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THE INFLUENCE OF AGGLOMERATION BINDER ON KINETICS OF GRANULES

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Abstract: For the correct design of a fluid bed granulator whose output may be granules with the required form and properties, it is necessary to know the process parameters, such as the amount and type of binder, the flow parameters, air distribution and the rate of rotation of the disc. This paper deals with the detection of the kinetics of growth of the granules, specifically their distribution characteristics depending on the binder concentration in the liquid phase. The experiments will be carried out in a fluidized bed granulator with a rotating disc, which was designed at the Institute of Chemical and Hydraulic Machines and Equipment's at the Faculty of Mechanical Engineering of the Slovak University of Technology in Bratislava. The output of the experiments will be the determination of the distribution characteristics of the resulting final granulate.
Keywords: granulate, binder, distribution characteristics

INTRODUCTION
In the course of designing industrial granulation equipment it is nowadays not possible to proceed without examining by experiment the process parameters. It is often a requirement for the specific distribution characteristics of the final product and optimization of the granulation time. This paper deals with the detection of the growth kinetics of the granules in a fluid bed granulator, in dependence on the amount of granulation liquid and the concentration of granulation binder in the liquid phase.

THEORY
The agglomeration of the particles is currently achieved by a number of conventionally used methods. One such method is fluid bed granulation, wherein the enlargement of the particles takes place by spraying a liquid binder onto the aerated processed material. Inlet air enables the movement of the powder without auxiliary components such as a blade or a screw in other granulation technologies. Satisfactory fluid bed granulation ensures a balance between the hydrodynamic, gravitational and interparticle forces.
At the Institute of Chemical and Hydraulic Machines and Equipment of the Faculty of Mechanical Engineering a fluid bed granulator with a rotating disc was developed. Compressed air, ensuring the creation of a fluidized bed is obtained from a compressor and is fed into the apparatus from below. Using a perforated distributor, air is uniformly distributed under the rotating disk. Exhaust is carried out by means of suction through the top of the device. The liquid is injected into the system by a nozzle through a metering pump. The device is operated in batch, therefore the product created after each measurement must be removed from the chamber.

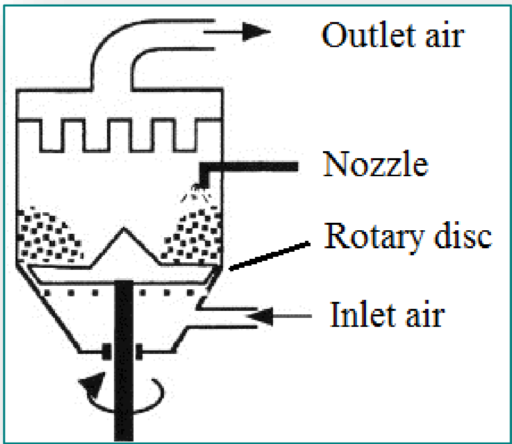


Figure 1: Diagram of experimental equipment

EXPERIMENTAL MATERIAL
The experimental material for the production of samples was finely ground limestone (Fig.2) with a microcrystalline structure. Selected properties of

ground limestone are seen on Table 1. A granulation liquid containing 10% rel. mass of liquid starch was used as a granulation binder, with the remainder being distilled water. Since ground limestone in the powder form is well wettable, it was not necessary to use further auxiliary additives. The distribution characteristic of the experimental material, (Figure 4), was measured by a Malvern Mastersizer 3000 particle size analyser.

Figure 2: Experimental material – finely ground limestone

Table 1: Properties of experimental material

Loose density	0,65	[g.cm⁻³]
Tap density	0,78	[g.cm⁻³]
Material density	2,71	[g.cm⁻³]
Specific surface area	1037	[m².kg⁻¹]
Relative humidity	0,1	[%]

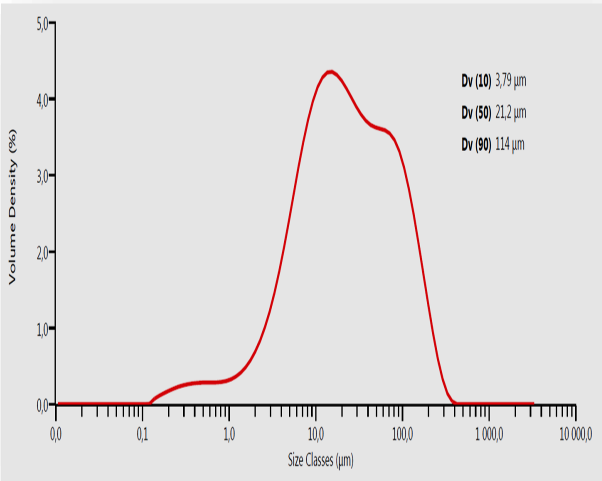


Figure 3: Distribution characteristic of experimental material

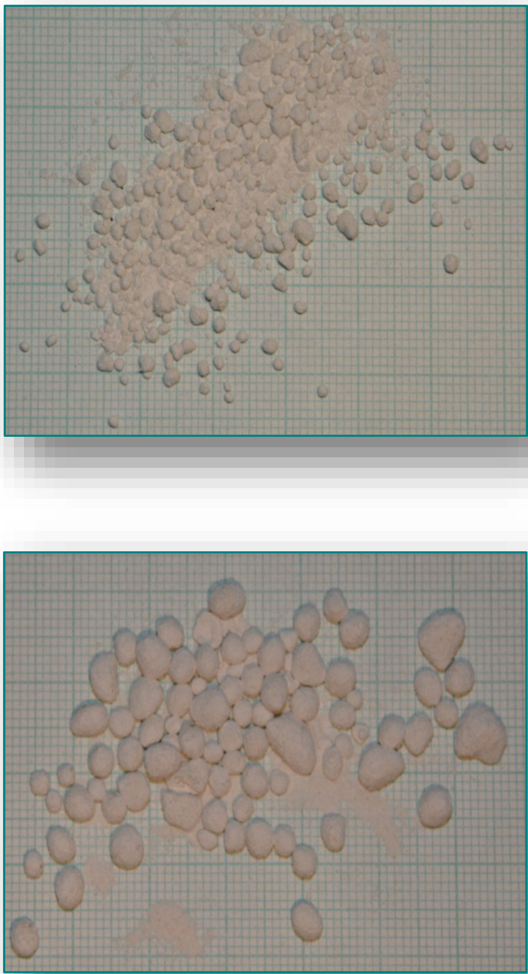
FLUID BED GRANULATION OF EXPERIMENTAL MATERIAL

Experimental measurements were made for the different amount of transported granulation liquid, with monitoring of the size reduction in dependence on the time of granulation. The same batch of fresh material was used for each measurement. The individual parameters of the granulation process are recorded in Table 2.

Table 2: Parameters of process

Speed of rotary disc	500	[s⁻¹]
Air flow in chamber	30	[m³.h⁻¹]
Mass flow of liquid	10-30	[ml.min⁻¹]
Batch mass	200	[g]
Granulation time	30-150	[s]

The resulting granules (Figure 4) were dried in a dryer at 120°C for 2 hours. Subsequently, the dried product is subjected to sieve analysis, which is determined by the diameter of the largest numbers of particles (median) d_{50}.



a)

b)

Figure 4: Resulting granulates before sieve analysis
a) granulation time 30 s,
b) granulation time 150 s

Table 3: Table of measured data

Sample number	Granulation time [s]	Mass flow of granulation liquid [ml.min^{-1}]	Particle diameter d_{50} [mm]
A.1	30	10	1,5
A.2	60	10	2
A.3	90	10	3
A.4	120	10	3,5
A.5	150	10	4,5
B.1	30	20	1
B.2	60	20	2,5
B.3	90	20	4
B.4	120	20	5
B.5	150	20	6
C.1	30	30	1
C.2	60	30	3
C.3	90	30	4,5
C.4	120	30	5,5
C.5	150	30	7,5

RESULTS OF EXPERIMENT

Evaluation of the experiments was designed to determine the kinetics of agglomerate growth in dependence on the amount of granulation liquid used. Measured data of parameters d_{50} for all samples examined are recorded in Table 3. Graphical function of the size of the granules, dependent on the duration of process, is shown in Figure 5.

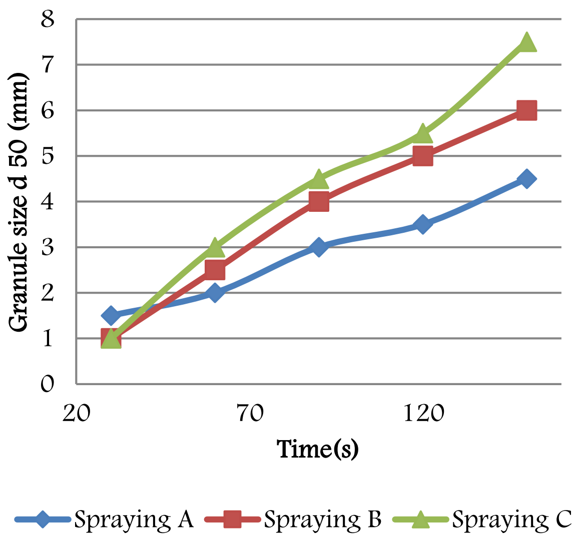


Figure 5: Kinetics of growth of granules

CONCLUSIONS

From the experimental measurements using a fluidized bed granulator with a rotating disc seems possible to evaluate the kinetics of growth of the granules in dependence on the amount of added agglomerating liquid. The results obtained suggest that the increase in median particle size is almost linear for the compositions with a lower and a higher content of liquid. Gradient of granular growth according to time of agglomeration was similar for all the examined liquid contents. The initial experiments proved the significant impact of added liquid on the growth of the granules. In following experiments it will be possible to observe the growth kinetics of the granules according to the process parameters that were constant in the initial measurements. These parameters include speed of rotation of the rotary disk, the amount of supplied air, and the filling of the charge chamber.

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Note

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