integrat
Segmented mould temperature control

Effective and energy-conscious temperature control. Significantly increasing productivity.
Mould temperature control = process quality

Temperature control and cooling have a decisive influence on the quality of moulded parts and the profitability of plastic processes.

Initial situation: Hot-Spot 142°C, long cycle time, warpage problems

Optimization: Core temperature 103°C, short cycle time, significantly increased quality
Important properties of moulded parts, such as
- **mechanical strength**
- **surface quality**
- **dimensional compliance**
- **warpage**

are determined by the quality of mould temperature control. At the same time, it has an influence on the cooling time that can be reached and is thus an important factor for the cycle time, and therefore the profitability of the injection process.

To determine the cooling time that can be reached, the highest quality and process relevant temperature of the moulded part must be considered. Unfortunately, in practice it is hardly the case that a temperature profile that is evenly distributed over the total moulded part exists. The reason for this is that generally thermodynamics do not play a part in the design and construction of an injection mould. The result of this in most cases gives uneven temperature distribution over the mould resulting in insufficient part quality and unnecessarily long cooling times.

Only thermally optimized injection moulds ensure high quality stable parts profitably. In order to achieve the target values for thermal mould design and to fulfill the mechanical, dimensional and optical requirements of the molded part we need to achieve the optimum mould temperature with even distribution over the mould in the shortest possible cycle time.

Moulded parts with complex geometries require more and more different temperatures in different areas of the mould. Therefore segmented mould temperature control is becoming more and more important.
"Drilling around corners" = Reduced costs

Securing a technologically leading position in international competition permanently requires highly developed procedures for producing plastic products. The most important role in the process chain is played by its chief link – the injection mould. The close-to-cavity cooling channels inserted by gwk using modern processes enable the mould insert system integrat 4D to fully meet the requirements of cycle time and quality which more traditional cooling channels are unable to meet.

Apart from modern production facilities we have qualified and specialized personnel for production and experienced, highly qualified project engineers and designers from injection mould and plastic technology. This team develops and produces the mould inserts with close-to-cavity temperature control – always in close cooperation with the customer.

Ideal heat exchange in the injection mould is the first criteria to be fulfilled. An even temperature profile over the whole of the moulded part surface is the target in order to achieve the optimal temperature control result. The cooling channels must be arranged inside the mould according to this requirement. In practise, it is often difficult to arrange the drill channels with conventional drill technology in a way that is required for ther-
mal reasons. A safe and proven method to increase productivity is close-to-cavity arrangement of the cooling channels with the *gwk integrat 4D-system*, an innovative technology, unlike traditional drill technology.

The special production method allows, so to speak, drilling "around corners", and by circumvention of openings, ejector pins and other installations to install in the mould an average of three times as large a heat-exchange surface in relation to conventional drill technology. An increasing number of renowned mould manufacturers are using this technology to produce moulds for packaging and technical products giving increased productivity.

Worldwide, there are already several thousand injection moulds with close-to-cavity integrated temperature control already in use.

**In practice:**

**Example 1:**
PA6.6 GF35 carbon brush guide, produced in MuCell-procedure with *integrat 4D*

*Result: saving of cycle time: ca. 26% *
Exacly reproducible, warp-free part quality
When fine tuning of the design is complete, the inserts are produced as blanks with the integrated, close-to-cavity temperature control included. The mould insert is constructed of several individual pieces. Inside these pieces the individual cooling channels are installed, circumventing openings, slide guides, ejectors and other insert openings. After the mechanical work is completed the individual pieces are connected with each other permanently in a high-temperature vacuum process. The strength of the combined pieces is equal to the strength of the basic material.

The mould manufacturer receives a blank with the following features:

- Excess material for trimming as agreed with customer. Installation of the finished blank and fitting will be carried out by your design and construction team with the usual processing procedures of the trade.
- Temperature control "channels" and all threads, openings and drillings have already been installed.
- The products are supplied hardened and tempered, after intensive quality checks. They comprise hardness tests, density test, flow determination and ultrasound checks of the joint levels.
- If desired, the surfaces of the cooling channels are coated with a special finish which prevents surface corrosion.

In practice:

Increased productivity through mould temperature control that follows contour – practical examples: Typical task for optimizing production costs and cycle times.

Example 2: PA6 GF30 gearbox casing

<table>
<thead>
<tr>
<th>Heat exchange surface in the fixed half:</th>
<th>Heat exchange surface in the moving half:</th>
</tr>
</thead>
<tbody>
<tr>
<td>With conventional temperature control:</td>
<td>With conventional temperature control:</td>
</tr>
<tr>
<td>6,847 mm²</td>
<td>6,253 mm²</td>
</tr>
<tr>
<td>With integrat 4D-temperature control:</td>
<td>With integrat 4D-temperature control:</td>
</tr>
<tr>
<td>19,016 mm²</td>
<td>18,972 mm²</td>
</tr>
</tbody>
</table>

Cost-benefit-analysis:

- Additional costs: 1,620 €
- Savings: 9,500 € p.a.
- Pay back: 2 months
The results:
- We reduce cooling times by about 30% compared to conventional temperature control systems.
- We increase moulded part quality by means of a homogenous temperature profile.
- We reduce the number of rejects.

Your advantages:
- Significant saving of valuable production time.
- Dramatic lowering of cost per part.
- Increase of your competitiveness.

A practical example:
An injection mould manufacturer of large parts receives a request to supply in the future per year 520,000 items instead of 400,000 items. However, the existing machine is operating at full capacity, and other existing machines are not suitable on the basis of their technical specification. The investment in another 27,000-kN-injection mould machine with periphery for about 1.2 mil. EUR and another mould for about 550,000 EUR are not worth the investment if operated at 30% capacity. The thermal mould analysis ordered reveals a savings potential of at least 35% if the temperature control in the injection mould is optimized. The comparatively low costs for the realization allow production of the additionally required parts on the existing machine at extremely profitable conditions.
B version with manual setting of flow rate

R version with automatic flow rate control
**integrat direct** – Modular flow control for water up to 95°C

**integrat direct** is innovative gwk-technology for cooling, multiple temperature control and temperature monitoring for plastic processing. When we developed the integrat direct, it was our objective to design temperature control processes that are safe, reproducible, fast and easy. We have combined the advantages of traditional water distributors, of impulse cooling systems and continuously operating temperature control devices while eliminating the disadvantages of each of these systems. **integrat direct** is the process compatible replacement for conventional water taps previously installed on every injection moulding machine. The water provided by a central supply (cooling plant, chiller or temperature control unit) is distributed to the individual mould circuits. Depending on the temperature differences or water quantities defined by the regulating unit, **integrat direct** automatically regulates the water flow rate for each mould circuit.
Energy conscious temperature control

Mould circuits

UV = Mould circuit supply
UR = Mould circuit return
KV = Cooling water supply
KR = Cooling water return connections
HV = Mould heating supply
HR = Mould heating return
Ideally, instead of standard partition plates the *integrat direct R* is installed close to the mould onto the clamping plates of the injection moulding machine. This eliminates the complex installation of traditional systems and minimizes the pressure loss in the temperature circuit. Flow and temperature is measured on the central water connection. Each regulating circuit is equipped with a flow meter, a return temperature sensor as well as a continuous regulating valve which automatically adjusts the water quantity according to the process parameters.

The modular structure of the valve blocks allows various configurations, so that it is possible to realize temperature spreads at different temperature levels depending on the number of connected temperature control units.

The regulating range lies between 1 and 15 l/min. This ensures sufficiently high turbulence and good heat transfer values for larger heat quantities to be dissipated, but also allows regulation for smaller heat quantities. In conventional systems on the market, this has been a weak point. The rated cooling capacity per circuit is 14 kW: this is a value that, in connection with efficient direct cooling, ensures high cooling quality. The system is designed for water temperatures of up to 95°C.

The modular structure of the *integrat direct* allows high flexibility of integration into new and existing processing systems. The regulating circuits can be integrated or positioned either on a rack close to the machine or integrated into the machine at a suitable location.

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**The process-optimised alternative to conventional cooling water distributors**

- Individual closed-loop control of the flow rate for each circuit
- Optimum process control through setting, regulation and continuous monitoring of the return water temperature and the flow rate
- Energy saving up to 70%
- Simple, intuitive operation via touch-screen
- Perfect integration into injection moulding machines possible, close to the mould
Touch screen control

All important operating parameters can be called up on the touch screen. The intuitively operated control interface is clearly structured for the respective operator. All setpoint and actual values are clearly shown for all circuits on a central colour display, which can also be installed close to the operator and separate from the regulating circuits on the injection machine.

For process monitoring, clearly structured tables and graphics provide an overview of the most important process parameters. The actual status is noticeable at a glance. All set data can be saved on the central mould management system and called up when a mould is re-used.

A mould check function gives individual indication of any fault in the installation including hose connections and fittings before production commences and a help function makes identification and rectification of any problems simple to correct. A

integrat direct
its advantages at a glance

The central functional element of **integrat direct** is a touch panel with coloured display which is used to operate all important functions. All parameters are represented in clearly laid out tables and graphic displays.

**easy**

Important features of the moulded part, such as mechanical firmness, surface quality, size accuracy and warping are determined by the quality of mould temperature control. By permanently monitoring the flow rate, the **integrat direct** makes this process safe.
help function related to the context makes identification and elimination of malfunc-
tions easy.
Interfaces allow continuous communication of the integrat direct with machine con-
trols and central computers.
The operating unit is usually placed immedi-
ately next to the controls of the injection
machine. Complete integration into the
operation of the injection machine is also
possible.

The **integrat direct R** regulates the flow rate
in each cooling circuit individually and con-
tinuously. Recording, monitoring and saving
of data ensures permanent process quality,
even after a mould is changed.

The functional principle of the **integrat direct**
allows exact and individual tuning of the water
quantity to the heat input per mould segment.
The result for the cooling process is a consider-
able reduction of the required water quantity,
which lowers the energy costs by up to 70 %,
even allowing for the increased production.
integrat direct –
Technical features at a glance

Important basic data / essential technical functions:
- Modular, permanent multi-circuit temperature control for segmented mould heating and cooling
- Individual temperature control of up to 128 temperature control circuits
- Highly efficient direct cooling
- No pump / no heating / no heat exchanger = Minimizing wear of consumables = Optimized availability
- Temperature monitoring / control via sensors in circulating water supply or return, or via external sensor installed in the mould
- Setting and monitoring of flow rate (B version)
- Setting and regulation of flow rate (R version)
- Continuity of the temperature control process through permanently regulating valves (R version)
- Mould check through water pressure and flow measurement
- Pneumatic mould draining option
- Hose rupture safeguard option
- Display of periodic maintenance instructions
- Graphic display of the process data
- Intelligent process data management
- Network compatible control system
- Interface compatible microprocessor regulation

Advantages:
- High process safety through monitoring and regulation of the flow rate in each individual circuit. Important parameters are defined, controlled and documented
- Optimal quality of moulded parts during the whole production process – 100% quality
- Touch screen with simple, intuitive operation
- Compact, space saving construction through multifunctional valve block
- Low complexity in terms of pipes and hoses
- Three-in-one – combines the advantages of the traditional water distributors, impulse cooling systems and continuously operating temperature control units and eliminates the disadvantages of these other systems

Technical data and standard equipment

<table>
<thead>
<tr>
<th>Type (B = Basic version, R = Control version)</th>
<th>itd B</th>
<th>itd R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium</td>
<td>water</td>
<td>water</td>
</tr>
<tr>
<td>Maximum temperature Standard version/ high-temperature version (°C)</td>
<td>95</td>
<td>95</td>
</tr>
<tr>
<td>Maximum heating capacity per circuit* (kW)</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Maximum cooling capacity per circuit** (kW)</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Flow rate (l/min)</td>
<td>1.0 bis 15</td>
<td>1.0 bis 15</td>
</tr>
<tr>
<td>Maximum operating pressure (bar)</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Flow monitoring</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>Flow control</td>
<td>–</td>
<td>•</td>
</tr>
<tr>
<td>Return temperature monitoring</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>Temperature setting of external water supply</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>Return temperature control</td>
<td>–</td>
<td>•</td>
</tr>
<tr>
<td>Common supply temperature for all circuits</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>On/Off of individual circuits possible</td>
<td>manual</td>
<td>automatic</td>
</tr>
<tr>
<td>Limited control temperature and flow rate</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>Process control using graphic display of temperature</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>Memory saving of mould data records</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>Mould check: Checking of flow rate prior to production</td>
<td>manual</td>
<td>automatic</td>
</tr>
<tr>
<td>Mould circuit supply / return connections per circuit</td>
<td>G ½&quot;</td>
<td>G ½&quot;</td>
</tr>
<tr>
<td>Central cooling water supply connections</td>
<td>G 1¼&quot;</td>
<td>G 1¼&quot;</td>
</tr>
<tr>
<td>Central cooling water return connections</td>
<td>G 1¼&quot;</td>
<td>G 1¼&quot;</td>
</tr>
</tbody>
</table>

* with additional external heating unit
** at 10°C cooling water temperature and 60°C process temperature

Technical changes reserved!
To fully utilize the advantages of segmented mould temperature control, we recommend using the multi circuit temperature control system **integrat 40**.

The basic principle of this technology is to take the different heat inputs from various areas of the mould and by controlling the individual flows and temperatures in such a way to give an even surface temperature over the whole mould. In connection with the direct cooling, **optimal mould quality at shortest possible cycle time** is achieved.

The mould quality is an important factor in the production process. Each item used in the process which helps to reduce rejects results in an increase of productivity. Not only are material and handling costs for the rejected parts saved, but also valuable machine time, which may be used for production of further items.
The new **integrat 40** – temperature control with minimum space requirement

**gwk integrat 40** is a modular multi circuit temperature control system that can be integrated into the overall process for segmented mould temperature control.

**The equipment consists of:**
- Central operating unit with touch screen and coloured display for input and monitoring of the process parameters
- Clearly structured operator guidance and process monitoring by means of tables and charts
- Saving of process data records in the integrated mould management
- Display of operation and error messages as text
- Limit comparator (tolerance monitoring of actual values with alarm report)
- Lowering to safety temperature
- Automatic air purge
- Automatic water top up via cooling circuit supply
- **Only one central electrical connection**
- **Only one central cooling water supply with in line filter**
- Filter in each process return
- **Digital flow indication for each circuit**
- Display of service intervals
- **Magnetically coupled stainless steel pumps**
- **Highly efficient direct cooling with flow regulation**
- Central pressure relief in the cooling water supply

**These options are offered additionally:**
- Hose rupture safeguard for cooling water supply
- Connection of external Pt 100 thermocouple
- Moulddrain via compressed air
- Interfaces for cable connections: Serial/Profibus
- **Cable-free communication interface:** Bluetooth (in connection with serial interface)
- Additional operating unit with touch screen for decentralized data input and process monitoring

The most visible advantage of the **integrat 40 multi-circuit temperature control system** in vertical design 6 temperature controllers on a footprint of 60 x 60 cms!
Multi circuit appliances enable precise partial influencing of the properties of moulded parts while at the same time optimizing the cycle time. This is achieved by thermal compensation of different flow path lengths, local hot runner influences inside the mould, wall thickness differences and different partial requirements for the moulded part concerning strength, surface quality, dimensional compliance and deformability. In addition, it is possible to a certain extent to compensate for temperature gradients between adjacent heating and cooling channels and any existing unfavourable design features in the channel layout.

The thermal analysis of moulded part and mould provides the basic data for optimal design of the temperature control system. Since for every consumer, the arrangement of the cooling channels is different and subject to constructive compromises, the temperature control system must be very flexible.

The **gwk** temperature control system **integrat plus**, is a modular, adaptive temperature control system for any number of circuits to be individually controlled. The different system components enable optimal adjustment to the process, under technical as well as economical aspects.

Selection of the components is always made on the basis to achieve all the desired properties of the moulded part at the lowest possible cycle time and at a maximum process safety with the lowest sensible investment costs.

**The temperature control system integrat plus consists of 4 modules:**

- **Electrobus** with a common cabinet and main switch for individual supply of the circuits. Quick plug in connection for the individual control modules.
- **Hydraulicbus** with a common cooling water supply and cooling water return for individual supply of the circuits. One separate process supply and return per temperature control circuit with inbuilt filter, which can be isolated individually. Quick coupling to cooling water supply.
- **Control module** per circuit with enclosure to IP 54 standard, with inbuilt gwk compact regulator and connection to each hydraulic module.
- **Hydraulic module** per circuit in housing including pump, heating, cooling, flow measurement, control and safety functions. Quick connection to the hydraulicbus.
The equipment leaves hardly anything to be desired:

- **gwk** compact regulator – easy to operate, interface compatible microprocessor control with high regulation accuracy
- Easy-to-understand central operating console with membrane-type keypad for data entry, function and disturbance indication
- Digital alpha-numeric clear text display of nominal and actual values in 4-line illuminated display
- Indication of operating and disturbance messages in text form with fault diagnostic
- Adjustable limit for set value (max. operating temperature adjustable)
- Limit comparator (tolerance monitoring of actual values with alarm report)
- Freely selectable ramp function for temperature changes during heating and cooling
- Electronically controlled pressure to limit outlet temperature
- Lowering to safety temperature during shut down
- Automatic venting
- Automatic water top up via the cooling water inlet
- Only one electrical connection
- Y-strainer in the cooling water circuit
- Filter in the process return line
- Shut-off devices in the process and cooling water circuit
- Continuous cooling control via motorized valve
- Flow control with digital display

The advantages are obvious:

- **Compact** space saving construction which can be integrated into any processing system
- **Flexible** design allows the hydraulic and electric modules to be installed independently from each other and in different places, e.g. hydraulic module close to the consumer, and control module in a position favourable for operation and controls
- **Continued** operation of the other circuits during maintenance or exchange of hydraulic and control modules
- **Combination** of different pump and cooling capacities possible
- **Reduced installation cost** through shared power supply and central cooling water connection
- **Connection** to the processing machine via any optional interface
- **High operative safety** even at high operating temperatures through elimination of thermal influences from the hydraulic module on the control module
- **Process monitoring** through integrated flow measurement
- **Leakage monitoring** through optional hose rupture safeguard
- **Start-up programme** can be utilized for pre heating of tools prior to production run
- **Saving** of error messages with time display in connection with optional 7 day 24 hour fully programmable timer
Technical data and performance features

**integrat 40 and integrat plus**

### Technical data and capacity information per circuit

<table>
<thead>
<tr>
<th></th>
<th>it 40</th>
<th>itp 60</th>
<th>itp 80</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of temperature control circuits per bus</td>
<td>2 to 6</td>
<td>2 to 12</td>
<td>2 to 12</td>
</tr>
<tr>
<td>Maximum operating temperature °C</td>
<td>95</td>
<td>140</td>
<td>140</td>
</tr>
<tr>
<td>Operating pump</td>
<td>Peripheral wheel pump</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum flow rate l/min</td>
<td>30</td>
<td>45</td>
<td>60</td>
</tr>
<tr>
<td>Maximum pressure bar</td>
<td>5,3</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Motor power kW</td>
<td>0,55</td>
<td>0,55</td>
<td>0,75</td>
</tr>
<tr>
<td>Heating capacity kW</td>
<td>3</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Nom. cooling capacity at cooling water temperature of 15°C and process temperature of 60°C kW</td>
<td>27</td>
<td>47</td>
<td>62</td>
</tr>
</tbody>
</table>

### Dimensions and weights

<table>
<thead>
<tr>
<th></th>
<th>it 40-temperature control module</th>
<th>itp-control module</th>
<th>itp-hydraulic module</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic width for the connection mm</td>
<td>608</td>
<td>138</td>
<td>88</td>
</tr>
<tr>
<td>Plus width per circuit mm</td>
<td>–</td>
<td>150</td>
<td>150</td>
</tr>
<tr>
<td>Height incl. plug and socket mm</td>
<td>1720</td>
<td>370</td>
<td>440</td>
</tr>
<tr>
<td>Depth incl. manifold mm</td>
<td>545</td>
<td>420</td>
<td>467</td>
</tr>
<tr>
<td>Weight per circuit kg</td>
<td>35</td>
<td>8</td>
<td>23</td>
</tr>
<tr>
<td>Circulating medium connections UV/UR</td>
<td>G½</td>
<td>–</td>
<td>G¾ / G¾</td>
</tr>
</tbody>
</table>

### Cooling water connections

<table>
<thead>
<tr>
<th></th>
<th>it 40</th>
<th>itp 60</th>
<th>itp 80</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply / return KV/KR</td>
<td>2 to 6 circuits</td>
<td>2 to 8 circuits</td>
<td>9 to 12 circuits</td>
</tr>
<tr>
<td></td>
<td>KV</td>
<td>KR</td>
<td></td>
</tr>
</tbody>
</table>

**integrate 40:** Each circuit is equipped with a pump and a heater. The connections for cooling water and circuit water are clearly arranged on the back of the modules.

**integrate plus:** Input and recall of all process data is effected via the central membrane-type keypad with integrated switching contacts. This is also valid for a multitude of reasonable options, as for example a starting program for mould heating, a timer with weekly program and the possibility of temperature data storage for different moulds.

### Cooling capacity at cooling water temperature of 15°C

![Graph showing cooling capacity at cooling water temperature of 15°C]

### Pump capacity

![Graph showing pump capacity]

Subject to technical modification without notice!
Perfect cooling and temperature control

Increased productivity
In many areas of the industry, cooling and temperature control provides a great potential for increasing productivity and thus for lowering costs.

Many factors serve to improve productivity:
- Reduction of cooling time, therefore savings in required machine hours
- Improvement of product quality
- Increasing availability of production plants
- Decreasing running cost
- Reduction of maintenance cost

gwk-integrat 4D
Optimal product quality through homogeneous temperature distribution with close-to-cavity cooled mould inserts.

gwk-teco cs
The universal solution for standard applications in the temperature range up to 160°C. Provides efficient options for continuous process monitoring.

gwk-teco wi/wd
Effective temperature control of applications with high material throughput. Also ideal for pre-heating of large mould tools.

gwk-teco cw
Most economic system to extract heat from consumers at very low temperatures by patented cold water temperature control.

gwk-weco
Controllable production in variable climatic conditions and high flexibility with compact, energy saving water chillers using environmentally friendly refrigerant.

gwk-hermeticool hybrid
Innovative cooling system to decrease the running and maintenance cost in comparison to conventional cooling systems.

gwk-SKL/SKW
Reliable and economic supply of cooling water in the low temperature range, even under the toughest ambient conditions.

gwk-moldclean
Increased productivity through effective, automatically controlled cleaning of heat exchange surfaces in cooling and temperature controlled circuits.

gwk-active
Adjusting and maintaining optimum capacity by means of constantly clean water, delivered from a fully automatic water treatment device.

gwk-service
Decreasing the maintenance cost and protection of company owned resources through professional installation and service including maintenance of cooling water.

Gesellschaft Wärme Kältetechnik mbH
Friedrich-Ebert-Straße 306 · D-58566 Kierspe
Tel. +49 2359 665-0 · Fax +49 2359 665-156
info@gwk.com · www.gwk.com