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What is the co-moving velocity and why should we care?

When two immiscible fluids move through the same pore space, they interact. It is therefore hard to believe that the relative permeabilities describing the mobility of each fluid should be independent of each other. Yet, ever since 1936 when the concept of relative permeability was born, they have been treated that way. It is the aim of this talk to demonstrate that the intuition however is correct; they are indeed related. To do so, I introduce the co-moving velocity [1-8]. This is the average velocity change of the immiscible fluids when the average fluid velocity changes.

It turns out that plotted against the derivative of the average seepage velocity with respect to the saturation, it is a straight line. This result translates into a differential equation relating the two relative permeabilities. In clear language: Knowing one, we know the other.

I will explain why the co-moving velocity is linear in the derivative of the average seepage velocity. What I cannot explain at this point is why it is so insensitive to the parameters describing the flow [8].

The relative permeability approach is valid as long as the capillary number does not enter as a parameter affecting the relative permeabilities. The validity of the theory behind the co-moving velocity goes beyond this constraint. I will discuss this non-linear flow regime and the co-moving velocity also in this context.

Lastly, I will explain how the co-moving velocity is an example of a new class of variables in the thermodynamics of mixtures.

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