# Capillary Action and its Applications

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## Introduction

- Capillary action present in many natural and technological process.
- Fluid movement through porous solids has grown in engineering and applied science fields.
- Applications limited by complex geometries, interface shapes and gravity.

## Methods

- The research strategy implemented mixed maximize on gathering potential information.
- Collected data was qualitative.
- Data from farmers who compared the soil matric approach and traditional irrigation were researched through **case studies.**
- **Literature reviewed** methods were used to accumulate information about oil extraction.
- The biomedical applications were studied through **experimental** processes and conclusions were drawn from respective reports.

## Capillarity

- Liquid rises through vertical tube when one end is immersed in liquid.
- Liquid in tube rises higher than liquid outside.
- Due to adhesion, cohesion, and surface tension
  - Adhesion: attraction between unlike particles
  - Cohesion: attraction between like particles
  - Surface tension: tendency of liquid surface to shrink
- Wetting liquid: concave surface in tube and contact angle < 90° **Fig 1.**
- Nonwetting liquid: convex surface in tube and contact angle > 90° **Fig 2.**

**Fig 1.**

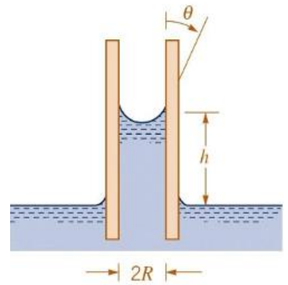
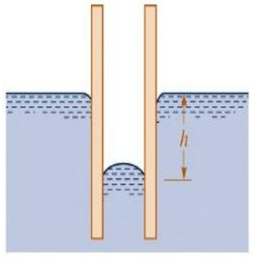



**Fig 2.**




## Applications

### Water Transportation in Soil and Plants

- Capillarity is primary force which enables soil to retain and regulate water.
- In plants, the xylem vessel acts as a capillary tube. **Fig 3.**
- Adhesion and cohesion make a two-step process to get water from roots to leaves.
- In agriculture, soil matric potential is used to measure available water for plants. **Fig 4.**
- Irrigation is scheduled based on soil matric potential.
- When water availability drops below certain threshold, irrigation is initiated.
- Best method for areas with unpredictable climates and delicate crops.

**Fig 3.**

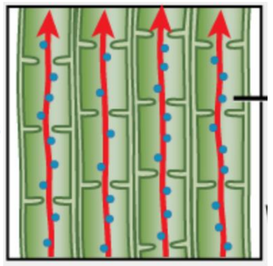
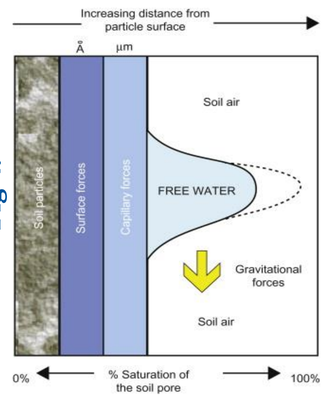


**Fig 4.**




### Oil Extraction from Reservoirs

- Capillary pressure in reservoirs forms transition zones.
- Transition zones are areas were hydrocarbons are recoverable.
- Height of zones rely on capillary pressure and densities of nonwetting and wetting fluids. **Fig 5.**
- To extract oil or water from reservoirs, displacement forces needed to overcome capillary force.
- Displacement force is equal in magnitude but opposite in direction to capillary force.
- Displacement force supplied by gravity working on the difference of densities of liquids.
- **Fig 6.** shows $CO_2$ used to provide displacement force

**Fig 5.**

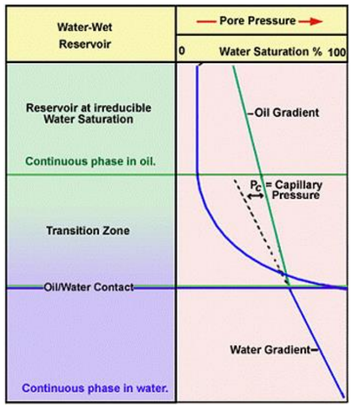
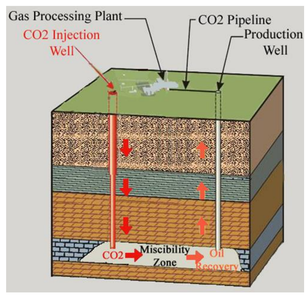


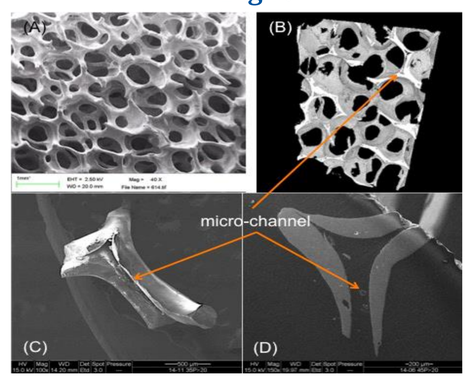

**Fig 6.**




### Biomedical Devices

- Capillary action aids in testing blood for alterations by measuring its viscosity.
- Blood ran through 3D printed capillary circuits:
  - Simple
  - Cost effective
  - Disposable
- Biogenic microenvironment templates contain microchannels acting as capillary tubes. **Fig 7.**
- This allows cells to travel from one end of template to another.
- Promotes absorption, retention, and habitation of cells.

**Fig 7.**




## Conclusion

- Capillarity governing phenomenon everywhere.
- Evolving topic in academia and industry.
- Has allowed for advancement in:
  - Sensitive crop yields with efficient irrigation systems
  - Petroleum engineering through precise predictions of hydrocarbon harvesting areas
  - Accessibility of medical equipment
- All examples show capillary action significantly improves results.

## References

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## Acknowledgements

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