Conveying sugar pneumatically?

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Zucker pneumatisch transportieren?

Sale determining Features of sugar are grain size, integrity, colour and shine of the surfaces. The customers of the sugar industry need in increasing measure exactly defined spectra which refined themselves increasingly more further in the last years for the most different commitments. Sale fractions with a spread factor of 200 µm are required in increasing measure. The fractionpurity represents today a further important quality characteristic.

In order to fulfil these claims, it is attempted to handle the sugar maximally mildly after the crystallization. Particularly the inevitable transportation of the sugar from the stock location to the sieving, to the truck silo vehicle loading and to the lot machines strains the granule through numerous deliveries and mechanical stress in the conveying-elements. This fact becomes conscious first if the scrap quantities which are sucked off by the cleansing of the conveying-ways are set into relation to the conveyed sugar amount. In order to hold granule harm and the loss resultant from that maximally small, it is attempted, that transportation so far is possible it, to implement via force of gravity. Often this is not, however, possible due to the local factors and the conveying-task and several deliveries are necessary, with considerable corporate spendings and raised operating costs.

Pneumatic transportation already is in the sugar industry in the commitment, for example for the transportation of dust-like products as finest and powder, also flight ash. Not all kinds of the pneumatic transportation are recommended for the transportation of sugar. Sugar has a shine which is identified as a quality characteristic and must be maintained through the surface and crust formn. Conveying - techniques which damage just these quality characteristics negatively can not be used.

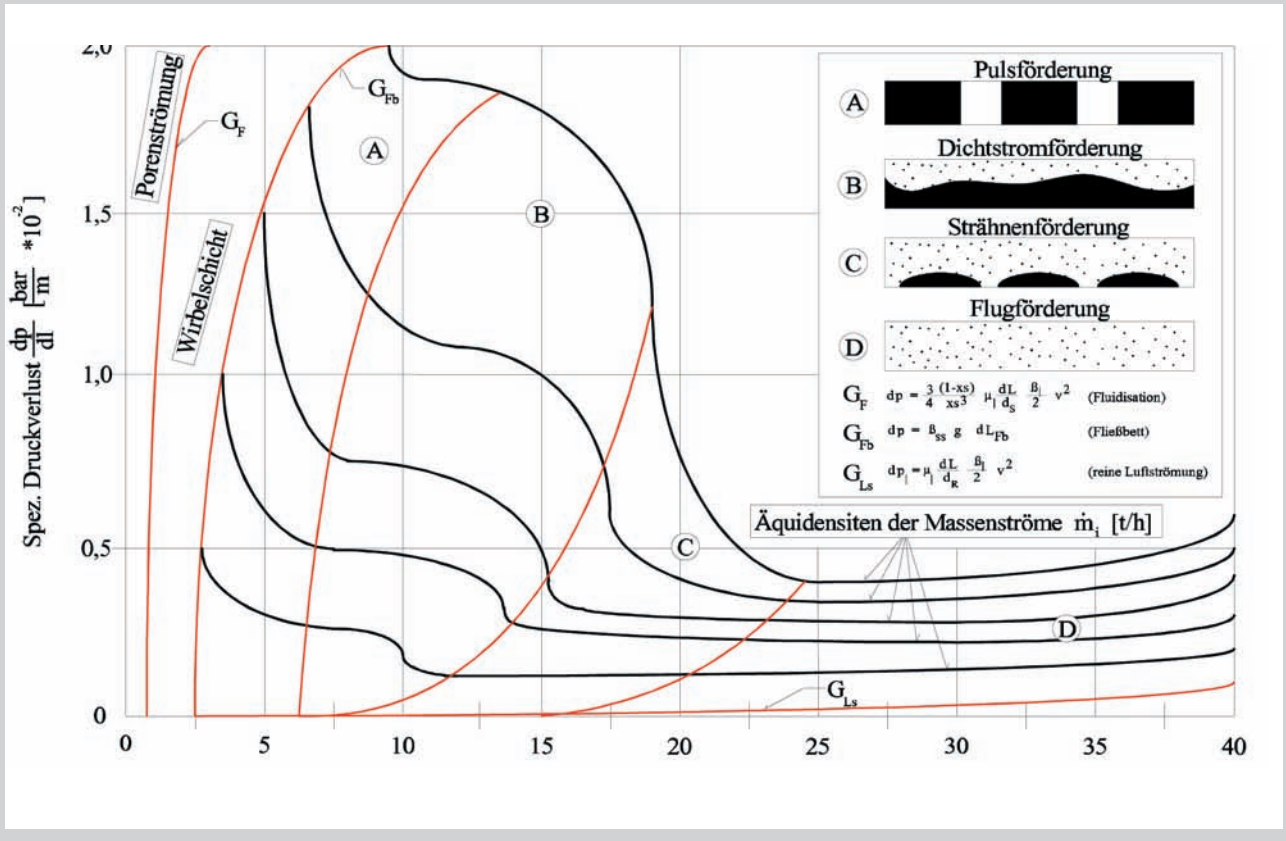


Fig. 1: Conveying-systems

Pneumatic conveying

We distinguish today basically 4 procedures of the pneumatic conveying:

» Flight conveying

» Strand conveying

» Dense stream conveying

» Plug conveying: and here the pulse conveying.

Flight conveying

During the flight conveying the sugar is advanced with a great amount of air . The sugar loading (Sugaramount to air in kg) of the conveying air is small, the conveying-velocity rates are very high. Air velocities are reached, the far more than 20 m/s.

Strand conveying

During the strand conveying a higher sugar loading is achieved. The sugar moves dune-like through the tubes, however, the conveying air is admitted also with product. Also here high conveying-velocity-rates up to 20 m/s.

From the representations of the graphics it can be noted which conditions with the procedures of flight conveying and strand conveying are to be expected. Caused by the high transport speeds the product becomes, in particular at routing-points, flung onto the tubes wall with high vigour and/or. the sugar crystals hit hard against each other. Both procedures cause a relatively strong crystal destruction and a shift of the granule spectrum into the fine field. That is to be tolerated only in the dust spectra and on the way to the dissolve plant. In addition the transport line is, subjected particularly in the tube bends to a strong wear.

Dense stream conveying

During the dense stream conveying higher sugar loading is achieved considerably than with the procedures previously mentioned. The sugar „pours“ through the tubes, only small partial sets of the product are carried with the conveyingair.
The transport speed rests with 6 - ~15 m/sec.
In the final flood up to 40 m/sec.

The dense stream conveying already approaches our demand; with it the wear is reduced by a smaller conveying-velocity-rate. Only a part of the sugar is advanced with the air and suffers to the above-mentioned effects. The main current of the sugar moves liquidly through the pipeline. The crystalls move continuously and cause however attrition through these touches. The part of the destroyed sugar is with this procedure far smaller than at flight and strand conveying, the shine of the granule is damaged by the continuous touch of the granules under each other, however, considerably. During the dense stream conveying is, according to process of the conveying, given a tendency towards clog ups, since the sugar loading is high. The plant must be designed therefore exactly so that clog ups do not arise and/or can be eliminated.

Plug conveying

During the plug conveying the transportation sugar is entered as plugs into the transport line and the plug is kept in a stable way. Behind the product plug an air cushion, which shifts the sugar, forms itself. The sugar loading with this procedure is higher around a multiple, than with the other procedures. Up to 300 kg product are supported per kg air. The transport speed is in the field of 3 m/s.
In the final flood ~ 6 m/s

It is known, that the granule destruction of the sugar increases proportionally with a 3 potency of the conveying-rate. We consider the plug conveying as the ideal pneumatic conveying-system because with small transport speed ~ 3m/s, high sugar loading and slightly transportation air the optimal result is attainable. The sugar crystals move in the plug only marginally, merely the crystals, that are near to the tubes wall are subject to wear. The surface of the plug represents, however, only a product amount to be neglected. Through the structure of the association of sugar , the different grain sizes and the

not controllable distances of the plugs under each other, the danger of clog ups increases. Differenet suppliersr use additional compressed air against that, that is inserted about so-called bypass valves into the pipeline. The bypass solution is relatively extensive, both in the corporate spending and in the maintenance.

On the search for a comparable system, with the good results of the plug conveying, without the disadvantage of the bypass solution, we found the company PTA. The company PTA offers a „plug conveying than pulse conveying“ with all advantages of the described plug conveying, however with a closed tubes of the sender up to the receiver, without bypass valves. The plugs become continuous fluidized, the friction at the inner sides of the trunk pipeline changes into a wear-poor glide, the distances of the plugs under each other remain unchangeable.

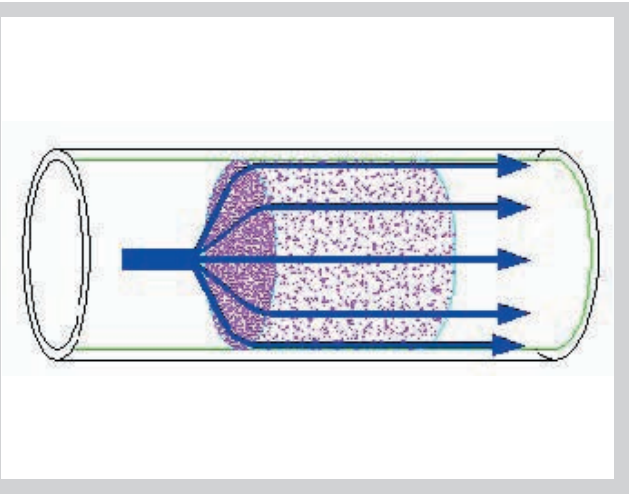


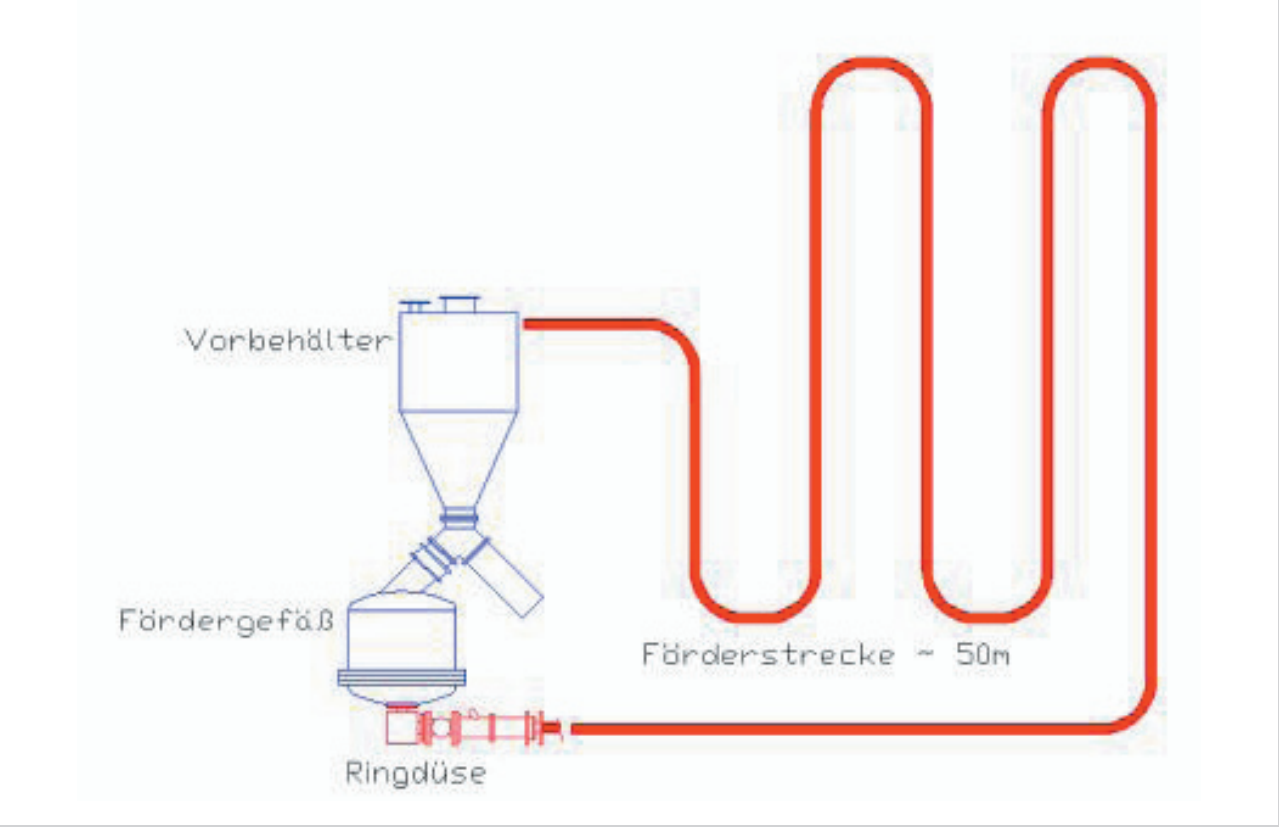
Fig. 2: Plug conveying

With the chair for hydraulics and pneumatics of the university Siegen we have carried out conveying-tests. In order to measure the high quality requirements that are put onto sugar in reproducible form, we started conveying-attempts measured through sugar factories and on the other hand judged by the university of Siegen. On request several sugar factories were ready to provide sugar for the tests. The test sugar was analyzed before the conveying by the labs of the shared sugar factories and subjected after the conveying to a further investigation.

For the test a pipeline-assembly which makes a maximally high wear was agreed upon in order to represent all conveying-tasks in reproducible form.

- A helical hose which maximizes the friction wear due to his wavy structure was employed as a transport line.
- A deflector was employed as a filter in order to represent the impingement and impulse wear. In a normal conveying a deflector is avoided on filters.
- The sectional view of the transport line was chosen with DN50 in a very small way in order to insert the unfavorable influences also here. At larger sectional view the surface contained in friction decreases in relation to the sugar contained in the plug significantly.
- 4 arches to 180 ° and 2 arches to 90 ° were placed; the pipeline conducted ~ 50 m, 2 m upright.
- Bar of conveying-pressure difference 1,2.
- Sugar: 25 kg refined sugar in crystals unsieved.
- In order to remove product residue from preceding conveying-tests, was „rinsed“ with in each case 25 kg refined sugar in crystals.

After the conveying the sugar was analyzed by the shared sugar factories again and examined in part also optically in order to evaluate the surface structure. With all conveying-tests a shift of the granule spectrum into the fine field was found.
The field to 200 µm increased on average around 1 %. The shift showed itself about the entire granule spectrum running to in the field of ~ 900 µm. Here it was to find a decrease that corresponded with the increase in the subordinate field.



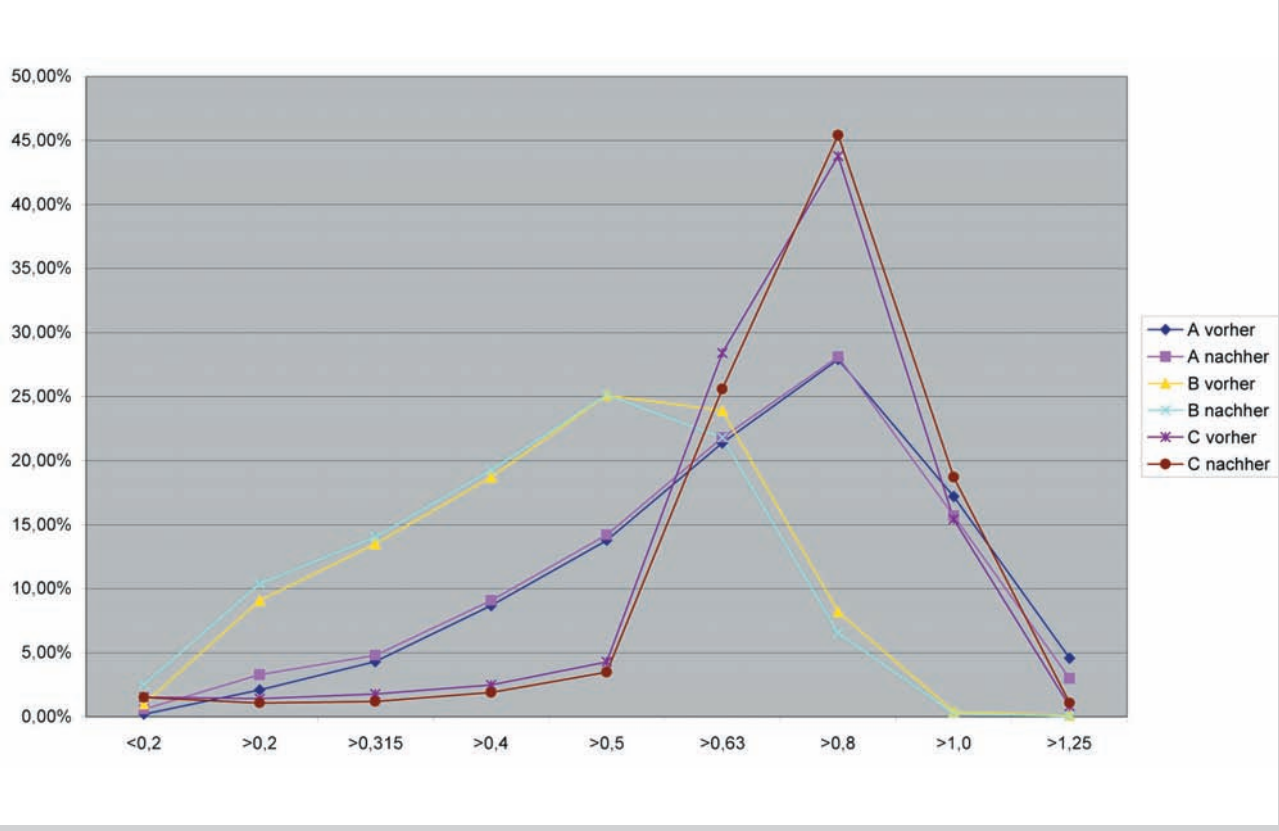


Fig. 3: Test pipeline | Fig. 4: Experimental results

We used the results for the comparison from a test with a conventional plant. During the analysis at the start and end of conveying were taken 10 probes.

We compare the result with the result of the pneumatic conveying-tests.

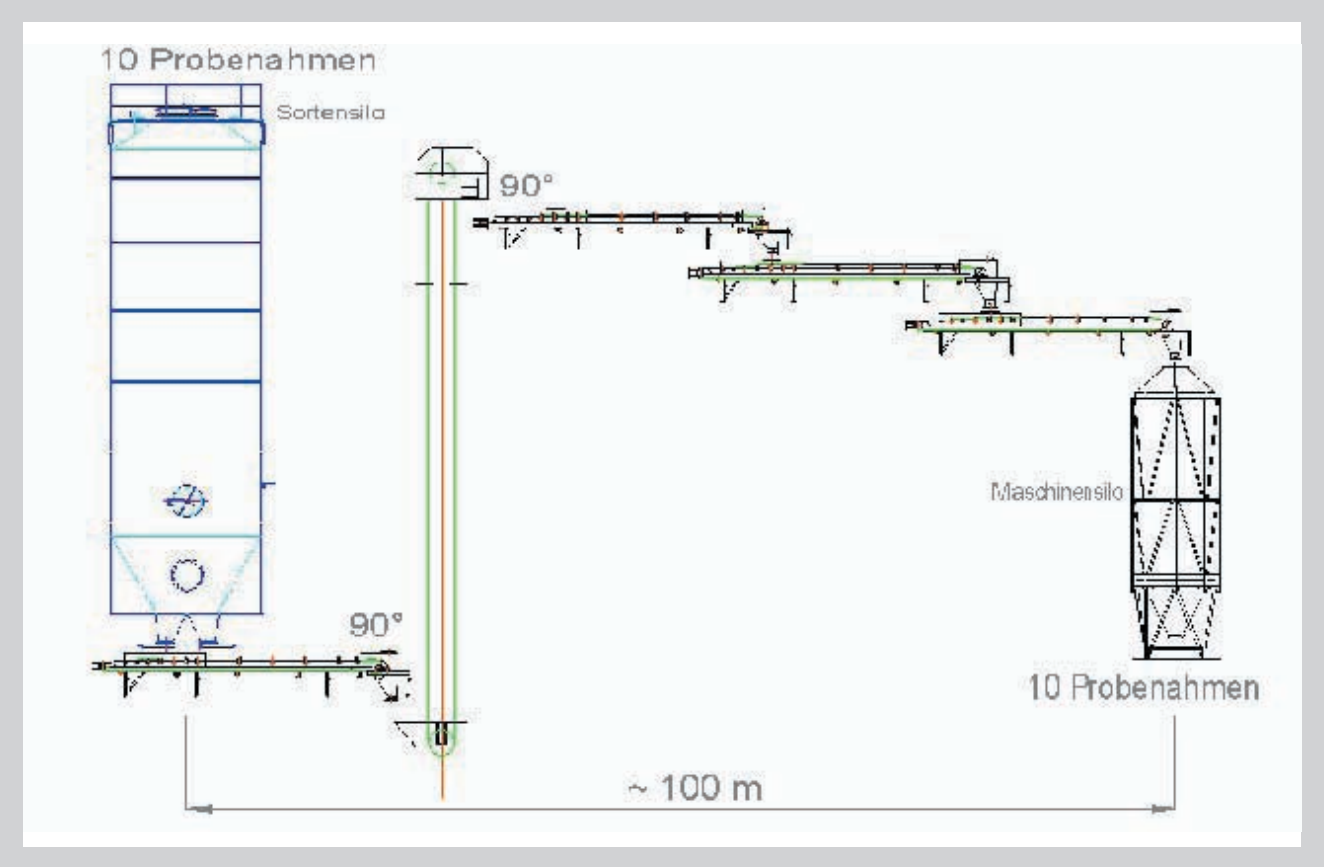


Fig. 4: Conventional Conveying

Grain / Remark	> 1,2	1-1,2	0,8-1	0,6-0,8	0,4-0,6	0,2-0,4	<0,2
Sort silo	2,9	29,11	42,32	20,56	4,56	0,48	0,06
Machine silo	1,82	26,66	44,34	20,17	5,58	1,01	0,43
Difference	- 1,08	- 2,45	+ 2,02	- 0,39	+ 1,02	+ 1,49	+ 0,37
	From the experiences with carried out plants in the sugar industry is included in case of conventional conveying ~1% of the total amount (from the fraction <0,2mm) by the dust collector (5 Gram/m³ raw gas) Therefore increases < 0,2 around 1 % on 1,37 % .						
Result	- 1,08	- 2,45	+ 2,02	- 0,39	+ 1,02	+ 1,49	+ 1,37

Grain / Conveying-kind	> 1,2	1-1,2	0,8-1	0,6-0,8	0,4-0,6	0,2-0,4	<0,2
Conventional	- 1,08	- 2,45	+ 2,02	- 0,39	+ 1,02	+ 1,49	+ 1,37
Pneumatic	- 0,84	- 0,91	- 0,79	- 0,9	+ 0,71	+ 1,77	+ 0,97

The surface finish and the shine is a further important criterion of the product quality. During the investigation of the surface structure no detectable change of the shine resulted. The number of the edges at the crystals increased itself slightly.

Crystal surfaces

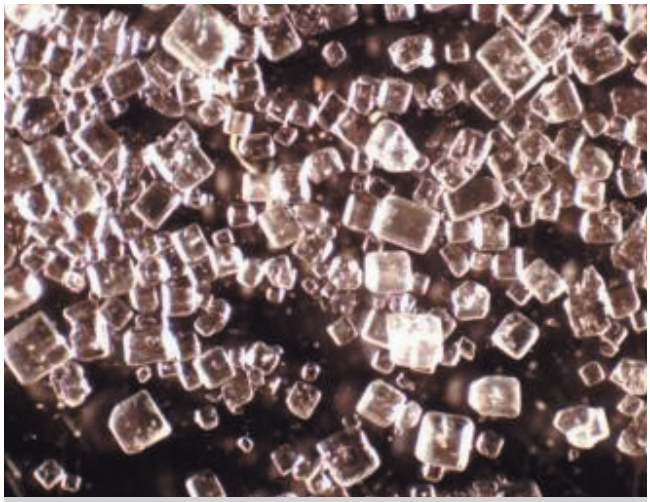


Photo 1: Before conveying

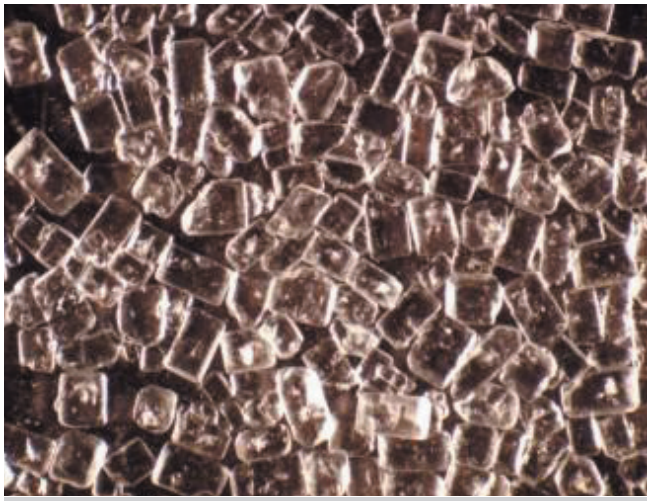


Photo 2: After conveying

In the result the conveying-tests are positively run. The conveying in the pulse procedure stresses the sugar in comparable measure, as a conveying with classical, mechanical conveying-elements. It can be observed that the pulse conveying is a reasonable complement to the today set in conveying in the sugar industry. The commitment must be examined on an individual basis in order to identify, whether classical, mechanical conveying or pneumatic conveying are to be set in. In this case plays both the amount to be advanced, as the transport path process, the costs for conveyingtechnique and buildings, vigour and maintenance have an important role. The described investigations showed that the pulse conveying represents an interesting alternative for the conventional conveying - technique.

We would like at this place to thank Prof. Hofmann (University Siegen) for the intense support.

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