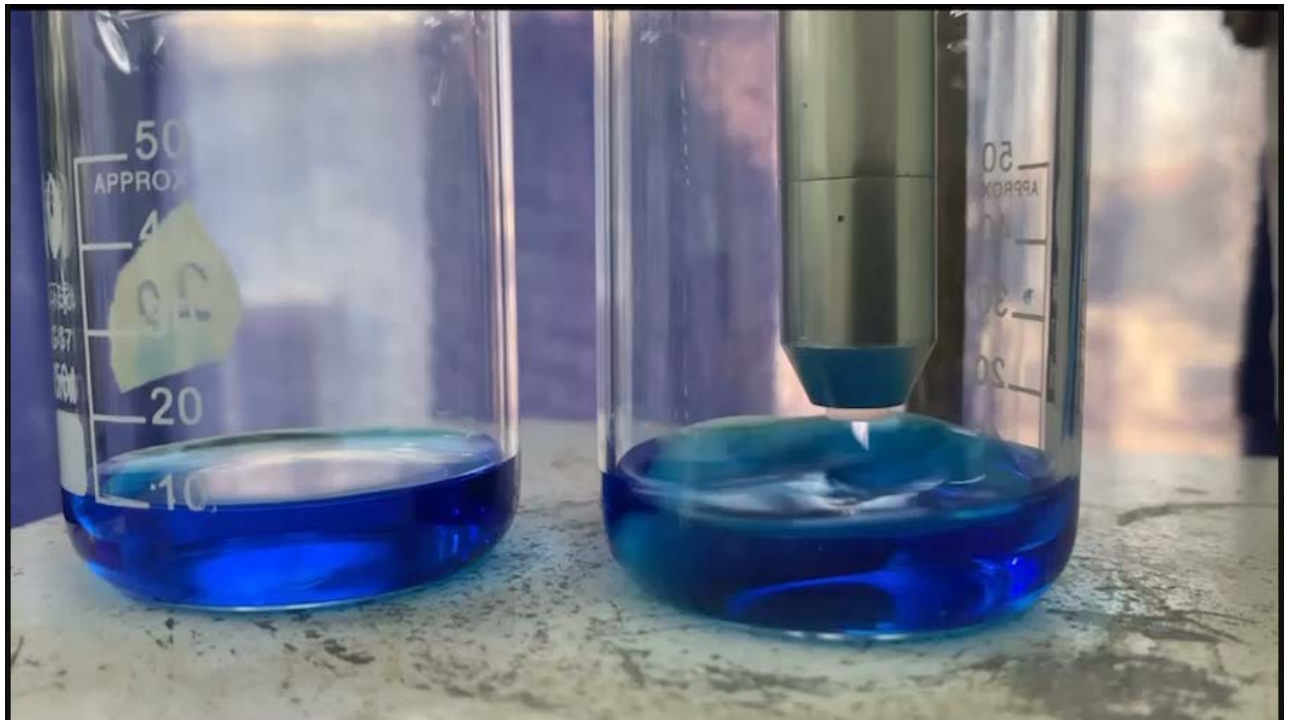
1.4. Scope of study

- Removal of Methylene blue in water by plasma liquid interaction
- Effects of parameters on the process
- Suggesting future study

2. Experimental

Low temperature plasma jet

2. Experimental



Note: faster play setting

Examined factors

- ❑ Stirring
- ❑ Distance
- ❑ Interacted time
- ❑ Concentration
- ❑ **Air injection into MB solution**

Analyzed products

- ❑ Concentration by UV-Vis
- ❑ GC-MS for products
- ❑ FTIR

3.1. Enhancing plasma catalyst process

Pulse waveforms

Frequency = 50 Hz

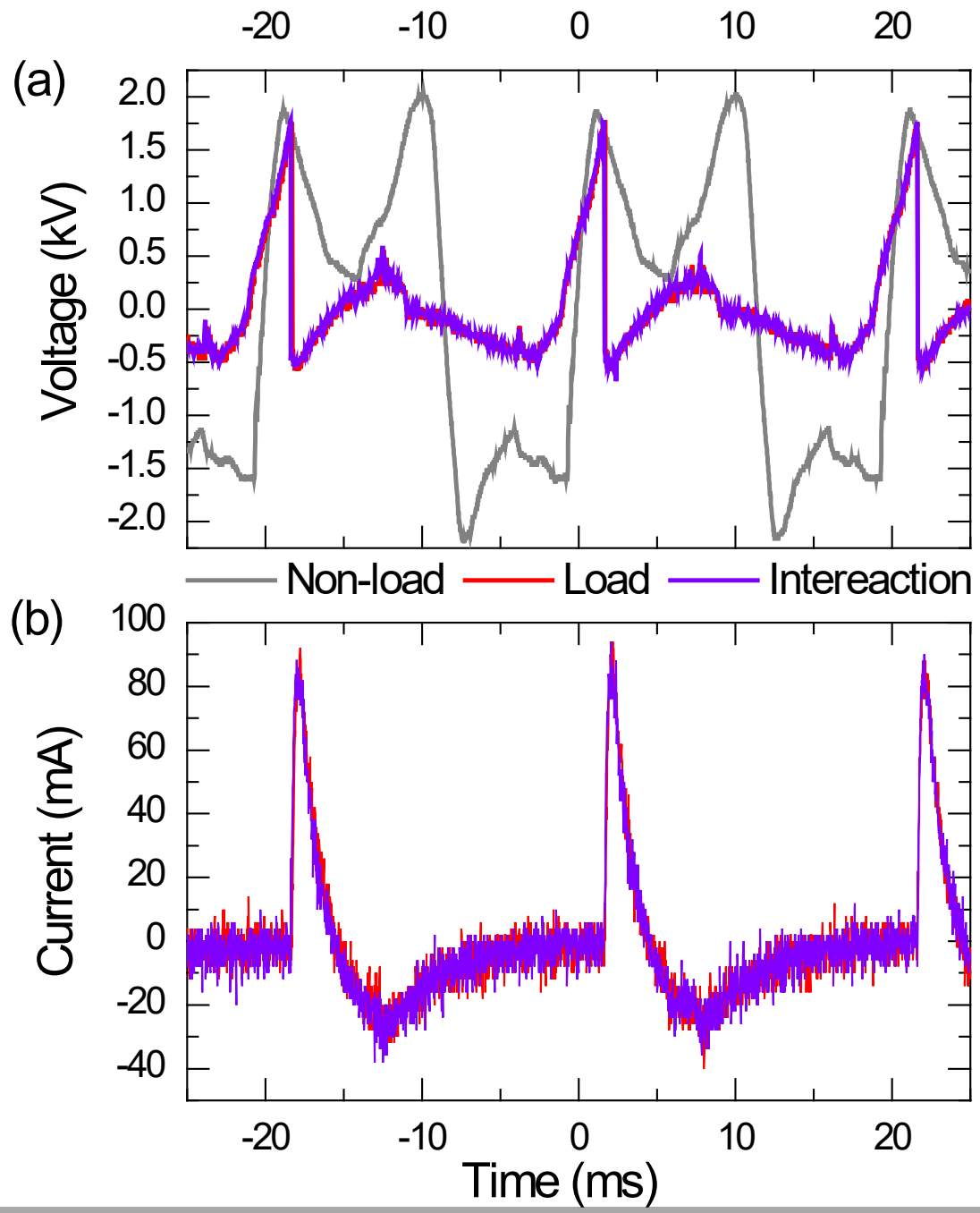


Fig. Typical waveform: (a) voltage and (b) current of the plasma jet (Ar flow rate = 3.5 L/min).

3.2. Effects of stirring MB solution

Stirring speed
100 ≤ Speed ≤ 150

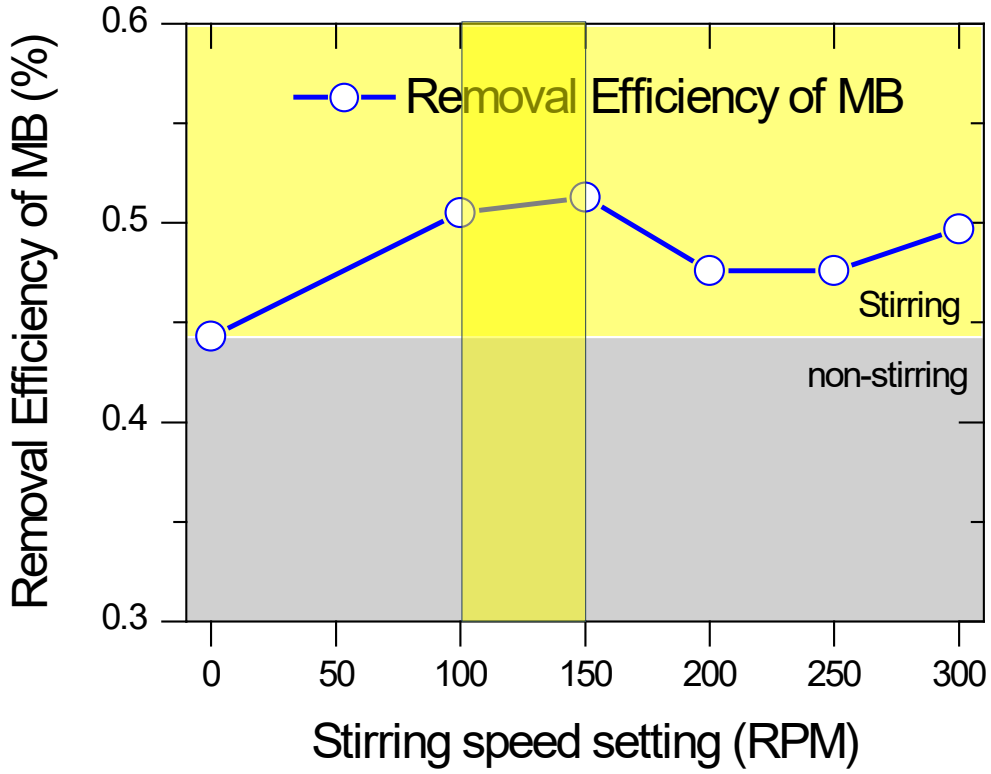


Fig. Effect of stirring MB solution on the removal efficiency (MB concentration = 10 mg/L, interaction time = 10 min; d= 5 mm).

3.3. Effects of distance

Correlation

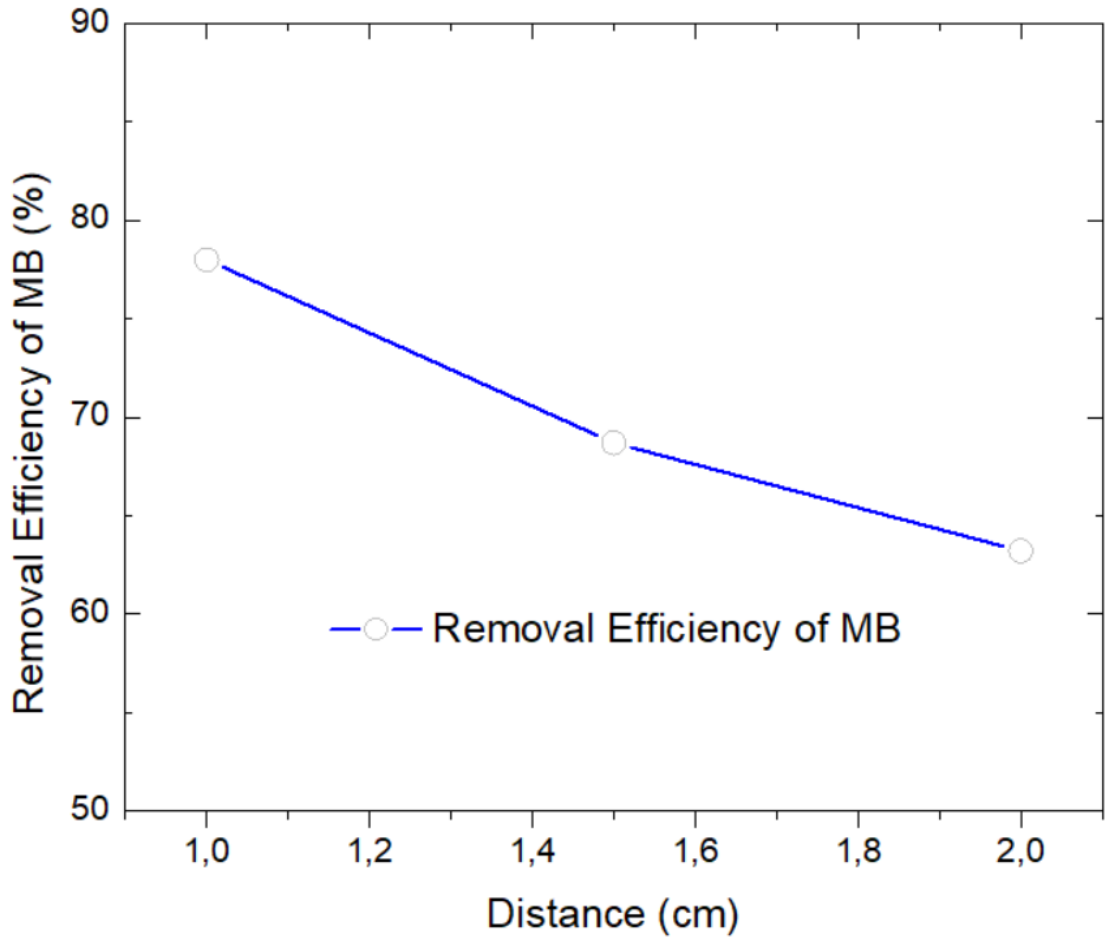


Fig. 2. Dependency of MB removal efficiency on the distance (MB10 mg/L, set stirring mode at 150 RPM, time reaction 10 min)

3.4. Effects of time interactions and concentrations

Completed Removal

Time Interaction ≥ 40 min

Concentration ↑↓ **Removal Efficiency**

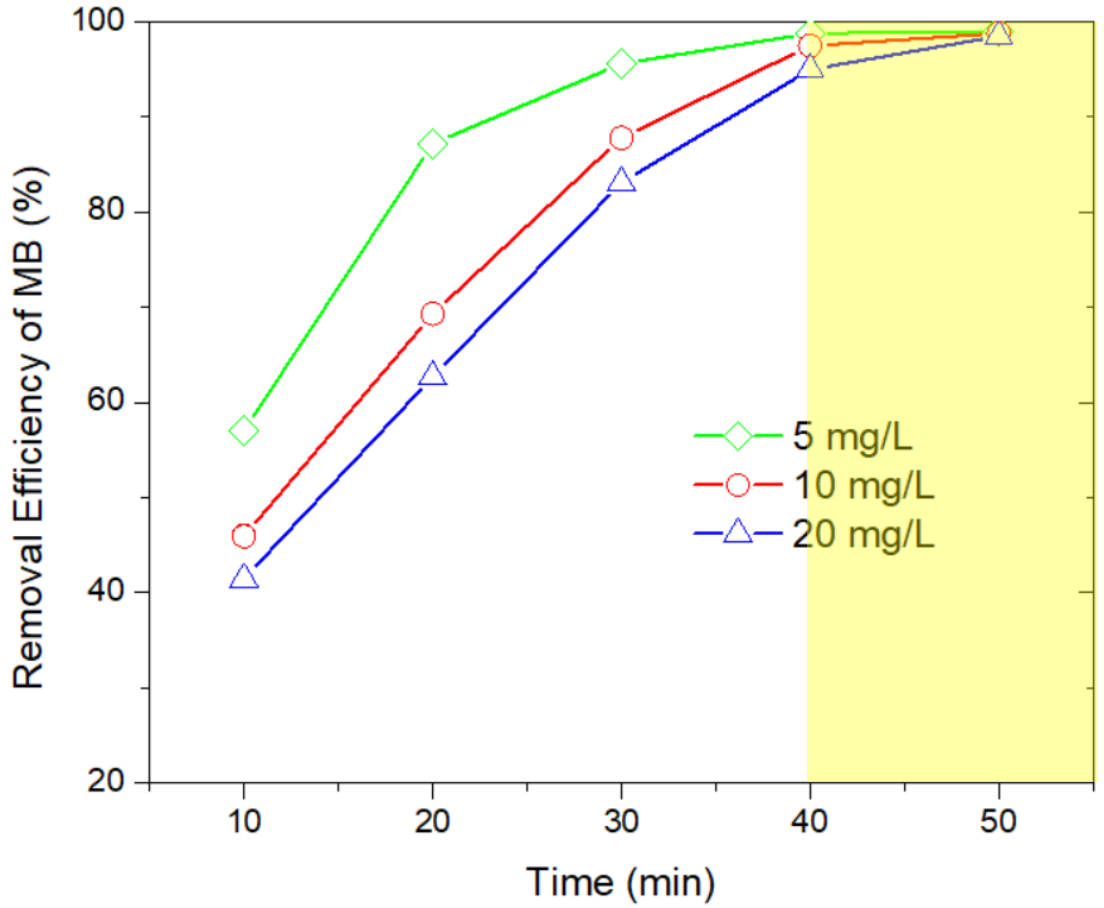


Fig. Dependence of MB removal efficiency on time interactions and initial concentration (d=10 mm, set stirring mode at 150 RPM)

3.5. Effect of air injection into MB solution

Removal efficiency: Insignificant increase

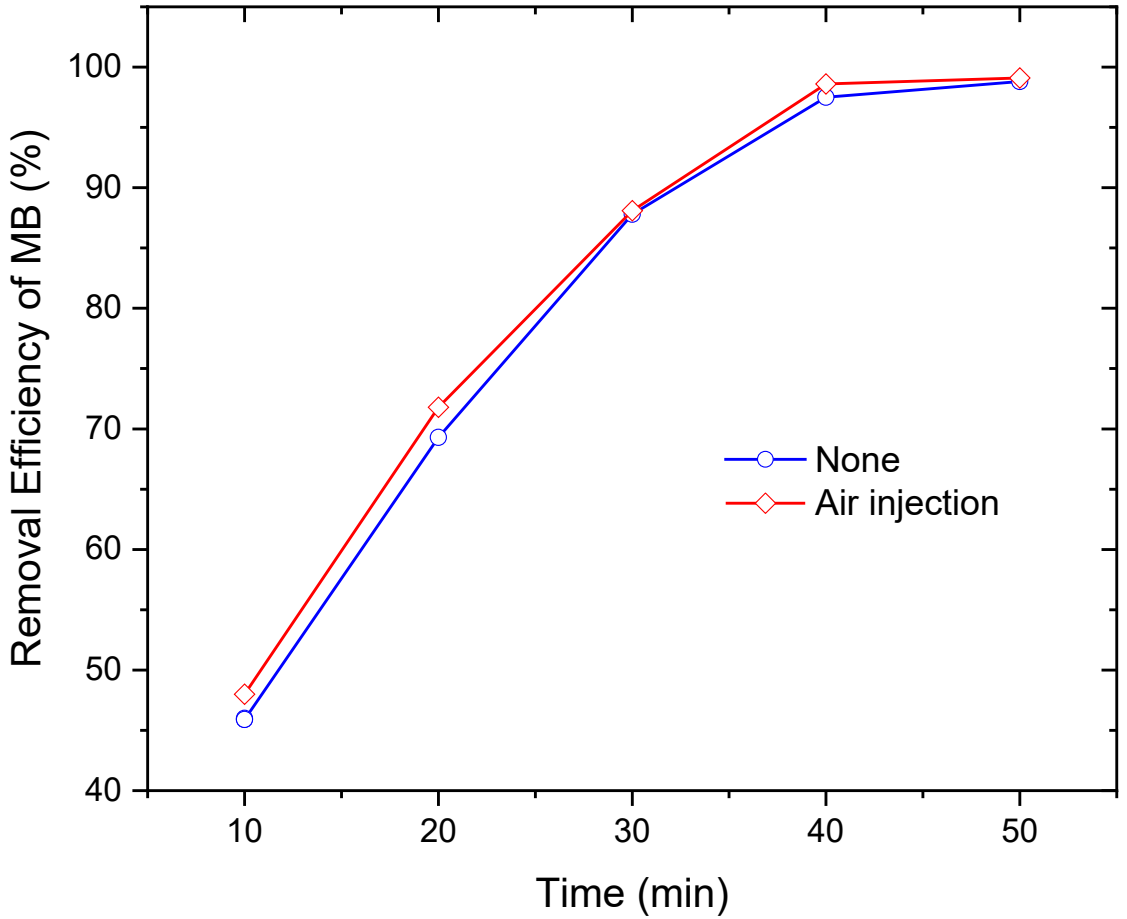


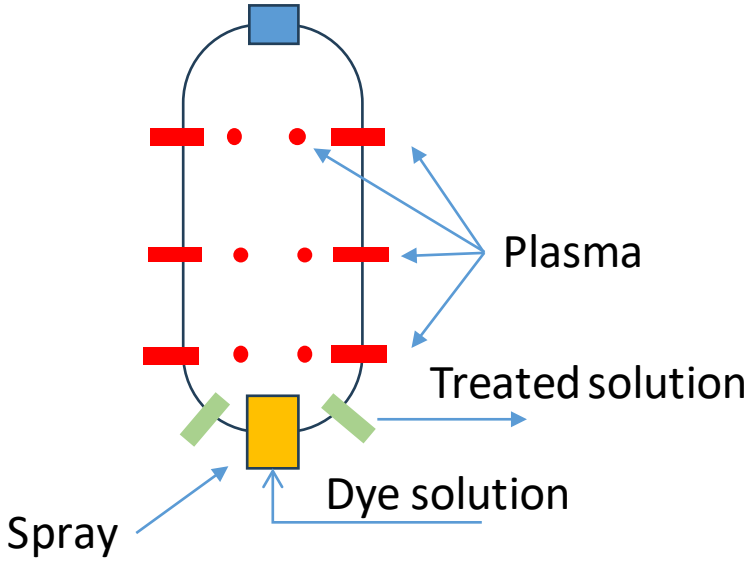
Fig. Comparison of MB removal efficiency variation with air injection into MB solution (d=10mm, Q_{air}=1,6 l/min, MB10 mg/L, time reaction 10 min)

4. Future study

large PLI

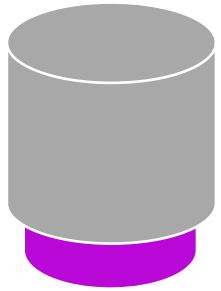
1

Tower



2

Large plasma jet



4. Conclusions

- ❖PLI by plasma jet is promising for dye removal
- ❖Removal efficiency depends on:
  1. Stirring solution,
  2. Time interaction
  3. Concentration
  4. Distance from exit nozzle to liquid surface
- ❖Developing large atmospheric pressure plasma for enlarging PLI

Acknowledgements

Thank you for your attention!
Questions and Answers