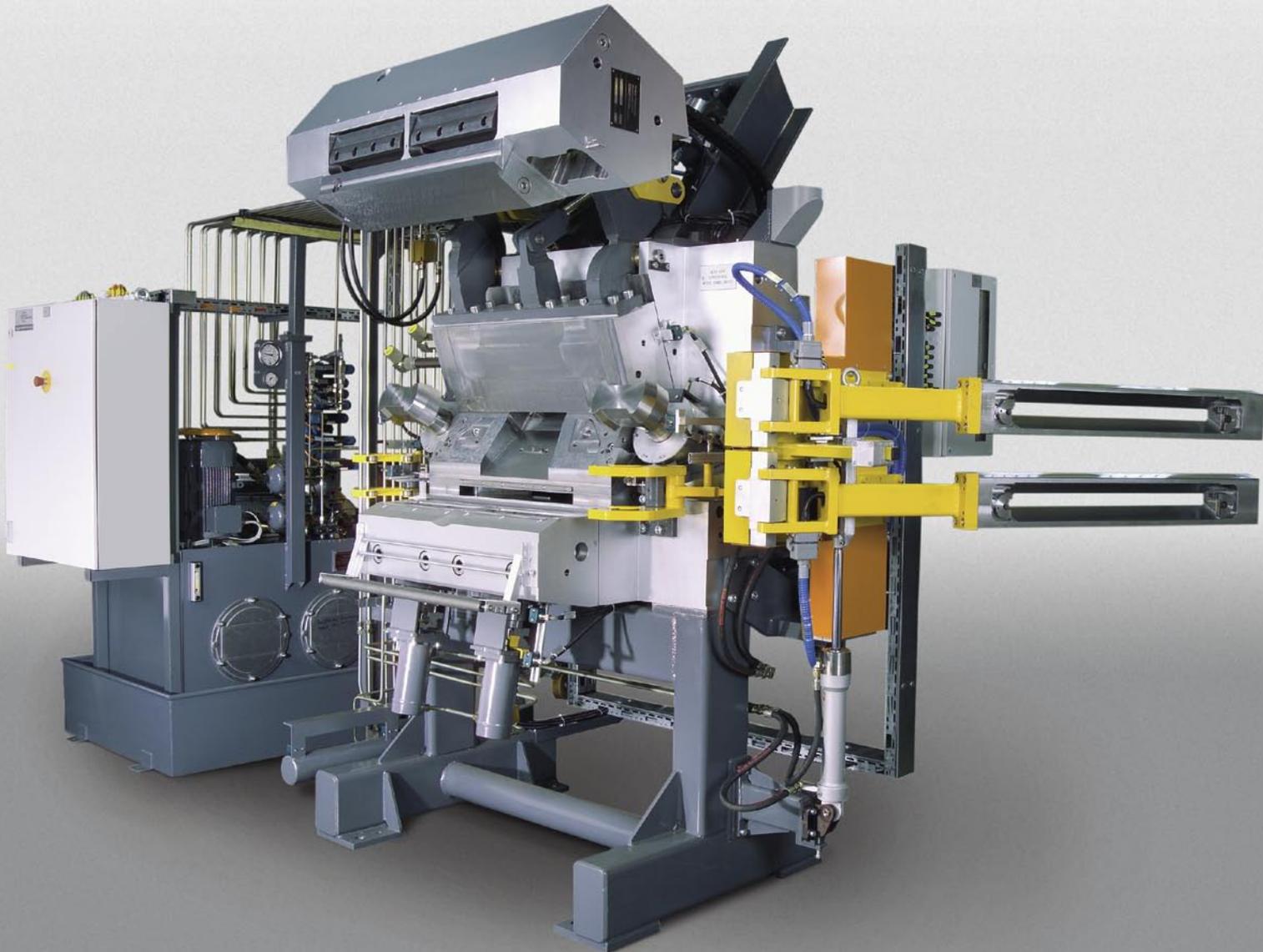
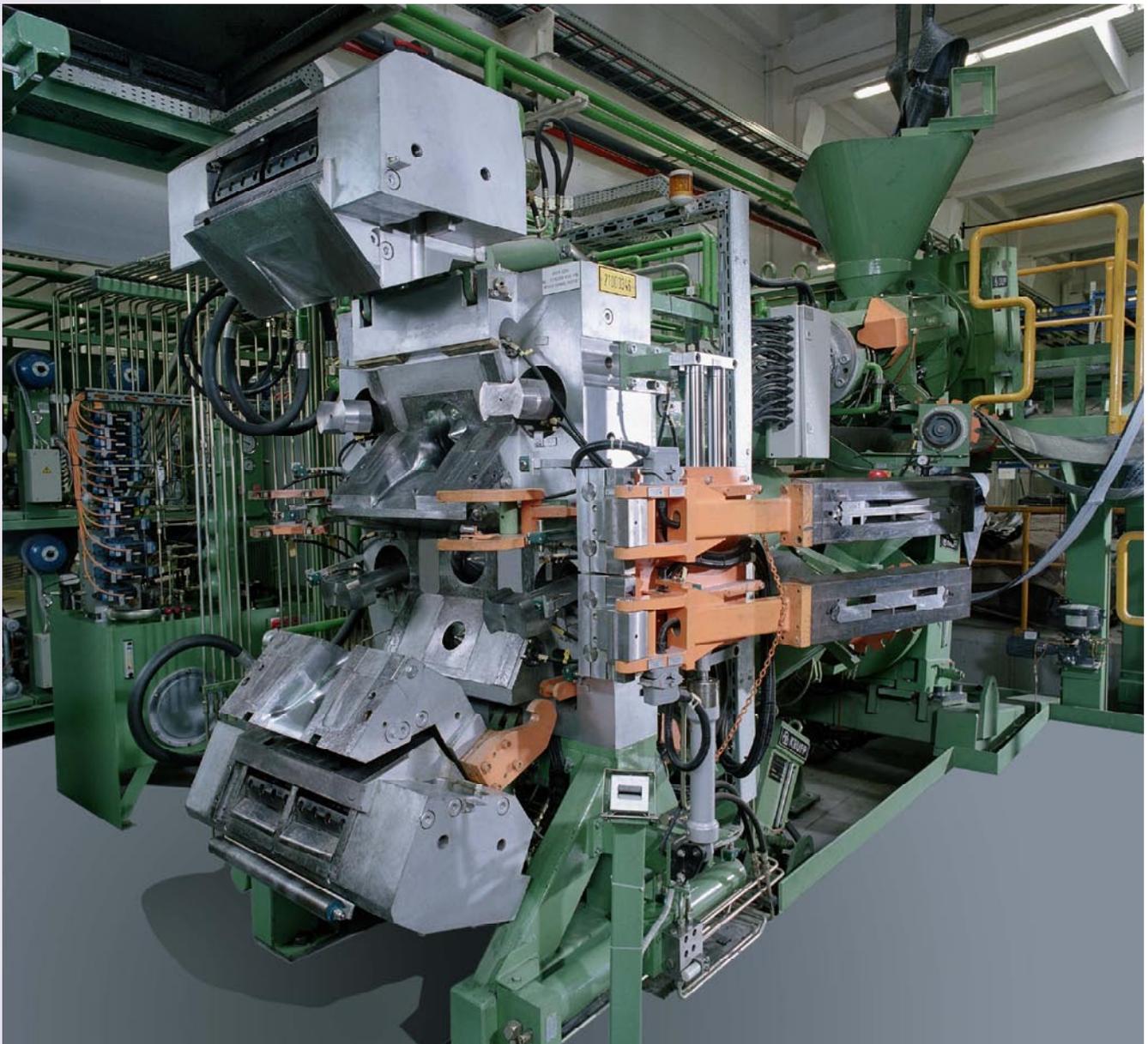


Extrusion Lines for Performance Tire Manufacturing



Highest Flexibility and Economic Efficiency in Tire Production

Harburg-Freudenberger extrusion aggregates enjoy an outstanding reputation based on well-engineered technology and longevity. For decades, the „Original KRUPP Extruders“ have been deployed to production facilities all over the world where they are known for their innovative technology and an exceptional cost/performance ratio.



Our „classic“ extrusion lines stand out through tried and tested technology. The essential parts of our processing equipment have been continuously enhanced throughout the years. Our know-how is based on the experience that comes with countless start-ups, on the improvements to aggregates and components developed in long-term partnerships and, last but not least, on the trust our customers place in our capability as innovators.

Insights won through laboratory testing of various compounds are implemented and integrated.

This translates into economic benefits for our customers. At the same time, the risks related to process-relevant production technology are reduced.

Our structured approach to engineering technology has generated a module-based design concept:

- A – extruders
 - B – extrusion heads
 - C – tooling
 - D – downstream equipment
 - E – winders and booking equipment
 - F – control system technology
- } Upstream

The Machine Concept

For years, the hot feed extruder determined the basic principles of today's extrusion technology. To this day, hot

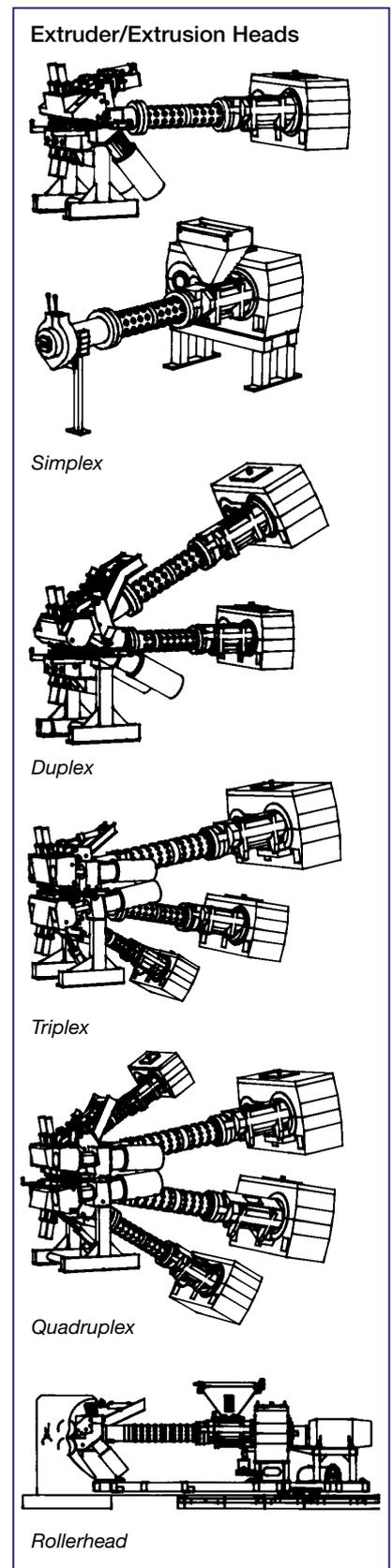
feed extruders are used for compounds with special process technological requirements (e.g. for truck tires) or for replacement investments within an existing production line.

However, it is the cold feed pin type extruder that now dominates all tire production areas. Especially the modern car tire production has now been completely based on cold feed technology for many years. When compared with hot feed extruders, cold feed pin type extruders offer a more economic operation – because no preheating mills are needed – which translates into a high acceptance rating for investments in new plant equipment. In addition, the investment costs for equipment and operation are further reduced because no calender is needed.

Modular Design of Extrusion Lines for Tire Production

Our extrusion heads offer a universal flow channel technology with a hydraulic hammerhead locking system to ensure a fast and safe changing of profiles in combination with a high degree of operational reliability and profile extruding precision. The extrusion head geometry and the selection of the corresponding extruders depend on the required output, the profile dimensions and the width. Various extrusion aggregates with different extrusion head widths are available to meet these demands.

	Tread	Sidewall	Apex	Innerliner
Max. profile	Simplex	Simplex	Simplex	Simplex
width (MW) 500 /	Duplex	Duplex	Duplex	Duplex
650 / 800 / 1000	Triplex	Triplex		
	Quadruplex	Quadruplex		
				Rollerhead



KGS extruder screw dia. ***	Ratio	Pins	Output *	Max. speed **	Drive rating
Type	(L/D)		kg/h	rpm	(approx.) kW
90	16	7x8	550	60	60
120	16	8x8	1000	55	110
150	16	9x8	2000	45	240
200	16	9x12	3400	35	320
250	16	10x12	5000	24	480

* depends on rubber compound and profile cross section

** depends on required extrudate temperature

*** other length/diameter (L/D) ratios on request

The Cold Feed Pin Type Extruder

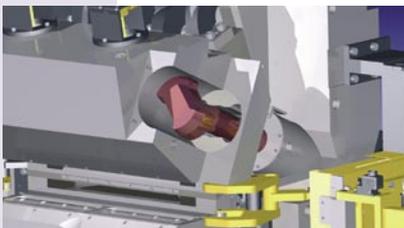
Our cold feed pin type extruders are available in all prevalent extrusion screw diameters.

We design our extruders to meet profile design, component specifications and compound characteristics.

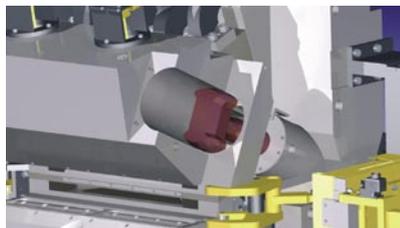
The Locking System

Our patented locking system within the extrusion head effortlessly absorbs the forces of the extruded compounds and reliably seals the flow channel surfaces. Forces of up to 350 bar can be absorbed. A safety shutdown sequence will automatically open the extrusion head should this value ever be exceeded.

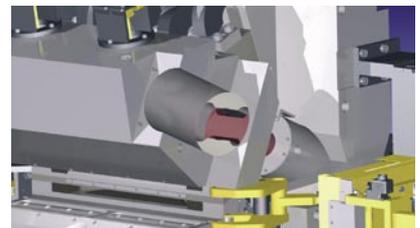
The use of hydraulic pressure and an oscillating rotation are the hallmarks of our hammerhead locking system (1-3). The design of the retractable locking system allows a close proximity to the flow channels which enhances accessibility, operability and maintainability.



1



2



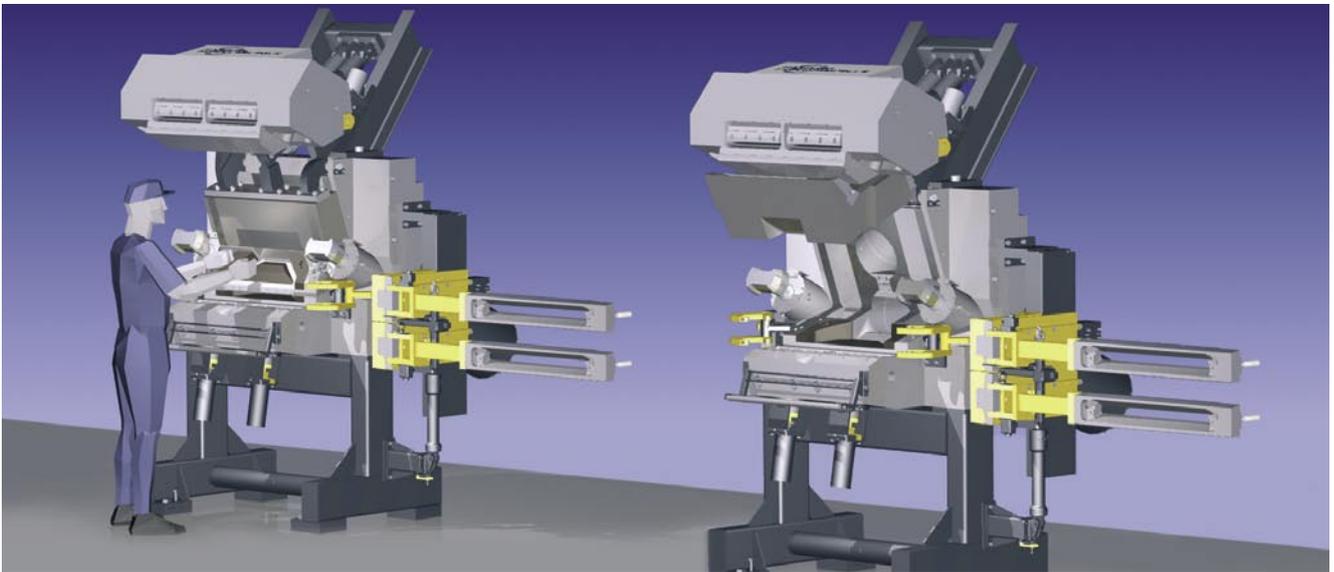
3

The MODULAR INSERT System

Important access areas can be opened individually to facilitate the change of inserts and/or compounds.

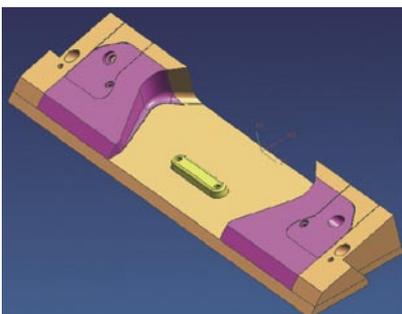
This reduces changeover times and increases flexibility.

Duplex extrusion head with opened insert and compound levels

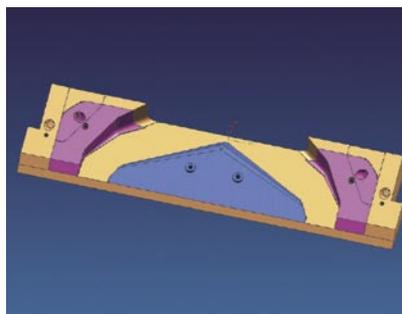


Upper channel open

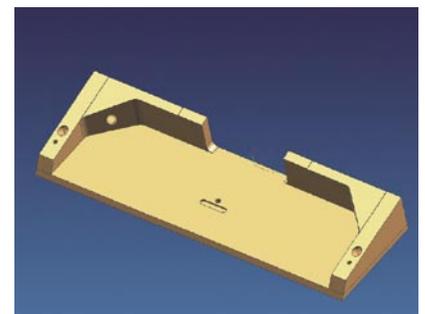
Lower channel open



Configuration for MW 350 mm



Configuration for MW 650 mm

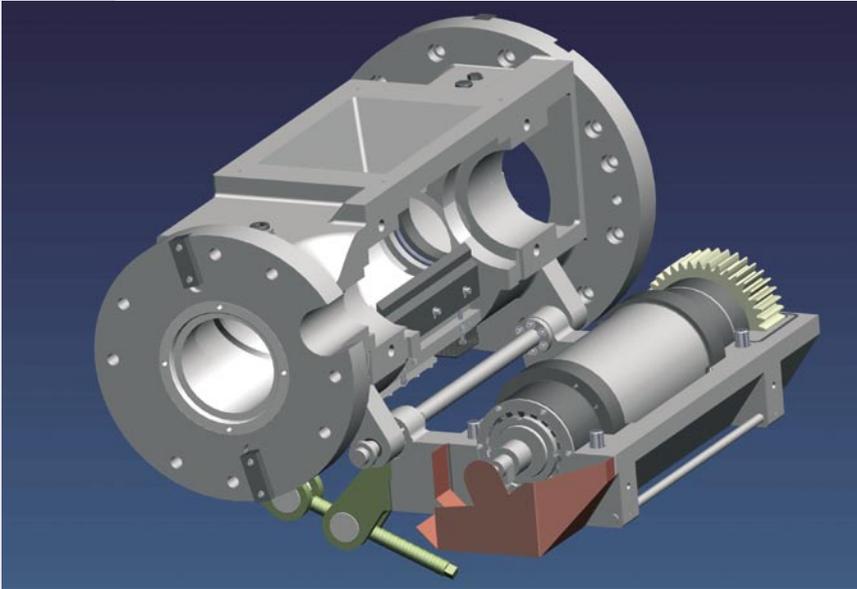


Basic insert, empty

System Description

The MODULAR INSERT System is Harburg-Freudenberg's concept for the reduction of profile changeover times which is geared towards individual extrusion channels.

Depending on the product (e.g. tread or sidewall), the system is adapted within the flow channel insert. In this case, individual lateral restrictors and humps correspond with the dimensions of the extruded product.



Feed roller in maintenance position

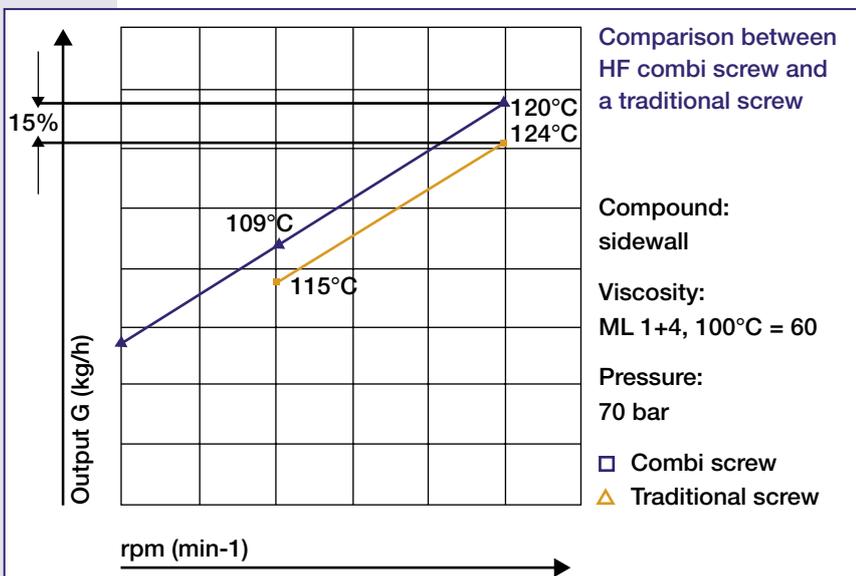
The Feed Roller Concept

Our feed roller has been a success story for many years. Its longevity, accessibility, simple opening mechanism and maintainability are features our customers value. The slab feeder steadily guides the slab to the feed roller, which in turn guides the slab to the extrusion screw.

The Extrusion Screw Concept

At our Freudenberger testing facility we test our extrusion screws based on theoretic design methods while taking our many years of experience into account. The results obtained determine the extrusion screw geometry variation that will enhance the productivity of new extrusion lines. In essence this concerns homogenization, high output and combi screws. Our customers use the insights won through consequential enhancement of existing extrusion screw designs to replace traditional extrusion screws – when changing to more modern compound, output and/or temperature requirements. In such cases we also offer qualified test runs at our Freudenberger testing facility.

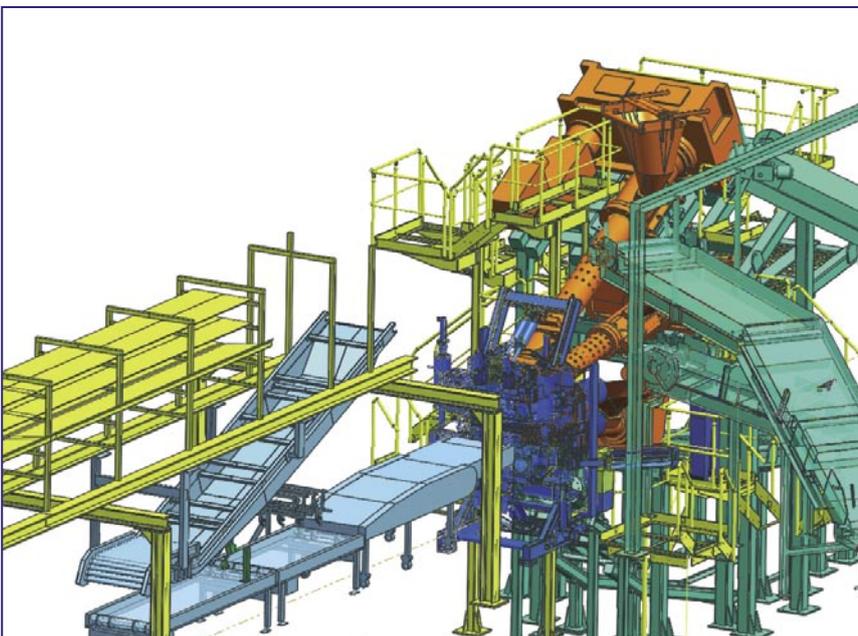
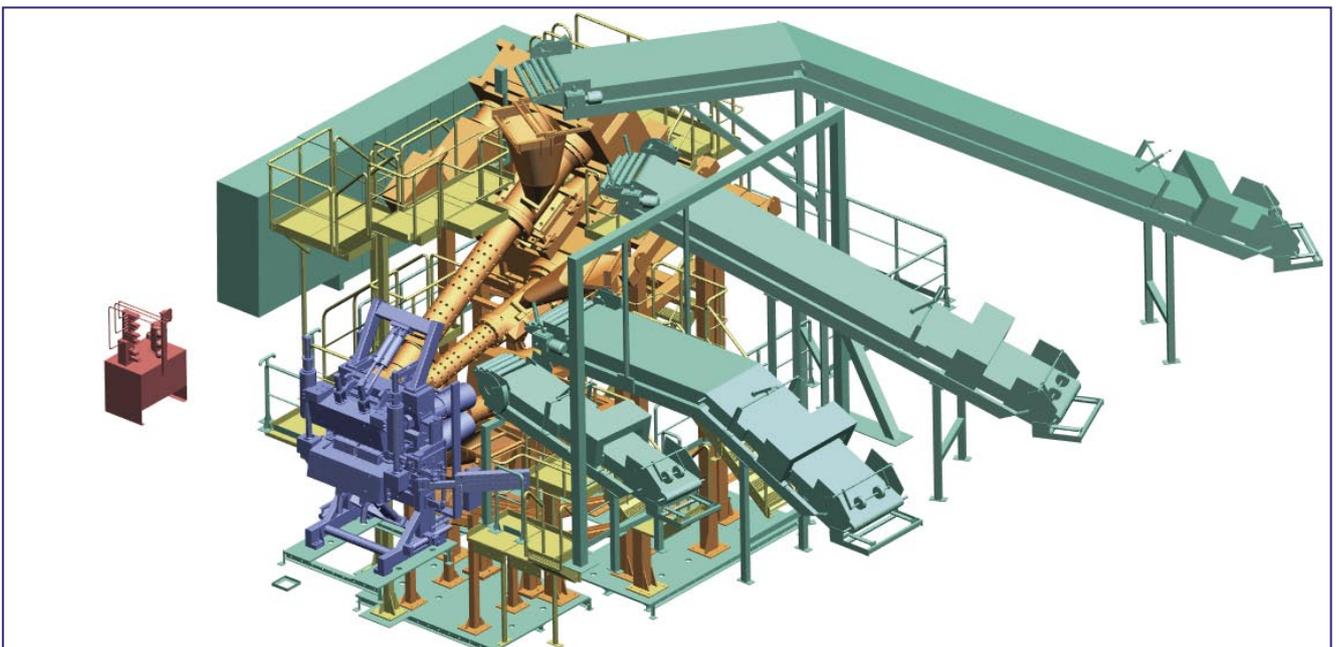
The diagram to the left shows an example of a comparison test for extrusion screw performance. The parameters analyze the performance of two different extrusion screw types run under identical testing conditions. The results show that systematic extrusion screw research work can increase productivity between 5 and 30 %.



The Upstream Equipment

The illustration shows the entire structure of the upstream equipment using a quadruplex extrusion unit with feeding devices as an example.

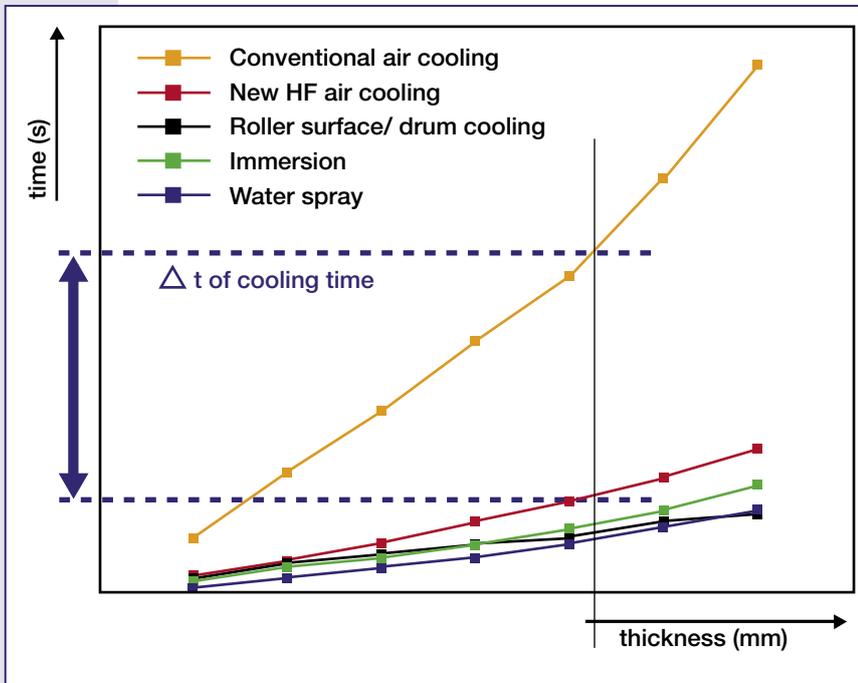
In addition, the importance of the supporting structure needed for the pre-assembly of the extruders and the extrusion head is clearly visible.



The Downstream Equipment

The downstream equipment assembly groups are determined by the profile which is to be produced. This could be tread, sidewall or innerliner. Downstream equipment is a collective term which encompasses the assembly groups which follow the extrusion head, such as:

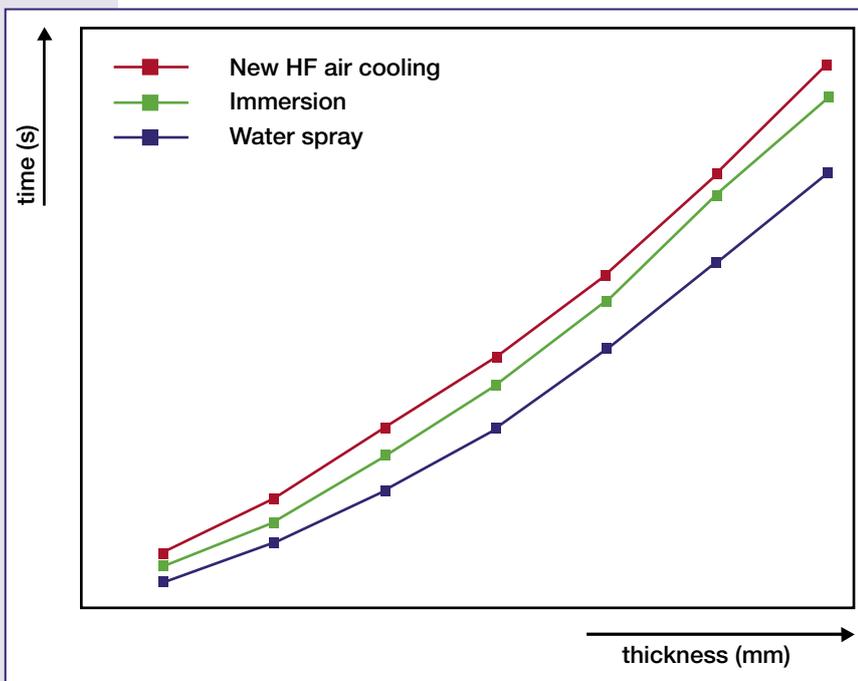
- shrinkage roller conveyor
- continuous scale
- camera systems
- marking devices
- calender (if requested)
- cooling line
- skiver
- winders or handbooking units



The Cooling Line Concept

Today, cooling line technology comprises immersion cooling, spray cooling, air cooling and drum steel band cooling. Cooling lines are designed to meet specific tasks and output profiles. The inlet and outlet temperature as well as the compound characteristics and the profile thickness are of special importance. The required cooling capacity is determined by the necessary retention time and the thickness of the profile. That is why the cooling system is usually specified by the customer.

As every cooling system has process limits, we continuously strive for enhancements which optimize output and economic efficiency.



The two diagrams on the left show the performance of various cooling methods; the upper diagram – for thinner profiles – shows how our newly designed „AirEco-Cool“ decreases cooling time and why it is much better suited to enable the shortening of cooling lines than conventional air cooling systems. Within certain process parameters, AirEco-Cool has considerable advantages over immersion, drum or spray cooling when it comes to process and economic efficiency.

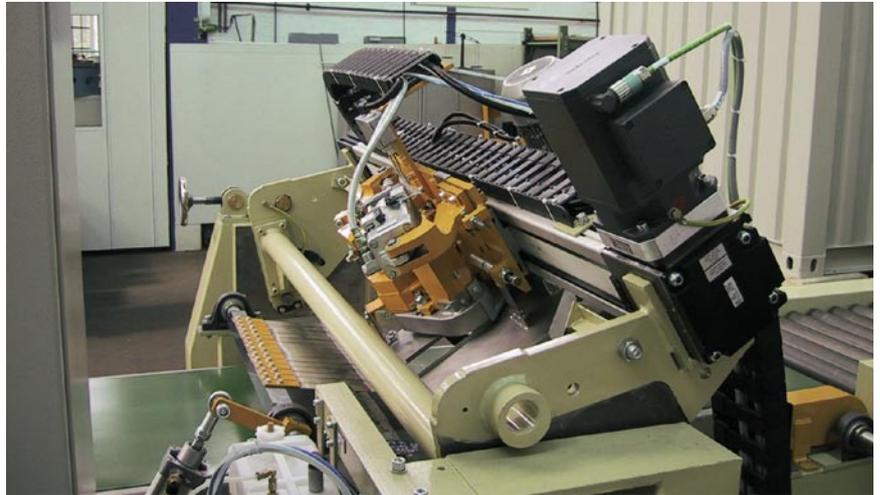
The lower diagram, by contrast, shows why (water) spray cooling is still an option for thicker profiles.

Harburg-Freudenberger offers cooling lines for brand new production facilities and for retrofitting.

The Skiver

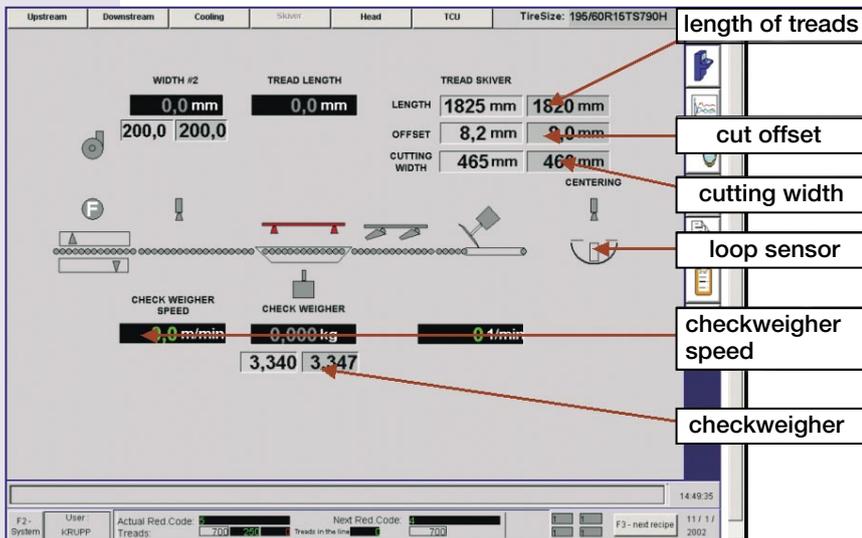
The Skiver made by Harburg-Freudenberg combines high cutting accuracy with short cutting cycles. The cutting angle can be freely adjusted with regard to the profile surface and to the direction of production.

Our program includes double cross cutting action for treads.



Description		Skiver 650	Skiver 900
Line width	mm	650	900
Max. tread length approx.	mm	2540	4000
Min. tread length approx.	mm	1350	2000
Knife diameter	mm	500	500
Tread thickness	mm	30	30
Cutting angle to extrusion line		70°-90°	70°-90°
Cutting angle to tread		20°-40°	20°-40°
Mechanical accuracy	mm	± 0,5	± 0,5
Number of cuts *	per minute	26	18

* The effective number of cuts (pieces per min.) is related to the line speed, depending on cutting length and width.



An example of process control and recipe management for the skiver

Process Control and Recipe Management

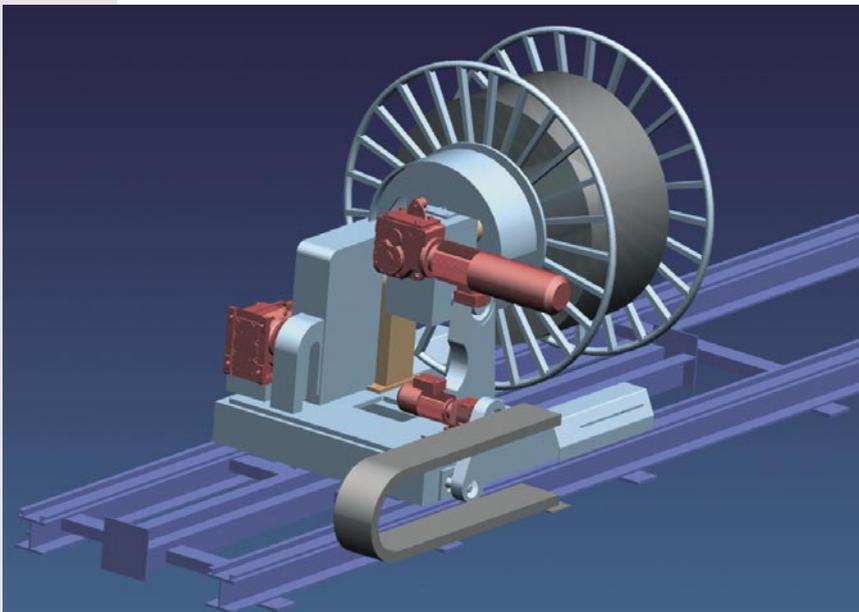
The process data is stored in the recipe menu as part of the customized process automatization and visualization. Important messages which need not be continuously monitored by the operator can be recorded and evaluated later for quality assurance purposes.

The HMI user interface with PLC background covers the following main tasks:

- monitoring
- operating
- entering recipes
- recording faults and fault locations
- collecting machine running time data
- collecting operation data

Winding Technology for Sidewalls and Treads

All important details concerning the design and technology of the winders are discussed with the customer. The illustration to the left shows an example of winding technology as designed for a customer. Cassette winding technology is also possible for all profiles.



Speed and Tension Control of Product Strip

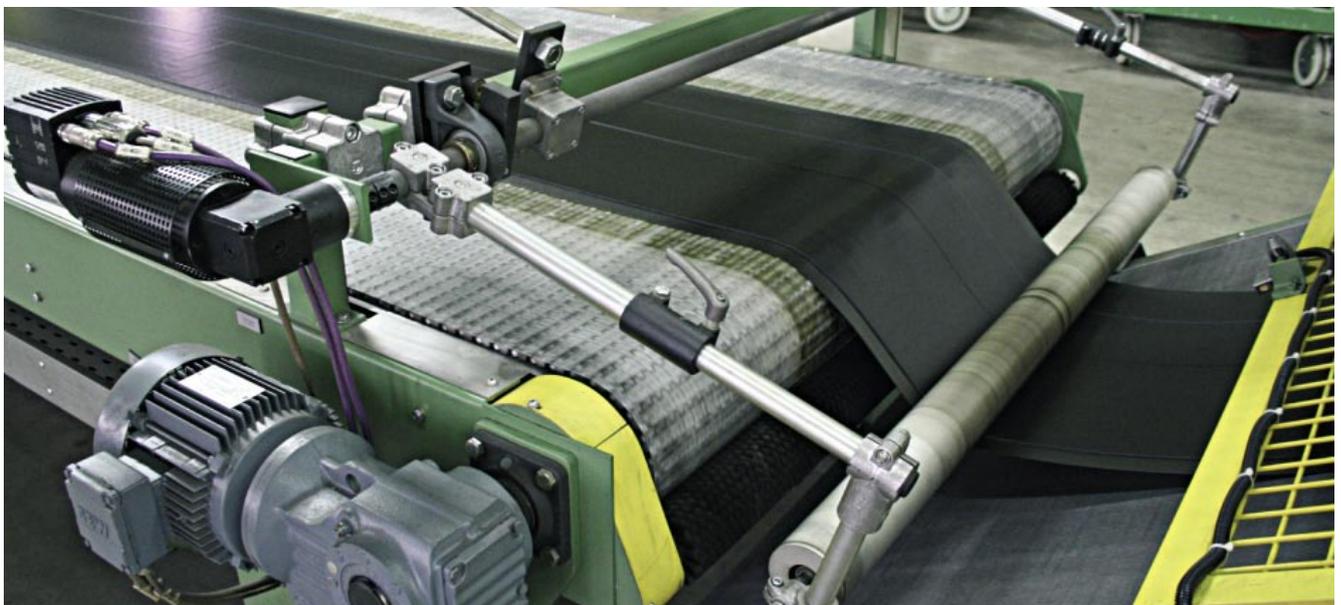
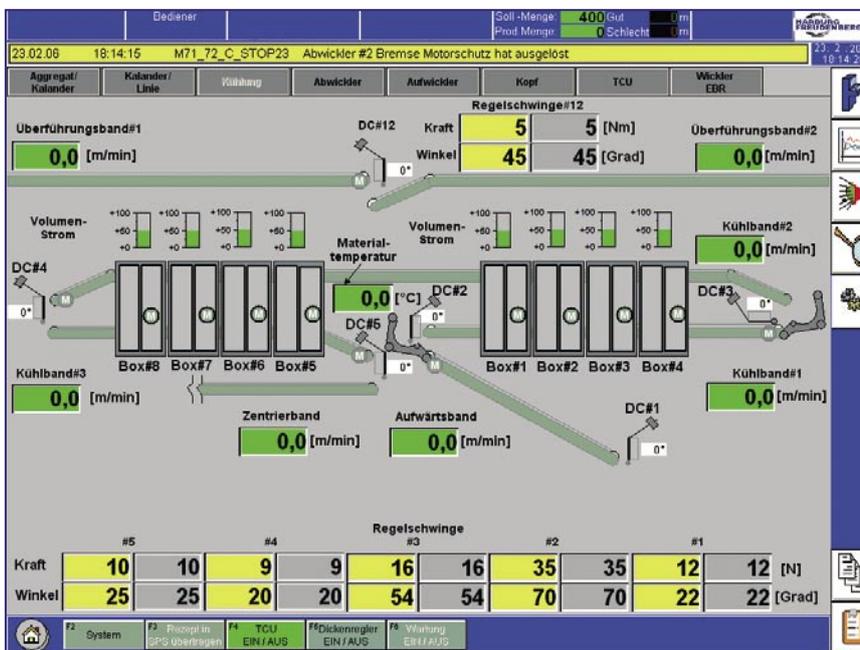
Various dancer types are used for speed and tension control of the product strip. Usually, mechanical roller dancers, load cells and non-contact loop controls (light curtains) are used. Angle and pressure points are essen-

tial for stress-free operation. It goes without saying that self-threading is optionally available for all dancer types.

The dancer is designed to enable:

- minimum tension adjustment and displacement
- adjustable pressure point
- operation data setting via recipe
- hinged roller arm at the upper limit of travel for self-threading procedures

The recipe settings and/or the HMI interface make it clear which values are possible for an individual product via angle and preset force.



Harburg-Freudenberger

We develop, build and distribute machines, lines and systems across our three company divisions based on 150 years of company tradition.

Rubber mixing technology

We provide the most comprehensive range of machines for the rubber and caoutchouc industry including all major preparation and processing stages.

- Complete mixing room systems
- Internal mixer
- Mixing mills
- Dump extruder

Caoutchouc technology

Production machines and lines for the manufacture of tires and technical rubbergoods from raw material feeding to vulcanisation:

- Extruder
- Extrusion lines
- Tire building machines
- Curing presses

Edible Oil Technology

Machines for processing oilseed, crude oils of vegetable origin and animal raw materials as well as screw presses for the dewatering of synthetic caoutchouc and similar products:

- Screw presses
- Extraction lines
- Refining lines
- Process engineering

We are always at your service

With our foreign offices and our service points we have a global presence.

If you would like to learn more about Harburg-Freudenberger or if you require information on specific services, please do not hesitate to contact us.



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