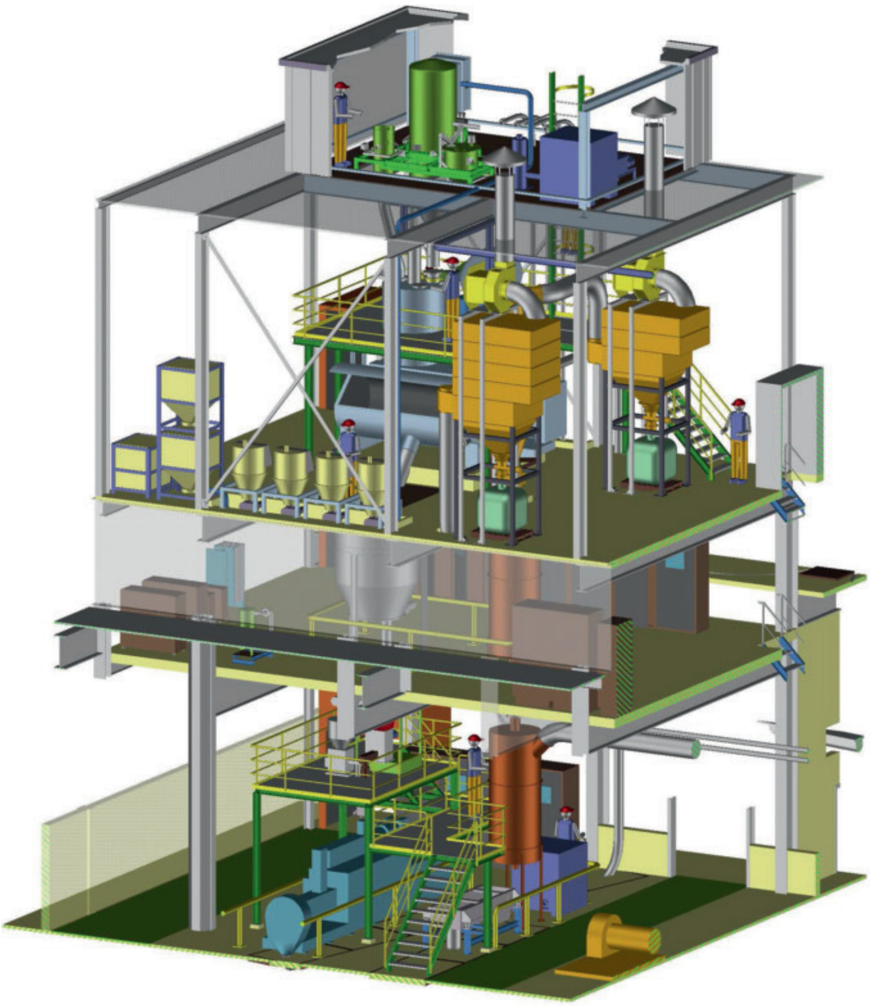
**Plant Concept for PVC Cable Compound.** It took about a year for the world's biggest compounding and pelletizing line for PVC cable compound to be built in Emmen in the Netherlands. The system is over four stories high and achieves a throughput of up to 5,000 kg/h. The adapted kneading screw geometry allows eight formulations to be produced in rapid succession.



It is not easy to integrate the plant concept for mixing and compounding PVC cable compound into an existing production facility. Large components, such as the heater-cooler mixer, must thus be positioned according to process-engineering and constructional criteria (figure: Draka)

# The First of Its Kind

FRANK KNITTEL

Buss AG, Pratteln, Switzerland, has delivered the world's largest polyvinyl chloride (PVC) cable compound line from a single source. The scope of delivery extends from the heater-cooler premixer for the PVC, though the quantec high-performance compounding system, to transfer of the cooled pellets to the bagging station. The package also included the planning of the entire plant, including fully integrated control.

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## Starting Point: Specification

Kabelbedrijven Draka Nederland B.V., Emmen, Netherlands, has operated a Buss plant for compounding halogen-free flame-resistant (HFFR) cable compounds for some time. Its excellent experience with the system led it to request a much larger and more effective plant for PVC cable compound **(Fig. 1)**. The guiding principle was a detailed specification from Draka, which included the following core requirements:

- It must be possible to produce all the eight required formulations with a single screw geometry – without modifying the mixing and kneading screw.

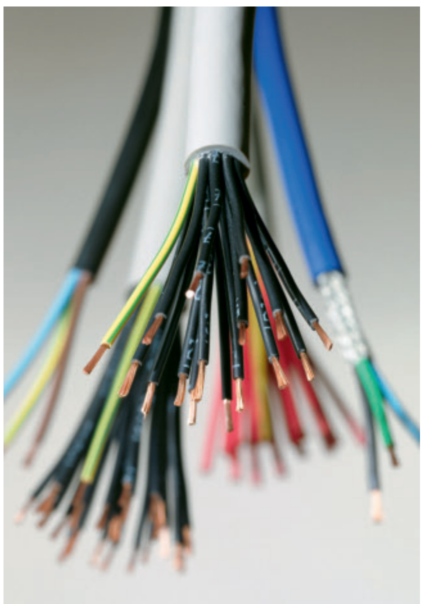

**Fig. 1. For reliable and long-life cable insulation, pellets of high-quality polyvinyl chloride are now used** (photo: Buss)

- The system must operate economically even with small batch sizes. This requires very short product change-over times.
- After a product change, only small amounts of residues must be produced.
- To allow the system to be integrated into the existing production site, it must take account of the structural conditions, such as the hall height and existing intermediate floors.

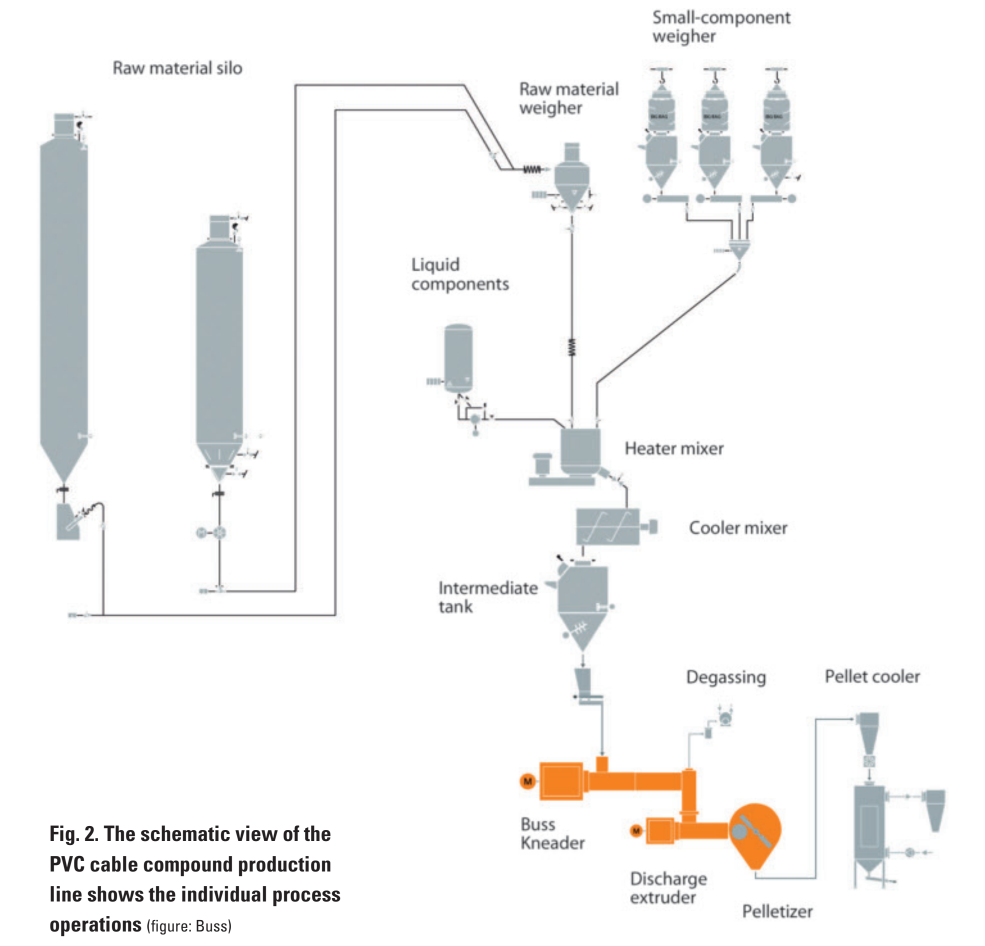


**Fig. 2. The schematic view of the PVC cable compound production line shows the individual process operations** (figure: Buss)

- The instrumentation and control technology must be planned to link the plant components via a control chain.
- This also requires coordinating the control systems for mixing (dry-blend production in discontinuous batch operation) and the compounding line (continuous operation). It ensures reliable compounding. It is also essential that only very small amounts of residue are produced at the start up and end of a batch, and on formulation changes.
- Last but not least, the entire system must be constructed so that it fulfils future guidelines for fine-dust emissions.

To keep sight of and incorporate the large number of requirements, it was advantageous to place the planning and execution of the plant in the hands of a single coordinator. The subdivision into several sub-deliveries would have generated a large number of interfaces and coordination tasks. That would have meant considerable extra work for the customer. The venture into a new dimension in throughput has an effect on all plant components. Here, too, it is helpful to have a single person in charge, with responsibility for all questions and agreements. The jointly worked-out plan for the entire system met all the requirements in the specification **(Fig. 2)**.

## Planning the Entire System

The heater-cooler premixer combination is the first component in this compounding line, both structurally and in terms of process workflow. A bulk feeder weighs and meters all the components automatically and supplies them to the mixer. The exterior and interior silos had to be newly purchased to meet the stricter requirements. Some silos or tanks – for example those used for plasticizer – had to be adapted, e.g. expanded or temperature-controlled.

One of the more difficult tasks was to integrate the entire compounding system into the existing four-story production shop **(Title photo)**. Large components, such as the heater-cooler premixer or the 4 m$^3$ intermediate silo, had to take into account the story heights. The feed for the intermediate silo, for example, therefore had to be accommodated in the hall ceiling. Good accessibility of all the plant components for subsequent cleaning and maintenance played an important role.

Another challenge was the project planning of time-saving assembly with minimum impairment of the running compounding operation. It was complicated not only to transport the new large components into the building, but also to dismantle and remove the existing large tanks that were no longer required. The last step comprised planning, pellet cooling and the subsequent filling of the final PVC compound into flexible intermediate bulk containers (FIBCs).

## Integrated Control

A central component of the plant was a clearly laid-out and easy-to-operate control system. Upstream and downstream components of the mixing and compounding line also had to be integrated. This function is performed by various interfaces, via which the control receives the relevant data. The control of the heater-cooler mixer is completely integrated.

The operating status of the entire plant can be displayed on a central operator monitor. Other detail information can be provided on auxiliary monitors by pressing the symbols for the individual plant components. The control predicts when an order will be completed from the data provided for work preparation. Then it successively empties the heating mixer, cooling mixer and mixing silo, followed by the compounding system and pellet cooler. Start-up with the succeeding formulation is performed in parallel with the →

least possible time delay – typically maximum 30 min.

The control also documents all the relevant production parameters. The processor can thus provide a constant compound quality.

## A Clear Plant Layout

Because of the many different components in the formulation, and the diffusion of the plasticizer into the PVC resin, it is necessary to produce a premix, known as a dry blend. For flexible PVC formulations, this is performed by a heater-cooler mixer. The plant from Draka includes one of the biggest heater-cooler mixers ever produced.

The heater mixer with a capacity of 2,000 l mixes PVC powder and other formulation components, such as filler, plasticizer and additives below the PVC softening temperature. The bulk goods plant automatically feeds the heater mixer with all the components for the formulation of the cable compound to be produced.

In the downstream cooler mixer, the heat generated during mixing is partially dissipated. For energy saving, it is cooled to a formulation-dependent dry-blend temperature of 60 to 100 °C. With a capacity of 6,000 l, the cooler mixer can also receive two batches from the heater mixer. To homogenize the dry blends batches, a tank equipped with a stirrer (also known as a stirred intermediate tank) with 4,000 l capacity is interposed. This also acts as a buffer to allow smooth transition from batch to continuous operation.

## Process Technical Configuration of the Buss Kneader

A high-performance quantec 110 EV Kneader is important for the compound quality **(Fig. 3)**. The Buss Kneader is equipped with an oscillating kneader screw (nominal diameter D = 110 mm). It also employs the four-flight technology already used in over 100 plants. The Kneader is followed downstream by a single-screw discharge extruder.

In view of the strict demands on compound quality and throughput, the system has certain special features. For efficient and accurate material feed, there are two gravimetric feeding systems. One feeder supplies the compounding line with the dry blend, the second recycles the scrap material. Above the Kneader feed hopper is an all-metal separator for particles of the order of 1 mm. Such particles can originate from silos, the heater-cooler mixer, the raw materials or from the return material. The increased volume in the feed zone also feeds very large amounts of powder.

**Fig. 3. At the heart of the PVC line is a high-performance Kneader with cascade pelletizer** (photo: Buss)

The effective process length was increased from 10 to 15 L/D. This ensures that very good compound quality is achieved even with a high filler content. Moreover, it permits the colors to be mixed in more efficiently with the extended process length. This in turn achieves clear savings with the pigment feed quantity with constant color quality.

The main drive of the Buss Kneader is water cooled. This permits low noise and dust development at the same time as energy-efficient running.

Despite the relatively long processing length, the residence time of the material in the process zone is only about 8 s. The very brief temperature loading of the PVC melt in the process, together with the low shear stressing without local shearing peaks, ensures the high quality of the compound. The uniform kneading screw geometry for all eight PVC formulations (together with the above-mentioned control coordination with the heater-cooler mixer) permits the required rapid formulation changes without significant product loss.

## Pelletizing under Pressure

From the single-screw high-performance Kneader, the fully compounded PVC compound falls through a shaft into the discharge extruder with a screw diameter of 250 mm. Its screw length is 6 D. A screen for melt filtration can be inserted before the die plate of the pelletizer if required. On formulation change, after the production of the relevant batch, the screen can be manually removed or exchanged.

During hot-face pelletization, there is no water contact with the die plate, no temperature or freezing problems can therefore occur in the nozzles of the die plate. The operator can swing aside the pelletizer with just a few manual operations. That facilitates access to the die plate, e. g. for maintenance work. Because the nozzle temperature and melt temperature are approximately the same, only a low pressure is required for pelletization. The water mist in the pelletizing hood cools the pellets very rapidly and ensures a solid surface. The PVC pellets are subsequently conveyed into two pellet coolers connected in series. From there, the final pellets are transferred for bagging, e. g. in flexible intermediate bulk containers (FIBCs).

## Acid Test in Continuous Operation

Since commissioning, the plant has produced high-quality PVC cable compound in continuous operation. It achieves throughputs of 4,500 to 5,000 kg/h depending on which formulation is running. After about a year of industrial experience, the process engineers and project managers at Draka emphasized the high, constant quality of the thermally sensitive PVC compound. The world's biggest cable PVC line with a full integrated control and the four-flight high-performance Kneader from Buss allowed Draka to improve the efficiency and economy of producing PVC cable compound. This will also increase its competitiveness. With very low emission values, the system already meets future requirements. ■

**THE AUTHOR**

FRANK KNITTEL, born in 1962, graduated mechanical engineer, joined Buss AG, Pratteln, Switzerland, in 1996, and is now business manager for machinery and plants in the application fields of PVC, cable compounds and masterbatch.