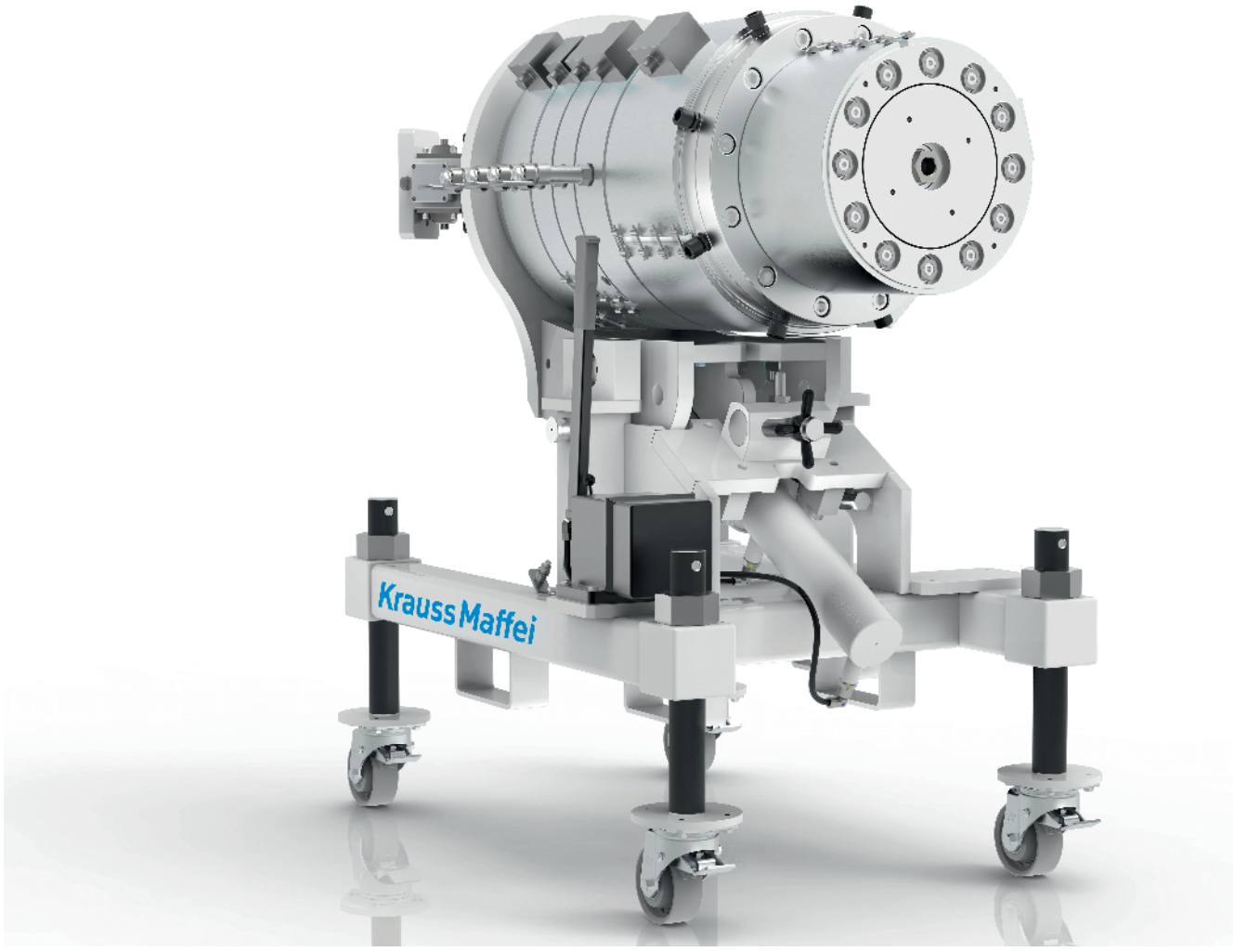
Innovative Head Design for PVC Multilayer Pipes

# Rethinking Distributor Geometry

PVC is the material of choice for many pipe applications. Using multilayer pipes can significantly reduce material costs. To manufacture such pipes, KraussMaffei Extrusion has developed the new pipe head KM 3L-RK 42 HP. The core of this concept is an innovative distribution geometry that ensures uniform wall thickness distribution and stable process conditions – even when using high proportions of recycled or foamed materials.




Decades of experience and precise knowledge of customer requirements have gone into the development of the KM 3L-RK 42 HP multi-layer pipe head. © KraussMaffei

Supplying drinking water and disposing of wastewater are essential components of modern societies. Over the past decades, plastic pipes have increasingly dominated piping installations in civil and building construction. They are relatively easy to manufacture, have a service life of over 50 years, and are cost-effective.

PVC is the preferred material for many pipe applications. However, ongoing cost pressures continue to drive innovation even in this traditional material. With a material share of 70 to 80 % of the total cost of a manufactured pipe, significant savings can be achieved – especially for low-margin products such as wastewater pipes.

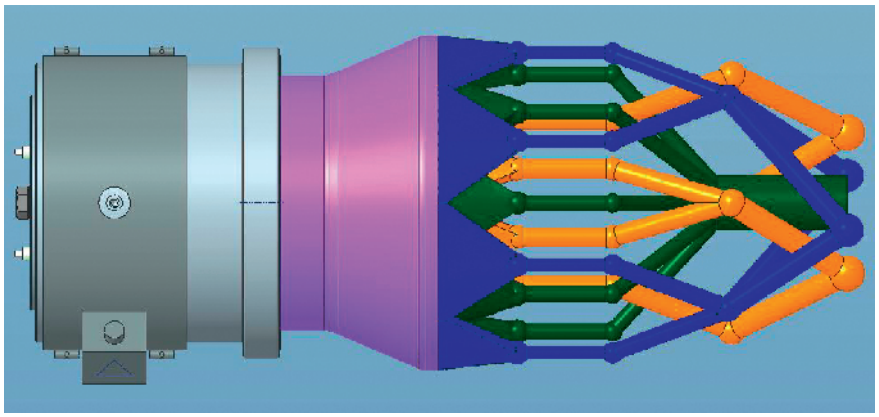


**FIg. 1.** The core of the KM 3L-RK 42 HP is the newly developed distribution concept.



## *The PVC Multilayer Pipe*

To save material costs, various approaches can be applied. More cost-effective alternatives can be sought in PVC itself, additives, or fillers. A long-standing solution for non-pressure pipes, such as wastewater pipes, is the use of three-layer PVC pipes, developed about 35 years ago. Originally intended as so-called lightweight pipes, where the middle layer is foamed to save material and costs, the use of recycled material has increasingly gained importance. Both variants reduce material costs and enable a more sustainable production process. Today, multilayer PVC drainage pipes account for over 30 % of the market.

In both foamed and recycled variants, the middle layer is sandwiched between thin outer and inner layers of virgin PVC, which may be colored or chalk-filled. Cost savings come from using cheaper materials compared to virgin PVC. For the middle layer, UV stabilizers are usually not required, offering additional savings. In a further step, the middle layer can be foamed with a blowing agent, which is possible with either virgin or recycled material. This can reduce material usage by up to 30 %, and the pipe's weight is reduced without compromising mechanical properties, improving handling and installation.

## *Extrusion of Multilayer PVC Pipes*

Extruding a multilayer PVC pipe requires specialized equipment. While downstream processes including socket formation remain largely unchanged, the extrusion group and calibrators must be adapted to the application. Producing such pipes typically requires at least two extruders; the same extruder can supply both the inner and outer layers if using the same material.

The heart of the system is the multilayer head. It must process a wide range of materials while maintaining tight tolerances and high product quality. PVC is thermally sensitive and prone to stagnation, which can lead to degradation and reduced product quality.

The performance requirements of the pipe head itself include uniform melt viscosity and flow velocity across the entire circumference. In designing the pipe head, both the viscous and elastic behavior of the polymer melts must be taken into account. One approach is to shape the cross-section of the flow channels so that it closely resembles the geometry of the die exit. The dimensions should be chosen to first eliminate the elastic deformations of the melt that may arise from the extruder's plasticizing unit. To achieve this, the melt is guided through sufficiently sized cross-sections under continuous flow. A well-designed pipe head should gradually increase the flow velocity, which is typically accomplished by continuously reducing the cross-sectional area of the channels.

In summary, the following requirements apply to a modern PVC head:

- A wide processing window for various materials
- The highest possible proportion of recycled material, especially for the core layer
- High output and long production times without the need for cleaning
- Good accessibility and easy cleaning

## *The Design of the New KM 3L-RK 42 HP*

Against this backdrop, KraussMaffei Extrusion decided to launch a completely new development on the market. Based on the experience gained over the past decades and today's customer requirements, a completely new design has been created that combines all the requirements for a pipe head.

The core element is the newly developed distribution geometry,

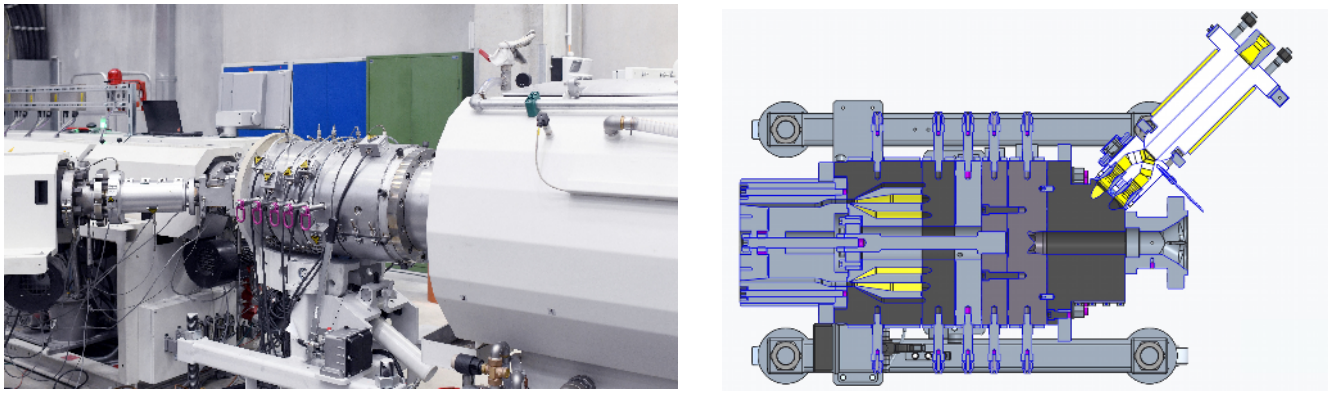


**Fig. 2.** Left: Head in production position, operation with two extruders. Right: Schematic diagram. 

which is unique on the market in this form (**Fig. 1**). To achieve optimum wall thickness distribution, it is necessary to ensure a uniform flow velocity across the circumference. What sounds simple requires a few tricks to achieve a good result with three layers. Uniform flow velocities in each layer require a symmetrical distribution geometry that conveys the plastic as a block flow without velocity differences across the channel cross-section.

To achieve this, the final annular gap is fed via several overlapping "trumpets." These are triangular distributors that divert a strand into a wide distribution. To harmonize the speed, a certain straight section is provided in front of these trumpets. The pre-distribution to the individual trumpets of the core layer is symmetrical and has the shape of a spider's web.

This type of distribution provides the shortest possible dwell time for this layer. The plate-shaped head allows the distribution of the inner and outer layers from the incoming melt strand to be gradually adjusted to the final number of trumpets. At the transfer points, particular emphasis is placed on a flow-optimized design. The aim is to keep pressure loss to a minimum and, above all, to avoid dead zones that can lead to material standstill and thus to damaged PVC material. The different type of distribution for the top layers and middle layer is unique worldwide in this combination and enables high throughput performance during long operating cycles.

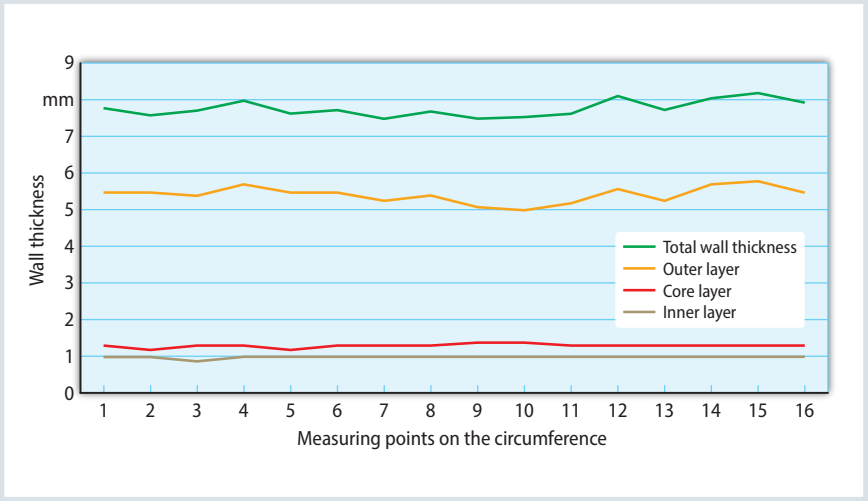



**Fig. 3.** Wall thickness measurement DN 250. Source: KraussMaffei

The process design is complemented by a complete structural overhaul that focuses on ease of maintenance and handling. A newly designed pipe head carriage, which places great importance on accessibility, allows easy access to all parts at all times. Tools can be changed either vertically after hydraulic tilting or horizontally using special lifting tools. The consistent design of the head, consisting of plates screwed together, allows for easy maintenance and cleaning (**Fig. 2**).

## *Operation and Results*

Once development and design work had been completed, a prototype was manufactured, tested at the KraussMaffei Technology Center in Laatzen, Germany, and presented at the Tec-Days in March 2025.

The head was operated with two twin-screw extruders (KMD 90–32D for the skin layers and KMD 90–36D for the middle layer). Several material combinations of virgin material, foamed material, and recycled material were tested. Pipes with dimensions between 110 and 250 mm were manufactured.

All materials demonstrated that high overall throughputs of 1200 kg/h are possible. During the technical center trial period, there were no problems with the burners. Despite a certain need for optimization in the area of tools, the manufactured pipes exhibit excellent wall thickness distribution for all raw materials (**Fig. 3**).

## *Summary*

For over 30 years, 3-layer PVC pipes have offered growing potential for producing cost-effective yet highly functional pipes, especially for transporting wastewater. The use of foamed middle layers or recycled materials allows manufacturers to produce pipes efficiently and competitively in a highly competitive environment. The material savings achieved through foamed components and the use of recycled plastic not only reduce costs, they also make a significant contribution to the sustainability of the pipe system. The new pipe head 3L-KM 42 HP enables manufacturers to increase productivity. With high output, long running times, and the possibility of using recycled material on all three layers, it opens up a future-proof option for the production of PVC pipes for non-pressure applications. ■

## Info

### Text

**Dr. Robert Weddige** is Head of Process Technology Pipe & Profiles and Process Technology Tire & Rubber at KraussMaffei Extrusion GmbH in Laatzen, Germany; robert.weddige@kraussmaffei.com
**Michael Kellner** is a development engineer in R&D Process Engineering at KraussMaffei Extrusion GmbH in Laatzen; michael.kellner@kraussmaffei.com

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