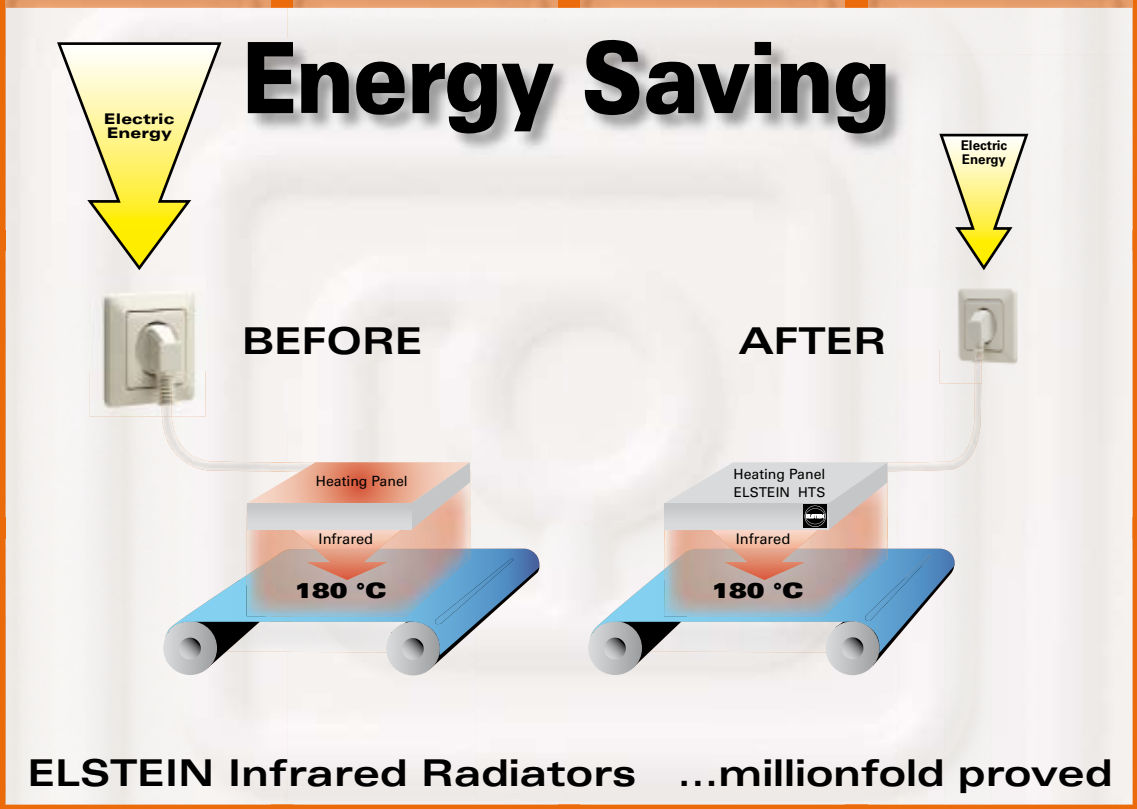

Energy saving with HTS

Energy saving potential of Elstein HTS-series

1. Task

The Elstein HTS series radiators are ceramic infrared radiators. Compared to full ceramic radiators the heaters of the HTS-series have an integrated thermal insulation material.

The task of this research was to determine whether radiators of Elstein HTS series have an energy saving potential compared to full ceramic radiators. Secondly the volume of energy saving should be determined.

2. Test setup

In order to determine the energy saving potential, water evaporation tests with 3 different infrared radiators were carried out. Figure 1 shows the test setup.

Figure 1: Test setup

A metal cup filled for each test with 100 g water was placed below an Elstein EBF/25 construction element. The temperature was measured at the middle on the bottom of the cup by using a thermocouple.

The Elstein EBF/25 construction element had a new and blank stainless steel reflector. The following test radiators were placed in this reflector:

a Elstein HTS/1 high temperature radiator 1000 W 230 V with integrated heat insulation

b Elstein FSR panel radiator 1000 W 230 V (full ceramic radiator)

c Infrared radiator from another manufacturer with FSR design 1000 W 230 V (full ceramic radiator)

At the beginning all test equipment parts were at a room temperature of 21 °C. In each test the radiators were turned on at the beginning of the tests. During the tests the electrical power was measured additonally to the measurement of the temperature of the metal cup.

The evaporation of water was used for proving the energy saving potential because it represents many drying processes for example in the food industry. However also production processes like thermoforming of plastic sheets correspond in many points to this test.

A further advantage of the evaporation test is that the end of the test can be determined easyly and exactly. When the water evaporated completely then the temperature of the metal cup increased relatively quickly and significantly above 100 °C.

3. Test results

Figure 2 shows the measured temperature curves of the three tests.

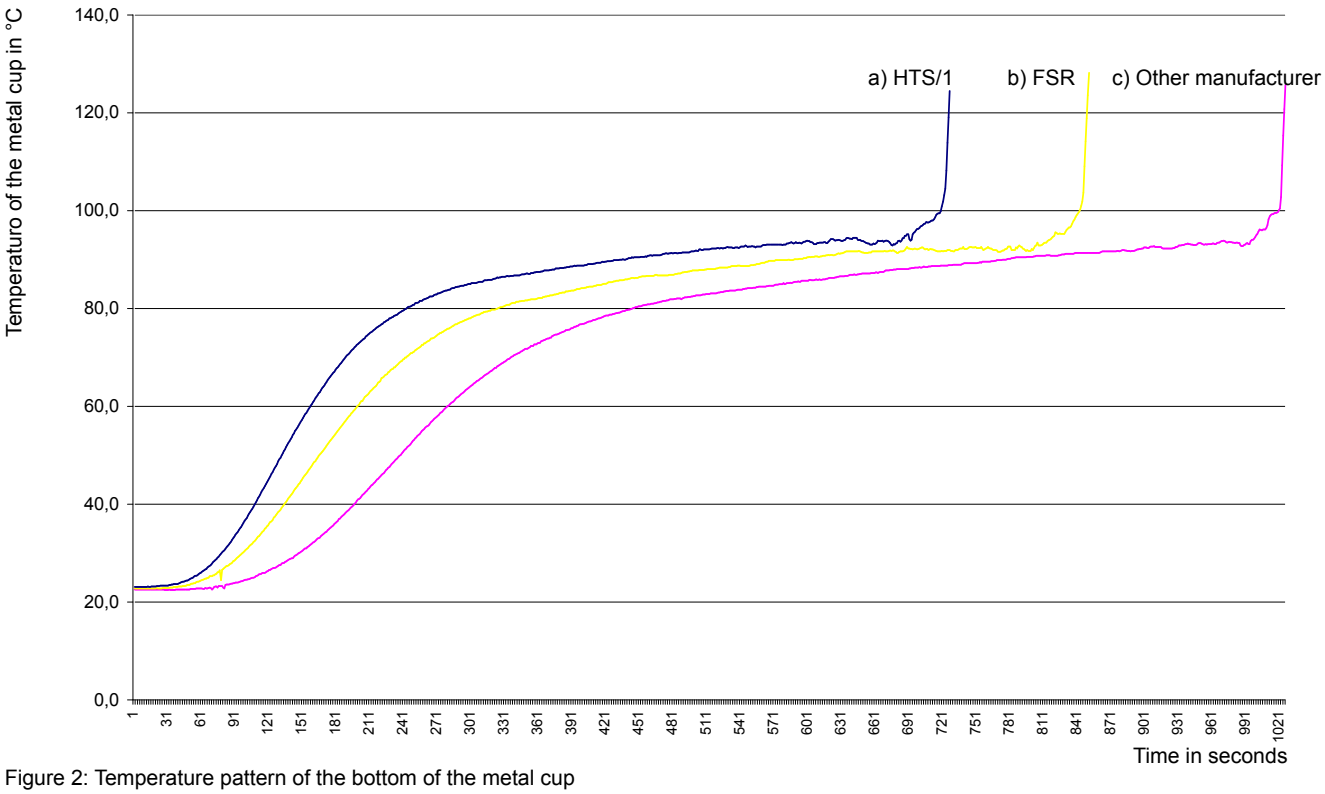

Figure 2: Temperature pattern of the bottom of the metal cup

The curves show a usual heat-up process. In the beginning the temperature increases strongly and remains some time within a small area below the evaporation temperature. After the water evaporated completely, the curves exceeded the 100 °C - line within a few seconds. For the evaluation the end of the test was set at the point where the curve reached 100 °C.

The following values resulted from the tests:

Test	a	b	c
	HTS/1	FSR	FSR (other manufacturer)
Power	965 W	976 W	978 W
Evaporation time	720 s	844 s	1021 s
Required energy (Power x Evaporation time)	0,193 kWh	0,229 kWh	0,277 kWh
Energy saving related to c	approx. 30 %	approx. 21 %	-
Energy saving related to b	approx. 15 %	-	

The test results show clearly the energy saving potential of Elstein HTS series compared to conventional full ceramic radiators.

However they enable further essential statements. For example if the cycle time of a heating task is significantly shorter, then the the energy saving potential improves further. This can be shown by using a simple example.

Assuming that the heating task is not to evaporate the water completely but to heat it up to 80 °C only. For this task HTS/1 needs approx. 240 s but FSR 320 s. In this case the energy saving is 25 %.

The results of these simple tests comply with results, which were determined in the field plastic thermoforming machines by customer in the year 1993 and being published in the magazine Kunststoff Journal /1/. Also here an energy saving of 18 % to 20 % is reported.

The advantages of Elstein HTS series are not limited to energy saving only. Due to the lower masses to be heated shorter cycle times can be achieved, which leads in many cases to a significant increase of the machines output.

Since the radiators of the HTS series are significantly cooler on the back side compared to full ceramic radiators they hardly transfer radiation heat to the reflector. Due to this they are almost insensitive on changes of the reflector placed behind them compared to full ceramic radiators. Normally reflectors become dirty during operation or they oxidise on the surface. This leads to a significantly reduced reflection behaviour and the electrical power of the full ceramic radiator must be increased bit by bit.

A further collateral advantage of the improved efficiency on radiators of the HTS series compared to ceramic full radiators is the lower temperature in the wiring compartments. The lower temperatures give lower stress to the insulation materials of the wirings, which leads to a longer service life of the wirings.

The final statement is that the radiators of the HTS series provide many advantages to the user and that they are the state-of-the-art. For this reason new systems should be equipped in any case with these radiators. However, for many machines equipped with full ceramic heaters a replacement to radiators of Elstein HTS series is recommended if higher machine operation hours are reached.

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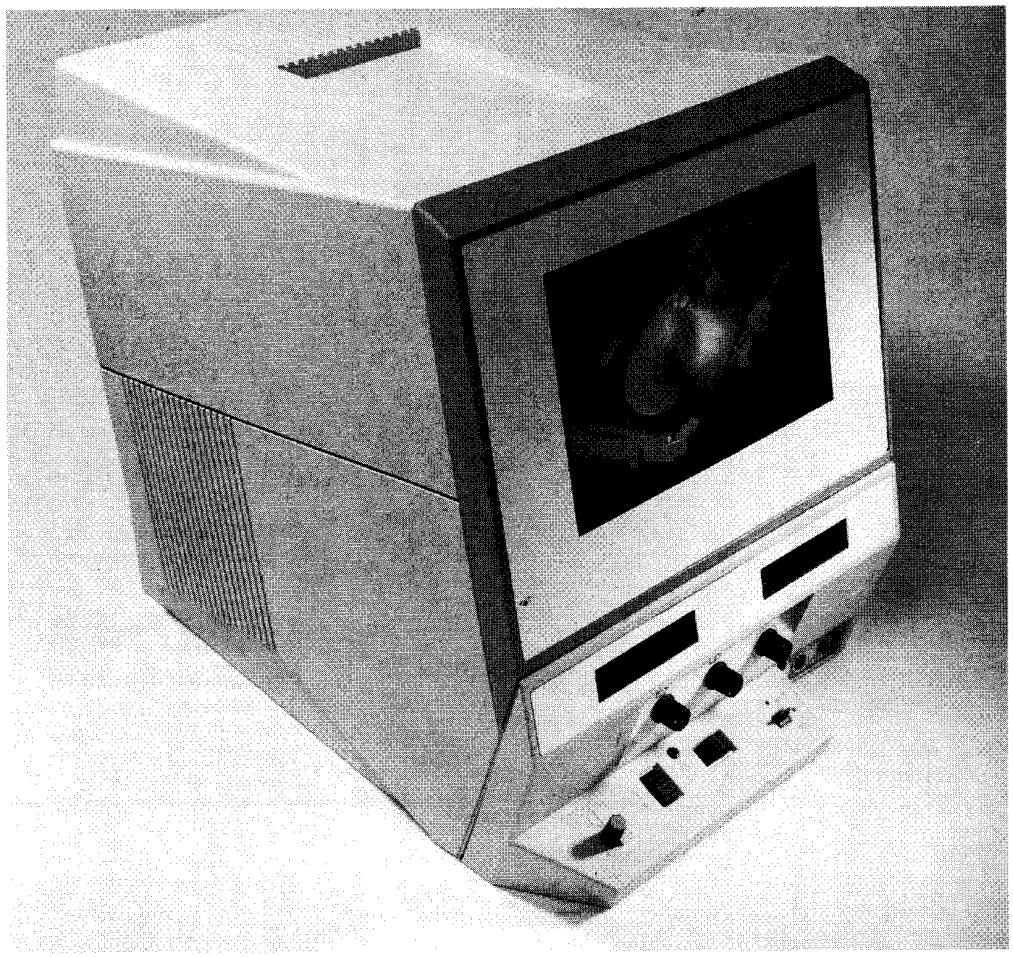
List of literature:

/1/ G. Kiefer: Shorter Cycle Times, Kunststoff Journal 1 / 2 –93, Pages 14-16



This new method for designing thermoformed parts allows efficient production and particularly aesthetical design. (Factory picture: Vitaro).

Shorter Cycle Times

by Günter Kiefer

Technical thermoformed parts from plates as much as 15 mm thick are being used more and more frequently in a wide variety of industries. Linear modular designed thermoform machine systems and new CNC-controlled reprocessing machines make it possible to efficiently manufacture these formed parts.

The second generation of the UA-g linear thermoform machine system makes other phases of expansion possible for even more efficient working regimes with shorter cycle times while saving energy with heaters that are upstream of the forming station.
Stages of completion are available for large-scale productions that provide for using two unloading points to directly extract plates from the transport pallet. This also allows interlinking with reprocessing machines and equipment while a modular design means optimum adjustment to each production project.

The Equipment in Detail

The core of this system is the mould unit. This is designed for the basic conception of manual charging and extraction where equipment for partially automatic format changes are standard equipment. This fast set-up system allows format changes in 10-15 minutes making the machine available for production again after a brief period of time. Development on the format system was initially started with the idea of building system equipment to allow low costs for formats. This was accomplished with available standard specifications and a format design handbook as part of the machine to give the mould builder the information needed for economically building moulds.

A vacuum is used to hold the mould tools on the mould table and the upper punch tools are fastened with pneumatically operated locking elements. Both of these pieces of equipment are automatically controlled by the retooling program while the format set is installed or removed as a complete package. Pneumatically moved ball rollers built into the mould table and rollers mounted

on the front flap make it easier to push it in and pull it out manually. The rollers on the front plate are fastened to guarantee that the format set can be set down on it and removed again with a fork-lift truck. The linear principle means that the front zone of the machine stays accessible.

Regulating Plastification

Special efforts were put into downstream development of the infrared radiation heating system to make sure that it can be regulated with energy savings.

Extensive tests and studies were carried out given the logical call for heating a thermoplastic plate or foil as evenly as possible over its entire surface before deformation. For instance, it was discovered that there has to be a means of regulating the natural isotherms (ring zones) that form at various temperatures with each infrared heating surface using pilot radiators to obtain even surface heating. That means that the temperature gradations once calculated for a machine size between the individual isotherms do not have to be changed later if the normal basic conditions such as mirrored clamping frames are given.

Numerous successful applications of isotherm regulation bear out the correctness of this procedure.
The multiple-position switching available as additional equipment also makes it possible to assign specific radiators to other regulating zones which can be used for extreme parts that call for varying deformation temperatures on the surface.

Ceramic infrared radiators are especially suited to temperature regulation and the new inside radiator structure of the new HTS model drives down energy reradiation to the reflector side.

That conveys more energy to the plate to be heated while improved efficiency brings about 18% electricity costs savings as compared with previously known radiators.

A bottom heating panel is standard equipment that is also equipped with ceramic radiators. These elements are so robust that they do not require any additional protective measures such as using covers from glass ceramic or the like. Working with intensive heaters via regulated temperature reduction has proven its worth for many years and it is also available with these state-of-the-art heating systems.

Temperature-regulated infrared heating systems guarantee constant cycle times from the start of the machine to the end of the series while keeping initial rejects to a minimum.

Choosing the Drive Equipment

The mould table and upper punch are moved pneumatically and the speeds for each direction are preselected and stored digitally via valve cascades. Furthermore, the travel way can be set on the upper punch via catches that can be adjusted by motor. These travel ways can also be stored. You manually adjust the travel ways from the control panel which means you no longer have to climb onto the machine.

Hydraulic systems can be supplied as alternative drive equipment for continuously setting the speeds and storing settings.

Completion in Stages

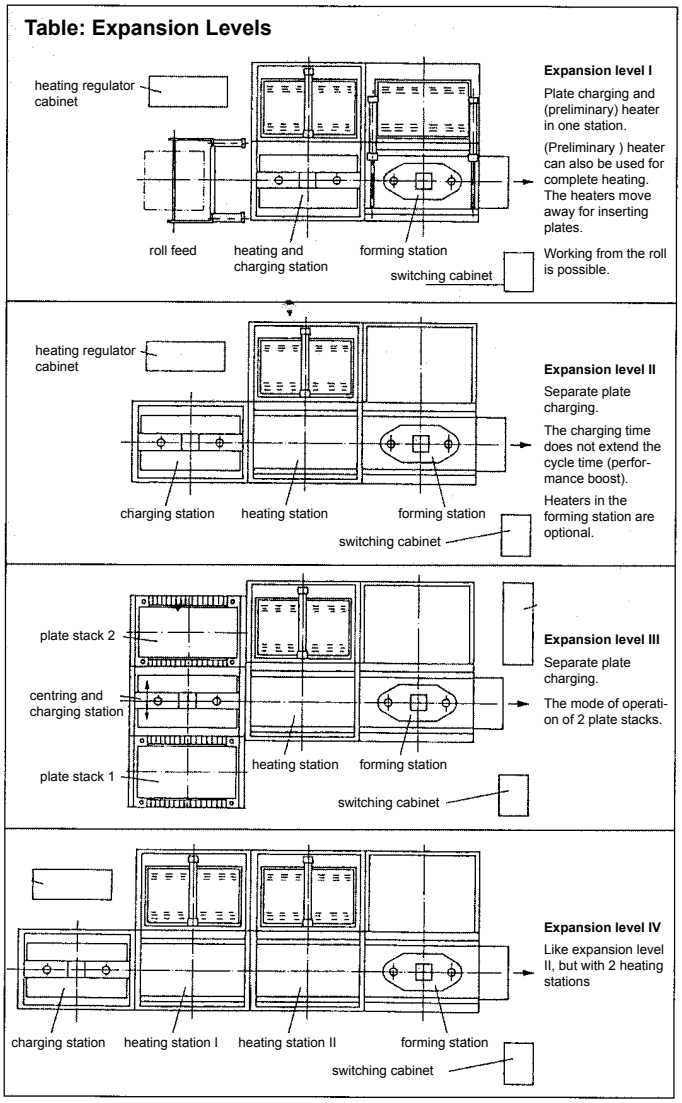
Production should not do without automatic charging with plates or foils or automatic extraction of the finished part because the boost in overall performance and low reject rates make this expansion level a profitable investment. Multiple-operation of hand-charged machines is no longer an argument.

The charging and extraction equipment is designed for automatically charging the forming station with plates or trim from the roll. The finished part is removed at the same time as transporting the trim or unmoulded plate in, which makes it much faster than manual charging.

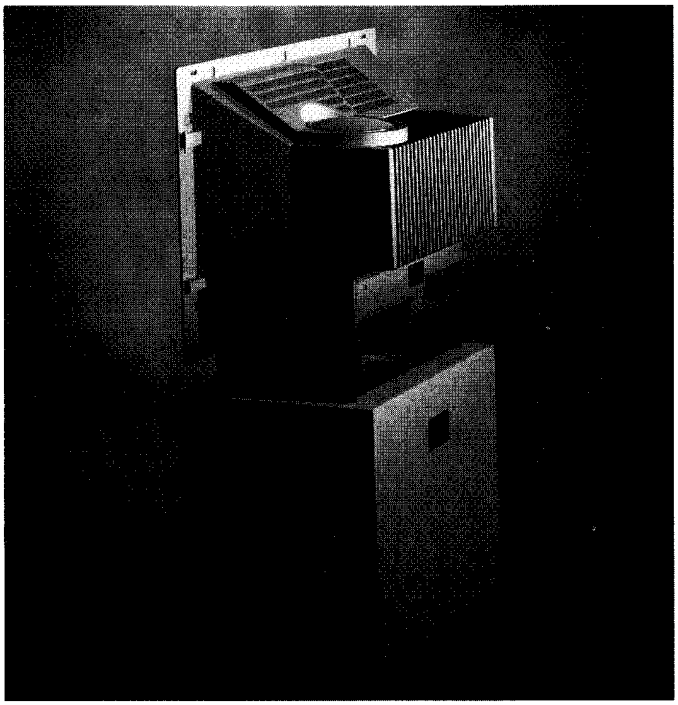
This equipment is mounted on the left-hand side next to the basic machine and the guide bars on the plate magazine for the plate stack can be adjusted by automatic digital input of the plate dimensions on the control panel via retooling program. The suction plates for lifting the plates into the transport system are available in a number of standardised sizes intended for automatically coupling with the lifting equipment.

The basic frame of this completion module already has the fasteners for installing the upper and lower preheaters that can be immediately ordered or supplied later.

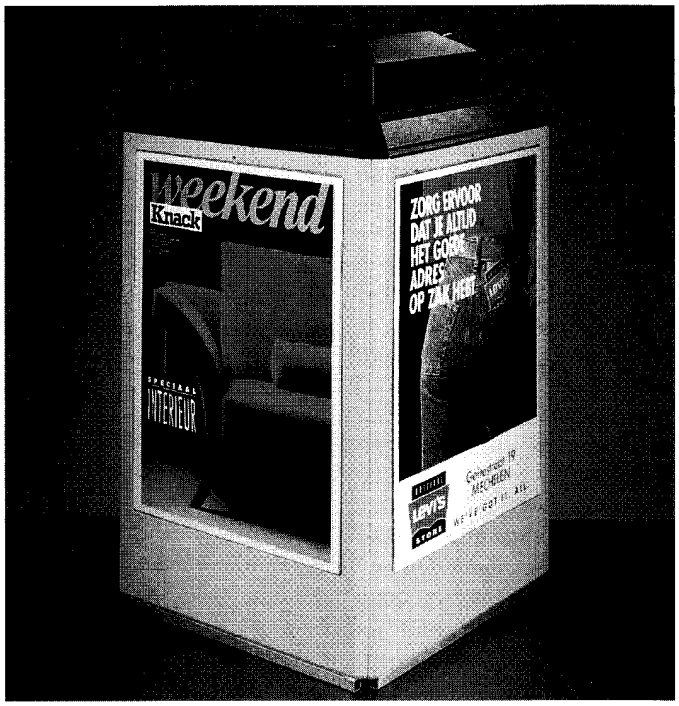
Table: Expansion Levels



Four expansion stations in the UA thermotransfer system make it possible for companies to adapt their operations to the maximum extent.



Formed with Illig machines: large-image monitor in a particularly aesthetical design (factory picture: Vitaro).



Efficiently produced advertisement boards made of plastic draw consumers' looks (factory picture: Vitaro).

Something new about the preheating system is the option of heating up the plate to the deformation temperature while stopping the heating in the forming station. This is made possible by a lower vertical moveable preheater that a coolable format frame is attached to and sealed. The plate inserted beforehand between the flap sides and the transport chain is clamped in by lifting the lower heater with the lower format frame against an upper frame fastened on a transport bar during the heating process.

Clamping makes air-supported heating possible where the clamping edges simultaneously stay cold and stable. This stabilisation allows the plate heated to deformation temperature to be transported without significant contraction in the direction transverse to transport. That means that it is charged and heated simultaneously with moulding, cooling and mould removal.
This expansion level allows a performance boost of as much as 50% as compared with hand-charged machine while as much as 20% energy can be saved per cycle. Performance diagrams are also available as a decision-making aid that show the potential production performance per expansion level depending upon plate thickness.

After the charging time from this expansion level goes into the overall routine time, installing a preheating module between the charging equipment and the forming station provides an additional performance boost. This expansion level is excellent for a number of applications. If the heaters are retained in the forming station, small numbers of pieces or individual parts can also be manufactured with hand charging. However, it only makes sense to add on two preheating modules if the heating time is determined by the cycle in regular production.

This expansion level is a profitable investment for production with large lot sizes.

An expansion level for charging two plate stacks from the pallet in large-scale production would make sense in the refrigerator industry.

A state-of-the-art PLC control unit allows full utilisation of mechanical module engineering and two stages of completion are available here.

A PLC with universal operation is supplied as the basic equipment. The set-up data for the product are stored on EE-PROM cassettes and the data are read into the control system again with another edition of the product. Provided that the material data and environmental impacts have not changed substantially, the product is manufactured again at the same output and quality as with the previous edition.
Automatic retooling is a component of the control program. First of all, the retooling program routine removes the mould where the moulds are unlocked in the package with the clamping frame and then moved into the alternating position with the mould table. The plate centring bars move into the zero position on the charging unit and the suction plates are unlocked and set down. Manual work is limited to a couple of actions.

A PLC with a colour monitor and storage unit for the product set-up data on diskette is available for more sophisticated tastes while the monitor shows the machine routines, heating temperature settings, set-up data for the mechanical/pneumatic routine and fault diagnosis. This control system design also allows operator-guided basic settings with new products.

The control system queries product data from the set-up man and calculates the set-up data in accordance with the input. This package of functions substantially reduces the initial rejects normally found with empirical calculation while this new modification system allows optimum adjustment.