Turnkey Compounding Plants from a Single Source

Turnkey system for compounding thermoplastic elastomers (figures: Coperion)

Plant Management. The journey from order placement to hand over of a finished compounding plant presents complex challenges for equipment providers. Aside from design, to delivery through to commissioning, there is a great deal more to consider than simply the technology itself.

KNUT HILGERT

A rising number of compounders are focusing on the production and sale of their products. They therefore increasingly expect the equipment supplier to deliver and install turnkey production systems as overall systems **(Fig. 1)**. Systematic design and implementation by the supplier takes a large number of project planning and coordination tasks off the hands of processors.

The conceptual design defines the economy as well as the operational safety and reliability of an overall system. The right systematic approach to the entire planning workflow **(Table 1)** and a partner with the necessary know-how are essential prerequisites for drawing up an optimum overall concept. The plant design is based on the demands and requirements of the customer with regard to the applied raw materials, process throughput, range of products and recipes, packing form of raw materials and finished products, production logistics, flow of goods, warehouse facilities and so on. Depending on the scope of the project and its requirements, each project requires an interdisciplinary and multi-site team that draws up a corresponding set of specifications in collaboration with the customer's experts.

These specifications then serve as a basis for the team to plan the process section of the plant as the first step. The main aspects that require alignment during plant design include the throughput of the overall system, the size of the compounding systems and, if applicable, distribution among several lines as well →

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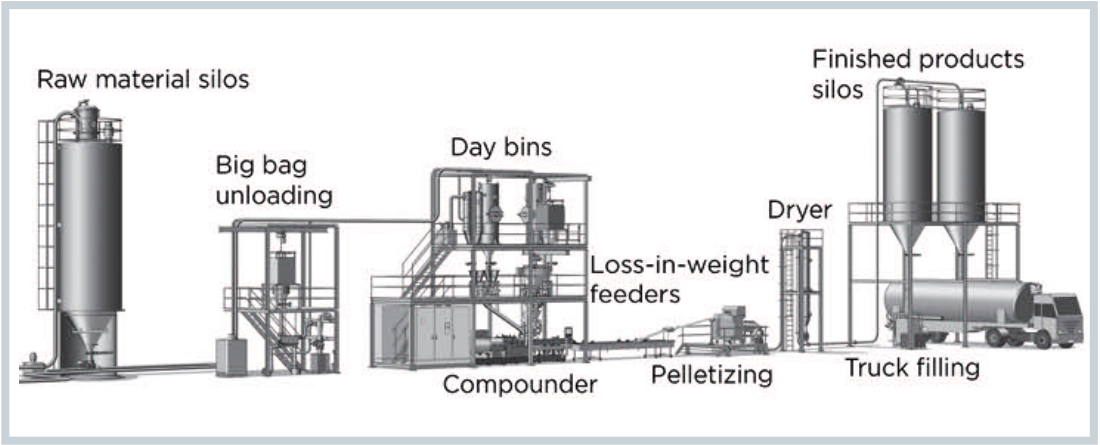

Fig. 1. Elements of a turnkey system for compounding technical plastics

Input	Conceptual work	Plant concept
Client's specification / material requisition or duty spec or Results of plant concept discussions with client	**Compounding & extrusion** Technical solution extruder, granulation system, etc. **Materials Handling** Technical solution air/gas supply, silos, rotary valves, etc. **LSTK scope** Civil, steel structures, MCC, cabling, lighting, package units (non conveying), sewer, roads, utilities **Controls & instrumentation** DCS, PLC, vizualization, controls package units, etc. **Site services** Time schedule, site equipment, cranes, supervision, etc. **Contracts management** "Commercial Part", client and subcontractors	**Scope description** **Arrangement concept** (3-D model or 2-D drawings) **Time schedule** **Contractual concept** **Project execution strategy**

Table 1. Planning schedule for a turnkey system showing the planning tasks

as the production batch size, the supplied form of both the raw materials and additives as well as the finished products and finally the requirements to be met by the system components with regard to their cleanability.

If the manufacturer produces all the main compounding system equipment at its own facilities (see box), the project manager can access the know-how for the technical process of the entire equipment chain down to the last detail. He does not have to rely on the expertise of external consultants or sub-suppliers. The result is a seamless process design that culminates in an optimum process concept for the customer with only a few iteration loops. The output of this phase of the workflow is a consistent process flow chart of the plant and the specification data of the process equipment including the necessary auxiliaries for operation and definition of the process emissions.

Aligning Objectives

On this basis the project team designs the equipment for the supply and distribution of auxiliaries such as electrical power, compressed air, nitrogen, cooling water etc. as well as the required equipment for emissions treatment (mainly vented gas and air and process waste water) in close collaboration with the customer. Compliance with local regulations and the incorporation of existing devices are also important aspects.

This data and information is used to design the layout of the plant. A number of requirements and aspects must be incorporated in the most suitable layout concept. This includes:

- Storage area for raw materials and additives as well as an economical flow of raw materials and finished product,
- space requirements for process equipment and secondary systems, for pipes and cable runs as well as building facilities (sprinklers, ventilation channels, drainage etc.),
- system operability, work safety and escape routes, accessibility for maintenance, repair and testing,
- material and personnel traffic in the production buildings as well as the path network including gates and doors, parking spaces etc.,
- installation requirements, e. g. delivering large components, crane locations, areas for pre-fabrication of silos and pipes etc.

An aspect that is often not sufficiently taken into account during layout design is the alignment of the plant's layout with the building's specifics and the building facilities. If systems have to be integrated into existing buildings, expertise and interdisciplinary thinking is required to keep, by means of a well-considered erection concept, the scope and cost of building intervention as low as possible. For example, heavy equipment or large silos are often planned on intermediate building levels. These then have to be statically modified to ensure the building's structural integrity, although this extra work would not have been necessary with a slightly modified concept.

A number of discipline engineers support the project manager during design work. They supply the necessary competence for all trades that are required for a plant alongside the process section. These include foundations and earthworks, building, building facilities and infrastructure, the steel structure for support structures, building levels and maintenance platforms as well as the electrotechnical equipment including cable trains and pipe networks for auxiliary energy. Other secondary systems and "package units", i. e. independently functioning system components with their own control units and signal communication to the process control system as well as installation including the installation strategy, installation sequences and auxiliaries are also required.

This approach permits the development of an overall plant concept that combines all demands to be met by the process, building, infrastructure, auxiliary supplies, installation and commissioning to create the most suitable solution.

Coperion GmbH in Stuttgart, Germany, relies on its own in-house personnel instead of external consultants, as iteration loops can then be avoided as far as possible when finding solutions.

Organizational Concept for Consistent Processing

End-to-end organization that covers all project phases from design, procurement and transport through to execution of all project phases is essential for the success of the project. For this reason a sound and clear organizational concept taking inter alia the following aspects into account is also an important part of project planning:

- Number of project team members, required expertise, possible incorporation of network companies and subcontractors, for example for constructional work,
- national aspects such as visa, customs duties, local tax legislation, labour regulations and official approvals,
- goods transport and imports,
- necessary construction site equipment and auxiliaries, installation material lo-

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gistics, construction site security, health and safety, environmental regulations etc.,
- commissioning, required auxiliaries, start-up material supply and disposal,
- guarantee runs, requirements and peripheral conditions.

The results of this design work culminate in a detailed project schedule that shows all implementation phases and the requirements for the worksteps and their interactions. Organizational charts for the local company and construction site teams as well as verbal descriptions clearly demonstrate other aspects of project organization. The project manager is supported by in-house experts for customs and tax law, plant planning, logistics, construction site management and commissioning planning alongside contract experts during this comprehensive scheduling that forms the basis for avoiding potential risks during project execution as far as possible. The network companies contribute to all respective national aspects of project organization.

Contract as the Basis for Cooperation of All Partners

The contract between the processor and the contractor governs the responsibilities of the partners during project implementation on the basis of the technical and organizational concept. Inclusion of a contract manager accompanying the project through all phases is an important pre-requisite for drawing up the contract concept with the customer. The more effectively the main requirements of the technical and especially the organizational concept as well as the specific circumstances of the erection site are taken into account, the greater is the chance to achieve a smooth contractual handling during the implementation phase.

The contract manager develops this concept together with the project manager and in close collaboration with the customer at the beginning and during the project's planning phase and accompanies the project team in the implementation phase through to successful handover of the system.

The network companies are as well involved in contract elaboration and implementation, their knowledge of local regulations and tax legislation is indispensable during the design and contract award stages as well as during subsequent implementation of the plant.

The Schedule as a Control Tool for Project Handling

The schedule is the most important tool for the project manager. This schedule forms the basis for the identification of the critical path, i. e. the chain of activities, which have to be completed in a certain sequence and which determine the lead time of the project. For turnkey system in general the following stations along this path are:
- Layout design with all load specifications for construction planning,
- civil works planning as well as the necessary liaisons with local authorities,
- the production times of the "long lead items" (generally extruders and pelletizing devices),
- transport times and time requirements for customs clearance,
- completion of buildings, initially for delivery of the large components, afterwards installation of the small components, pipes, cable runs and cables. →

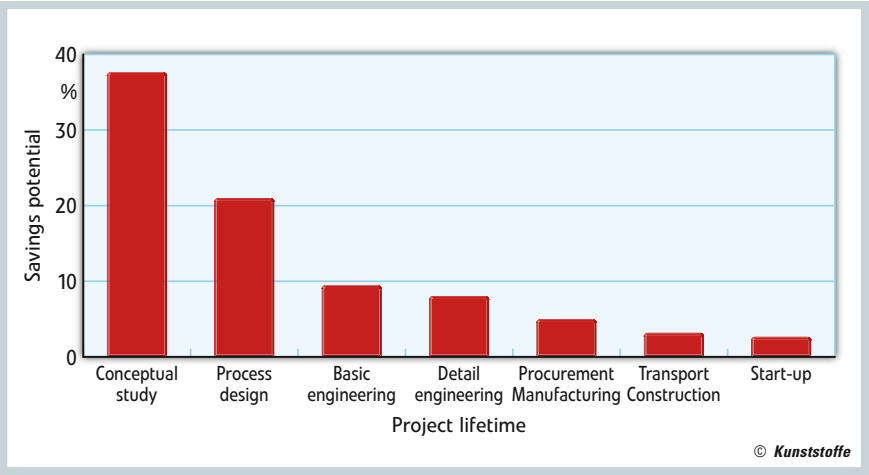

Fig. 2. Possible savings potential during project handling

All other project activities are also covered and determined so that a finished, elaborated and detailed schedule for all required work can contain from 2,000 to 4,000 activities. Local conditions play an important role during scheduling and their effect on the sequence has to be incorporated accordingly. For example customs handling aspects (documentation and duration), the climatic conditions during concreting work, the time required for official approvals etc. must be investigated. These investigations are already carried out in the project planning stage, i. e. before conclusion of contract, and are included in the schedule.

This consistent schedule, to be structured as clearly as possible, accompanies the overall system project through all implementation phases. Clear assignment of responsibility forms the basis for correct planning of personnel resources and coordination of all personnel and departments involved by the project manager. Such a schedule, effectively converted by the project manager, serves as a basis for preventing risks during project execution as far as possible.

Delivery, Logistics, Installation and Commissioning

The plant design elaborated during the project planning phase is implemented as a coherent execution schedule during basic and detailed engineering. It is also decisive that the project manager has a comprehensive understanding of all disciplines and work beyond the process section of the plant. Only then he is able to guide the people involved in the project, the specialist departments and sub-contractors or consortium partners, e. g. for buildings, through this phase efficiently and without delays.

The normal standard documents and information such as pipe and instrumentation diagrams, equipment, consumer and instrument lists, detailed design on 3-D models, elaboration of the tender documents for buying in and services etc. are not discussed any further at this point. In addition to this documentation and information, many more aspects are handled for a "single source overall system", such as

- early and precise information as the basis for civil works design,
- detailed determination of process emissions,
- inclusion of sound insulation in technical planning,
- the basic documents for public authority approvals, transport approvals and customs handling,
- transport planning, i. e. partial deliveries coordinated with the installation sequence.

Compilation, procurement and coordination of these secondary documents and this information require a great deal of coordination work which is often underestimated and requires many years of experience and local knowledge in the respective countries.

In-time Procurement, Production and Quality Assurance

The project team is supported in schedule monitoring by the same experienced project controlling personnel who drew up the overall schedule together with the project manager. Discipline engineers assess the progress of manufacturing and construction work additionally. Schedule monitoring also includes progress reports from suppliers, schedule monitoring by phone as well as expert visits to the site. Schedule monitoring for parts procured in the country of installation, such as steel structures, pipes and hoppers is supported by the Coperion network companies in close collaboration with schedule monitoring experts.

Inspection and test plans available for all assemblies and trades serve as standard documents for quality assurance. These documents are modified depending on the project during basic and detail engineering. Dates for intermediate and final inspection are normally agreed with suppliers upon award of contract but always before manufacturing is begun, and then integrated into the overall schedule.

Logistics and Goods Transport

The logistics department collaborates with construction site management un-

! Turnkey Systems

From Planning to Production from One Source

The turnkey systems discussed in this article are mainly used for the production of reinforced compounds of technical plastics as well as polyolefins. A turnkey system can comprise several compounding lines with a throughput ranging from 300 to 6,000 kg/h and more. With its network companies Coperion is the only single source service provider for the design and installation of such overall systems.

Material feeding and conveying:
Coperion S. r. l., Ferrara, Italy and Coperion GmbH, Materials Handling, Weingarten, Germany;
Dosing:
Coperion K-Tron GmbH, Niederlenz, Switzerland
and Coperion K-Tron Pitman, NJ, USA;
Compounding extruders:
Coperion GmbH, Compounding & Extrusion, Stuttgart, Germany;
Pelletizing:
Coperion Pelletizing Technology GmbH, Offenbach, Germany;
Pellet classification:
Rotex Global, LLC, Cincinnati, OH, USA;
Bagging and palletizing:
Coperion S. r. l., Ferrara, Italy.

This network is supplemented by almost 30 sales and service organizations around the world that contribute their knowledge of the local conditions and provide support for all local project activities.

der the supervision of the project manager to draw up the details of the delivery sequence for process and secondary equipment. The aim is optimum coordination with the installation sequence. Effectively calculated buffers prevent unexpected delays potentially leading to downtime on the construction site, especially in the case of sea transport.

In addition to scheduling, the packaging type (crates, one-way or rented containers etc.) and the storage strategy have to be aligned with the installation sequence. This leads to a smooth workflow during unloading, incoming goods inspection and storage or immediate site delivery and prevents unnecessary goods transport. Effectively coordinated shipping documentation with consistent materials lists aids incoming goods inspection and economical material management at the construction site.

From Construction Site Management to Guarantee Run

The construction site phase starts with preparation of the construction site and the spaces for material storage and, for example, pre-fabrication of pipes and silos. As a rule, the necessary works are carried out by the same local partner who does the construction work. During the basic civil construction work, the site management team coordinates work with the construction partner and monitors progress at the site to ensure compliance with the planned date for starting installation.

The maximum possible, but also reasonable overlap of the start of installation and final completion of the building and its infrastructure permits cost-efficient and timely execution of all site activities. It is normally most effective to divide the construction site into sections to ensure this overlap and to complete construction and installation work as quickly as possible.
During installation and commissioning of the plant, in-depth training courses for the customer's personnel, induction courses at one of the company's sites and then final training courses on the new system are necessary.

After commissioning of the entire factory and a trial run with extensive functional tests and a guarantee run, the plant is handed over to the customer for subsequent operation. It is important that the equipment supplier is always available to answer all questions and solve any problems during its practical operation. With all such projects the savings potential when planning is started is much greater than during later planning phases or even during implementation **(Fig. 2)**.

User Benefits of Single Source Turnkey Systems

The advantages for customers who are supplied with all goods and services for a turnkey compounding system from a single source are obvious. Thorough planning from the outset – with the inclusion of all trades – results in an inexpensive turnkey system. The interfaces within the overall system are shifted from the user to the supplier, who has specific specialist know-how. All technical, organizational and schedule-related aspects of the project are coordinated so that the project's processing time can be cut considerably. ■

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