A Particle Design Model for Spray Drying of Suspensions and Large Molecule Formulations

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Introduction

Design Targets for inhalable particles

i- Desired final dry particle properties
ii- Desired solid state
iii- Desired layered structure for stabilization or controlled release

Design Options

i- Empirical Approach - time and resources consuming
ii- Numerical models - long implementation time
iii- Analytical models - limited accuracy

New approach present here:

A hybrid numerical-analytical model - **easy-to-use without numerical model development with improved accuracy.**

Methodology

I- Numerically solve a normalized version of the diffusion equation in spherical coordinates for a range of Péclet numbers relevant to suspensions and large molecule formulations ($Pe > 25$), under the following assumptions.

i- Diffusion is the main mechanism of mass transport.
ii- Constant evaporation rate.
iii- Constant diffusion coefficient.

$$\alpha = \frac{c}{c_o}$$

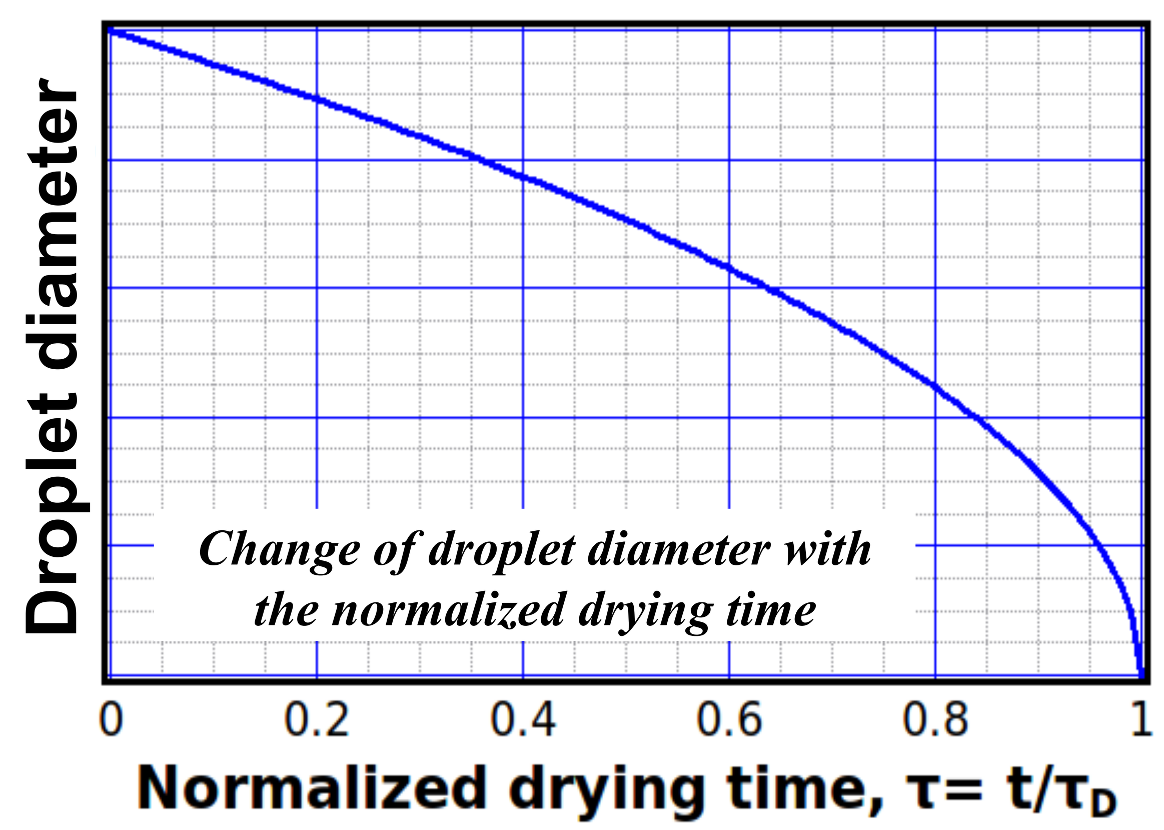
$$R = \frac{r}{r_s(t)}$$

$$\tau = \frac{t}{\tau_D}$$

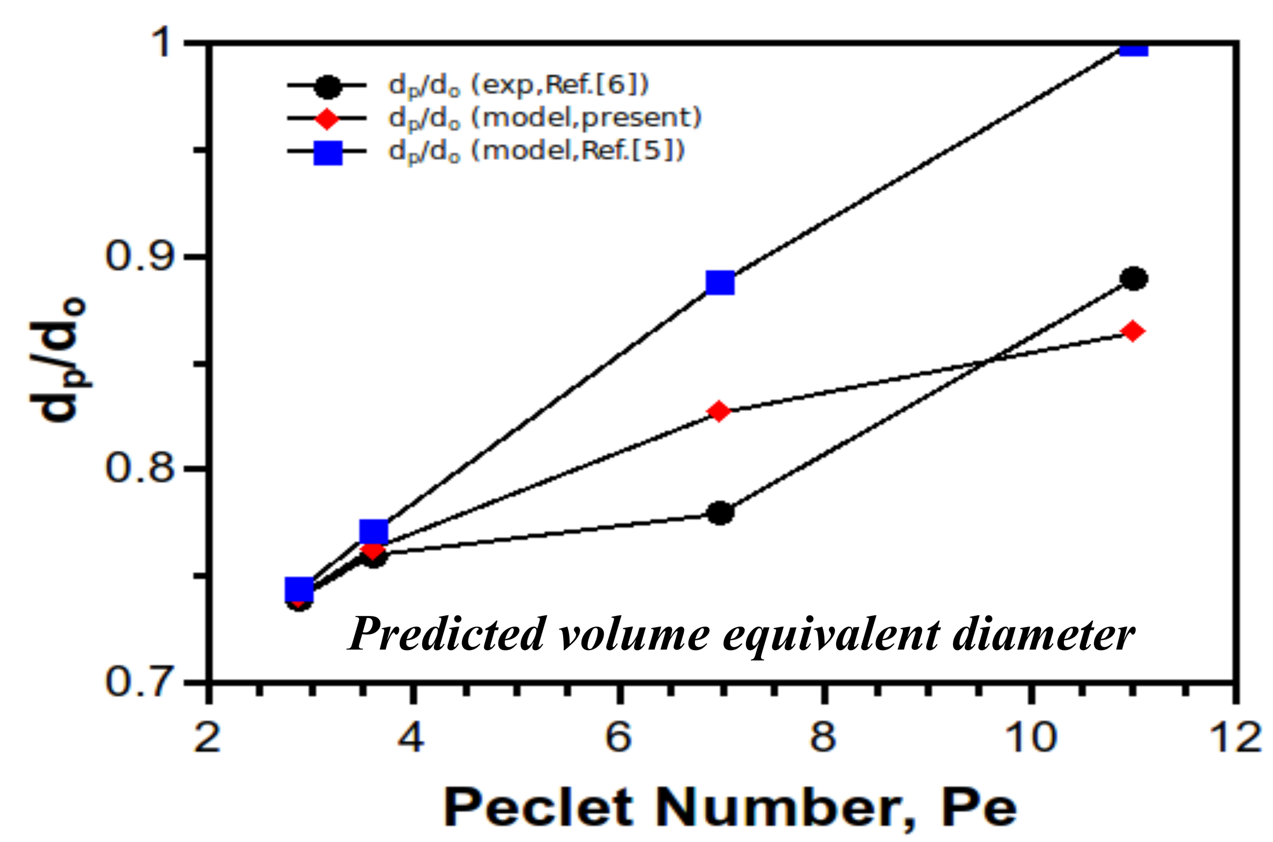
II- Fit the normalized numerical results with simple analytical equations.

III- Derive the final dry particle properties (i.e. volume equivalent diameter, particle density, shell thickness for high Pe number formulations) and iterate *in silico* if necessary.

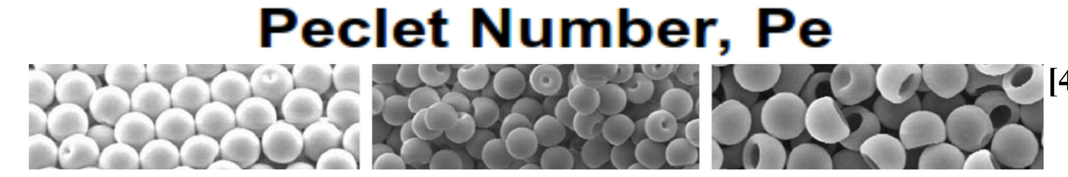
Results

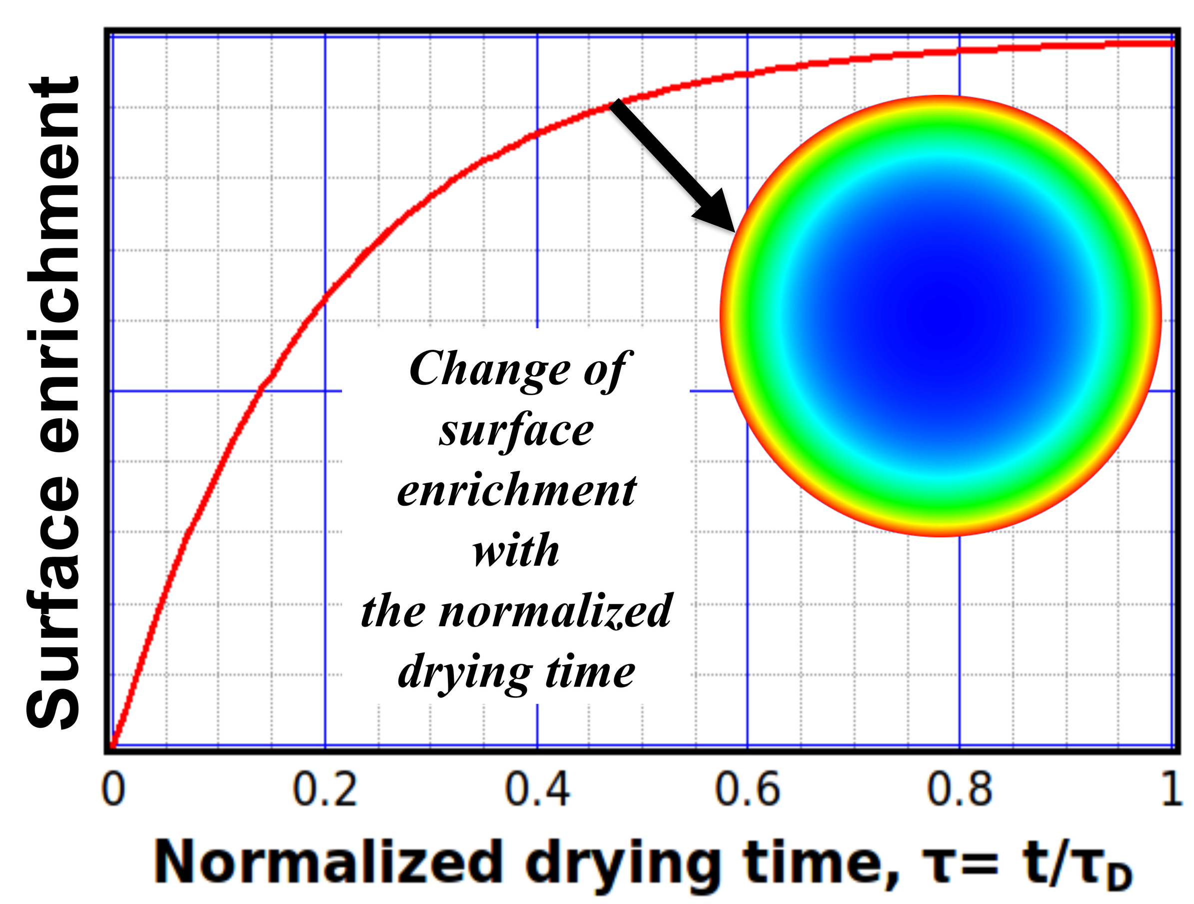


Change of droplet diameter with the normalized drying time

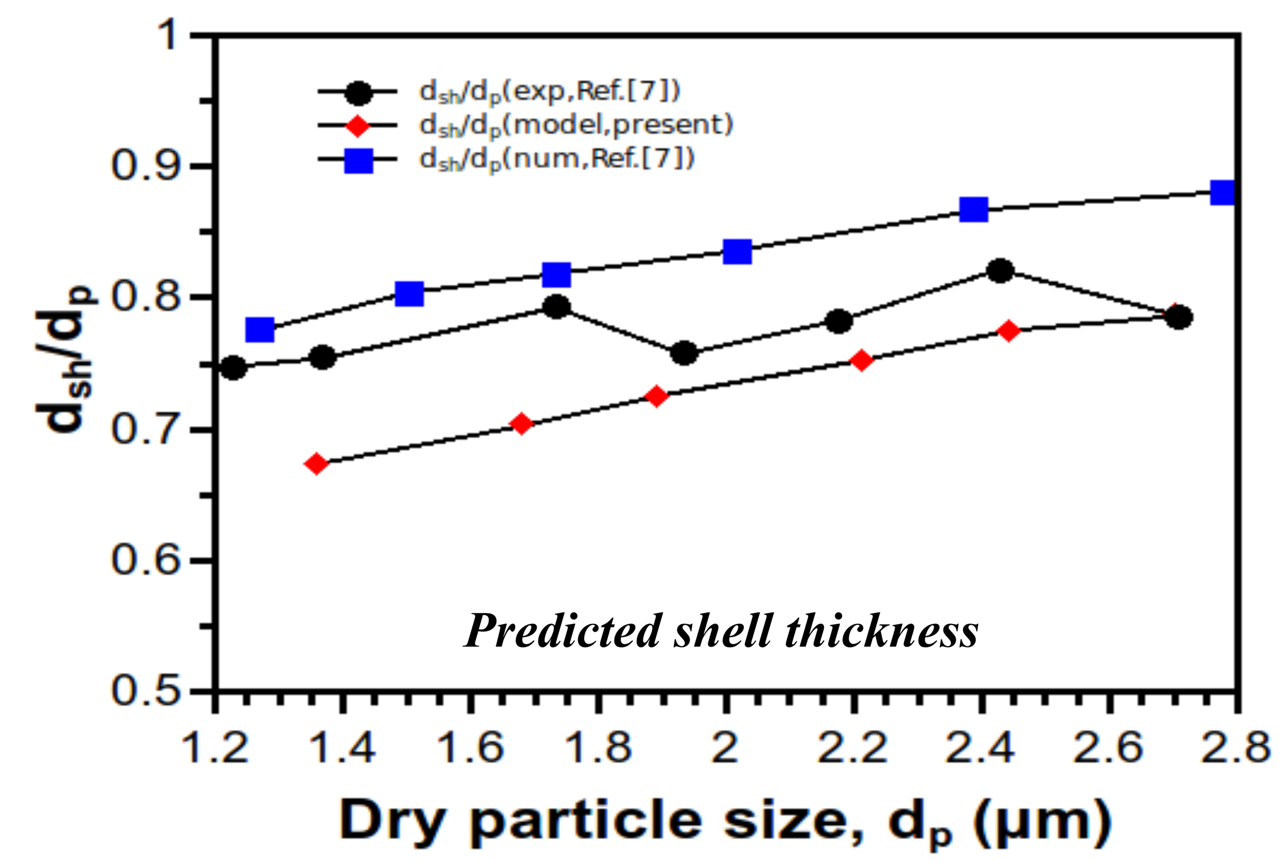


Predicted volume equivalent diameter

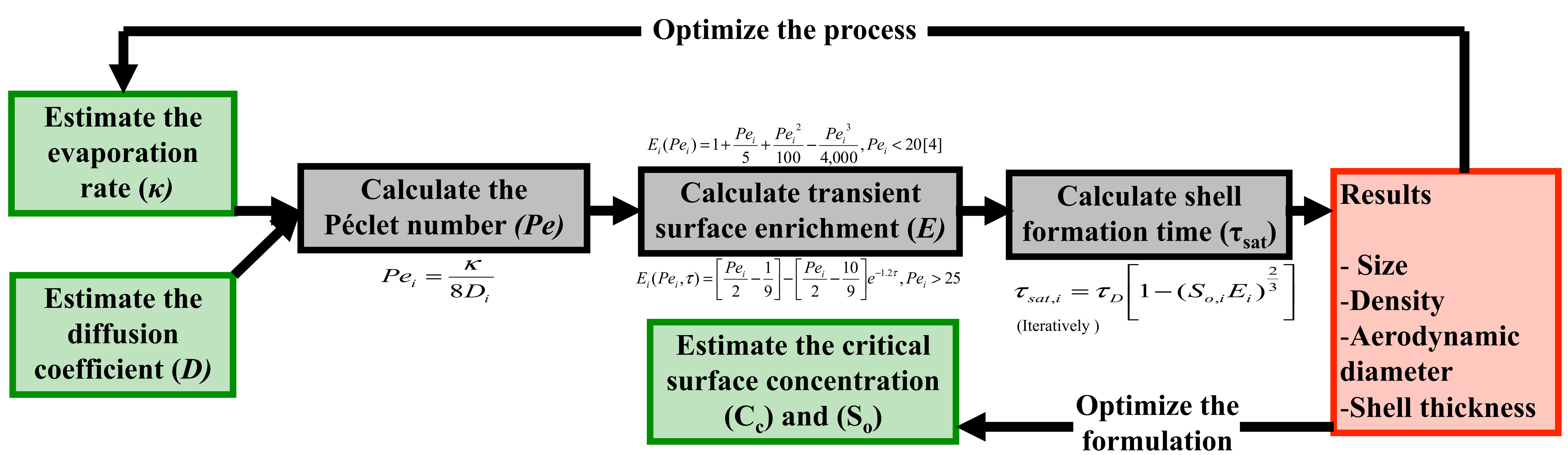




Change of surface enrichment with the normalized drying time



Predicted shell thickness



Conclusion

This model has a wider range of usability. It has the ability to predict the following final dry particle properties without numerical model development.

Model outcomes:

-Final dry particle volume equivalent diameter (assuming a spherical particle).
-Particle aerodynamic diameter
-Particle density
-Shell thickness
-Radial composition and solid state of components.
-Shell composition for multi-component formulations.
-Shell thickness for nanoparticles suspension formulations.

Model advantages

- Easy to use, does not require lengthy implementation.
- Well suited for the design of structured, multi-layered and multi-component formulations.
-Good accuracy
-Accelerates respirable dosage form design significantly (see poster # 8).

References

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