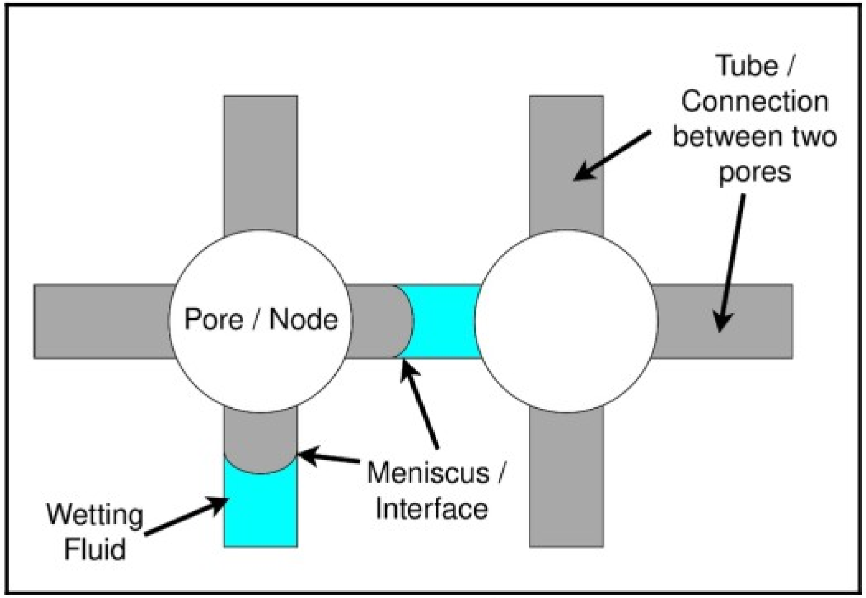

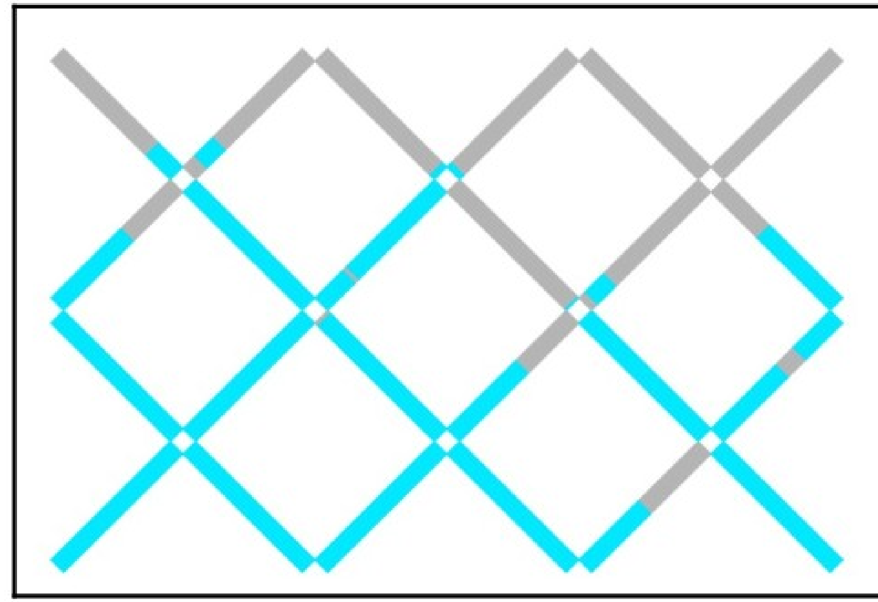

Conference Presentation: Model of Two-Phase Flow in Porous Media

Full title of the work: Simulation of Two-Phase Flow in Porous Media using a Two-Dimensional Network Model

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Presented at: 65 MIPT Conference, Dolgoprudny
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Part-1 Introduction

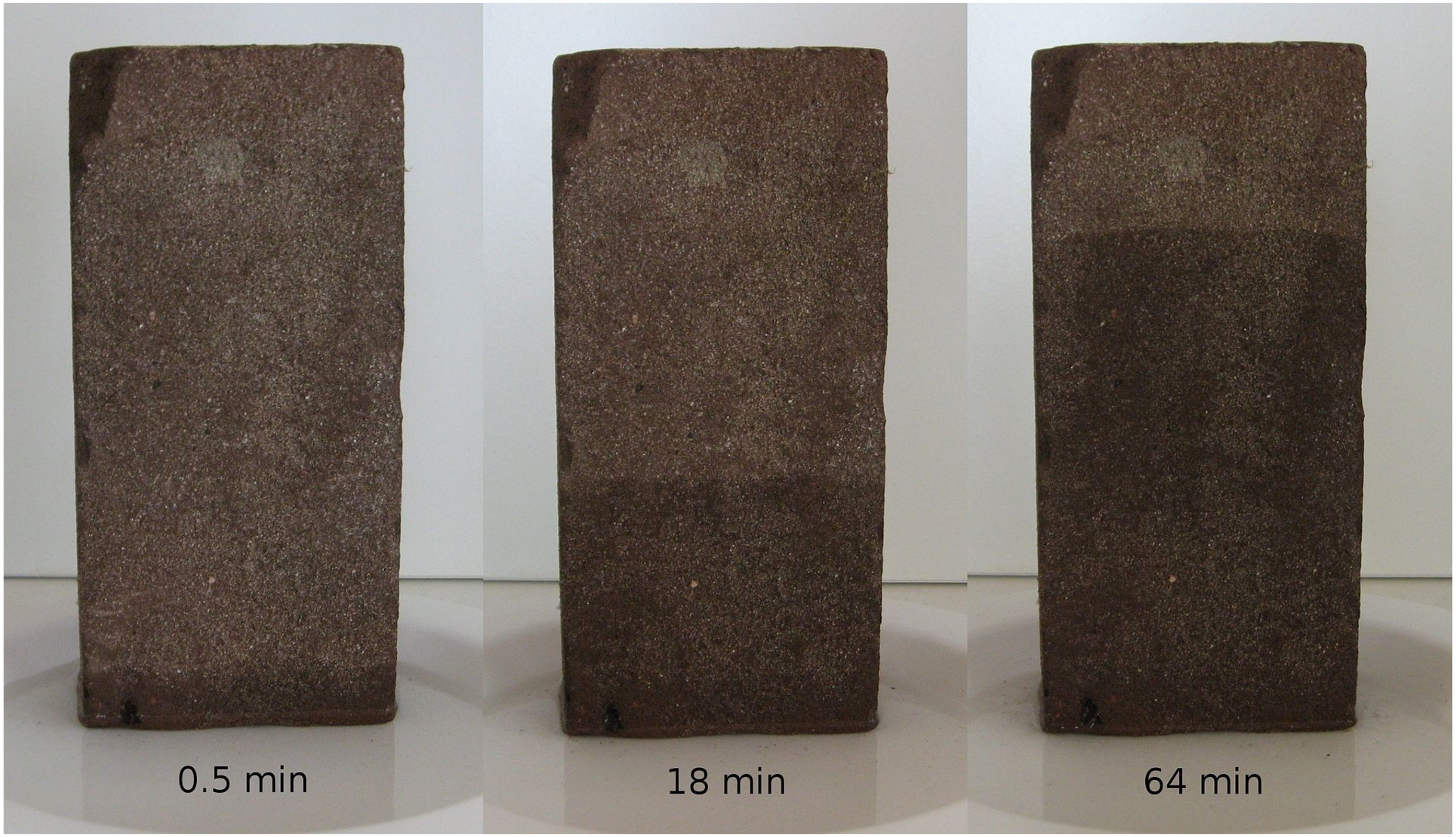
Network Model:

- Flow of phases in porous media
- Determination of pressure
- Determination of flow Rate
- Updating step by step

Practical Applications:

- Oil recovery
- Hydrology
- Electricity production (pressurized water through heated pipes -> into steam)

Part-1 Introduction



Part-2 General Aim

The algorithm can be used to simulate:

1)Saturation of a phase with respect to time

2)Model imbibition

3)The Hysteresis Curve [the pressure across the porous body reversed, total capillary pressure =f(saturation)]

4)Determination of permeability (Darcy’s law)

Part-2 Aim and Task

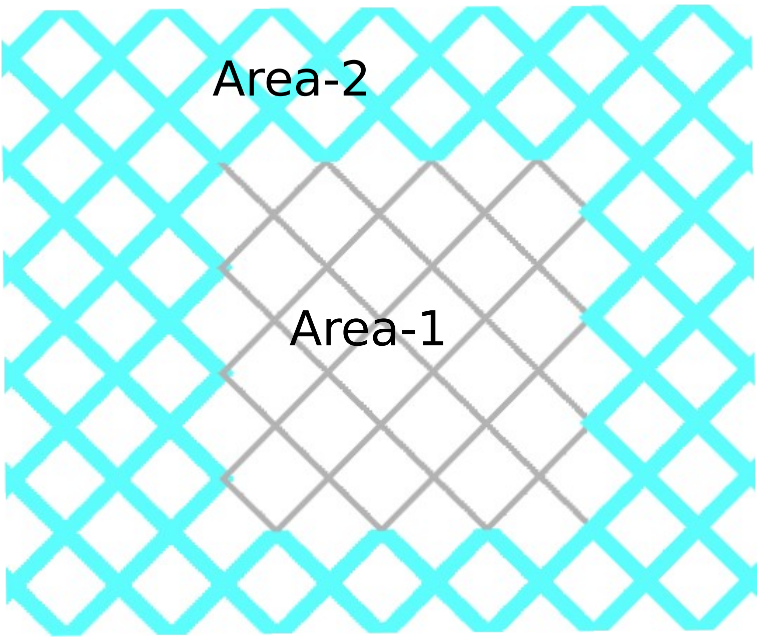
Model imbibition

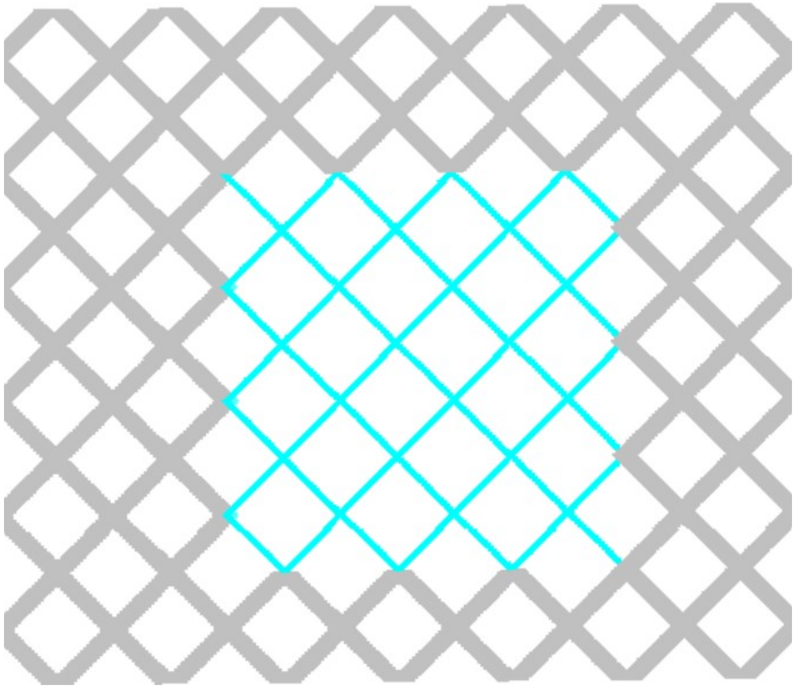
- Wetting fluid displaces non-wetting, thinner capillaries

Description of the particular problem presented today

- Area-1 non wetting
- Area-2 wetting
- Volume-1 = Volume-2
- Radius-1 = Radius-2 / 3

Part-2 Aim of the work





Part-3 Tools and Methods Used

Computer Simulation

Input Files:

- Radius distribution
- Phase Distribution

Compiled C++ Program processes

- Solution of linear equations
- Euler Method of Integration

Only simple Data Structures used, no external libraries

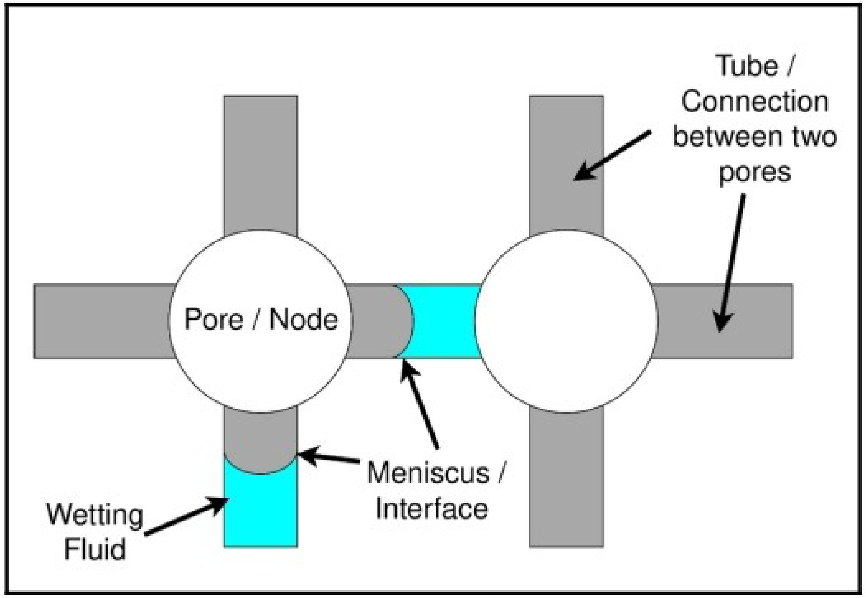
Part-4 Work: Equations

$$\sum Q_i = 0 \quad (1)$$

$$Q = \frac{\pi R^4}{8Ml}\left(\Delta P + \frac{2s\sigma}{R}\right) \quad (2)$$

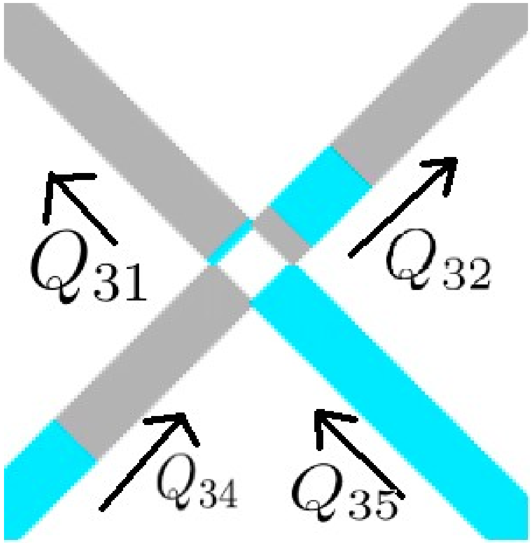
$$M = \sum \mu_i \frac{l_i}{l} \quad (3)$$

$$Q = \frac{\pi R^4}{8\mu}\frac{\Delta P}{l} \quad (4)$$



Part-4 Work: Algorithm

1. From (1), relates five pressures.
2. N(equations) = N(nodes in network model)
3. Equations solved using Gauss-Jordan Elimination.
4. Flow rates calculated using (2)
5. Time step is chosen according to the nearest meniscus reaching the node.
6. At each of the nodes the flow is distributed to the outgoing tubes such that the tube with the smallest radius is filled first with the wetting fluid, this is due to the favor of energy.



Part-4 Work: Result

Part-5 Conclusion

- Adjusting radius distribution, coefficient of capillary force, and viscosity: explains physical phenomena.
- Can be modified to the case where there are more than 4 tubes connected to a node. Example: Hexagonal Structure, 3D model
- All Equations and Integration steps are linear and large network models (100 x 100) can be simulated on a personal computer.