

## Granulation – still an important process

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Granulation means forming solid particles of appropriate shape, dimensions and physicochemical properties. The ambiguity of this definition makes room for a wide variety of, often quite disparate, methods of obtaining such products. These methods may be associated with other unit operations, such as crystallization or drying. It is therefore difficult to devise a simple classification or division of granulation methods, although some endeavour to do this.

One of the ways of obtaining granules is to use material in the form of melt, spray it to form drops of adequate size and cool it to crystallize into more or less regular spheres. This method may for instance be applied to obtain crystalline sulphur, where the process is carried out in the so-called prilling towers, with the melt being sprayed in the top part and air being forced at adequate velocity at the bottom. Granulation from suspension can be effected in a similar manner and in similar apparatus in combination with drying and agglomeration (clustering of particles into larger granules) of fine particles formed during the initial stage of the process (as a result of collisions between particles).

Granulation from suspension can also be conducted in mixing vessels provided with mechanical agitators (the vessels usually equipped with a heating jacket), wherein upon evaporation of the liquid the processed material forms a paste, then turns into a solid, which is continuously ground into irregular agglomerates.

In most cases, however, the starting material for granulation is in the form of fine solid particles (powder, dust), and the product is in the form of larger granules which are agglomerates of the initial particles. Such operation can be effected, in terms of process applied and equipment used, in various ways. One can distinguish between non-pressure and pressure granulation. Non-pressure granulation can be effected in a fluidized bed or in a free-flowing layer of granular material (tumbling, disk and vibration apparatus). In pressure granulation (tableting, briquetting, pressing) increased pressure is applied, which causes mechanical strengthening of defined portions of original grains due to bringing them closer together and, often, plastic deformation thereof. In some cases pressure granulation is conducted at elevated temperature, which may be dictated by some requirements of the process or of the application of the final product (for instance, extruders used in processing of foodstuffs). When powdered materials are subjected to granulation, then a binding liquid is used in the process of agglomeration, both in pressure and non-pressure granulation. Such liquid may either facilitate the bringing together of particles only during the granulation process, or generate permanent cohesion forces which increase the strength of bonds between original grains and are also retained after drying of the product.

The various methods of granulation discussed above clearly show how diverse are the mechanisms and physicochemical phenomena occurring in specific cases. This demonstrates how broad is the research area of granulation in general. Its significance and importance is highlighted by the features that make the granular form of raw materials and products stand out above the powdery form. The most important advantages of the former include:

1. suppression of dusting during handling.
2. avoidance of caking.
3. better behaviour during transport on conveyors and during feeding.
4. prevention of segregation in multicomponent materials.

Moreover, appropriately formed granules enable conferring different properties related to dissolution speed. Traditional methods of non-pressure granulation are also used to produce multicomponent granules where the individual ingredients are applied in the form of surface coats, which determines the sequence of their release as the result of dissolution.

Granulation is applied in order to obtain a convenient final form of the product acceptable by the users, but also raw materials and intermediates are often granulated to facilitate, or even enable application thereof in certain processes. An example of that is the granulation of material or waste from mines, prior to processing, as well as solid biofuels co-burned in conventional utility furnaces.

Granulation of products is applied in many manufacturing processes. In terms of production output, chemical industry is the dominating sector, particularly the fertilizer industry, but granulation is also common in food and feed processing industry, as well as in the production of various solid feedstock for power generation. It is also applied in many processes related to environmental engineering.

In the light of the above, it is no surprise that granulation is the focus of a number of research groups across the world. Those issues are first of all dealt with by chemical and process engineers, but they are also the point of interest of experts on mineral processing and on food processing. On a world scale, an "International Symposium on Agglomeration" is organized regularly with the backing of the European Federation of Chemical Engineering, the Society of Powder Technology of Japan and the Particle Technology Forum of AIChE. Research in this area in Poland has been or is being conducted by more than a dozen institutions, among them the Fertilizer Research Institute in Puławy, Industrial Chemistry Research Institute in Warsaw, Institute of Industrial Organic Chemistry in Warsaw, Institute of Glass and Ceramics in Warsaw, Institute For Chemical Processing of Coal in Zabrze, Institute of Inorganic Chemistry in Gliwice, AGH University of Science and Technology in Cracow, University of Technology and Life Sciences in Bydgoszcz, University of Warmia and Mazury in Olsztyn, Universities of Technology in Białystok, Łódź, Warsaw and Wrocław.

At the turn of the 1970s and 80s, the decision-makers in Poland, being aware of the importance of research on granulation, established a pertinent research sub-programme financed by the State as part of the "Chemical Engineering and Apparatus and Chemical Plant Control and Design Systems" programme. The sub-programme was coordinated by the Fertilizer Research Institute in Puławy, and the results of research conducted by several participating teams were presented in 1982 at a symposium titled "Granulation – present state and prospects for process and equipment development". That symposium was given number I and was followed by regular meetings of scientists and practitioners dealing with these issues. In 2012 it will be the 9th symposium. The venue is traditionally in Puławy or nearby (Kazimierz Dolny, Nałęczów), and the main organizer (and an exemplary one, no doubt) is the local branch of SITPChem (Polish Association of Chemical Engineers), backed by the Fertilizer Research Institute and "Zakłady Azotowe" (fertilizer manufacturer) in Puławy, and, since recently, by the Lodz University of Technology. The symposia are a meeting place of representatives

of research centres specializing in chemical and process engineering, chemical technology, process equipment, mineral processing, food processing and environmental engineering. All symposia were attended by representatives of fertilizer manufacturing plants ("Zakłady Azotowe") in Puławy, Kędzierzyn, Włocławek, and among those attending the earlier events were representatives of: Przedsiębiorstwo Zagospodarowania Odpadów Elektrycznych (Power Plant Waste Processing Company) in Katowice, Engineering Office of "Zakłady Azotowe Puławy", Engineering Office of "Zakłady Azotowe Kędzierzyn". Each symposium so far had about 60 participants and a dozen or so papers presented.

One important feature of these symposia is the active and numerous participation of industry representatives. They usually make up more than 50% of the participants and deliver about 40% of the papers, presenting both the results of their own experiments, as well as the problems they face in their plants. It is a rare occasion in

Poland for scientists and engineers to share their opinions and present research results on the one hand and practical issues on the other hand. Discussions held during the symposia also help indicate the desired areas of future research.

The growing interest in the symposium, evidenced by the significant increase in the number of participants and papers in this year's event, proves the purposefulness of the undertaking, and must be a source of satisfaction and commitment for the organizers.

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## Polymers in Medicine 2012

1-5 July 2012

Prague, Czech Republic, Europe

### Official Information

The 76th Prague Meeting on Macromolecules: Polymers in Medicine will be focused on the latest innovative developments in drugdelivery systems. The conference will bring together multi-disciplinary researchers from both academia and industry in the areas of pharmaceuticals, polymer and materials science, imaging, cell and molecular biology, genetics, and medicine.

### Conference Topics

- delivery systems with active and passive targeting
- polymers for gene delivery
- polymers for diagnostics
- systems for combination therapy
- smart delivery systems
- systems for sustained release

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## Royal Society of Chemistry Symposium 2012

**Not Costing the Earth - Profit from Green and Sustainable Chemistry** Organiser Royal Society of Chemistry Location Barcelona, Spain Details

13 – 14-Jun-12, Barcelona, Spain

This two day international symposium will be held in conjunction with the Chemspec Europe and Chemsources Exhibitions organised by Quartz Business Media. The symposium will highlight recent advances in improving the sustainability and efficiency of processes in the scale up and production of speciality chemicals. Topics to be covered include: Production of reactants from renewable raw materials, Increasing process efficiency, Bio-engineering processes, Sustainable solvents and cheaper catalysts, Reduction of waste and hazards. Free attendance at this symposium.

### Contact

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