When the Silo and the Hopper Talk to One Another

Trend Report on State-of-the-Art Material Handling

Even where conveying a material from A to B is not trivial: the challenges to materials handling are arising less from the processing of new materials than from digitalization. Standardized interfaces, artificial intelligence, and individually tailored controls are high on the agenda of system manufacturers.

A conveying line from Zeppelin: conveying bulk materials with water represents a product-friendly alternative © Zeppelin

The ***Kunststoffe*** magazine inquired among several system manufacturers: what trends have arisen from the developments of the last few years, and what challenges are facing the handling of materials? This article provides an overview of the current state of affairs.

The last two turbulent years have had diverse affects on the economic picture of manufacturers in the field of materials handling. Zeppelin's new plant engineering business was hit hard by the Corona pandemic of 2020. "It came to project postponements and withdrawals worldwide," was CEO Rochus Hofmann's reply. "Some major projects that had already started were canceled altogether. The China market was the only one to recover quickly after a short decline. Zeppelin Systems utilized the quieter project situation elsewhere to target new markets and advance new technologies. Among these are recycling concepts for large capacity systems as well as systems for manufacturing battery materials. Our strategy began to show success with a very good order intake in the first quarter of 2021. For the entire year 2021, we expect a positive result on a level with or even above the Corona crisis."

AZO also began the year with challenges: "Corona was accompanied by quite a difficult year 2020 in which we were not quite able to achieve our project goals in the plastics area. Since the beginning of the year, however, we have seen a disproportionately high level of incoming orders and sense a clear improvement in the willingness to invest. Thus, we assume the result for 2021 will be positive," said Thomas Stegmeier, Head of Sales in AZO's Poly division.

From "Emergency Stop" to Full Order Books and a Good Outlook

Carsten Koch, Executive Partner at Werner Koch Maschinentechnik GmbH, is pleased with the positive business trend: "As a family owned and managed company,

Rochus Hofmann, Managing Director Zeppelin Systems, prefers hydraulic conveying as raw material quantities rise: "Since it overcomes almost any conveyor path while it enables throughputs far above 100 t/h" © Zeppelin

we have fast and direct access to internal processes and are able to react to market changes or trends. As in early 2020, when the entire economy came to a rather abrupt slowdown: we then reacted just as quickly without having to lay off anyone at all. Suitable measures then have a positive effect on the annual result. Since November 2020 we have seen a very high level of incoming orders and can say that the first half of 2021 has had the most sales in the company's history to date."

The outlook at Wittmann is also good. The statement by Michael Wittmann, Executive Partner of the Wittmann Group, contains superlatives: "In the past twelve months, our group of companies has achieved its highest total number of incoming orders in history on an annual basis. In terms of sales, the first seven months of the financial year 2021 have been extremely successful. Due to the increasingly difficult situation in the availability of raw materials and components and given our current state of knowledge we have to reckon with a somewhat weaker sales performance in the last months of the year. At the moment, however, indications are that the annual financial statement for 2021 will be positive."

Trends that Change the Market

In the last few years, currents have emerged that affect the manufacturers' product portfolios. Among the bulk plastics PP, PE, and PVC, Zeppelin has noticed a trend toward systems with even higher production capacities. They would require adaptations and/or new equipment developments: "In addition to pneumatic conveyors, more and more hydraulic conveyor systems are being used for long conveying paths with high-volume conveyance in the field of large polyolefin systems", according to Rochus Hofmann. "Particularly where conveyor paths are long and the quantity of raw material is growing, hydraulic conveyance is the logical one, since it overcomes almost any conveyor path while it enables throughputs far above 100 t/h." This manufacturer sees a further advantage for hydraulic conveyance in respect to the operating costs: hydraulic systems are said to save between 60 and 80 % on the energy costs of a pneumatic approach.

Wittmann perceives increasing energy efficiency to be an important developmental topic, specifically for peripheral devices that have corresponding load carriers, such as heaters and pumps. To quote Michael Wittmann: "This is why we equip our dryers and central conveyor systems with numerous functions aimed at the best possible use of energy." The manufacturer regards the digitalization and networking of products as another important issue especially in the field of materials handling to injection molding machines or to superior MES/ERP systems is involved. Settings, recipes, parameters and error messages from peripheral devices can be transferred to a central point and be saved, interpreted, or integrated

Fig. 2. Claimed to save up to 64 % on energy: the Luxor A dry air dryer with ETA air-quantity regulation and temperature adjustment © motan-colortronic

Fig. 1. The Card primus 10 compressed air dryer is available as a package solution with FIT control and Vaculet conveyor © Wittmann

accordingly there. What is involved here is bi-directional data exchange – data can also be transmitted back to the peripheral devices.

Product Highlights on Display at the Fakuma 2021

AZO's portfolio serves all branches of the plastics industry with systems for the handling of raw materials. From compounding to PVC manufacturing, from extruder feeding to even including industrial series production by 3D printing. "The latter will be one of our main themes at the Fakuma," Thomas Stegmeier emphasized some weeks ago.

Wittmann supports the operator beginning with the material feed, where barcode readers help ensure that the drying hopper is filled with the right materials, and reaching all the way to the user of the material. For this they have a well-balanced portfolio of dryer and conveyor solutions that begin at a material throughput of 0.16 kg/h and reach materials capacities of more than 1000 kg/h. A large selection of dosing solutions is included in the portfolio. At this year's Fakuma, Wittmann presented two further units in its existing primus series. The Card primus 10 and 20 was added to the well-known primus models Drymax and Aton (**Fig. 1**). "This expansion will allow us to »

offer our customers optimum solutions in both the low-quantity drying range and in the range of post-drying directly at the machine intake," said Michael Wittmann.

The booth of motan-colortronic GmbH, whose know-how covers every aspect of materials handling and logistics management, featured two new dosing and mixing units, the Minicolor SG-V and the Gravicolor 110 gravimetric dosing and mixing unit. Another novelty in their program is the Luxor SG 50 small dryer (**Fig. 2**). "Moreover, we will exhibit our revised Metro HES line of single conveyors," Marketing Head Rüdiger Kissinger added.

The product portfolio from Koch contained the entire peripheral technology in the fields of mixing, dosing, conveying, drying, and storage of plastics granulates. The following products were focused on at the Fakuma:

Michael Wittmann, Executive Partner at the Wittmann Group: "The proportion of skilled workers in a production environment is steadily decreasing, so peripheral devices have to work more intelligently." © Wittmann

Rüdiger Kissinger, Head of Marketing at motan-colortronic: "Our program includes special conveyor systems for regrinds and flakes. We also have solutions for drying R-PET which isn't always easy." © motan-colortronic

- The EKO-N type dry-air dryer they claim can save up to 50% energy in combination with their patented eco-energy system control.
- The KKT mobile granulate dryer with new touchscreen control: the color displays are larger than previously and offer the advantage of uncomplicated and complete integration into the company's own special production processes.
- New controls for the Graviko dosing and mixing units (**Fig. 3**) that calculate the process parameters fully automatically and are known for uniform dosing.

Zeppelin System Solution's portfolio includes products and complete systems in the areas of conveying, weighing and dosing, cutting and separating, storing and unloading, mixing and compounding. This company, which did not exhibit at the Fakuma, calls the takeover of MTI Mischtechnik its this year's highlight. Zeppelin's portfolio of mixing technology has thereby been expanded to include heating, cooling, and universal mixers for plastics compounding and applications in the chemical industry.

New Raw Materials, Electro-Mobility, and Individual System Control

What challenges are faced by materials handling? The dominant ones are the hyped topics climate control, circular economy, and digitalization that will be treated later in greater detail.

Thomas Stegmeier of AZO describes the hurdles in the processing of new materials: "Conveying a material from A to B sounds trivial, but that is rarely the case in reality. The production of recyclable or even naturally degradable biopolymers requires much more sophisticated raw materials. Renewable natural fibers weigh little, but are hard to store, and/or difficult to manage without a discharge aid. Recycling products from foil snippets or other materials behave differently from classic granulate. That is why everything depends upon the competence of the system manufacturer in raw materials to optimally design the system according to the needs of the raw material. Moreover, even new technologies, such as additive manufacturing, present almost every system with new challenges."

Motan-colortronic's product portfolio has also been adapted to new materials: "Recyclates of course play a role in our field," states Rüdiger Kissinger. "Our program includes special conveyor systems for regrinds and flakes. We also have solutions for drying R-PET which isn't always easy."

For Zeppelin, the requirements in the field of battery technology for e-mobility are playing an ever larger role. New system concepts are required for the compounding of battery materials. Also important, besides high throughput and precision dosing, are the security requirements regarding hazardous substances and explosion protection.

Wittmann emphasizes the constantly rising demands on the central materials supply which add to plant complexity. Michael Wittmann: "Our M8-IPC network control introduced freely programmable modules with which even the most individual inquiries can be modularly and flexibly realized. Here's an example: in the event a materials source runs empty, it should automatically switch over to another source. These new possibilities for specifying logical operations in a simple way enable the user to program sequences that are perfectly tuned to the particular process."

Standardized Interfaces, Artificial Intelligence and Sensor Technology

What is happening in the field of digitalization? Carsten Koch remarks: "The trend is moving clearly toward digitalization. A large role is being played here by intelligent and individual production controls as well as the integration of digital networks and mobile applications. Specifically, the Koch team is developing their control systems further. "At the moment, the SPS-based controls are undergoing new development based on the S7–1500 control. In the course of this, all communication will be switched from Profibus to Profinet. The controls will receive new functions and receive an OPC UA interface in order to be able to com-

Fig. 3. The Graviko gravimetric dosing and mixing units from Koch have new controls that calculate process parameters fully automatically © Koch

municate with superior systems. Our KKT mobile dryer, for example, is getting a new control, making it OPC UA capable just like the Graviko gravimetric dosing system and previously the MCT and SLT volumetric dosing controls," said Koch.

"The development of an OPC UA interface made motan-colortronic one of the first suppliers whose peripheral equipment could communicate with processing machines manufacturer and platform independent," said Rüdiger Kissinger. "The consistently modular structure of the control components in conjunction with a periphery or communication network also enables all the manufacturer's devices to network consistently and transparently." Some of motan-colortronic's digital highlights:

- Central and mobile monitoring of all systems connected to motan Controlnet.
- Remote Maintenance Box: the system contains a comprehensive software package for troubleshooting and analysis of system components as well as the monitoring and documentation of system states.
- "Linknet" process visualization that protocols all process relevant data from the delivery of materials into the silo to the processing machine.

Wittmann peripheral devices make an OPC UA interface available. In principle, the OPC UA open industrial standard enables communication between any and all devices.

Compatibility with any other manufacturer is given this way. "Generally speaking, it is important that the operation of devices for handling materials is self-explanatory and intuitive, and continues to develop in this direction," said Michael Wittmann. "To the same degree, the components have to make many decisions on their own and have numerous sensors that reliably enter and analyze the current operational state and surrounding conditions. The proportion of skilled workers in a production environment is steadily decreasing, so peripheral devices have to work more intelligently."

The greatest potential seen by AZO's Head of R&D, Steffen Günter, lies in self-learning and self-adjusting raw materials automation: "It lowers energy consumption, for instance, to an optimum level. With our AZO Prometheus, AZO is operating such an AI-based system for optimizing product safety, plant protection, and energy efficiency. This system is currently being developed and tested with various raw materials under real conditions in several use-cases." Smaller system components have also been developed further with respect to their usability and energy efficiency together with well-known manufacturers. For example, Festo and AZO have developed an independently "thinking" docking station for loading containers. All of this aims at facing future challenges and trends in a solution-oriented manner.

Zeppelin's Smart Mix Digital offers an integrated software solution for batch processing. This software provides a user with a common recipe and report interface that is independent of the location of his mixing system.

The system makes it possible to create recipes, plan production, and set various target values. Data are called from the Scada software and downloaded to the SPS level to run batch production. »

The greatest potential sees AZO's Head of R&D, Steffen Günter, in self-learning and self-adjusting raw materials automation: "With our Prometheus, we are operating such an AI-based system for optimizing product safety, plant protection, and energy efficiency." © AZO

Carsten Koch, Executive Partner at Koch Maschinentechnik GmbH: "Frequency regulated motors have been our standard for a long time. Energy is used only when it is really needed. This saves up to 50% on energy." © Koch

Five Questions to ...

... Prof. Daniel Schwendemann, since 2010 Head of the Department of Materials Development, Compounding, and Extrusion at the Institute of Materials Engineering and Plastics Processing (IWK) at the Eastern Switzerland University of Applied Sciences (OST) in Rapperswil-Jona, Switzerland.

On the one hand, manufacturers are demanding increased production capacities – on the other, energy savings. Isn't this circular logic?
The one doesn't necessarily exclude the other. Higher throughputs can be used economically and energy efficiently by such conveying methods as dense phase conveying or hydraulic granulate conveying. Moreover, coupling to a cogeneration unit makes sense in order to utilize excess waste heat for granulate drying.

Several factors determine energy consumption. When will energy efficiency become truly measurable and comparable?
Not until the infrastructure, that is, sensors and interfaces for collecting the data are present in the systems will it be possible to record energy consumption detail. Preliminary concepts are appearing now, but it will take years before we have either renewed or expanded and networked the entire production environment.

What role does the use of recyclates play in material handling?
The use of recyclates, especially regarding their shapes, is presenting great challenges to conveying and drying. An enormous drop in pourability is often accompanied by increased dust formation and massive abrasion of the conveyed material, as well as on the piping. It is often a rough path from general feasibility in the lab or testing plant to a trouble-free sequence in 3-shift operation. A standardized measurement of conveyor characteristics would be important for the systems to be designed and operated well.

What are the challenges presented by artificial intelligence?
To begin with, AI offers many improvements. For instance, these systems can already tell the operator precisely which materials are running low, how well different charges are being processed, where he has to reckon with problems, and what measures have to be taken. Nowadays, the dryer area works with fixed times and temperatures, but these are mainly oriented to the worst charges. With adapted sensors and intelligence, these processes could be run with notably lower energy input.

Which "nut" still needs cracking?
The system manufacturers are exhibiting intelligent solutions. However, networking the individual system components will be a challenge. Every manufacturer naturally wants to protect his know-how. Without standardized interfaces and data exchange, too many areas are still overlooked, and an enormous potential for both commercial and energetic savings goes unused. Intelligent overall systems are required, not island solutions.

Prof. Daniel Schwendemann

"The goal has to be an intelligent over all system – not an island solution."

Smart Mix Digital takes the process data from Scada and stores them in its databank in order to create all reports relating to production, materials consumption, stock, traceability, batch mixing curves, downtime analysis, etc.

Catching up on Sustainability

The field of materials handling has to do a lot of catching up before it attains sustainability. The energy efficiency of its systems can only be measured to a limited extent, since the energy consumption of a drying and conveying system is made up of product-dependent basic consumption and application-dependent heating and/or conveying energy. The energy efficiency of the different systems can be compared via the basic consumption which has to be based on a standardized amount in order to make meaningful comparisons.

Michael Wittmann: "When we went on the market with a standard for comparing the energy consumption of granulate dryers back in 2008, we were many years ahead of the industry's needs. The result of our efforts regarding manufacturer independent energy comparison is the "Energy Sticker" on our dryers. The reference value is the energy requirement normalized to 1000 kg of air and is well suited for comparisons." An objective presentation of energy efficiency is difficult nonetheless: "Innumerable ambient parameters and application-depended factors affect the result which in practice would not allow comparability of values even if the application and interpretation of a test arrangement were only minimally different. The verifiability and traceability of detected values have to be secured simply and easily. Otherwise, any communicated values would lose their credibility very quickly and be regarded for their marketing value only," Wittmann emphasizes.

New Energy Concepts: Use Waste Heat, Pause the Motor

Koch's customers can opt to record the energy efficiency of individual system components such as dryers or vacuum pumps. This is done in a databank in process visualization and can be read out and saved as required.

For Carsten Koch, energy efficiency plays a leading role in the area of drying technology: "In the field of drying equipment and vacuum generation, frequency regulated motors have been our standard for a long time. Energy is used only when it is really needed. This saves up to 50% on energy. We have realized an interesting, also energy saving solution for several customers who have installed cogeneration units for energy generation. One of the heat exchangers supplied by us is used to take excess energy in the form of warm water or air from the cogeneration unit to our drying units. That is energy that the customer has generated and thus is available for free. Each drying container then receives prewarmed air from the cogenerating unit, and the container heater simply adds a couple of degrees up to the desired drying temperature, which saves energy costs. We also save energy with our KEM dye dosing unit. Together with the introduction of a touch panel, we installed a step motor in the KEM Touch units. The speed-controlled motor saves 70% on energy compared to the earlier shaded pole motor, and the dye is dosed more precisely."

Rüdiger Kissinger describes how motan-colortronic is implementing the energy efficiency issue right now: "The energy efficiency of our systems can be measured currently at the electricity meter. Intelligent control and regulation systems reduce the drying power achieved to the level momentarily required. That way there are no excess power losses. We also apply energy recovery systems.

What Will Be Important in the Future

Zeppelin is also working on future concepts for conveying energy efficient materials. Above all, product purity is important for this in order to prevent undesired mixing. Moreover, traceability is important throughout the production process.

"The definition of standards can rightly be called a hard nut that has to be cracked," says Michael Wittmann. "Here it is mainly a matter of unifying communication protocols to get manufacture-independent and comprehensive exchange of data between the injection molding machine and peripheral device, and also from peripheral devices and central system to an MES/ERP system. Also very promising are Euromap's initiatives that have laid the right groundwork with E82.x on an OPC UA basis."

For motan-colortronic, energy is the dominant issue: "The energy efficiency topic already plays a large role, but is coming closer and closer into focus. This also includes minimizing the use of materials by avoiding the losses of material during material handling – "zero loss" is the keyword here," Rüdiger Kissinger notes.

A Peek into the Crystal Ball

When the statements from the companies we asked are combined, the future factory they wish for looks like this from the viewpoint of material handling:

The circular economy will strengthen and together with it the returning of material flows to production. Regrind will gain in significance and be regarded as a valuable material.

Conveyors will cope with new materials such as natural fibers or recycled foil snippets as well as with traditional granulates. Dusty materials or materials of different grain sizes will be no problem for processing. Mixing will not occur – raw materials will remain sorted. Thanks to standardized interfaces, a system operator can put together the individual modules of his system technology at will, and compatibility with every manufacturer is given.

Few people will be seen in the production hall then. Robots, automated systems, and artificial intelligence will reduce the need for manual intervention, since the systems regulate themselves. The factory desired will run at top productivity and energy efficient, since all system components and the particular application are optimally matched with each other.

Conclusion

As of today, we are probably not a long way from this future scenario. To realize it, it will be decisive for all partners involved in the value chain to work together toward this goal. ■

Susanne Schröder, editor

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This article was written with the assistance of **Prof. Daniel Schwendemann**, since 2010 Head of the Department of Materials Development, Compounding, and Extrusion at the Institute of Materials Engineering and Plastics Processing (IWK) at the Eastern Switzerland University of Applied Sciences (OST) in Rapperswil-Jona, Switzerland.

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