

Flow Geometries and Dimensions

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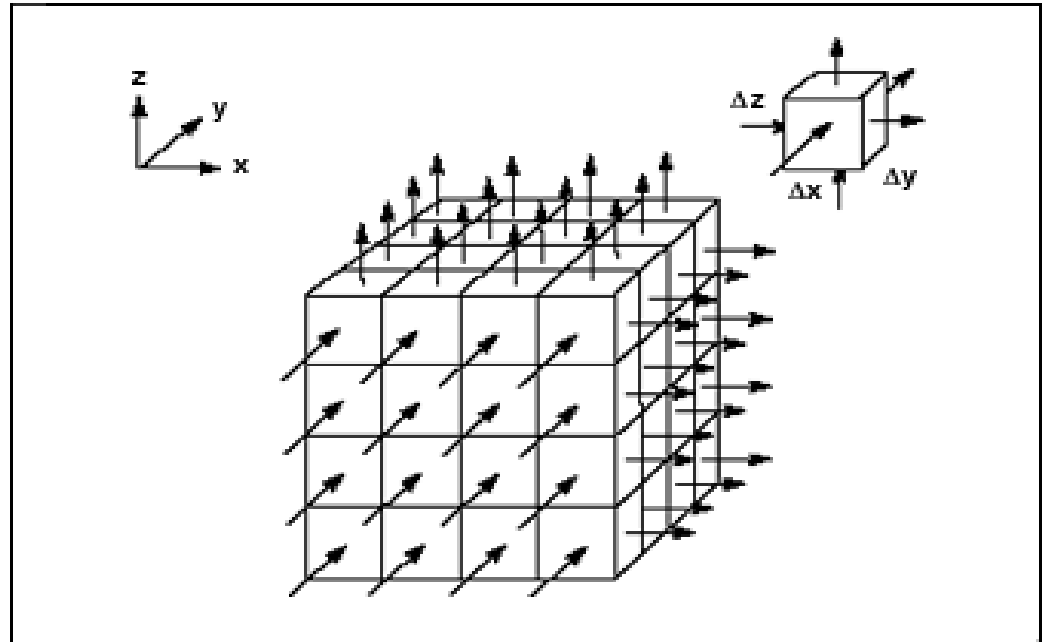
Introduction

- ▶ **Selecting a higher number of dimensions to represent a system may be *scientifically* correct, but we may lack the information or the computational overhead needed to assign this many dimensions.**

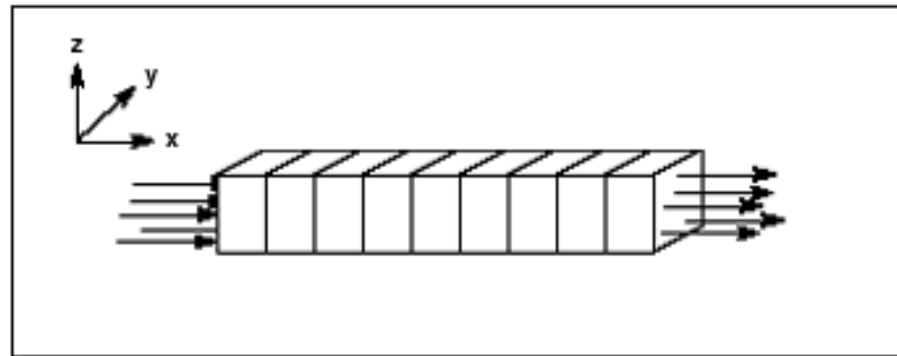
Rectangular flow geometry

- ▶ **Rectangular geometry is the one that is most familiar to us.**
- ▶ **Most field-scale multi-well studies are done in this co-ordinate system.**

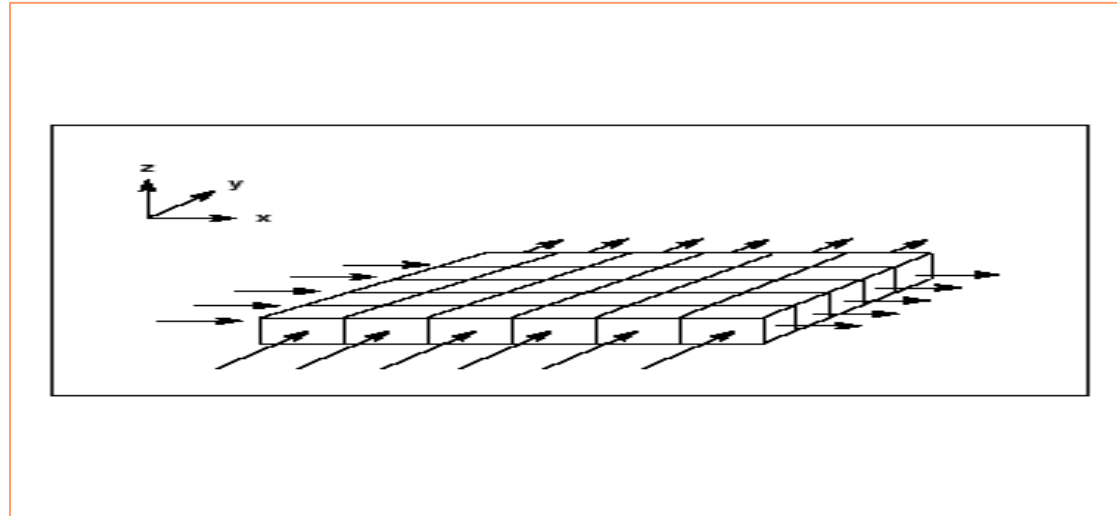
- ▶ The fluid particles moving in straight lines, at different speeds in different directions and locations.
- ▶ Streamlines are parallel to the three principal axes (x, y, and z), which are orthogonal.



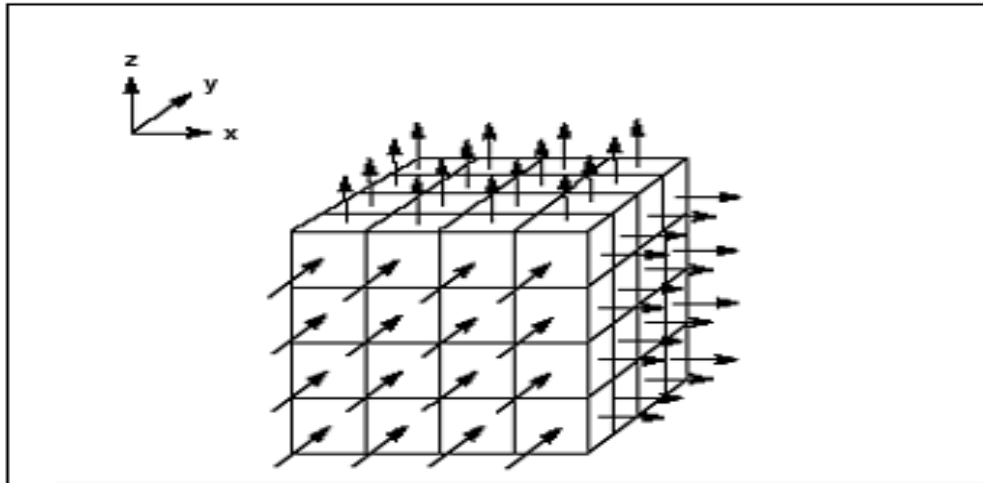
- ▶ Many types of analyses and systems do lend themselves to description as one-dimensional.



Many reservoir simulation studies employ two-dimensional Cartesian coordinate systems.



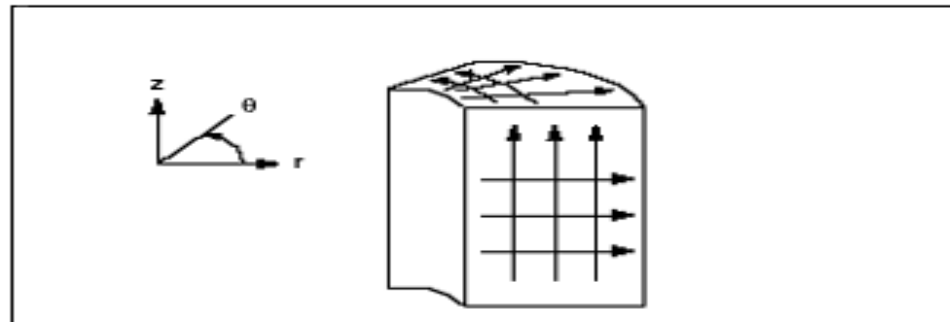
Account for directional permeability variation and lateral well distributions thin.



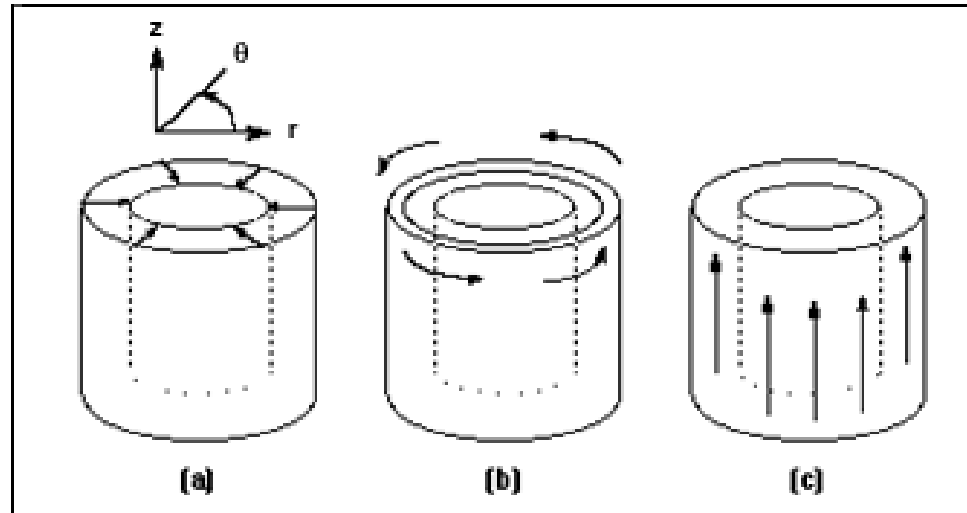
A three-dimensional representation allows us to accommodate a wide variety of problems of practical interest, such as layered reservoirs (with or without cross flow), partially penetrating wells, multi-layered production schemes, and thick reservoirs where gravitational forces could be significant.

Radial-cylindrical flow geometry

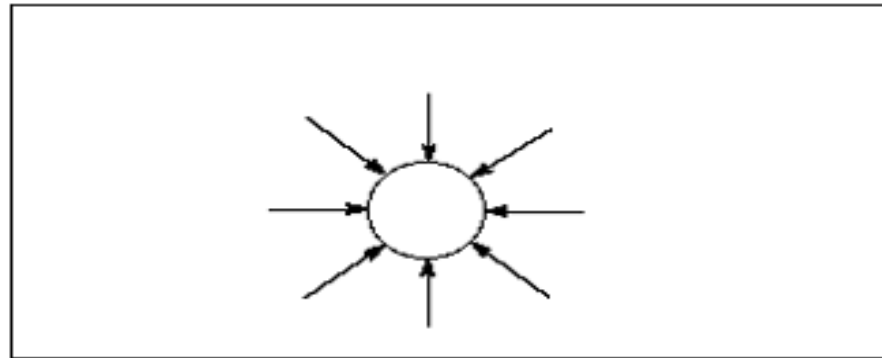
- ▶ Describes a single-well problems



- ▶ A particle moving in a three-dimensional radial-cylindrical flow geometry can be illustrated as

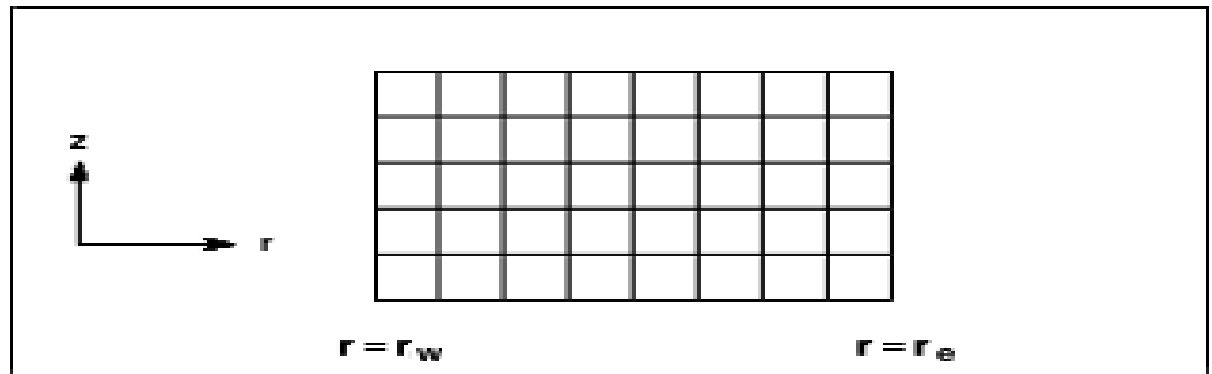


- ▶ A typical one-dimensional, radial-cylindrical flow model is the classical representation used in well test analysis

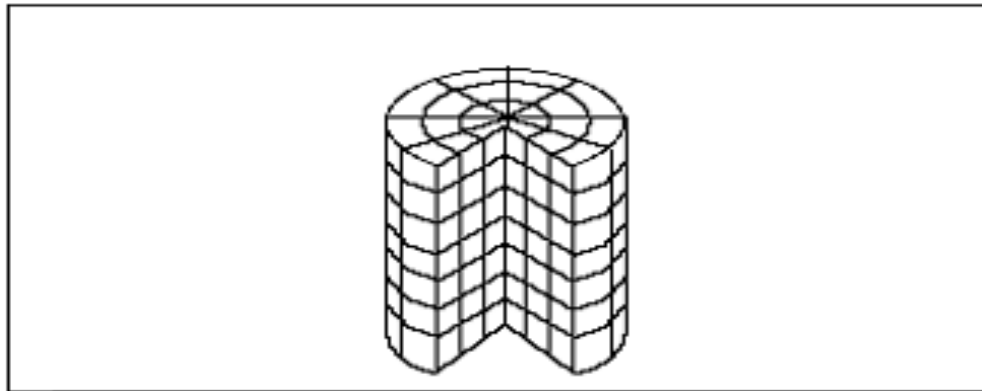


In this case, flow is constrained to the r -direction such that streamlines are rays converging towards the center of the well.

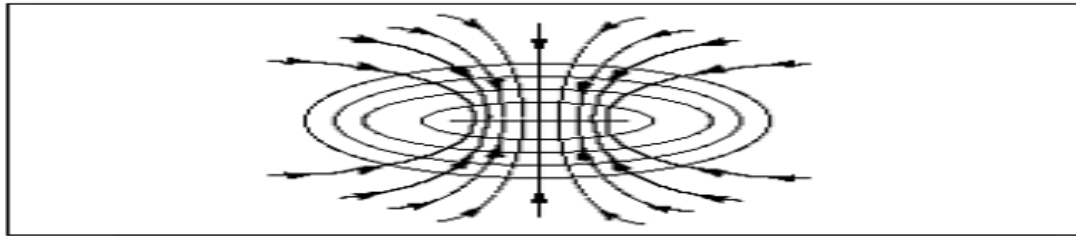
- ▶ The two-dimensional r - z plane can be taken at any location without changing the problem because of its axi-symmetric nature.



- ▶ The **three-dimensional flow structure** in radial-cylindrical coordinate system admits property variation in all three directions.

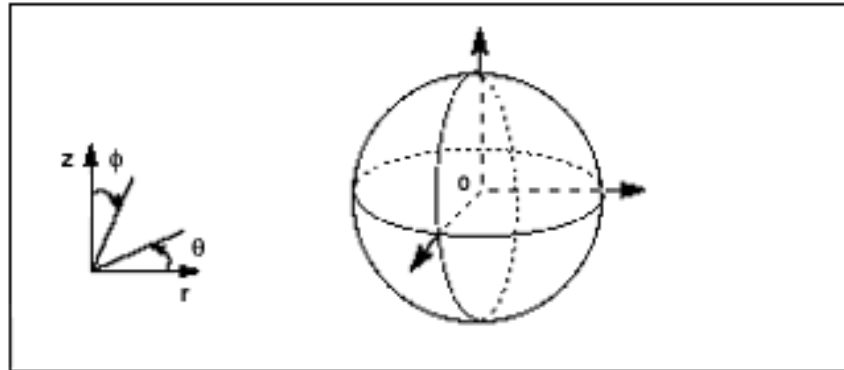


Elliptical-cylindrical flow geometry



- In single-well studies when a strong permeability contrast exists in two principal directions on the lateral plane.**
- When vertical well is intercepted by a vertical, high-conductivity fracture.**

Spherical flow geometry

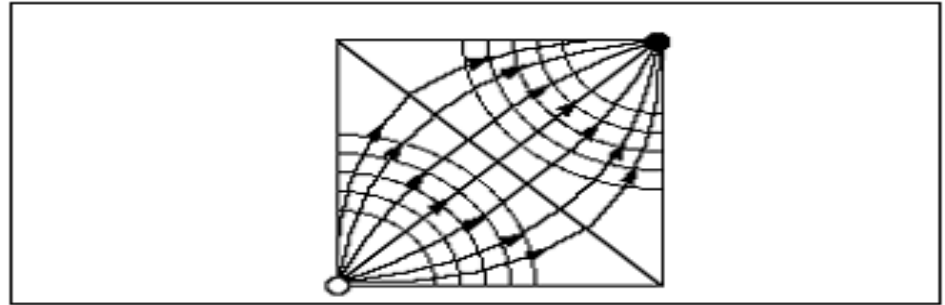


Provides a good representation of some specific reservoir engineering problems. **Two examples** are partial penetration to a thick formation by a production well, and flow around perforations.

Curvilinear flow geometry

- ▶ **A curvilinear coordinate system allows a better representation of the flow geometry, as well as the boundary geometry.**

- ▶ Implementation of **curvilinear coordinates** to a **five-spot injection/production pattern**.



The streamlines and equipotential contours define the curvilinear elemental volume.

- ▶ **Choosing the appropriate coordinate system and number of dimensions is not only paramount to a simulation study's success, but also to its relative simplicity.**

- ▶ **We must exercise good engineering judgment in establishing the scope of our study.**