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Process Engineering

in

Rotary Drums

2016

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Heat Transfer
- Radial, circumferential and axial temperature distribution
- Heat transfer coefficients
- Heat transport coefficients

Solid Material Transport
- Transversal solid bed motion
- Axial solid transport
- Residence time

Process Engineering in Rotary Drums
Modelling - Simulation - Measurements

Energy Production
- Flame simulation
- Fluid dynamics

Gas Solid Reaction
- Reaction kinetic
- Mass change

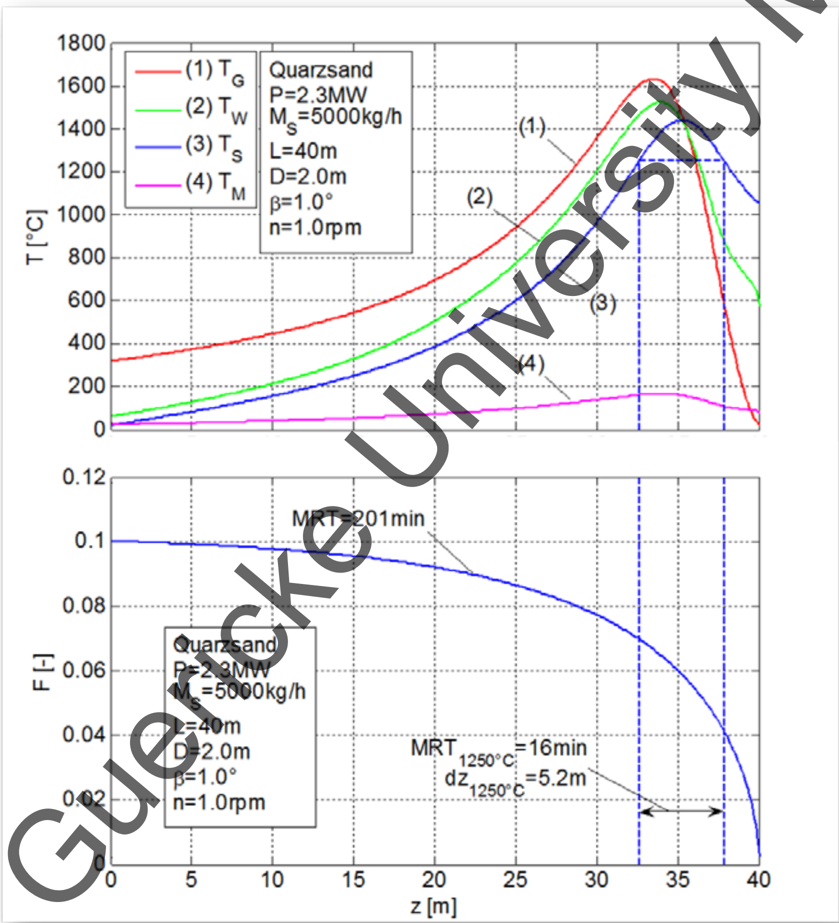
Experimental Tools
- Pilot plant rotary kiln for process analyses
- Pilot rotary drum for heat transfer analyses
- Pilot rotary drums for solid motion behavior analyses
- Pilot tube drum for reaktion analyses
- Thermo analytical laboratory
- Thermography laboratory

Numerical Tools
- Modell development and simulation (Matlab Simulink)
- Software development with user interface
- Simulation of fluid dynamics and temperature distribution (CFD, ANSYS, Fluent)
- Particle based simulation (Discrete Element Method - DEM)

A mathematical model was developed to describe the complex phenomena of heat transfer and solid transport inside the rotary drum. The model considers all influencing process parameters like:

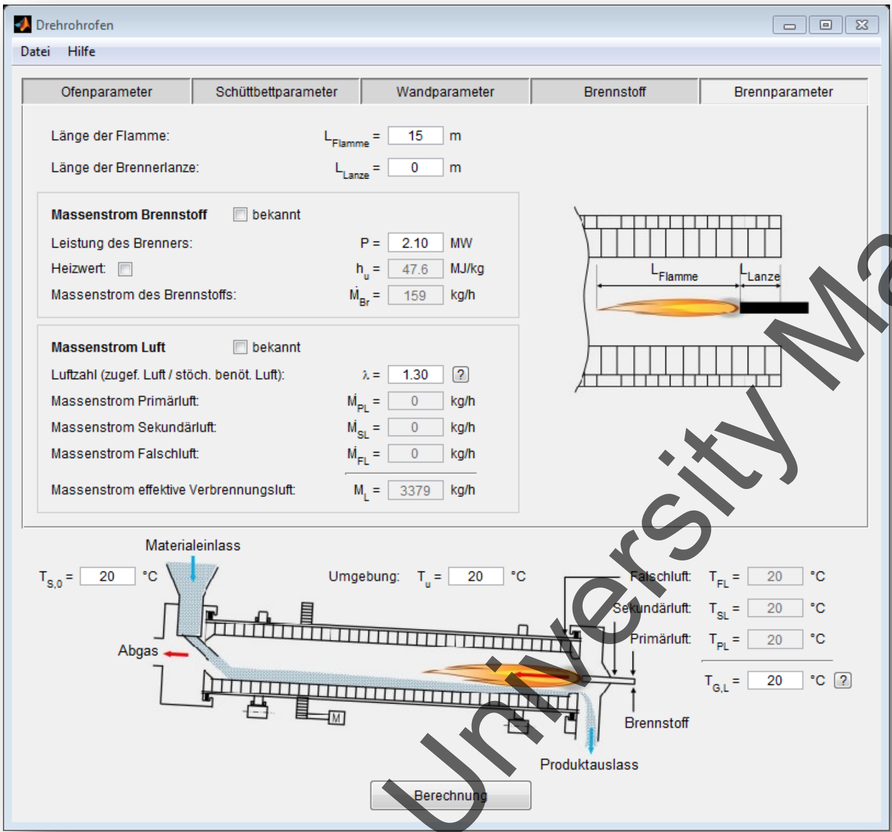
- Dimension parameter: Diameter, Length, Inclination angle
- Operation parameter: Mass flow, Rotational speed, Gas throughput
- Heating parameter: Kind of fuel, Flame length, Flame shape, Heat distribution (indirect)
- Solid parameter: Particle size, Particle distribution, Particle shape, Bed density, Dynamic angle of repose, Heat capacity, Heat conductivity, Reaction behavior

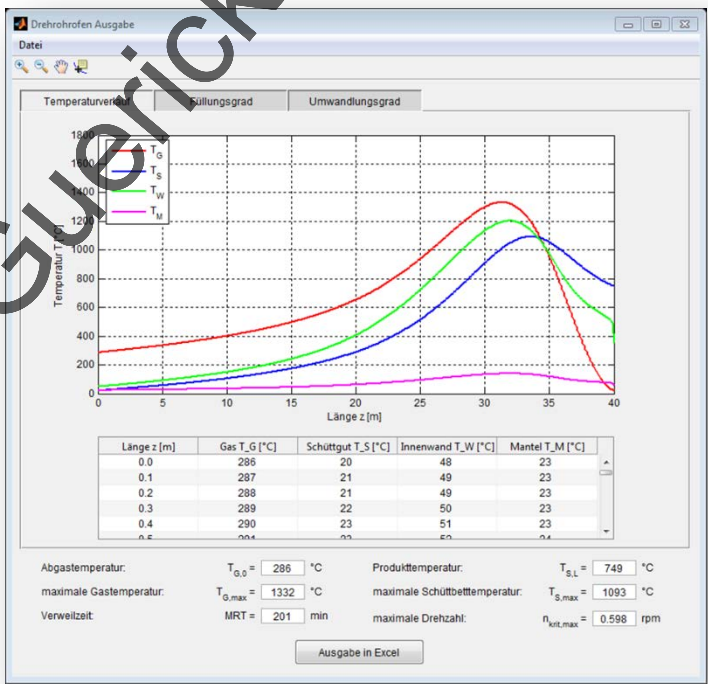
With the model the axial temperature profiles of the gas phase, the solid bed, the inner wall, the outer wall shell as well as the axial profiles of the filling degree (bed height) and reaction. Further output parameters are the Exhaust gas and product temperature, the exhaust gas composition, the heat losses through the drum wall and the residence time of the material.



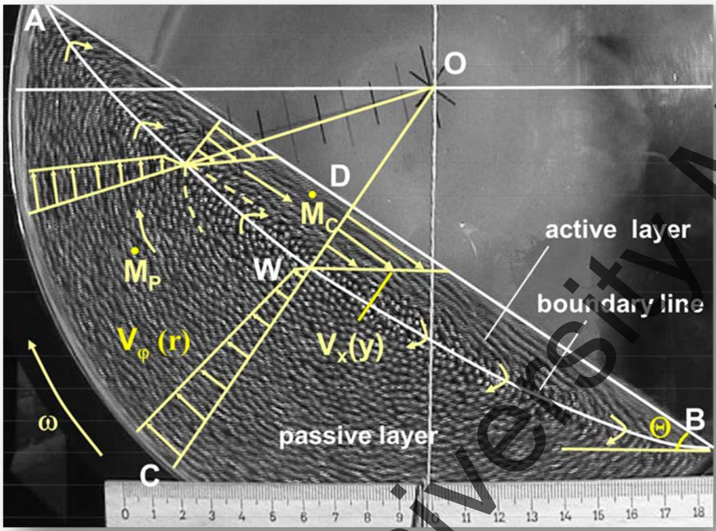
The model could be used for a safe and accurate design of kilns as well as for an effective optimization of the processes. Moreover the model is suitable to train and educate the employees and to control the process.

Commercial software has been developed to ensure an intuitive work with the process model. For this purpose a user-friendly interface that is specially adapted to the wishes of the company was designed. So parameter variations can be performed quickly and easily. The output data can be transmitted via the software directly in MS Office.





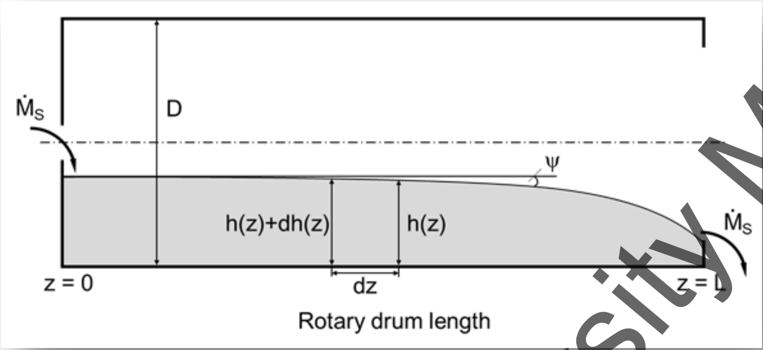
To describe the transversal motion behavior at rolling mode a mathematical model was developed. This allows for the first time the calculation of the boundary line between active and passive layer without adjusting parameters. From this, the thickness of the active layer over the entire bed cross-section as well as the average particle velocities and residence times in the active layer were determined. As in rotary kilns different transverse motion types may occur, the criteria for the transitions between the types were defined. The limits for the Froude number (rotational speed, drum radius), coefficient of friction and filling degree (bed height) were determined. Furthermore, the relationship between the angle of repose (lower, upper and dynamic) could be determined.



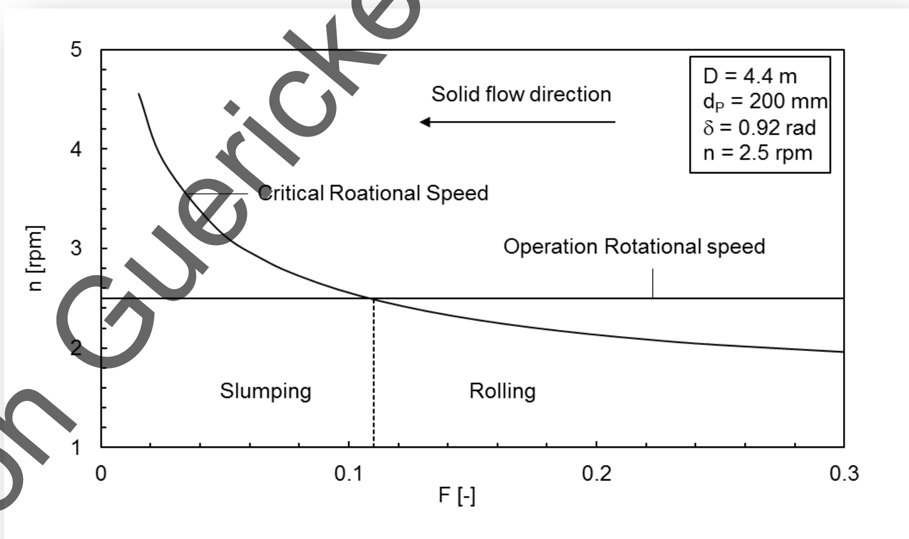
Another focus of the analysis of the transverse motion behavior is demixing / segregation effects. These are a result of the fundamental properties of particles, such as size, density, shape or surface characteristics and occur in particular with polydisperse packings. While the grain size caused segregation in the field of Rolling Motion, trickle the smaller particles in the active layer through the interstices of the larger particles through - what is referred to as percolation. On emerging from the active layer, these particles arrange in the core of passive layer. This process is repeated until the particles in the packed bed are completely segregated.

Mellmann, J.; Specht, E.: Mathematical Modelling of the Transition Behaviour between the various Forms of Transverse Motion of Bulk Materials in Rotating Cylinders (Part 1 and 2). English and German. Cement, Lime, Gypsum International 54 (2001), 380-402.
Liu, X.: Experimental and theoretical study of transverse solids motion in rotary kilns. PhD Thesis University Magdeburg, 2005

The bulk material is fed with a defined feed rate at the inlet of the rotary kiln, flows along its length to the outlet, and occurs at this. As a result, that adjusts an axial solid bed height profile. The axial transport of bulk materials is thereby caused by the height difference between the inlet and outlet ports as well as the longitudinal inclination of the pipe. The resulting axial filling degree profile is calculated using a numerical model. Thus, the mean residence time of the solid material can be determined on the one hand, the heat transfer surfaces at each position of the rotary kiln can be determined on the other hand. Experimental measurements on industrial and pilot plants are in good agreement with the simulations.



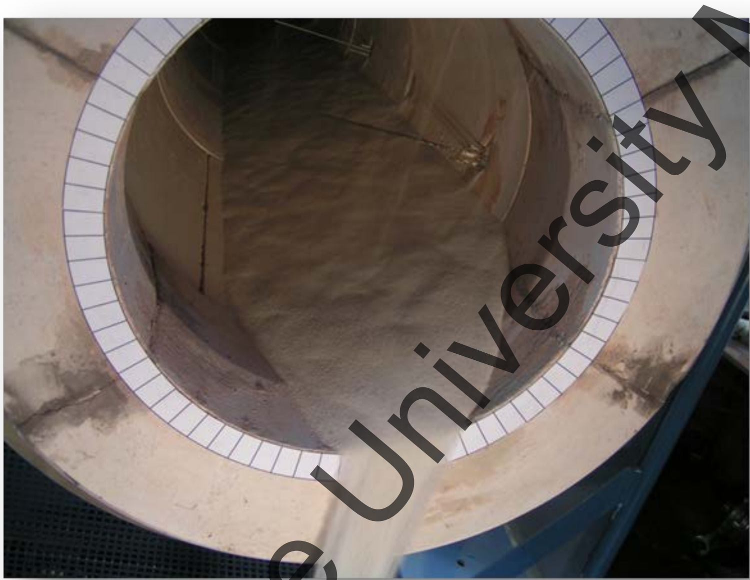
Due to the decrease of the filling degree it can cause a change in the transverse motion behavior during the process. This can lead to a change in the mixing characteristics and thus the homogeneity of the product stream. To determine this transition point between modes of motion, an analytical model was developed. This makes it possible to define a critical rotational speed, depending on the operating and dimensioning parameters.

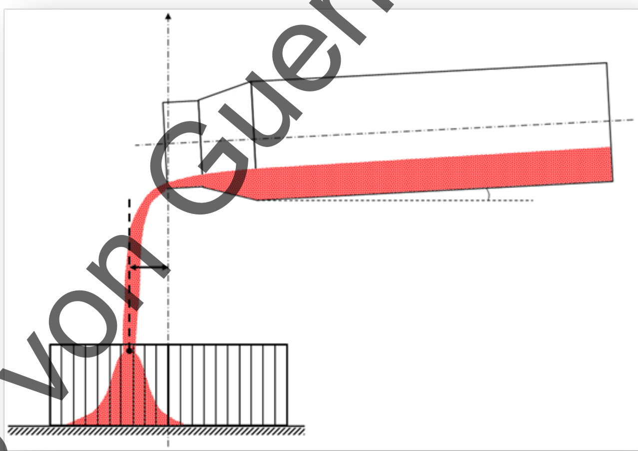


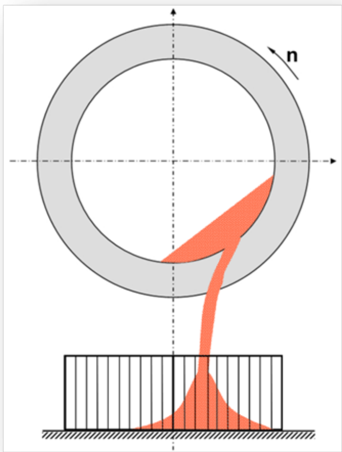
Liu, X.; Specht, E.: Mean residence time and hold-up of solids in rotary kilns. Chemical Engineering Science 61 (2006), 5176-5181.
Liu, X.; Zhang, J.; Specht, E.; Shi, Y.; Herz, F.: Analytical solution for the axial solids transport in rotary kilns. Chemical Engineering Science 64 (2009) 2, 428-431

Solid bed motion behavior at the outlet of rotary kilns is especially important for the design of downstream equipment such as coolers. To define the discharge behavior, the axial and radial velocity of the particles must be calculated at the outlet. For this purpose, a model for the filling degree at the outlet cross-section has been developed which is related to the axial filling degree profile.

The dependence of the operating and design parameters will be described on the newly introduced bed number. Thus finally the offset of the outflowing material in radial and axial directions can be calculated from the discharge velocity. To validate the model data experimental measurements with different materials were performed on different pilot plants. The particle distribution was measured below the discharge opening in the axial and radial direction in order to determine the offset. The model data was validated with good accuracy.







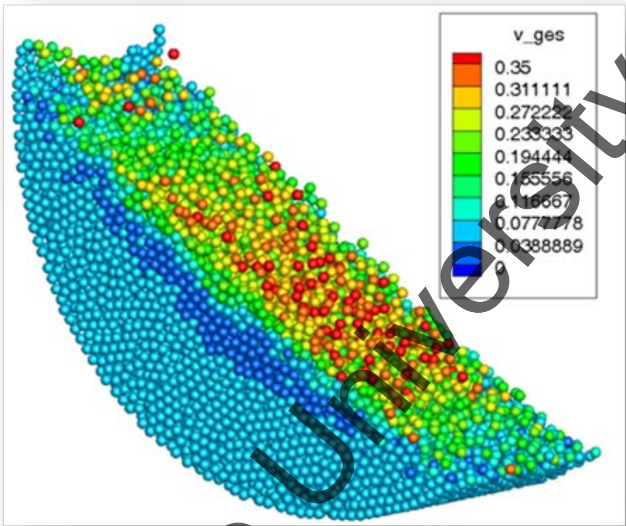
Shi, Y.: The outflow behaviour of particles at the discharge end of rotary kilns. Dissertation Universität Magdeburg, 2009
Shi, Y.; Specht, E.; Herz, F.; Knabbe, J.; Sprinz, U.: Experimental investigation of the axial discharging velocity of particles from rotary kilns. Granular Matter 13 (2011), 465-473.

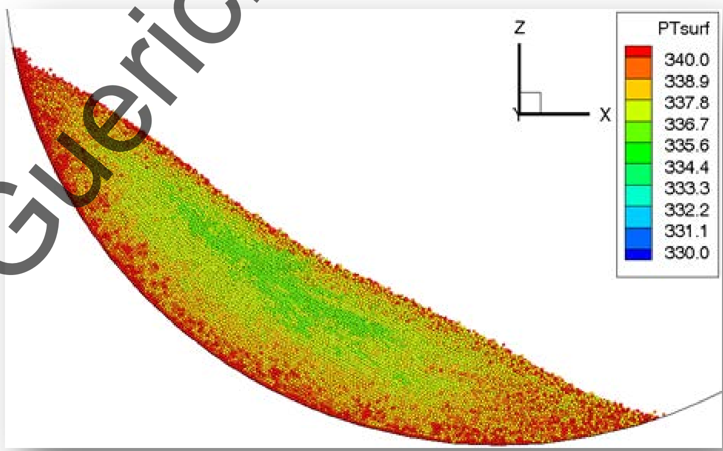
Particle Based Modeling (DEM)

Collaboration with Prof. V. Scherer – Ruhr-University Bochum

The motion and heat transport processes in the rotary kiln are previously set forth with continuum models. Hence effects on the individual particles cannot be demonstrated. The interactions of the individual particles in the collective of the bed are described with the particle-based modeling approach of discrete element methods (DEM). This makes it possible to quantify for the first time the movement of the particles along the boundary line, and in the active layer. Thus, for the time proportions and residence times of the particles on the free and covered bed surface and the mixing characteristics were determined.

In cooperation with the Ruhr-University Bochum (Prof. V. Scherer) experimental and numerical investigations for transverse motion behavior, the heat transfer in the bed as well as for thermal mixing characteristic were conducted on different batch plants. A good agreement between the DEM simulations and the measured results could be shown.

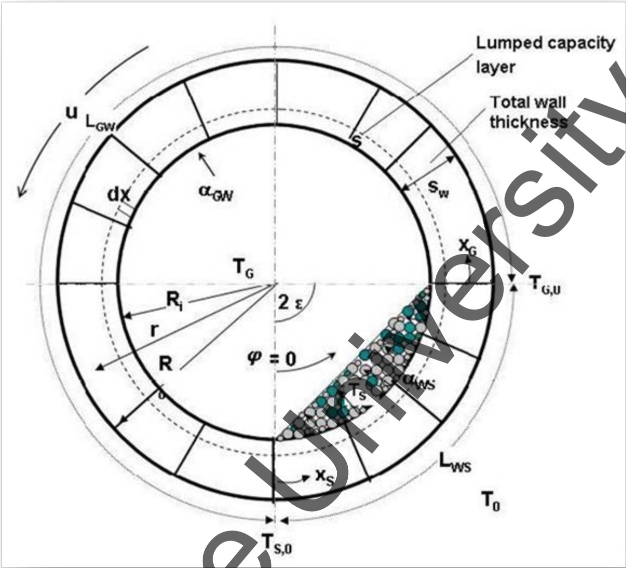


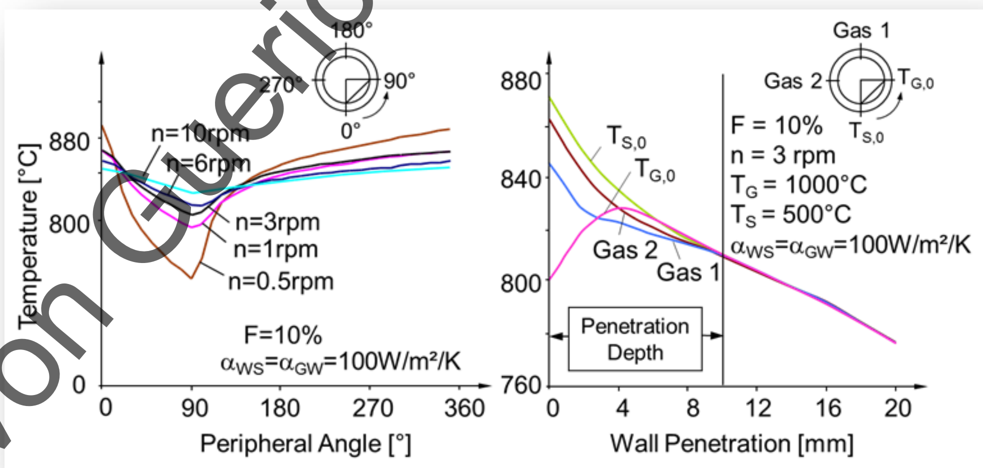


Komossa, H.; Wirtz, S.; Scherer, V.; Specht, E.; Herz, F.: Transversal bed motion in rotating drums using spherical particles: Comparison of experiments with DEM simulations. Powder Technology, 264 (2014), 96-104

Nafsun, A.I.; Herz, F.; Specht, E.; Scherer, V.; Wirtz, S.; Komossa, H.: The contact heat transfer in rotary drums in dependence on the particle size ratio. Proceedings of the 15th International Heat Transfer Conference (IHTC-15), August 10-15, 2014, Kyoto, Japan

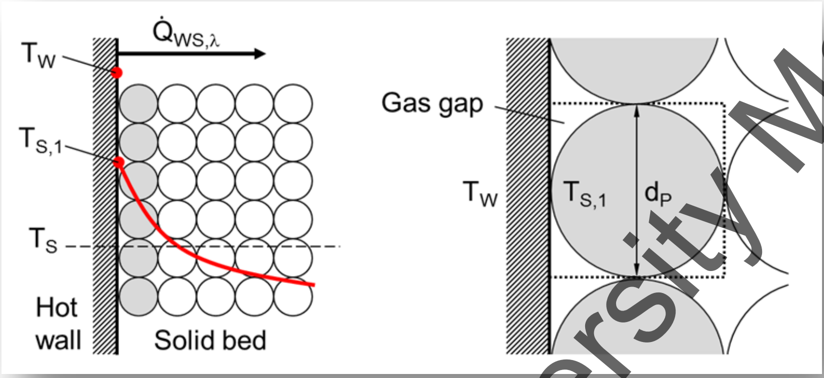
The wall gains heat at the free surface and transports it under the bed, where it is transferred to the bed by conduction. This two-dimensional heat transport in the radial and circumferential direction is referred to as regenerative heat transport. It is composed of the effective heat transfer by convection and radiation from the gas to the free wall surface, the peripheral heat transport in the wall and the contact heat transfer from the covered wall on the covered packed bed surface. Through numerical simulations (FVM, FEM) it was observed that the temperature penetration depth in the wall with a few millimeters is relatively low. This results in a thin thermally active layer near the surface, in which the peripheral temperature change due to the rotation of the drum takes place, and an inactive stationary layer whose temperature does not change in the circumferential direction. The temperature fluctuation was calculated in the wall as a function of various parameters. An analytical model for the heat transfer coefficient was defined by approaching the active layer as a semi-infinite body, so that the computing time could be minimized. The numerical results are in good agreement with the analytical.

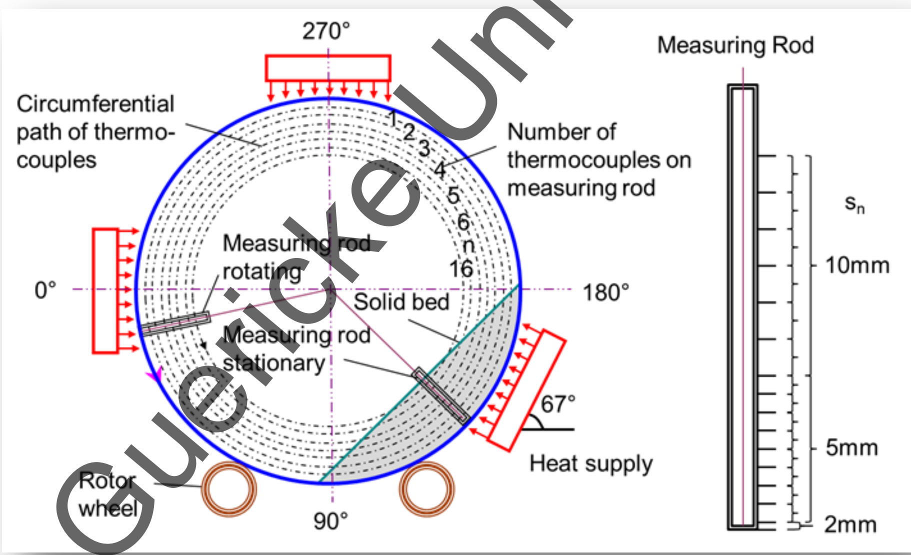




Queck, A.: Untersuchung des gas- und wandseitigen Wärmetransportes in die Schüttung von Drehrohröfen. PhD Thesis University Magdeburg, 2002
Agustini, S.: Regenerative action of the wall on the heat transfer for directly and indirectly heated rotary kilns. PhD Thesis University Magdeburg, 2006

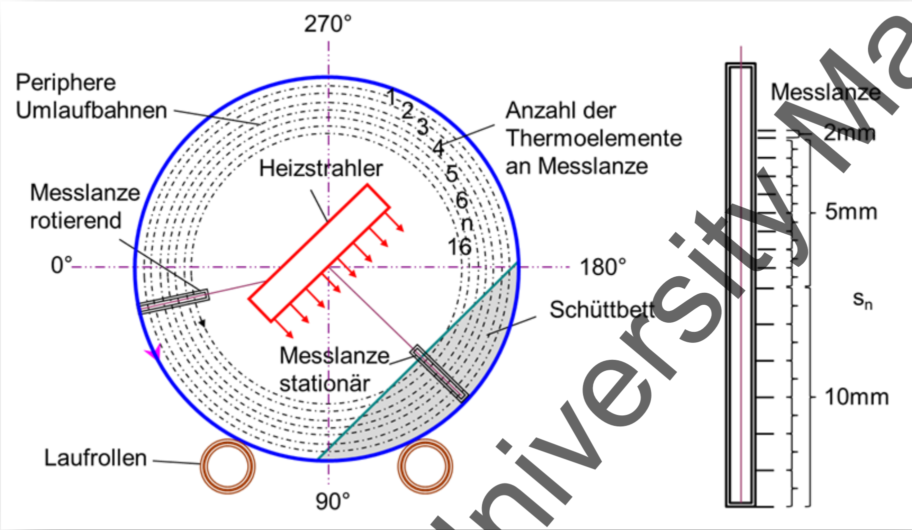
The contact heat transfer between the covered wall surface and the lower packed bed is made up of the series of a contact resistance between the wall and particle penetration and a resistor in the other layers of the particle bed. For a description of the contact heat transfer coefficient exist some mathematical models in literature, but they differ quantitatively to a factor of three and are validated by experimental measurements inadequate. That is why a huge number of experiments in an indirectly heated batch rotary drum were carried out with different materials and extensive parameter variation. In particular for the first time polydisperse packings were analyzed. Based on these analyzes, new good validated coefficients for calculating the contact resistance could be determined for both monodisperse and polydisperse systems.

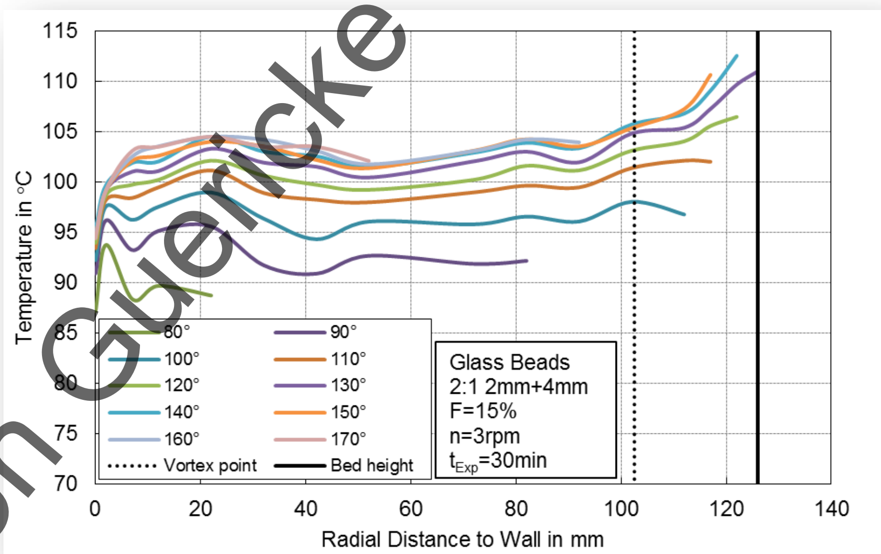




Herz, F.; Mitov, I.; Specht, E.; Stanev, R.: Influence of operational parameters and material properties on the contact heat transfer in rotary kilns. The International Journal of Heat and Mass Transfer 55 (2012), 7941-7948.
Herz, F.; Mitov, I.; Specht, E.; Stanev, R.: Experimental study of the contact heat transfer coefficient between the covered wall and solid bed in rotary drums. Chemical Engineering Science 82 (2012), 312-318.

The heat transport from the free surface into the inner core of the bulk bed is mainly determined by the heat transport through the active layer. To describe this heat transfer, the effective thermal conductivity of the active layer is introduced. As part of a research project this thermal conductivity could be quantified for the first time and the influence of different operational and design parameters are shown for various materials. For this purpose, experimental tests were carried out in an internally heated batch rotary drum and the temperature distribution in radial and peripheral direction of the bed was detected. So the thermal conductivity in the active layer with the known heat flux and the temperature gradient could be determined. The thickness of the active layer is here calculated with the self-developed models for transverse motion behavior.

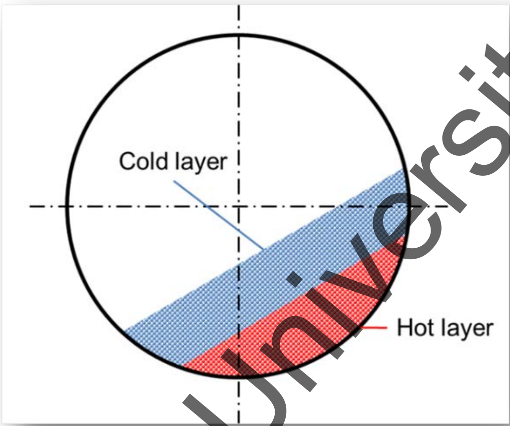


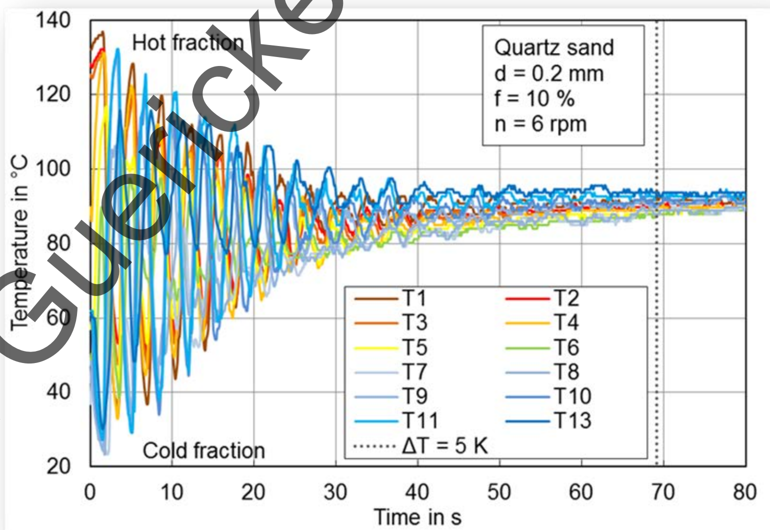


Herz, F.; Sonavane, Y.; Specht, E.: Analysis of local heat transfer in direct fired rotary kilns. Proceedings of the 14th International Heat Transfer Conference (IHTC14-22086), August 8-13, 2010, Washington, DC, USA.
Nafsun, A.I.; Herz, F.; Specht, E.: Analysis of heat penetration into the solid bed of rotary drums. Proceedings of the 10th International Conference on Heat Transfer, Fluid Mechanics and Thermodynamics (HEFAT 2014), July 14-16, 2014, Orlando, USA

To describe the temperature distribution in the solid bed the mixing behavior must be analyzed. The mixing is an essential criterion to ensure product quality, as large temperature gradients occur in the solid bed inhomogeneity of the final product cannot be excluded. The thermal mixing was experimentally studied in a batch rotary drum. Two fractions of particles were introduced with different thermal conditions from one another in the drum, and the radial temperature distribution measured until reaching the mixing temperature for the experiments. From the curves, the mixing time and the necessary number of bed changes and drum rotations can be determined. Based on this a dimensionless mixing quality depending on the different materials and operating parameters was defined.

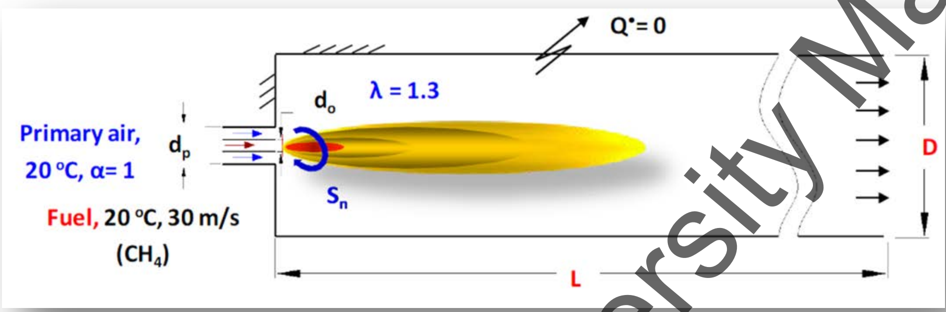
As part of a research project with the University of Dortmund (Prof. Walzel) the results of thermal experiments were compared with results from cold experiments. A good agreement was could be observed. This also showed up at particle-based DEM simulations that as part of another research project with the University of Bochum (Prof. Scherer) were carried out.

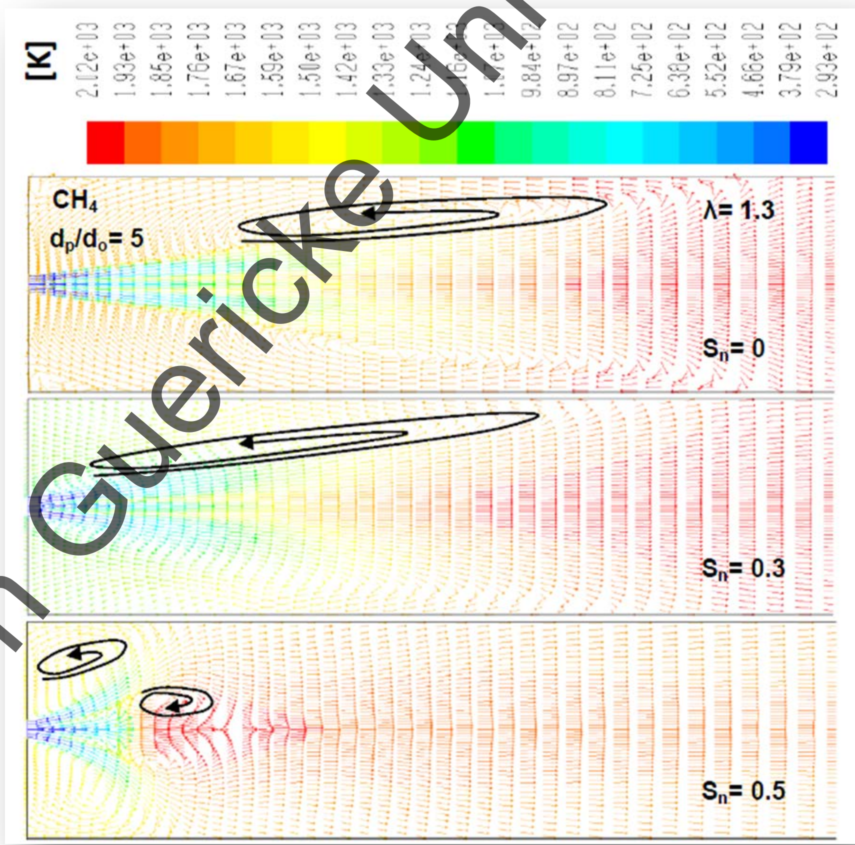




Herz, F.; Sonavane, Y.; Specht, E.; Bensmann S.; Walzel, P.: Mixing Behaviour of Granular Material in the Agitated Bed of Rotating Drums. Bulk Solids and Powder-Science and Technology 4 (2009), 109-116.
Sonavane, Y.: Influence of the wall on the heat transfer process in rotary kilns. PhD Thesis University Magdeburg, 2010

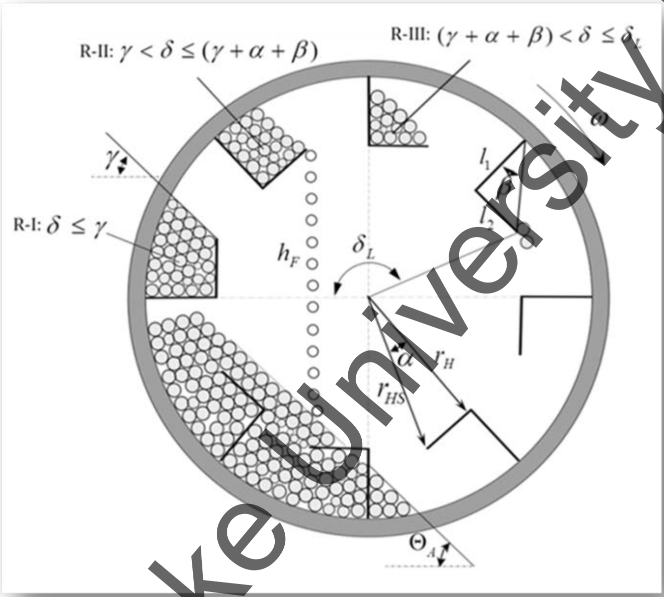
In direct-fired rotary kilns usually diffusion burners are used, so that the combustion intensity along the flame is mainly determined by the mixing speed and long flame shapes can be produced. In particular, the local profile of heat release along the flame is a decisive factor in the process modeling. Because thus it is possible to calculate the amount of heat that is produced per volume proportion of the flame and is transferred to the solid bed and the inner kiln wall. Through our own CFD simulations the flame length can be analyzed as a function of various influencing parameters. Thus, the influence of different burner designs, the kind of fuel, the air ratio, the swirl of the combustion air and temperature were analyzed by parametric studies. For this purpose, a two-dimensional axisymmetric model to simulate the free and confined jet flame was developed. Due to the validation of the numerical calculations based on experimental and analytical data, additionally a three-dimensional flame simulation could be carried out in an industrial rotary kiln.

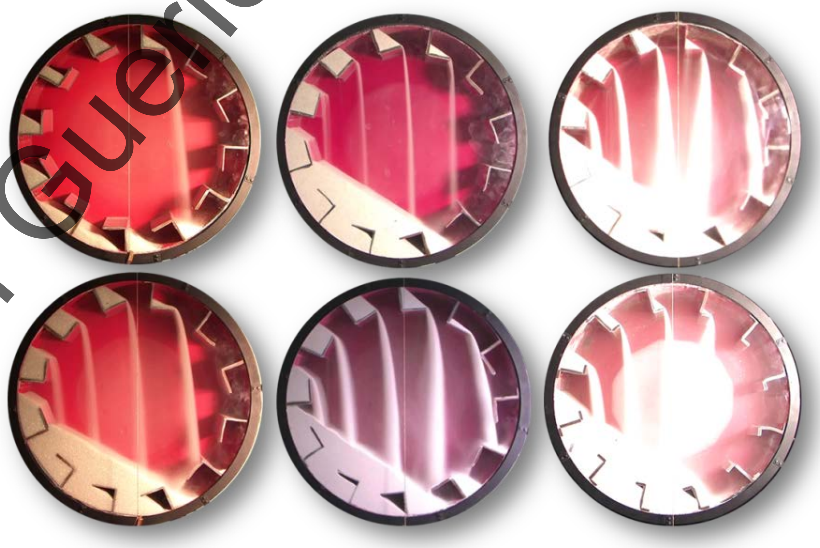




Giese, A.: Numerische Untersuchungen zur Bestimmung der Flammenlängen in Drehrohröfen. PhD Thesis University Magdeburg, 2003
Elattar, H.F.M.: Flame simulation in rotary kilns using computational fluid dynamics. PhD Thesis University Magdeburg, 2011

At the feeding inlet of a rotary kiln typically low temperatures occur, so that the radiation heat transfer is significantly lower. Here, however, a lot of heat is often required when for example the material must be dried. To increase the convective heat transfer therefore constructions like lifting flights are used in the inlet area, which raise the bulk material and then drop steadily. The effectiveness of the use of such installations is dependent on the extent and uniformity of the gas-solid contact and the residence time of the material in the drum. These in turn are largely determined by the number, size and shape of the flights. Based on force balances and geometric relationships, a macroscopic description of the transverse motion behavior in rotary drums with L-shaped flights was developed. With the help of experimental studies at different batch rotary drums, the model could be well validated. In addition, models were analyzed for axial solid transport and heat transfer. In a research project with the University of Bochum (Prof. Scherer) models were developed on basis of DEM / CFD coupling in order to describe the particle based motion behavior, axial transport and heat transfer.



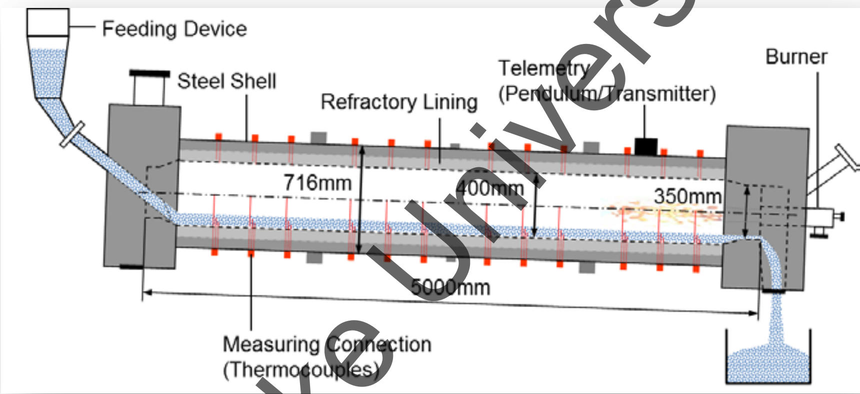


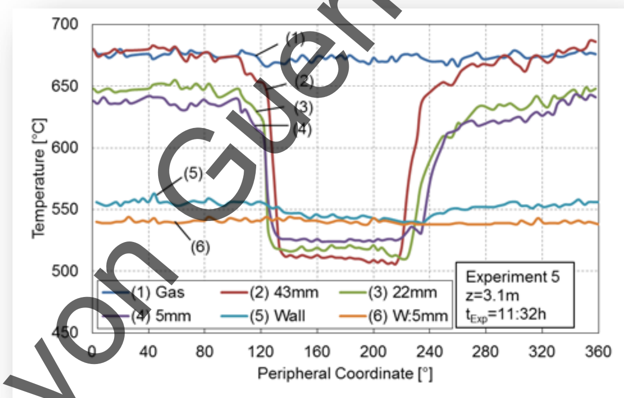
Sunkara, K.R.: Granular flow and design studies in flighted rotating drums. PhD Thesis University Magdeburg, 2013
Sunkara, K.R.; Herz, F.; Specht, E.; Mellmann, J.: Transverse flow at the flight surface in flighted rotary drums. Powder Technology, 275 (2015), 161-171

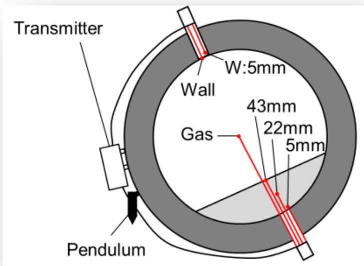
A direct fired rotary kiln is available, which can be operated in both continuous counter and co-current mode or in batch mode. Thus, it is possible to simulate processes, to drive campaigns and quantify parameters influencing the process.

Inner Diameter	400 mm	Length	5 m
Solid Throughput	≤ 700 kg/h	Energy Input	50…200 kW
Product Temperature	1300°C	Rotational Speed	0…10 rpm
Inclination Angle	-5°…5°		

Over the entire length of the rotary kiln measuring connections are provided in the wall, where thermocouples were introduced in the interior of the rotary kiln. The thermocouples are installed in different radial distances from the inner tube wall. With special measuring technology, the peripheral positions of the thermocouples are determined so that simultaneously the radial, axial and peripheral temperature distributions in the packed bed in the wall and in the gas phase are detected. In addition to the temperature curves in the interior of the rotary kiln, the outer shell temperature and the composition of the exhaust gas are recorded. The outer shell temperature is measured by thermocouples and radiation pyrometers at different axial positions. The composition of the exhaust gas is measured by extraction by means of a flue gas analyzer to verify the air leakage through the seals on the two furnace head housings and to detect solid reactions.





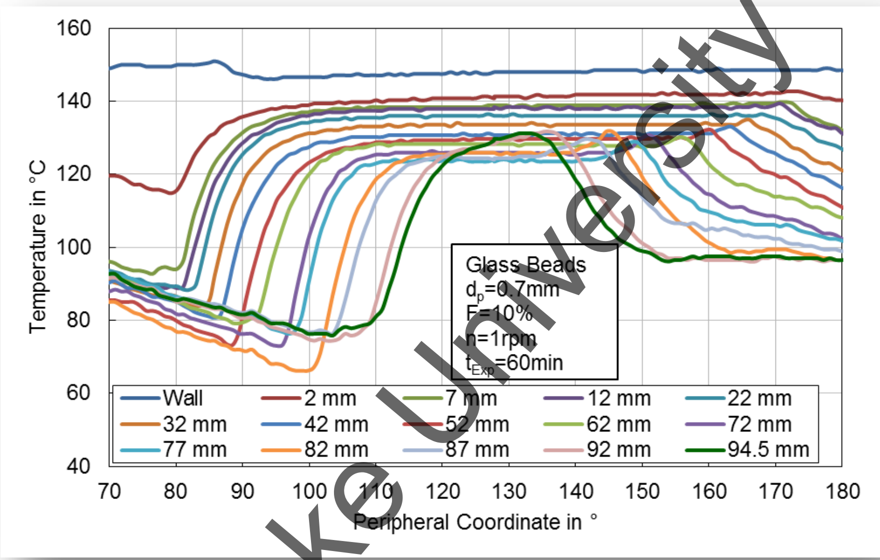


Herz, F.: Herz, F.: Entwicklung eines mathematischen Modells zur Simulation thermischer Prozesse in Drehrohröfen. PhD Thesis University Magdeburg, Docupoint Verlag GmbH, Magdeburg, 2012 (ISBN 978-386912-075-1)

For the analysis of heat transfer and temperature distribution in the solid bed a batch rotary kiln is available. This is electrically heated, the heat can be entered both indirectly from outside through the outer shell surface as well as directly from the inside on the free bed surface.

Diameter	600 mm	Length	450 mm
Energy Input	5 kW	Product Temperature	200°C
Rotional Speed	0...10 rpm		

In order to detect the temperature profile in the solid bed, thermocouples were installed at different radial distances to the inner drum wall at two measuring lances. One measuring lance was positioned stationary in the bed to measure the radial temperature distributions. The second measuring rod rotates continuously with the rotary drum wall, so that in addition recorded simultaneously the peripheral distribution of temperature in the packed bed. Also simultaneously, the inner wall temperature and the outer shell surface temperature are measured with radiation pyrometers and other thermocouples.

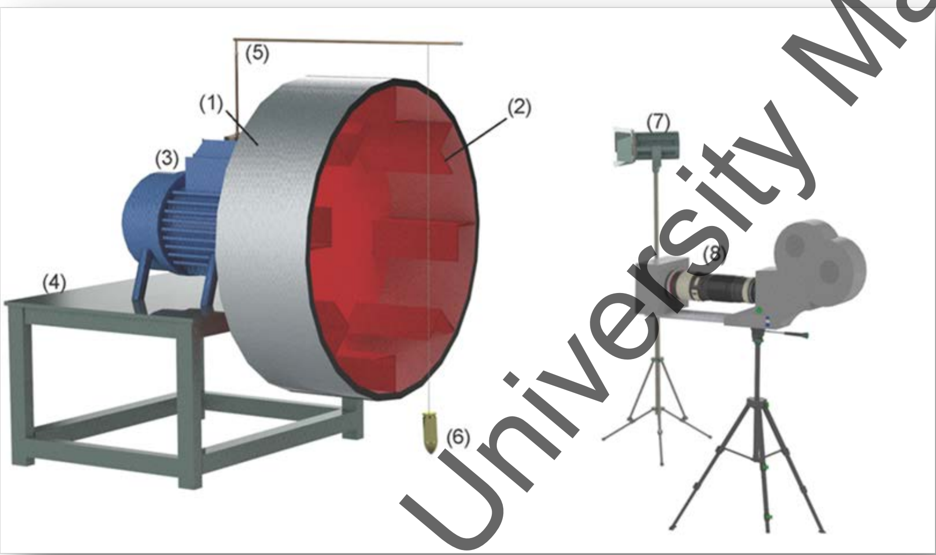


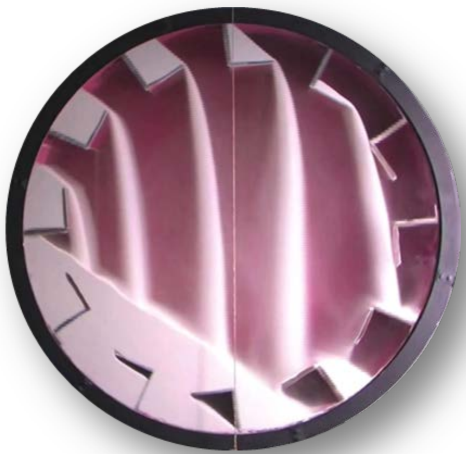
Herz, F.: Herz, F.: Entwicklung eines mathematischen Modells zur Simulation thermischer Prozesse in Drehrohröfen. PhD Thesis University Magdeburg, Docupoint Verlag GmbH, Magdeburg, 2012 (ISBN 978-386912-075-1)
Herz, F.; Mitov, I.; Specht, E.; Stanev, R.: Influence of the motion behavior on the contact heat transfer between the covered wall and solid bed in rotary kilns. Experimental Heat Transfer, 28 (2015), 174-188

The transverse movement behavior of the bed in rotary kilns with and without internals is studied in batch rotary drums of various dimensions.

Diameter	200…1000 mm
Length	100…300 mm
Rotational Speed	0…30 rpm

The rotary drums are positioned horizontally and provided on the front side with a glass wall. Thus, an insight is offered into the bed. The motion behavior of the particles is taken both with high-resolution cameras as well as with high-speed cameras. With the help of various software and evaluation routines the frames are analyzed.



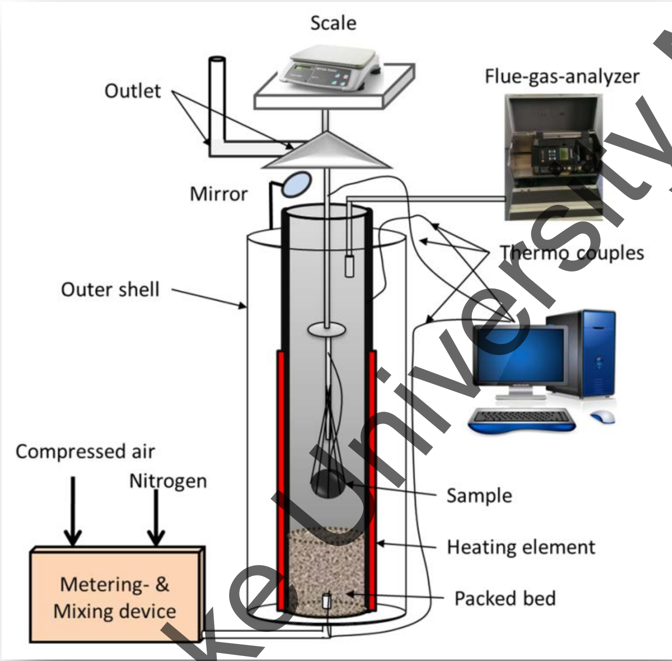


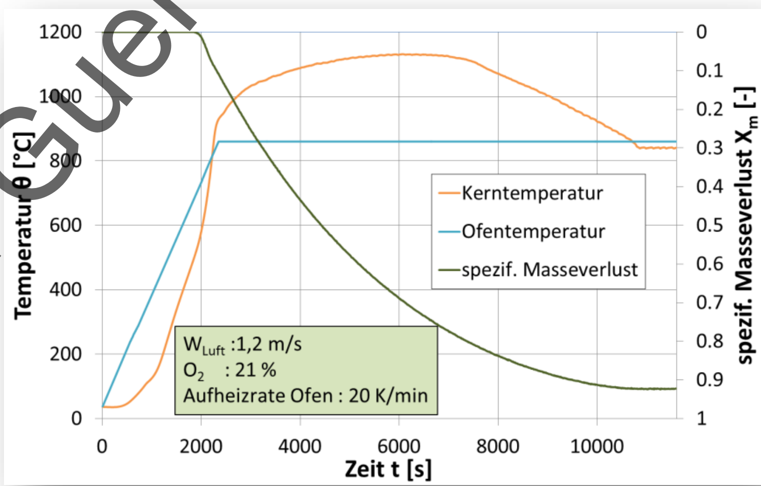
Liu, X.: Experimental and theoretical study of transverse solids motion in rotary kilns. PhD Thesis University Magdeburg, 2005
Sunkara, R.K.; Herz, F.; Specht, E.; Mellmann, J.: Influence of flight design on the particle distribution of a flighted rotating drum. Chemical Engineering Science 90 (2013), 101-109.

In order to analyze the reactive behavior of a solid bed a thermobalance is available. This is an electrically heated tube furnace with the following characteristics:

Height	1200 mm	Diameter	80 mm
Energy Input	7 kW	Temperature	1300°C

In order to ensure a defined atmosphere in the tube a gas stream, such as Air, nitrogen or CO2, is injected at the lower end of the tube. The bulk sample to be examined is located in a cylindrical mesh tube (V = 300 ml). This vessel is installed on a precision balance, so that continuously change in mass of the sample can be detected. In addition, thermocouples are in different layers of the sample bed positioned to simultaneously measure the temperature gradients. An exhaust gas analysis at the upper end is provided.





Hallak, B.; Woche, H.; Herz, F.; Specht, E.: Einfluss der Ascheschicht auf das Abbrandverhalten stückiger Kokse und Anthrazite. 26. Deutscher Flammentag, September 11-12, 2013, Duisburg, Germany

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Measuring Possibilities

- Specific Heat Capacity c_p (T)
- Phase Change Enthalpy
- Density ρ (T)
- Thermal Extension Coefficient β (T)
- Temperature Conduction Coefficient a (T)
- Heat Conductivity λ (T)

up to1600°C for example

- Metals (also fluid)
- Ceramics
- Insulations

Technology

- Dynamic Differential Scanning Calorimeter Netzsch DSC 404 C Pegasus (20°C – 1650°C, Measuring Error < 5 %, Measurement in different atmospheres)

- Dilatometer Netzsch DIL 402 C (20 °C – 1700 °C, Measuring Error < 3 %)

- Laser-Flash-Plant Netzsch LFA 427 (20°C – 1600°C, Measuring Error ± 3 %, 0,001 < a < 10 cm^2/s)

- Thermal Analyzer SETARAM TG92 Simultaneous, calorific und thermo gravimetric Measurement, coupled DTA/DSC and TG with a Mass Spectrometry (Thermolab 1210), Temperature range –100°C – 1600°C.

- Hot-Disk-Plant Determination of the Heat Conductivity Solids, Fluids and Solid Beds Measurement Range: 0.01 – 500 W/m/K Temperature Range: RT till 230°C (Kapton-Sensor), RT till 750°C (Mica-Sensor)

Silva, M.: Experimental investigation of the thermophysical properties of new and representative materials from room temperature up to 1300°C, PhD Thesis University Magdeburg, 2009

Silva, M.; Specht, E.; Schmidt, J.: Thermophysical properties of limestone as a function of origin. Part 1: specific heat capacities. Cement Lime Gypsum No 2 (2010) 55-62.

- High Resulotion Infrared-Thermography-System THV 900 and Therma CAM SC 3000 with different optics and accessory lenses and following parameter

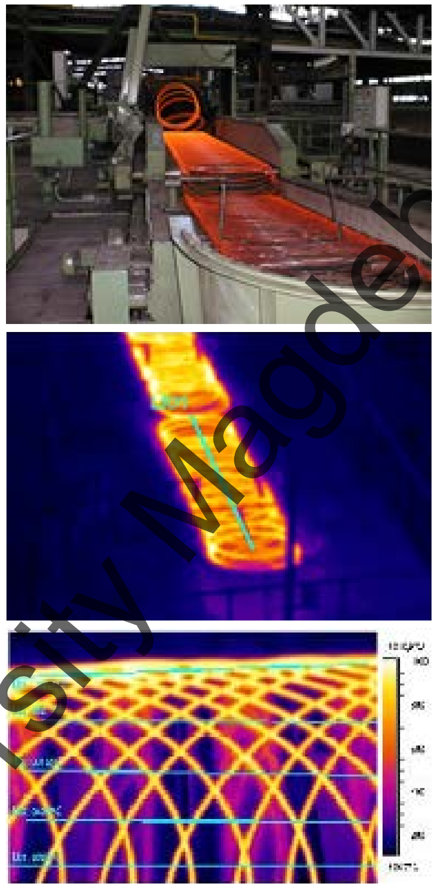
  - Temperature Range –30°C to 2000°C
  - Local Resolution to 0.2 mm per Pixel
  - Frame Rate 30 Hz
  - Fast Linescan (2500 Lines/Second)
  - 5°- and 20°-Optic each with Close-up-Lens
  - Analysis Software AGEMATM Research

- Black Body – Calibrating Emitter M335 (Mikron)

  - Temperature Range 300°C to 1500°C
  - Hollow Diameter 17 mm
  - Hollow Depth 150 mm

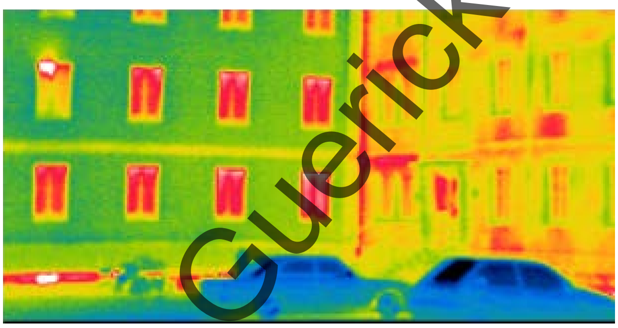
- Sika-High-Temperature-Calibration TP28850

  - Temperature Range: Ambient temperature to 850°C
  - Block drill 18 mm, Depth 100 mm
  - Different Transition hulls

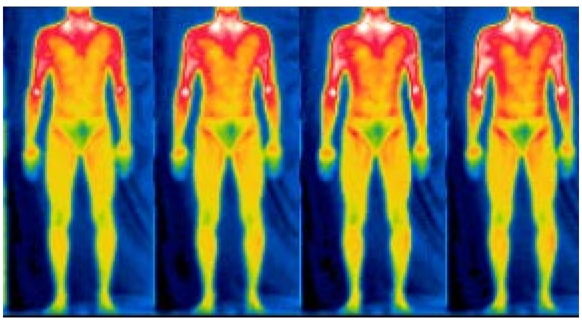


Rolling Stock Cooling

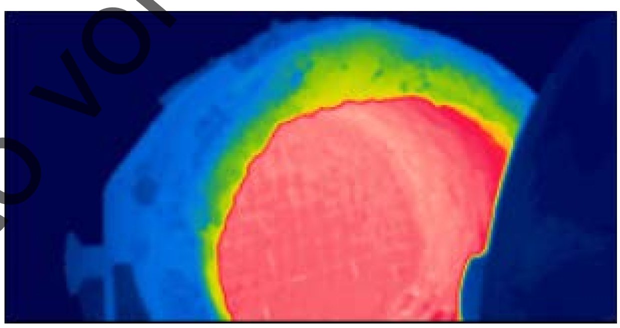
The thermography system is used in many research projects, in particular also for the determination of heat transfer coefficient. The applications are from the low temperature to the high temperature range.



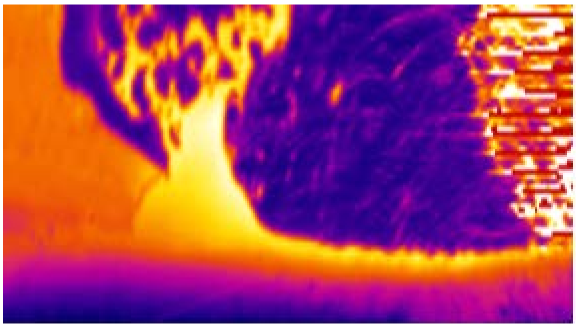
Comparison reconstructed/constructed House Front



Heating of a Swimmer



Casting Ladle



Weld Pool

1. Dr.-Ing. Andreas Queck: „Untersuchung des gas- und wandseitigen Wärmetransportes in die Schüttung von Drehrohröfen“, 07.10.2002

2. Dr.-Ing. Anne Giese: „Numerische Untersuchungen zur Bestimmung der Flammenlängen in Drehrohröfen“, 13.06.2003

3. Dr.-Ing. Xiaoyan Liu: „Experimental and theoretical study of transverse solids motion in rotary kilns“, 19.05.2005

4. Dr.-Ing. Silvia Agustini: „Regenerative action of the wall on the heat transfer for directly and indirectly heated rotary kilns“, 10.07.2006

5. Dr.-Ing. Yichun Shi: „The outflow behaviour of particles at the discharge end of rotary kilns”, 03.07.2009

6. Dr.-Ing. Yogesh Sonavane: „Influence of the wall on the heat transfer process in rotary kilns“, 15.06.2010

7. Dr.-Ing. Hassan Fawzy Mohamed Elattar: „Flame simulation in rotary kilns using computational fluid dynamics”, 08.09.2011

8. Dr.-Ing. Fabian Herz: “Entwicklung eines mathematischen Modells zur Simulation thermischer Prozesse in Drehrohröfen”, 23.07.2012

9. Dr.-Ing. Koteswara Rao Sunkara: „Granular flow and design studies in flighted rotating drums“, 11.07.2013

10. Mohammed Karali: „Analysis study of the axial transport and heat transfer of a flighted rotary drum operated at optimum loading“, 20.08.2015

11. Aainaa Izyan Binti Nafsun: „ Experimental analysis of heat transport in the solid bed of rotary kilns“, 26.11.2015

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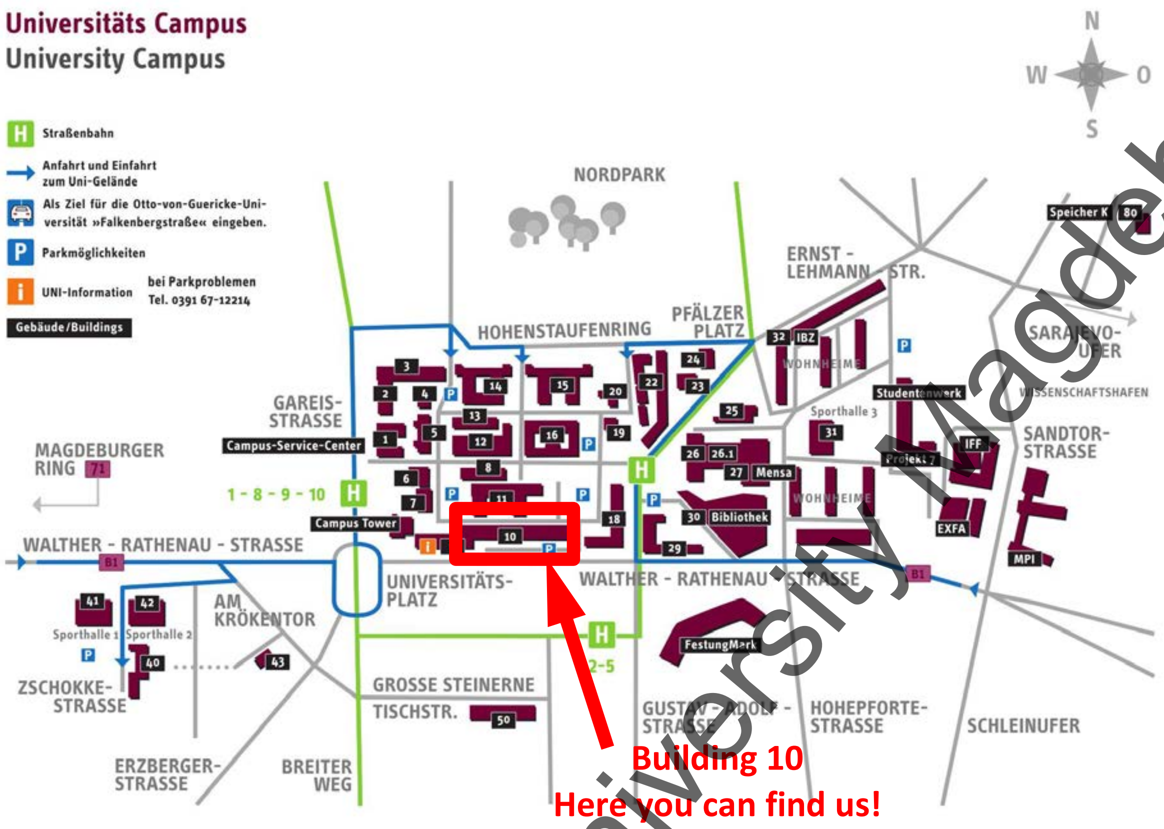
Arrival by Car



- Via the A2 (from Berlin or Hannover), exit 70 "Magdeburg Central" onto the Magdeburg ring road (E49/B189) southwards, exit "Albert Vater Strasse" onto the B1 eastwards as far as Universitätsplatz (large roundabout).
- Via the A14 (from Halle/Leipzig), exit 105 "Magdeburg Sudenburg, centre" onto the Magdeburg ring road (B81/E49/B71) northwards, exit "Albert Vater Strasse" (Helmstedt, Dessau, Burg, centre, Olvenstedt) onto the B1 towards "Dessau, Burg, centre" (east) as far as Universitätsplatz (large roundabout).
- Via the B1 from the west as far as Universitätsplatz (large roundabout); do not go through the tunnel (see map).
  - Drive ¾ of the way around the roundabout and then turn into "Gareisstrasse".
- At the first set of traffic lights turn right into "Henning von Tesckow Strasse".
- If you are coming from the east on the B1 (from the direction of Dessau or Burg), cross over the two bridges over the Elbe. Then turn right at the second set of traffic lights after the bridges into Pfälzer Strasse (see map).

Arrival by Train

Every hour there is IC-Connection to all Metropolises
When Arriving: Use the main exit of the train station and <u>not</u> the exit "Kölner Platz".

Tram Connection

Line	Station	Direction	No. of stations	Driving Time
1	CITY CARRÉ/Hauptbahnhof	Lerchenwuhne	4	7 min
8	Hauptbahnhof	Neustädter See	5	8 min

Route: Hauptbahnhof - CITY CARRÉ/Hauptbahnhof - Alter Markt - Breiter Weg - Opernhaus - Universität

Otto von Guericke

The university is named "Otto von Guericke". The naturalist is one of the fathers of experimental physics. For his work as a scientist, natural philosopher and engineer, he has far beyond the borders of Germany, gained recognition and is still regarded as one of the most famous scientists of the 17th century.

Otto von Guericke was 30 years mayor of Magdeburg and worked in his time as a talented and skillful diplomat. He succeeded, with brilliant scientific ideas and inventions to draw different discussed by philosophers question of the existence of the vacuum in a practical, obvious and convincing experiments. With its vacuum he created the first larger airless rooms. He demonstrated thus the existence and intensity of the air pressure and researched properties of air. He thus became one of the founders of Vacuum Science and Technology, a scientific discipline that has also been represented at the University. The most famous and still impressive experiment Otto von Guericke is the hemisphere experiment with 16 horses, which was first demonstrated in 1658 in Magdeburg.

Sightseeing

- Magdeburger Cathedrale,
- Cathedrale Square and old City wall with a view over the river Elbe,
- “Hundertwasserhaus“ - „Green Citadel“ (worldwide greatest and last masterpiece of the artist),
- Hasselbachplatz (Old Town) with intensive scenery of bars and restaurants,
- Jahrtausendturm in the Elbauenpark (highest wooden tower in Germany, third in the world),
- Magdeburg Water Bridge „Elbe-Mittellandkanal“ (biggest aqueduct in Europe)