

# Der virtuelle Sandkasten

Ass.Prof. DI Dr. Stefan Radl  
TU Graz

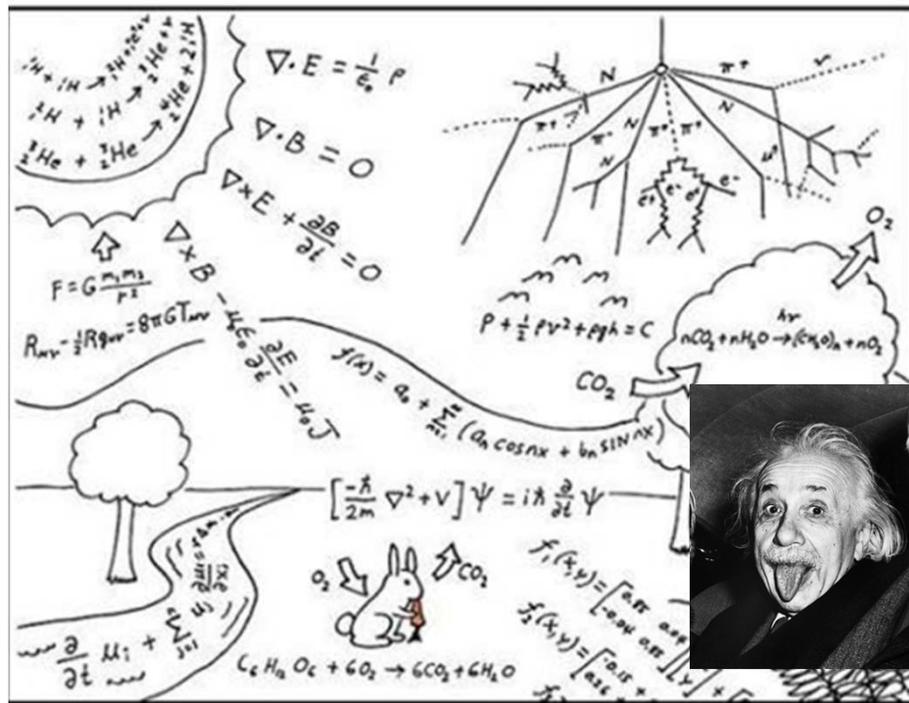
Forschung – Was ist das?

1.3.2017

# Natur- und Ingenieurwissenschaften

Der Klassiker: Physik!

Ingenieure – auch hier wird geforscht!



<http://www.burghausen.com> (Borealis)

# Verfahrenstechnik

...ist eine Ingenieurwissenschaft



Die **Verfahrenstechnik** beschäftigt sich mit allen **Prozessen** in denen mit stofflichen Umwandlungsschritten aus **einem Rohstoff ein Produkt** geschaffen wird

**Weizen**

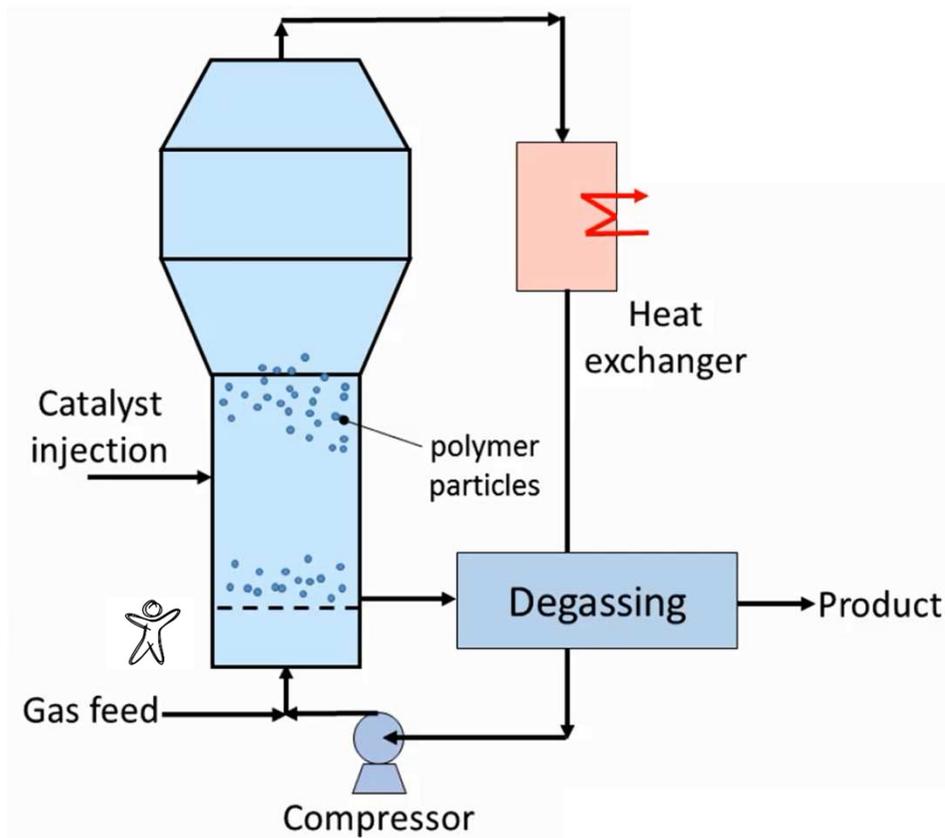


**Brot**

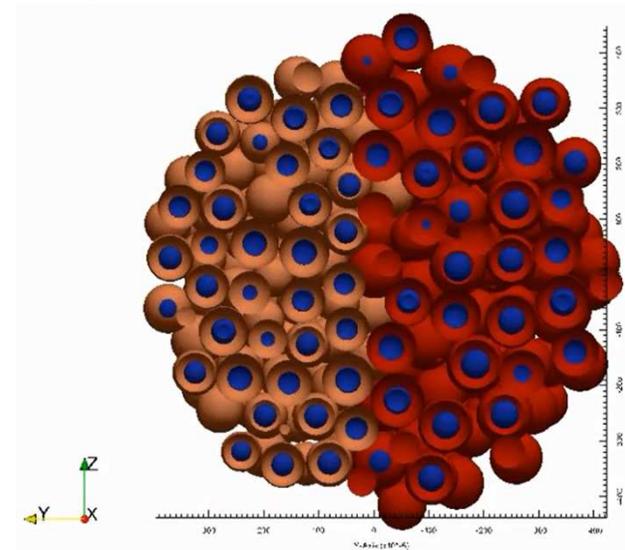


# Verfahrenstechnik

...was ist ein typischer Prozess?



Die **Polymerherstellung** passiert in großen Reaktoren (z.B. in Wien Schwechat). Dazu wachsen die **Polymerkörper** auf winzigen Katalysatorpartikeln an.



# Verfahrenstechnik

...mehrere Prozesse...

## TECHNICAL DETAILS

### LSR-rotor design

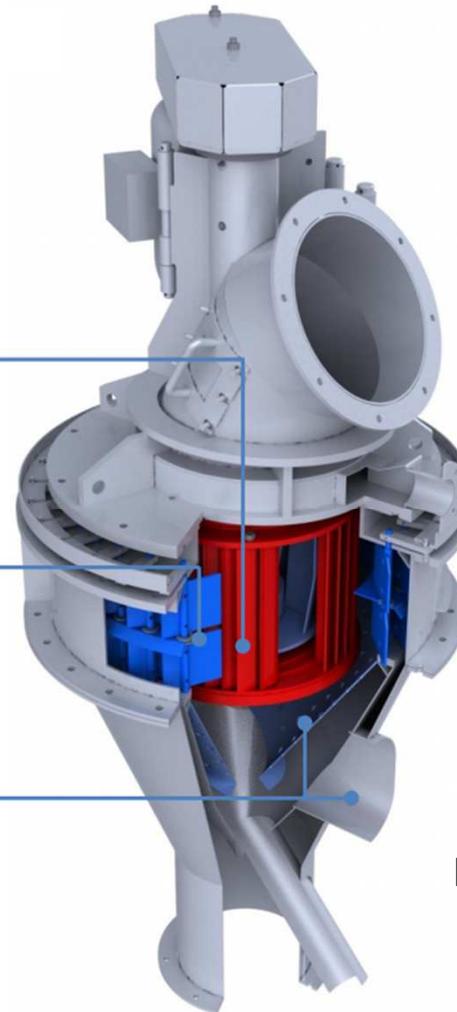
- „low-speed-rotor” blades for intensified forces in classifying area

### guide plates

- for pre-classifying effect
- optimized distribution of air+material

### optional: post-classifying equipment

- secondary air inlet
- post-classifying distribution plates

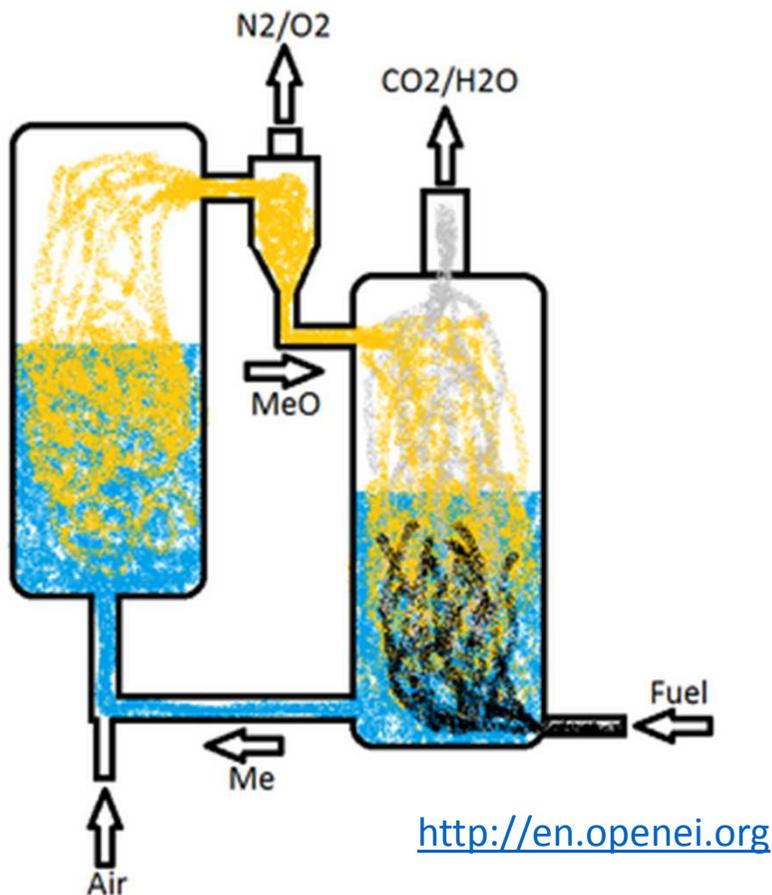


Bei der **Zementherstellung** wird Gestein gebrannt, und anschließend klassiert, d.h., kleine von große Partikel getrennt.

<http://www.pm-technologies.at>

# Verfahrenstechnik

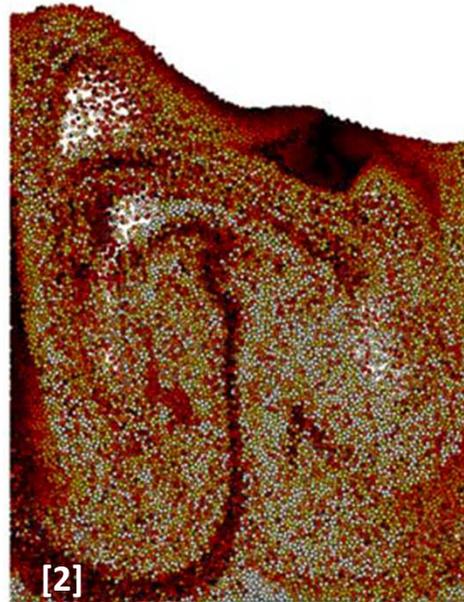
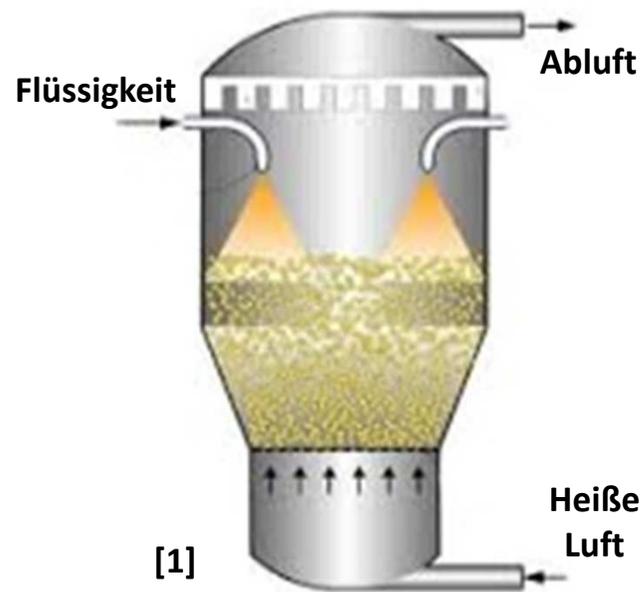
...mehrere Prozesse...



$\text{CO}_2$  kann durch eine geschickte **Prozessführung** bei der Verbrennung abgeschieden werden. In Zukunft können wir somit  **$\text{CO}_2$  „recyclen“**

# Verfahrenstechnik

...mehrere Prozesse...



Bei der **Medikamentenherstellung** wird ein Pulver (z.B. ein Zucker-Wirkstoffgemisch) mit **Flüssigkeit besprüht** um die Pulvereigenschaften zu beeinflussen.

[1] Sharmista Chatterjee, *AAPS Annual Meeting*, 2011

[2] Askarishahi et al., *AIChE J*, 2016

# Wer forscht?



**Forschungsfirmen**



**Universitäten und Hochschulen**



**Betriebe**



**Die Europäische Kommission**

# Was kommt bei Forschung heraus?

**Patente,  
Prototypen**

Journal homepage: www.atlantis-erica.com/powder

**Powder Technology**

Liquid transport rates during binary collisions of unequally-sized particles

Mingqiu Wu\*, Johannes G. Khinast<sup>†</sup>, Stefan Radl\*

\* Institute of Particle Technology, University of Leoben, Austria; <sup>†</sup> Institute of Chemical Engineering, TU Graz, Austria

ARTICLE INFO

ABSTRACT

**1. Introduction**

Granular particle beds are usually composed of particles with different sizes (i.e., they are polydisperse). It is well known that particle size polydispersity and shape significantly influence the transport of mass and liquid in a fluidized bed [1, 2] and spread bed systems [3]. Therefore, a better understanding of these systems (i.e., the underlying physics of different sizes) helps to improve the control of many engineering applications, including fluidization, mixing, agglomeration, coating, etc. In addition, binary polydisperse fluidized bed systems often show a greater mixing performance [4-7]. Furthermore, other researchers showed that wide particle size distributions result in improved fluidization of dry systems [8-11]. To study the question about how polydispersity affects wet fluidized beds, the experimental systems in which a thin liquid layer (or droplet) is present on the particles' surface in these systems are addressed and compared to wet (1) the prediction of the amount of liquid in each liquid bridge, and (2) the magnitude of cohesive forces due to these bridges.

The wet liquid bridge formation (i.e., the amount of liquid in the bridge as a function of time) plays an important role in respect to the liquid's surface energy. Dababneh et al. [12] revealed that controlling the liquid bridge volume connecting two liquid particles is the key in obtaining the wet-cohesion results of their experiments. Thus, the amount of liquid present in the bridge is decisive if particles separate, or agglomerate [13]. Thus, it is important to quantify these interactions to predict the overall flow rates in a fluidized bed. Although these particles are always encountered in many applications [14-17], it is still difficult to transport rates of liquid. This is because particles are not the same size and the rate of exchange of liquid is complex.

Next, we briefly review the latest research in mixing and polydispersity. Our previous study that attempts to model the wet liquid bridge for equal-sized particles.

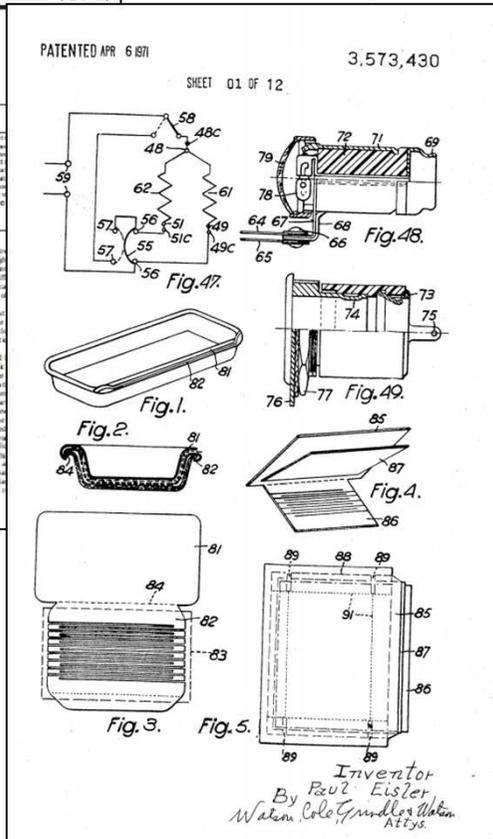
Many researchers have studied static wet wet monodisperse particles and binary [18], interfacial agglomeration between particles by reduction of the liquid bridge. Xu et al. [19] presented a wet liquid bridge of two particles model. Mikawa et al. [20] demonstrated a wet liquid bridge of two particles as a function of the size and separation distance based Young-Laplace equation (YLE). The YLE is described the geometry of the liquid bridge. The authors also presented a formal approximation of the YLE. The authors also presented a formal approximation of the YLE. The authors also presented a formal approximation of the YLE.

Corresponding author: E-mail address: miqu@leoben.ac.at (M. Wu).

http://dx.doi.org/10.1016/j.powtec.2016.02.009  
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PATENTED APR. 6 1871 3,573,430

SHEET 01 OF 12



Inventor  
By Paul Eister  
Watson Cole, Gardner & Watson  
Attys.

```
void surfacesClose(SurfacesCloseData & scdata, ForceData & i_forces, ForceData & j_forces) {
    if (liquidtracking) history_offset = 0; //if liquidtracking fix is used no "contflag" required
    Index = static_cast<int> (historyIndex);

    const double r = sqrt(scdata.rsq);
    const double rinv = 1/r;
    const double radi = scdata.radi;
    const double radj = scdata.radj;
    double dist = r - (radi + radj);
    double * const hist = &scdata.contact_history[history_offset];
}
```

**Computer-  
programme**

**Publikationen**



**Forscher**

S. Radl, E. Reichel 2017

# Wie wird geforscht?

**Herausforderung  
& Idee**

QR code

**Experiment**



ippt.tugraz.at/vsb

**Beobachtung**

QR code

**Modell**

$$\Phi_a = -\beta_f(u_f - u_p)$$

$$\beta_f = 18\rho_f\gamma_f\varphi_f(1-\varphi_f)\frac{F(\varphi_f, Re)}{d_p}$$

$$F(\varphi_f, Re) = 10\frac{1-\varphi_f}{\varphi_f^2} + \varphi_f^2(1 + 1.5\sqrt{1-\varphi_f})$$

$$+ \frac{0.413 Re(\frac{1}{\varphi_f} + 3\varphi_f(1-\varphi_f) + 8.4Re^{-0.343})}{24\varphi_f^2(1 + 10^{3(1-\varphi_f)}Re^{-\frac{1}{2}(1+(1-\varphi_f))})}$$

$$\rho_{pd}V_{pd}\frac{\partial u_{p,i}}{\partial t} = f_{cont,i} + \beta_f V_{pd}(u_f - u_{p,i}) - V_{p,i}V_{p,i} + g$$

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**Berechnung**

QR code

**Simulation**

```
for (int i = 0; i < nlocal; i++) {
  if (mask[i] & groupbit) {

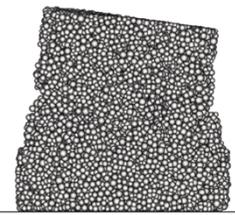
    // velocity update for 1/2 step
    dtfm = dtf / (rmass[i]*onePlusCAddrhoFluid_);
    v[i][0] += dtfm * f[i][0];
    v[i][1] += dtfm * f[i][1];
    v[i][2] += dtfm * f[i][2];
  }
}
```

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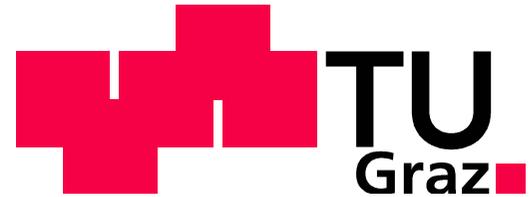
**Auswertung**

QR code

**Vorhersage**



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