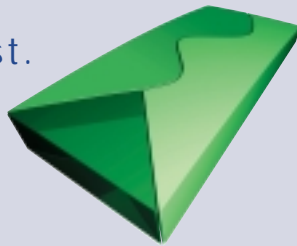


be the first.



Machines

- ENGEL VICTORY
- ENGEL DUO
- ENGEL CLASSIC
- ENGEL E-MOTION
- ENGEL INSERT
- ENGEL ELAST
- ENGEL LIM

Integrative technology

- ENGEL ROBOTS
- ENGEL CONTROL SYSTEMS
- ENGEL PRECISION MOLDS

Technology

- ENGEL COMBIMELT
- ENGEL FOAMMELT
- ENGEL GASMELT / WATERMELT
- ENGEL TECOMELT
- ENGEL FIBERMELT
- ENGEL X-MELT

Services

- CUSTOMER SERVICE DIVISION

Language

- german
- english
- french
- italian
- spanish



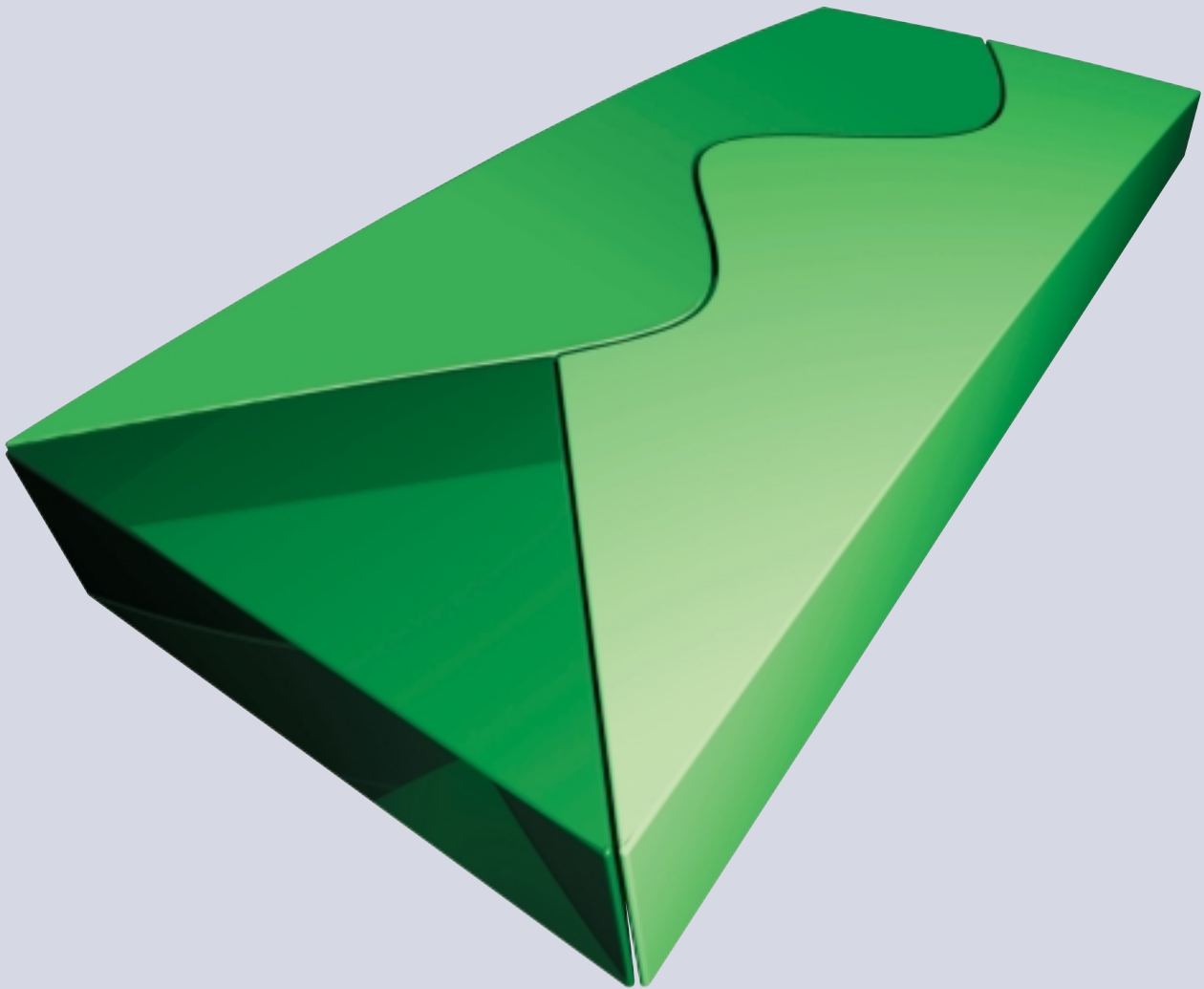
ENGEL NORTH AMERICA: www.engelmachinery.com

Canada: Engel Canada Inc.
Guelph N1K 1C2 Ontario
phone: (519) 836-0220,
Fax: (519) 836-3714
e-mail: sales@engel-ec.com

USA: Engel Machinery Inc.
York, 17402 PA
phone: (717) 764-6818,
Fax: (717) 764-0314
e-mail: usasales@engel-ec.com

Mexico: Engel de Mexico S.A. de C.V.
Mexico City 11230, Mexico
phone: (52-555) 399-8999,
Fax: (52-555) 399-2649
e-mail: engel@prodigy.net.mx

>> To achieve the possible, one has to keep
trying the impossible. << Hermann Hesse (german novelist and Nobel prize winner)
be the first.



Innovative injection molding technology

ENGEL
combimelt

ENGEL COMBIMELT.
Innovation through combination.

2





The whole is always greater than the sum of its parts.

Alloys, mixtures, mergers, fusions, blends, symbioses, joint ventures – all are combinations of one kind or another, and all of them testifying to the fact that it is better to join forces than to go it alone.

Combinations unite individual properties to form a more advantageous whole, for unity is strength.

ENGEL COMBIMELT technology, which is based on this principle, embraces all the known techniques of producing multi-component injection molded parts from plastics, featuring different properties and/or colors or from completely different types of material.

ENGEL COMBIMELT.

The process at a glance.

4

ENGEL COMBIMELT technology embraces all the various types of injection molding processes for the production of composite parts from thermoplastics, elastomers and thermosets.

These multi-component injection molding processes can be divided into two main groups, according to the intended function of the molded part:

- a composite molding
- b assembly molding

a Composite molding

Sequential molding

This process, which also includes multi-color injection molding, involves the sequential addition of different plastic components. It is used, for example, for the mass-production of control elements, such as keys and pushbuttons, incorporating abrasion-resistant back-lit symbols molded from translucently pigmented plastics.

Another typical example is the multi-component injection molding of rear light covers, featuring differently colored segments.

Overmolding

This process is used, for example, when handles and finger grips on equipment housings have to be provided with a soft, non-slip covering.

This is done by overmolding the thermoplastic part with an elastomer.

Co-injection

Also known as sandwich molding, this process can be used for the production of multi-layer parts (usually three layers) and involves separate injection of the skin and core melts.

The two outer skins provide the part with a high-quality surface finish, while the reinforcing materials in the central core improve the part's mechanical and heat-resistant properties. The use of reclaim for the core can help to reduce costs considerably, and a foam core reduces weight.

b Assembly molding

Component assembly

By selecting materials which do not adhere to one another, it is possible to produce articulated parts – knuckle joints, for example – assembled in the mold, thus waiving the need for downstream assembly.

Assembly molding of seals and gaskets

Special rigid/flexible composites, e.g. combinations of thermoplastic polymers with thermoplastic or conventional elastomers, can display an extremely high strength bond without any need to coat their mating surfaces with coupling agents.

Rubber/thermoplastic composites, which are used in cases where low weight and freedom from corrosion are of the utmost importance, are rapidly replacing rubber/metal composites. A similarly important area of application is the in-mold fitting of seals and gaskets. Thermoplastic elastomers are used as sealing materials in most cases.

Material combinations – suitability and bond strength.

The achievable tensile strength and shear forces between the bonding surfaces are dependent on:

- the material combination
- the process and the process control system used
- the part geometry

The time available for forming an intimate bond between the component materials is extremely short. This means that, irrespective of the anchoring mechanisms in the materials (interlocking action of the molecules or chemical reactions), free molecular movement must be present in the contact surfaces. Thus, the important parameters here are the temperature of the contact surfaces and the crystalliza-

tion or glass transition temperatures of the materials to be joined together. Further factors influencing the strength of the bond are additives and fillers, and also specific conditions of use. It is possible to modify the adhesion behaviour of certain materials by means of compatibilizers. The table below provides an overview of the achievable bond strengths of various material combinations. In the case of combinations of incompatible materials, i.e. materials which do not readily bond together, the connection must be effected mechanically, through a positive interlock, for example. In-mold assembly techniques utilize such incompatibility for the production of articulated joints.

| MATERIAL COMBINATIONS | | Thermoplastics | | | | | | | | | | | | | | | | Rigid / flexible composites | | | | | | | | | | | |
|-----------------------|----------------|---------------------|-------|----|-----|------|--------|-----|----|----|------|------|-----|----|----------|----|-----|-----------------------------|-----|-------|-------|------------|-------|-------|------|--------|-----|-----|--|
| | | | | | | | | | | | | | | | | | | TPE | | | | Elastomers | | | | | | | |
| | | ABS | ASA | CA | EVA | PA 6 | PA 6.6 | PBT | PC | PE | PETP | PMMA | POM | PP | PPO mod. | PS | PSU | PVC-W | SAN | TPE-A | TPE-E | TPE-S | TPE-U | TPE-V | EPDM | NR/SBR | SBR | LSR | |
| Preform / Insert | Thermoplastics | ABS | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | ABS/PC | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | ASA | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | CA | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | EVA | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | PA 6 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | PA 6 mod.+25 % GF | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | PA 6.6 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | PA 6.6 mod.+25 % GF | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | PA 6.12 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | PA 12 mod.+25 % GF | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | PBT | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | PC | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | PC/PBT | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | PE | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | PETP | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | PMMA | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | POM | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | PP | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | PPO mod. | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | PPE mod. | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | PS | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | PSU | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | PVC-Hart | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | SAN | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | D TPE | TPE-E | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | TPE-U | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | Elastomers | BMC | | | | | | | | | | | | | | | | | | | | | | | | | | |
| EPDM | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| NR | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| SBR | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| LSR | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Bond strength of various material combinations:

- Good bond (cohesive fracture)
- No bond
- Bond modification
- Peroxide crosslinkage
- Poor bond (adhesive fracture)
- No test results
- Sulphur crosslinkage

ENGEL COMBIMELT.

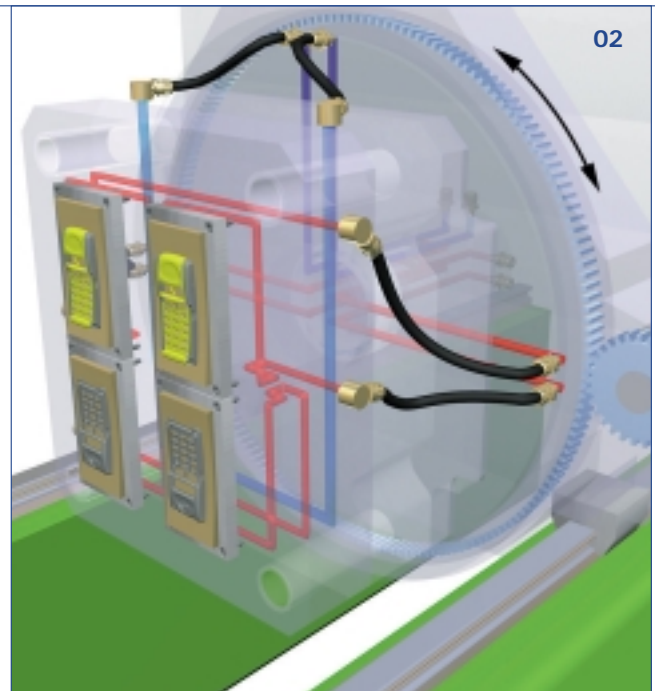
Rotary table system – with vertical rotary module.

6



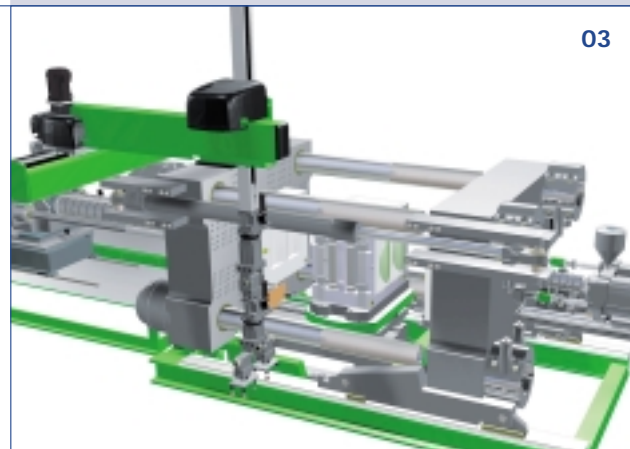
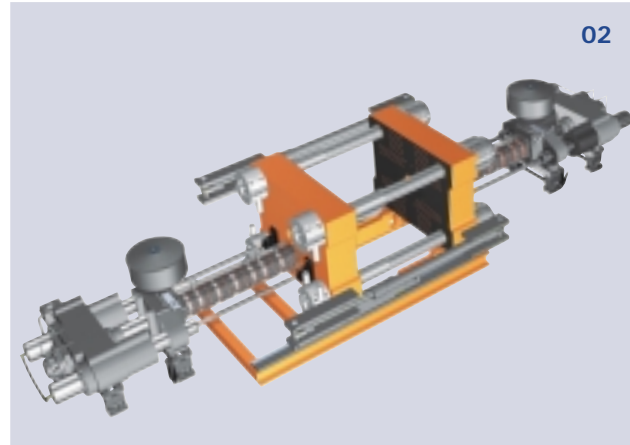
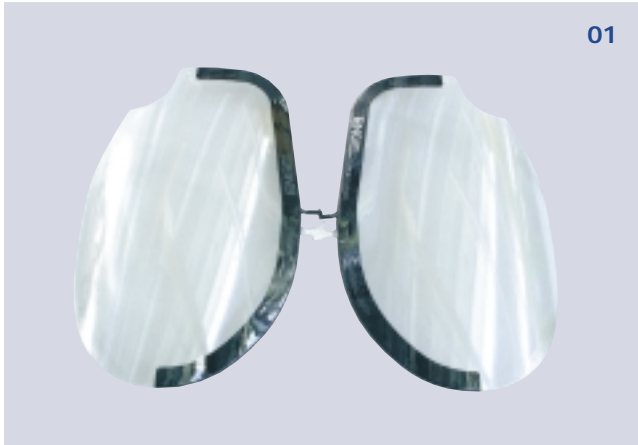
Mode of operation

The rotary table system is the one most frequently used with the Combimelt process. It is used for both overmolding and sequential molding processes. The moving platen of the machine is equipped with a rotary module. The stationary mold half has two different mold cavities, while the moving mold half has two identical cavities. After the first injection operation in station 1, the rotary table turns through an angle of 180 degrees and transfers the preform to the second, larger cavity in the stationary mold half. The empty space between the preform and the cavity wall is now filled with the second material. The rotary table is rated for alternating rotation through an angle of ± 180 degrees. A special rotary coupling permits the unrestricted supply of media to the injection mold. As the rotary table is an integral part of the injection molding machine, it can be used for several molds. Rotary tables are available with up to 4 indexing positions.



- 01** Mobile telephone housings sequentially molded in two colors.
- 02** The rotary table is a standard option which is available on every Engel injection molding machine. A special rotary coupling permits the unrestricted supply of media (heating-cooling medium, electrical wiring, hydraulic oil) to the injection mold.

Reversing slide system – with horizontal rotary module.



Mode of operation

An ideal solution for the production of large – and especially for long – parts, is the use of the large-capacity ENGEL DUO (two platen) injection molding machine. The machine is used in conjunction with a rotary module, mounted on a sliding carriage inside the clamping unit, and an injection unit mounted on each platen.

For such applications, the combination of the horizontal rotary module and the cube-shaped central part of the injection mold makes better use of the available space between the tie-bars than is possible with a rotary table system.

What is particularly advantageous about this system is that the two injection units are mounted on the two opposite platens. This permits a simple design of the central, moving part of the mold and waives the need for a complicated hot runner system.

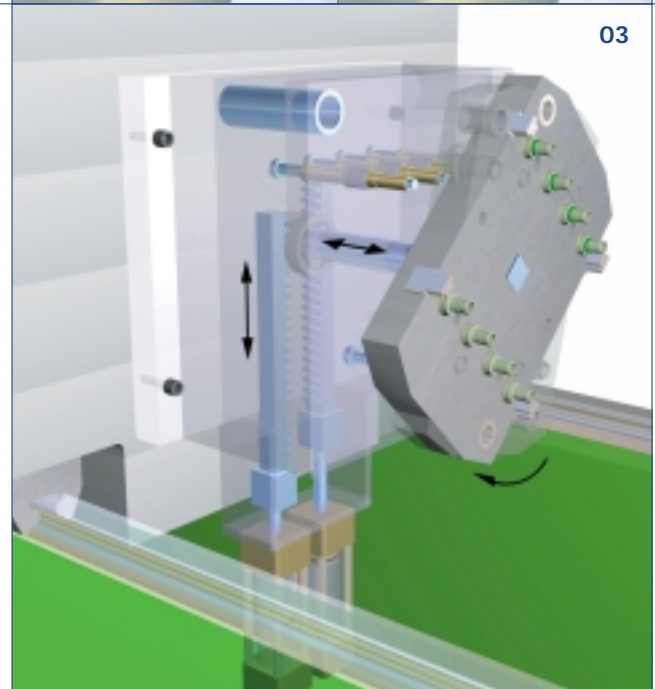
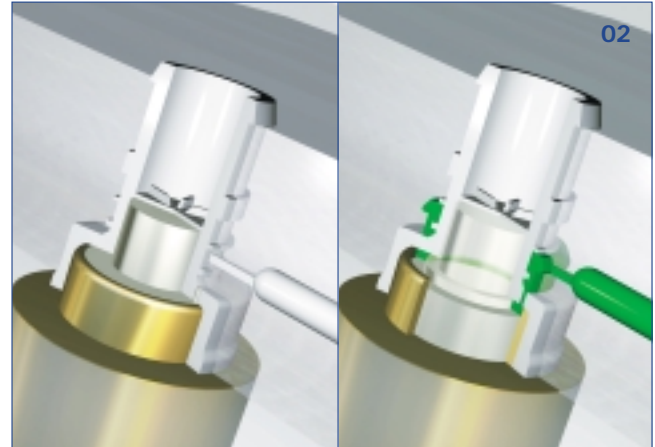
This system is particularly suitable for large-area parts with integrally molded seals or gaskets (e.g. car window panes).

- 01** Car headlight lenses.
- 02** Combined with two injection units mounted on both platens and a horizontal rotary module integrated into the clamping unit, the ENGEL DUO machine provides the basis for the reversing slide system.
- 03** The horizontal rotary module carries the central part of a double-daylight (stack) mold. The combination of the horizontal rotary module and the cube-shaped central part of the injection mold permits optimum utilization of the available space between the tiebars. As the central part of the mold can revolve in steps of 90 degrees, it affords optimum access for insert-placing and parts-removal robots. As in the case of any standard double-daylight (stack) mold, the central part of the mold is kept in a central position, in relation to the platens, during the opening and closing movements of the clamping unit by means of a positively actuated hydraulic control.

ENGEL COMBIMELT.

Index plate system – for unlimited scope.

8



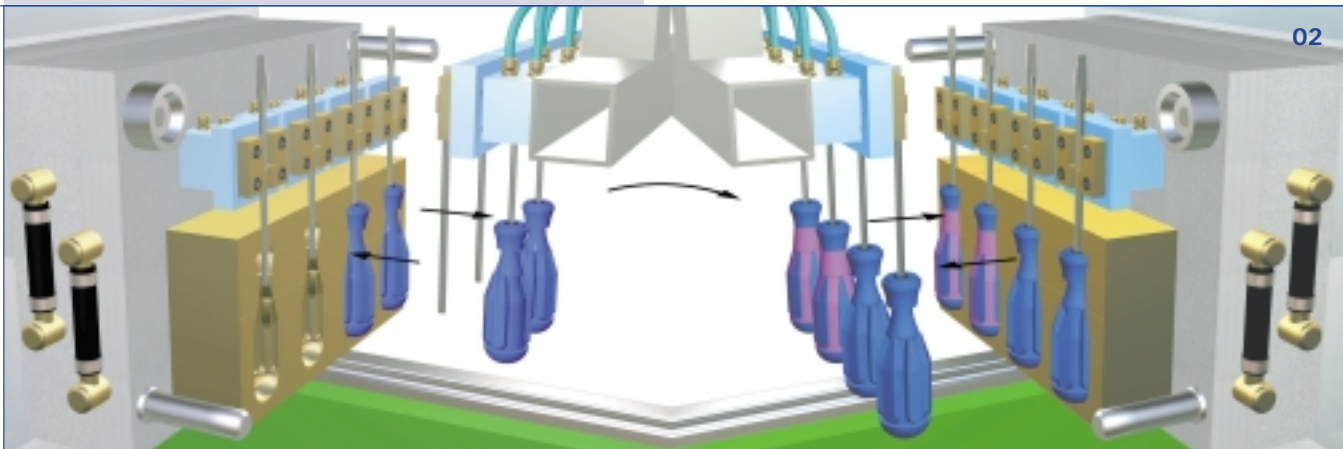
Mode of operation

With the index plate system, the rotating and transfer functions are integrated in the mold. This system must be used in cases where the second component material is to be molded onto both sides of the preform (moving mold half and fixed mold half). To this end, the preform, after being molded in station 1, must be transferred to station 2, overmolded on one side, rotated, and then overmolded on the other. This is done by means of a so-called index plate in the mold, which removes the partially molded part from the cavity, rotates it and replaces it.

The drive of the index plate is integrated into the mold and adapted to the actual molding requirement. The index plate system affords the greatest possible scope for combining two or more materials in a molded part.

- 01** Precision closure with integrated seal for medical apparatus.
- 02** Process stage 1: injection molding of basic part (preform)
Process stage 2: Transfer of preform to station 2 and injection molding of seal
- 03** The "index plate" is normally an integral part of the mold. After each injection operation, the index plate moves out of the "parent" mold, rotates together with the part, and then moves back into the mold in readiness for the next injection operation. The system is limited in terms of size by the maximum part weight that can be handled by the index plate.

Transfer system – for small batches and special solutions.



Mode of operation

This process is used primarily in cases of application where composite injection moldings have to be combined with awkwardly sized or shaped inserts or where the use of a rotary table or index plate system would necessitate the use of a disproportionately large clamping unit.

The transfer system is also used instead of the index plate system when the preform cannot be held by an index plate because of its geometry.

A handing robot is used for transferring the parts from cavity 1 to cavity 2. The transfer operation may take place either in the same mold, without any need for rotation, or between two adjacent injection molding machines. Vertical rotary-table indexing machines with workpiece holding fixtures are also used in special cases.

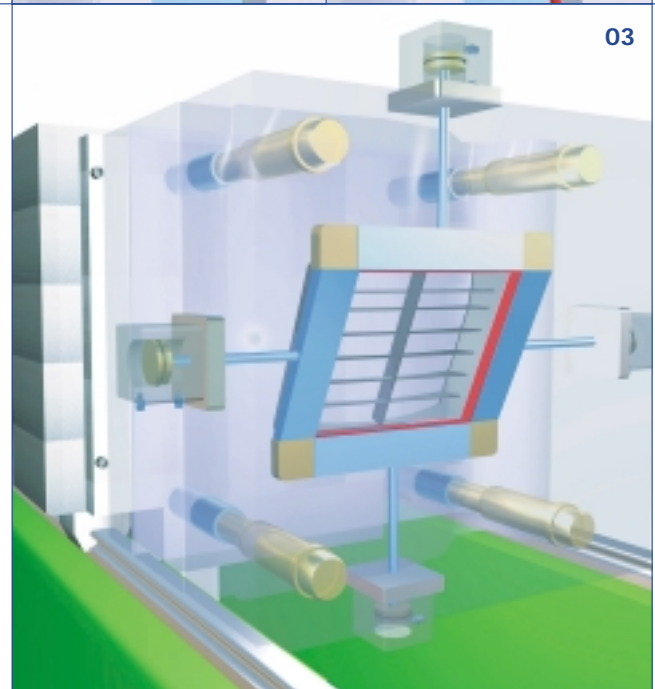
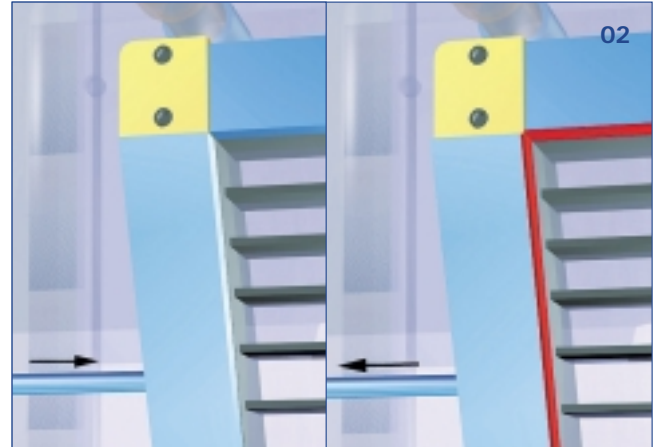
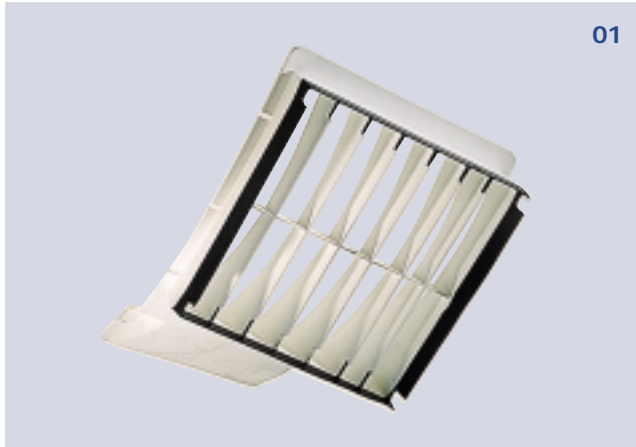
01 Typical example: screwdriver combining insert with two-component injection molded part.

02 The transfer of molded parts is possible not only between two adjacent injection molding machines but also on just one machine, such as an ENGEL INSERT rotary-table machine (see ENGEL INSERT brochure) equipped with 2 or 3 injection units. The combined operation of two Combimelt-equipped injection molding machines, each equipped with two injection units, readily permits the production of four-component parts.

ENGEL COMBIMELT.

Sliding split system – Combimelt without transfer of parts.

10



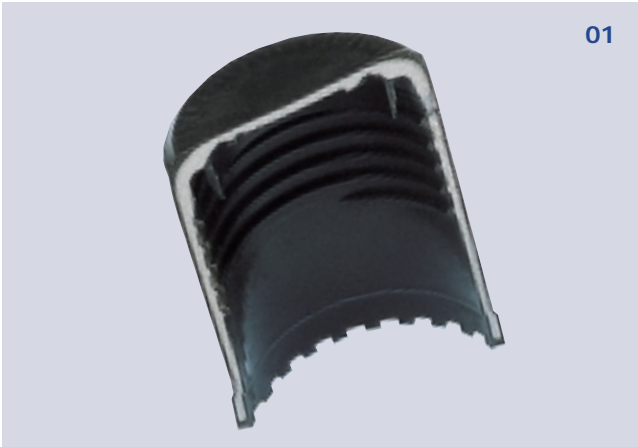
Mode of operation

With the in-mold slide method, the cavity area of the second material is sealed off by hydraulically actuated slideable inserts or locking slides, which are opened after injection and initial cooling of the first material. In contrast with the other methods, injection of the second material is not done simultaneously, but sequentially without opening the mold.

With no need to transfer parts, and with a less complex mold construction, this method may be economically viable for lower volume production, in spite of the longer cycle times generally associated with this method. Also, the more compact mold construction allows – in some cases – the use of smaller machines. The feasibility of the in-mold slide method is heavily dependent on part design.

- 01** Air duct with molded-on seal.
- 02** Photo on left: injection mold for two-component in-mold slide method. Slide in closed position for injection station 1. Photo on right: Slide in open position, permitting injection of second component.
- 03** The use of the in-mold slide method for sequential multi-component injection molding necessitates close collaboration between product designers and application engineers. The design of the molded part must permit economically efficient use of the in-mold slide method, notwithstanding its inherent complexity.

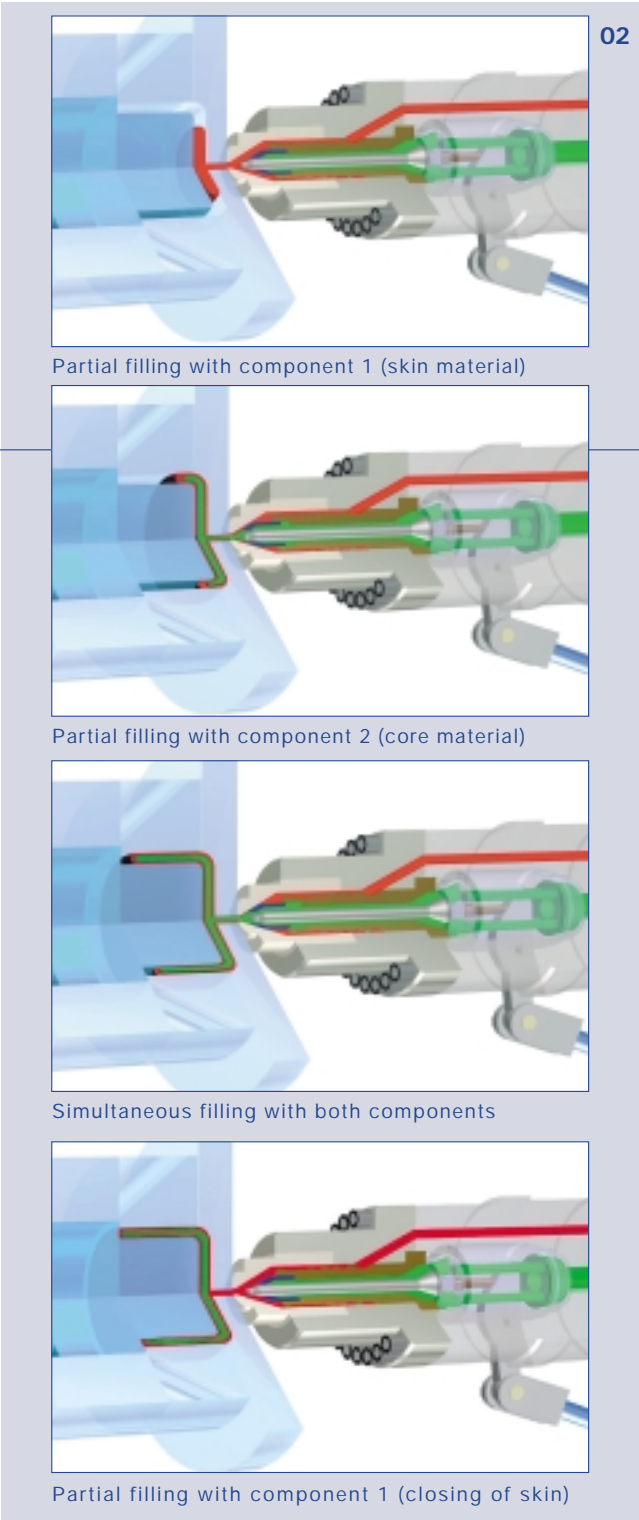
Co-injection – for sandwich and multilayer parts.



Mode of operation

The co-injection process is used – in cases where multilayer parts are a possible alternative – either for reasons of cost (use of reclaim as core material) or for the sake of functionality (internal strength combined with high-quality surface finish). For this application, Engel offers an equipment module for mounting on an injection molding machine equipped with a second, vertically arranged injection unit. This module consists of a special co-injection nozzle which connects the two injection units. The nozzle feeds the melt streams via forced feed mechanisms in such a way that a defined partial filling of the mold cavity takes place with the "skin material" prior to injection of the core material, via the same gating system. Thus, one material is injected into the other. The already solidified outer layers of the skin material cannot be displaced and thus completely encloses the core material.

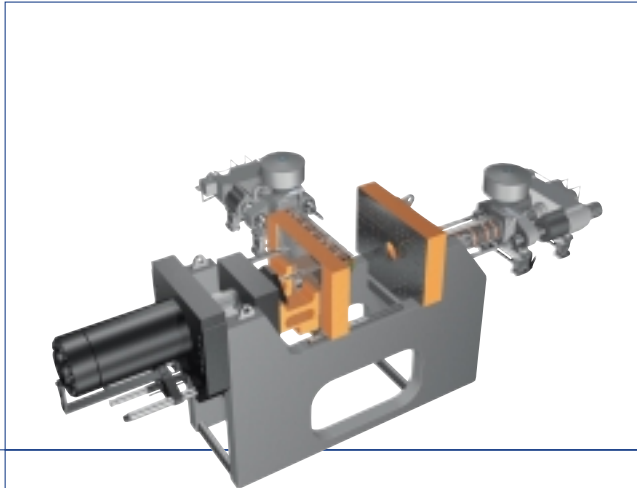
- 01 Two-component screwcap (virgin material for outer skin, reclaim for core)
- 02 The ENGEL COMBIMELT co-injection process produces a multilayer composite by feeding different streams of melt through the same nozzle. The mold does not normally differ from a standard type of injection mold. It is not equipped with rotary modules.



ENGEL COMBIMELT.

Injection unit combinations in "L" arrangement.

12



Injection units in "L" arrangement

Injection unit combinations in the "L" arrangement afford free access to the plasticizing unit. The nozzles can be centred by means of a crank mechanism for coupling to the stationary and moving platens. "L" combinations can be utilized on any desired size of injection unit, and on all basic machine models.

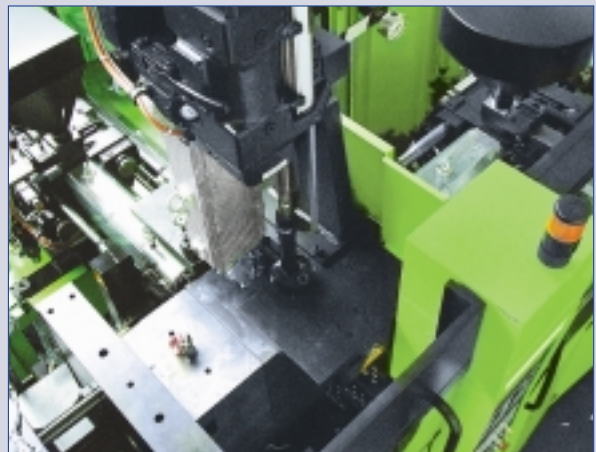
The machine equipment packages for the Combimelt multi-component injection molding process are generally of modular construction and comprise of:

- injection units from Engel's entire range of models
- drive modules – hydraulic and electric
- CC 100 control system: the integrated multi-tasking Multimaster system permits the control of time-critical parallel processes in many Combimelt applications, with just one control system. Using the standard ENGEL MICROGRAPH PLUS software, the control system displays the process curves of all injection units simultaneously, and in real time, on a high-resolution VDU.
- rotary-table units, available in diameters of up to 2 metres

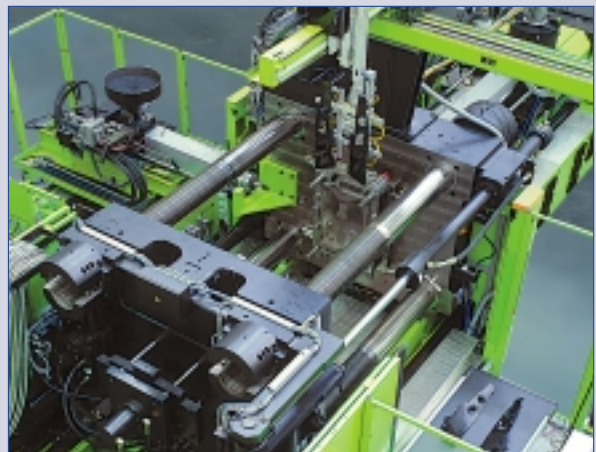
Combimelt injection molding machines are available in a wide range of standard configurations. Non-standard versions can also be supplied for special requirements – please inquire.

01 By reason of the simple design of their clamping units, tiebarless injection molding machines are ideal for use in conjunction with ENGEL COMBIMELT injection modules.

02 Combimelt injection modules are available for the entire range of Engel injection molding machines – including large-capacity ENGEL DUO machines.

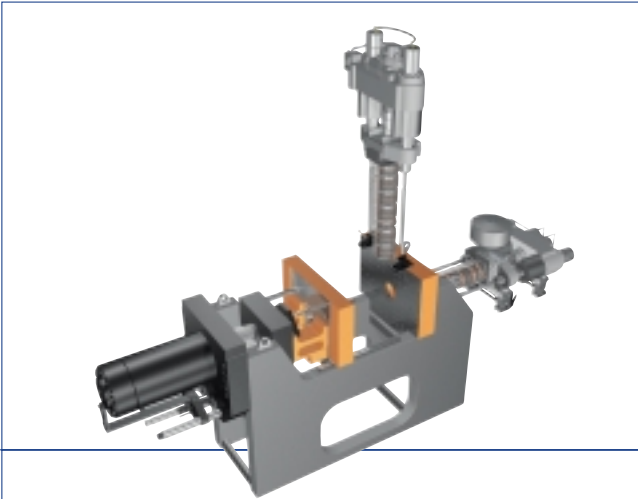


01



02

Combined horizontal and vertical injection units



Vertical injection unit

Vertical injection units are mounted above the stationary platen on a moving carriage. When the mold has to be changed, the vertical injection unit can be pushed back in the direction of the horizontal injection unit. This feature also permits easy and accurate centering of the injection nozzle over the gate.

Machines featuring combined horizontal and vertical injection units can be readily converted for co-injection. With this in mind, the rails for the moving carriage are extended towards the horizontal unit, permitting connection of the vertical unit with the horizontal unit by means of the special co-injection nozzle. This co-injection arrangement has proved ideal for use on small and medium-sized machines.

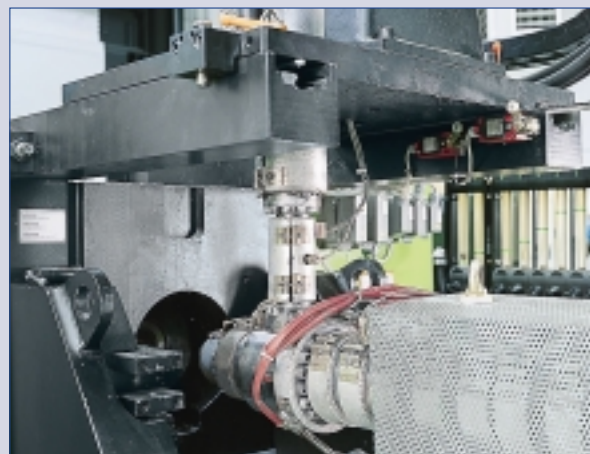


01

13



02



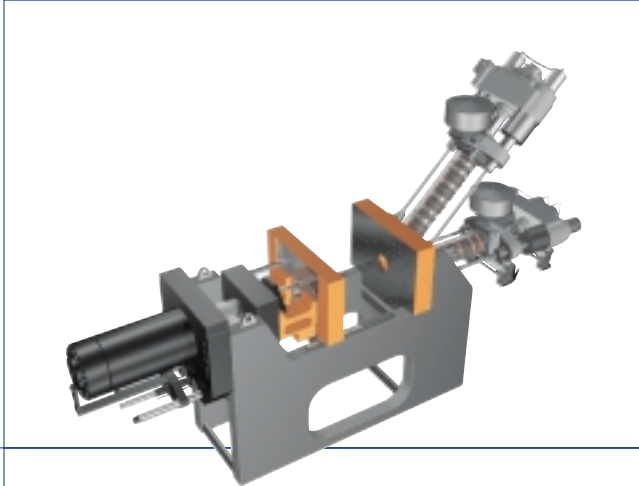
03

- 01 Small Engel tiebarless machine with vertical injection unit.
- 02 Tiebarless injection molding machine with a clamping force of 660 tons – the largest tiebarless machine which can be equipped with a vertically positioned second injection unit.
- 03 Vertical injection unit coupled with co-injection nozzle. (A standard option for two-component injection molding).

ENGEL COMBIMELT.

Injection units in "piggyback" arrangement.

14



"Piggyback" injection unit

The piggyback injection unit (i.e. second injection unit positioned above the main injection unit) constitutes a space-saving solution for an automated Combimelt production machine with a handling robot mounted on the stationary platen. The second unit is positioned at an angle above the main unit. Both injection units move in parallel, ensuring a constantly equal distance between nozzles regardless of the respective depths of insertion.

The upper injection unit is equipped with an additional contact pressure unit which permits independent nozzle retraction or nozzle insertion to different depths. The piggyback arrangement of the injection units within the ENGEL COMBIMELT range of machines is based on a standardized distance between the nozzles. Non-standard versions are also available – please inquire.

- 01** Production cell of medium-sized, tiebarless Engel injection molding machine with injection units in piggyback arrangement.
- 02** Close-up view of "piggyback" arrangement of injection units. This arrangement constitutes the most space-saving option, as the floor space required is no greater than that taken up by a standard machine. An additional advantage is the possibility of using standard demolding robots.
- 03** Piggyback injection units can also be combined with large-capacity ENGEL DUO machines.



01

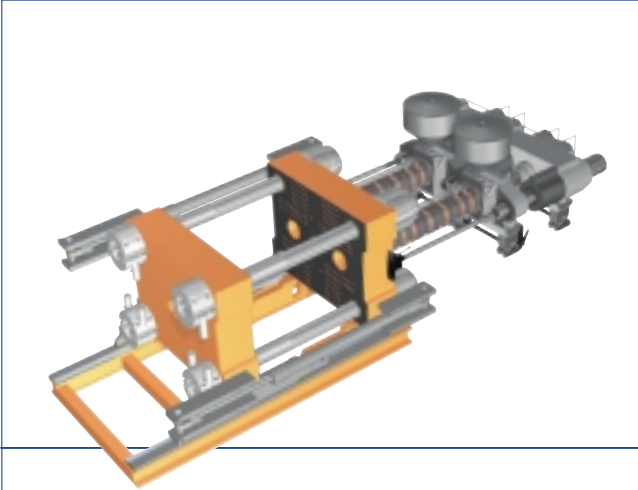


02



03

Parallel injection units for special jobs.



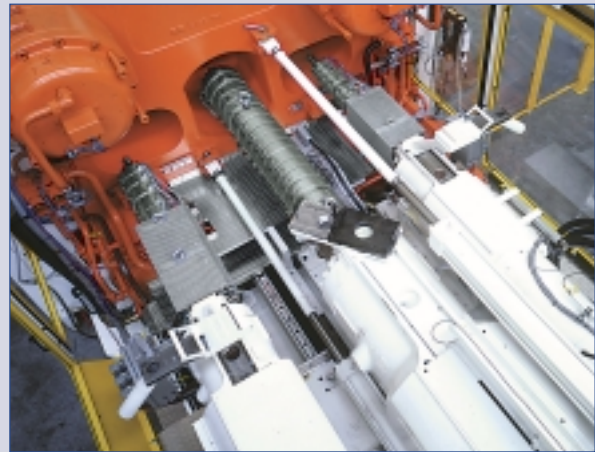
Parallel injection units

Combimelt injection molding machines equipped with several injection units in parallel arrangement can be used for a diversity of applications. One of the principle applications is the production of multi-color rear light covers and other multi-component parts. The machines used are primarily of the large-capacity type, equipped with up to four parallel injection units of varying size.

Further typical applications for parallel injection units are the co-injection of parts on large-capacity machines or the multi-point gating of large injection molds for conventional – i.e. one-component – parts.



01



02



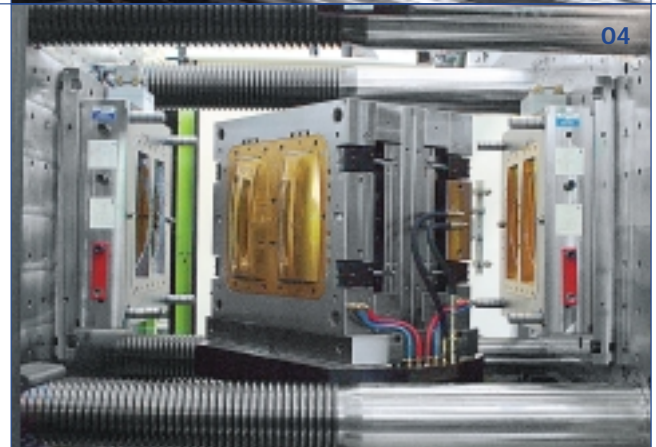
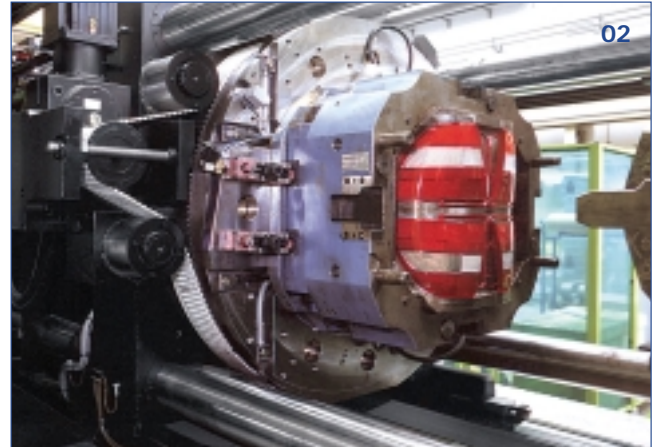
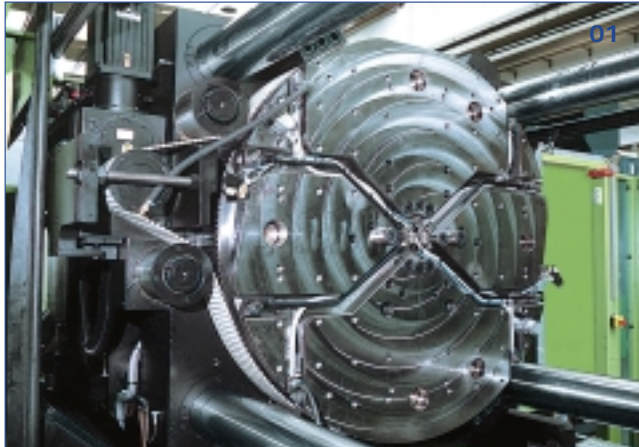
03

- 01 Example of a four-unit machine with three parallel injection units and one additional injection unit in the "L" arrangement, for the production of rear light covers.
- 02 Close-up view of an ENGEL DUO machine with three differently sized injection units in parallel arrangement.
- 03 Parallel injection units can also be used for special applications, such as the parallel gating of two molds simultaneously, or for the production of large two-component parts.

ENGEL COMBIMELT.

Rotary tables – universal, service-proven, efficient.

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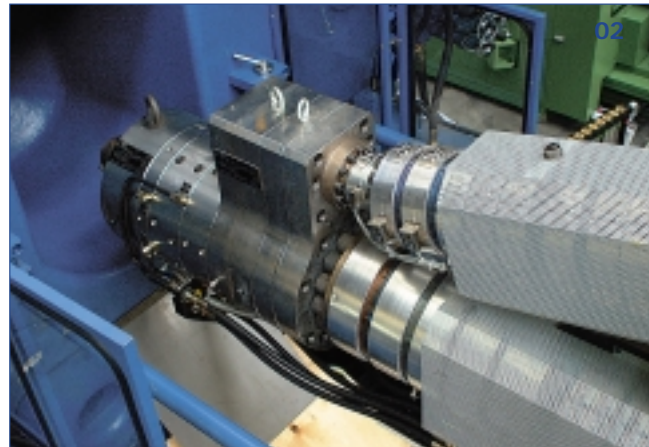
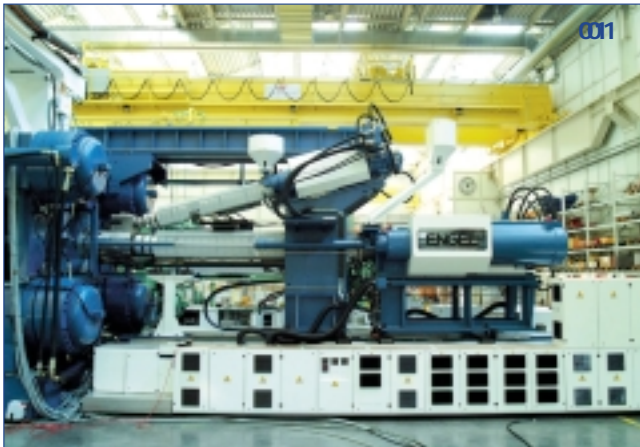
Engel rotary tables are distinguished by the following features:

- Available in a range of diameters from 23.6" (600 mm) to 78.7" (2000 mm), to suit the entire range of Engel machines. Other sizes are also available – please inquire.
- Rotary table drives are generally hydraulic – electric motor drives are available as optional alternatives.
- Fast rotation:
 - > less than 1 second for 180 degree turn of a 23.6" (600 mm) dia. table
 - > approx. 2 seconds for 180 degree turn of a 55" (1400 mm) dia. table
- Max. table thickness 5.3" (135 mm) when equipped with hydraulic drive. This means that mold height compensation, by extending the length of the machine frame, is only necessary in very special cases.
- All rotary tables feature an electronic rotation angle control for absolutely exact indexing.

- All rotary tables have provision for the fitting of lead-through couplings for the media (including multi-circuit heating-cooling water or oil).
- All rotary tables are available for two-station or three-station indexing operation, with either reversing or full rotation.

- 01** Two-station rotary table with electric toothed-belt drive. An integrated manifold system is available for distribution of the media from the central lead-through coupling to the connection points located on the outside of the rotary table unit.
- 02** Example of rotary table application with a two-station injection mold for the production of rear light covers.
- 03** Rotary table with hydraulic drive and integrated lead-through coupling interface.
- 04** Application example of a horizontal rotary table used in conjunction with an injection mold with rotating central plate, for the production of car headlight lenses.

Co-injection for large parts.



- 01** ENGEL DUO injection molding machine equipped with a 4400 tons clamping unit and two injection units in piggyback arrangement, for injection via a common co-injection nozzle.
- 02** Close-up view of co-injection nozzle.
- 03** Co-injection molding machine with injection units in angled arrangement.

ENGEL COMBIMELT.

Multi-component injection molding – for a whole diversity of value - e

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ENGEL VICTORY 1350H / 330L / 400TL Combi

Two-component production cell for the manufacture of two-color parts or rigid/flexible composites. With the addition of a discharge conveyor and a sprue separating station, this production unit is capable of fully automatic, unattended operation.



Tiebarless injection molding machine with a clamping force of 400 US tons.

Second injection unit in "L" arrangement.

ENGEL ERC 63 / 1-CH 3 axes servo linear robot.

Robot peripherals comprising of discharge conveyor and sprue separating and disposal station.

Electric shaver

For products of everyday use – such as kitchen appliances, haircare products and tools – combinations of colors, materials and properties considerably enhance their value. Combimelt injection molding is the ideal process for the production of such products.



- enhancing applications

ENGEL INSERT 1350H / 650 / 750H / 3 x 90 V-SO

Special Engel machine with rotary-table clamping unit and 3 injection stations for the multi-component injection molding of tool handles.



Rotary table with workpiece holding fixtures for metal inserts (screwdriver or knife blades).

Injection mold for injection station 2.

Injection mold for injection station 3.

Injection mold for injection station 1.

Screwdriver handles

Screwdriver handles with components injection molded from thermoplastic elastomer for improving their functional properties. In principle, all kinds of handles can be molded onto metal objects. This example stands for the many different applications of the Combimelt injection molding process.

