1. Introduction
A weak point in the modeling of drying processes still is the description and prediction of the drying kinetics of a given material under given process conditions. Even up to now, in design and optimization of drying processes, there is a big need for stable and reliable models to quantify and predict drying rates and drying times with a satisfying accuracy. During the last decades several approaches have been proposed about how to deal with mass and heat transfer phenomena in materials during a drying process.

2. Methods
Generally, in drying processes internal heat transfer occurs much faster than internal mass transfer, which means that in most cases a uniform temperature of the drying material may be assumed. Then temperature histories can be obtained straightforward from a macroscopic instationary or quasi-stationary enthalpy balance over the drying material.

Which respect to the internal mass transfer it appears to be much more complicated to develop a reliable and manageable description. And that is exactly the focus point of the approximate models. Unfortunately, for the time being there does not exist a clear view as far as the practical usefulness and the reliability of these methods are concerned. In this presentation an overview of these approximate models is given and some conclusions are drawn.

The models discussed can be classified according to the considered physical phenomena:

Mechanistic models (porous, non-porous)
- Equilibrium drying model
- Characteristic drying curve

Retreating front models
- Uniformly Retreating Moisture Front model
- Method of Yoshida et.al.

Lumped diffusion coefficient models
- Constant diffusion coefficient
- Weighted averaged diffusion coefficient
- Power law diffusion
- Regular Regime analysis (Schoeber)
- Similarity of moisture profiles
- Flux ratio method
- Rigorous numerical method

Some of these models also enable the evaluation of moisture dependent diffusivities from experimental drying curves of slabs.

3. Results and Discussion
For the time being it is not yet possible to judge the practical usefulness and reliability of these methods. All diffusion models sofar are departing from a continuously decreasing value for the diffusion coefficient as the moisture content decreases. In shrinking/non-shrinking materials this is not always true, as can be seen from the graph below.

Most approximate models have been developed via computer simulations. However, real and thorough experimental validations are scarce. Kerkhof [2] studied several drying kinetics models in the simulation of a fluidized-bed drying process of bio-products and observed unacceptable deviations with respect to the 'exact' behavior. In general, there is a need for more experimental validation and for establishing the usefulness of the approximate methods in overall models for industrial drying processes. This should be done for many different materials, in order to find criteria to decide which approximate method should be preferred in a given situation and to stimulate further developments in this field of research.

References