



TECHNICAL DATA SHEET

SK1TIAC

Thermo Infusion Automated Center

► DESCRIPTION

TIAC is used for manufacturing of parts made of composites by methods of High Temperature Resin Infusion and RTM (Resin Transfer Molding) and their modifications, including parts final polymerization. The center provides transfer technological processes in automated and manual mode with strict respect to preset parameters with high process repetition.

Basic equipment of the center:

- Injection unit with heating tank, and programmable interface for operations with high temperature resins,
- Heating unit with high homogeneity level at chamber's working space,
- Interlinked supervision systems of modules



Operations performed by TIAC using preset program:

- Resin preparation, heating and degasing,
- Controlled injection (feed by pressure) of resin in a mold or resin infusion (suction due to vacuum bag depressurization),
- Polymerization of manufactured part,
- Technological experiments recycle.





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Injection unit allows control and studying of process of reinforcing material impregnation by 6 technological parameters:

- Resin temperature
- Resin pressure (at RTM processes)
- Resin weight, injected in the mold
- Resin injection speed
- Leak resistance of vacuum bag or tooling
- Vacuum level, max. possible 1 mbar.

Heating module should allow studying of the curing process during the polymerization by at least 7 parameters:

- Air temperature in the chamber
- Temperature of the tooling
- Temperature of manufactured part
- Influence of the heating rates on the quality of manufactured products
- Influence of the cooling rates on the quality of manufactured products
- Time of heating cycle / curing
- Vacuum level.

In order to increase the accuracy of work, improve technological process and simplify reporting systems at the end of the process, the injection and heating module's software should be unified to exchange parameters of temperature, vacuum level, equipment availability to start the process, tool availability (tool temperature) for resin feeding, resin availability (degassing state / heating) for injection during all the process.

Computer system of control and data registration; software allows:

- simple and fast programming
- Precise temperature control for complex parts by gradient programming depending on part temperature
- data storage
- automatic report system of realized process
- language software – English and Russian

The integration with unique software of Heating module and Injection module allows a total control of the infusion process by following all parameters of the process:





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- Temperature of the part in the Heating module,
- Vacuum level in the bagging,
- Resin temperature in the Injection module tank,
- Resin weight injected to the part,
- Duration of each step of process,
- Guaranteed repeatability of the process by removal as much as possible of the Heating Module man factor.

The both way communication between the Heating module and Injection module allows a perfect synchronization of the process.

The software being specially designed for the infusion process, it allows:

- To define all curing cycle in the Heating module with unlimited number of segment
- To allocate to all segment DURATION, TEMPERATURE, VACUUM LEVEL, HEATING SPEED, COOLING SPEED
- To specify conditions linked to Injection module before changing segment
- To hold the heating cycle if resin in Injection module is not ready
- To start the injection at anytime decided with programming of conditions

The full process progress is visible on the screen of the control cabinet and allows the operator, providing he has the right authorisations, to change manually the parameter during the cycle.

The start of injection and end of injection can be decided either in automatic or in manual mode. As required, the injection can start only at a defined temperature of the part or after a certain time of heating of the part. The end of injection can be linked to the injected weight or to the duration of process as needed.

TIAC is a full-automatized equipment dedicated to infusion process.

The software includes a reporting module, which allows to record and to print all necessary quality report and that allow to keep the full traceability of the cycles.

► DESCRIPTION OF HEATING MODULE

Module is an industrial furnace, which corresponds to general standards: CE, UL, AQSIIQ, and for standards of aircraft industry such as NADCAP, AMS2750, BAC5621.

That type of equipment allows realizing the following types of heat treatment: drying, polymerization, vulcanization, preheating, stabilization etc. at temperatures up to 550°C for all kinds of composite materials, including aggressive media. Oven body is a modular construction, made of welded frame with internal welded skins. External skins are made of portable panels, connected with screws to the structure. To minimize heat losses the gap



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between skins is filled with ecologically clean nonflammable thermal insulation from mineral fiber. The floor and roof as well as sidewalls, are filled with thermal insulating material.



Oven: 2,1×1,1×1,3m, volume 3,00m³
Operating T=250°C



Oven: 3×4×2m, volume 24m³
Operating T=220°C



Oven: 5,5×6×3m, volume 99m³
Operating T=220°C

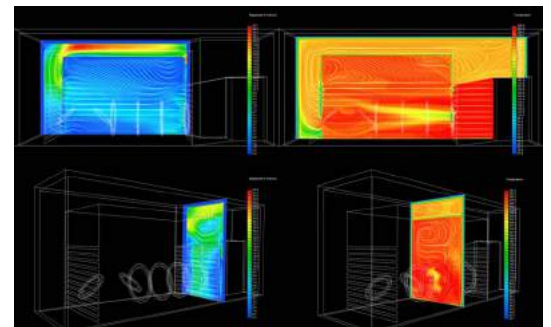


Oven: 6×22×4m, volume 528m³
Operating T=220°C

► HEATING SYSTEM

The heating of working volume is achieved by electrical heating elements sheathed in stainless steel protective housing. The heating elements are accessible and can be replaced from the outside of the oven.

Speed of heating and cooling is regulated by thermistor according to cycle recipe. Heating elements are specifically located to provide maximum thermal homogeneity.



Heat flow simulation during oven design



Maximum temperature gradient in ovens is defined by the customer during oven development and can be equal to $\pm 1^{\circ}\text{C}$. (For standard oven version the gradient is equal to $\pm 3^{\circ}\text{C}$).

The position of heaters of forced convection is determined according to size and shape of an oven by simulation method.

► FORCED COOLING SYSTEM

Quantity and location of suction fans is defined according to the oven volume and cycle recipe. Suction fan is installed on the oven's body. There is a gate on exhaust dust, which is opening when a fan is switched on. Suction fan is used to remove hot air after the finish of heat treatment process and to accelerate cooling of parts. Air cooling is realized by transmission shaft with the help of a turbine fixed on it. Shaft rotation is controlled by heating stop and by alarm in the case of breakage. Adjustment of the temperature homogeneity in the oven is made by changing the position of air baffles panels. That exhaust gate serves as an explosion protecting valve.

► TECHNICAL DATA

- Useful size of the oven: is defined by Customer. All oven useful volumes are possible.
- Three-phase supply line voltage: 380 Volts.
- Maximum use temperature: 550°C .
- Minimal heating speed: $0,2^{\circ}\text{C}/\text{min}$.
- Maximum heating speed: $8^{\circ}\text{C}/\text{min}$.
- Possible operating temperature range $40-550^{\circ}\text{C}$.
- Heating speed of working area is defined by operator.
- Cooling speed of working area is defined by operator.
- Possible doors: hanging doors on hinges (double shutter /single shutter), guillotine type door.
- Door actuation: manually / motorized opening.
- Possible design: pusher oven /box oven.
- Oven can be demounted after manufacturing.
- Oven has interior light
- Possible installation of observation windows in a door.

► VACUUM SYSTEM

The vacuum in the system is created by a vacuum pump. To avoid rarefying pulsation, vacuum system is equipped with air receiver.

According to customer technical specification the system is provided with different number of air suction lines, each vacuum line is equipped with solenoid-operated valve, which is closed in the case of vacuum leakage, manual independent valve, vacuum gauge and quick-disconnect plug for connection of vacuum hoses.

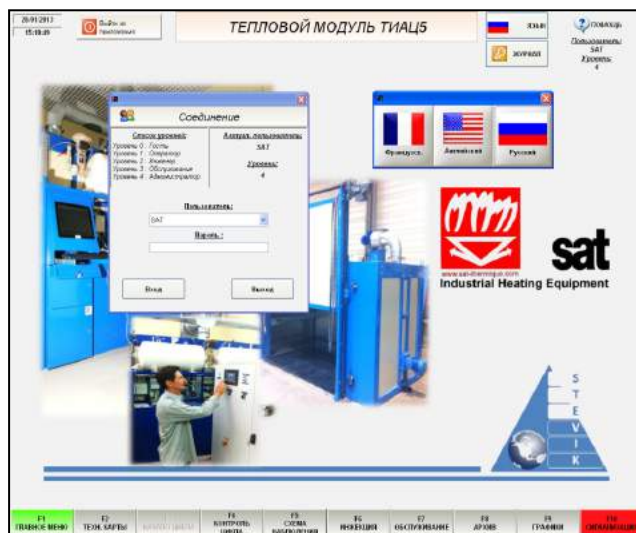


Example of vacuum system assembled

► SOFTWARE

Oven is provided with computer-aided control system, which allows setting and controlling process parameters of thermal treatment. Software is integrated for stuff of 5 different levels:

- 0: Visitor
- 1: Operator
- 2: Engineer
- 3: Maintenance
- 4: Administrator



First page of software : menu

Access level defines the amount of different operations and decreases the number of errors, which can appear during programming of process objective values by non-authorized stuff. Specialized pre-installed software provides oven control in one of 3 languages in the menu: French, English and Russian.



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The system can be connected to Ethernet of customer enterprise and can be remote-controlled

Software function «RECIPE » makes possible creating of a program cycle by choosing of the following sections:

- Velocity linear measurement: Setting of target temperature and step. That segment indicates time interval for achieving of predetermined temperature.
- Time linear measurement: Setting of target temperature and time. That segment indicates time interval for achieving of predetermined point.
- Delay: Setting of delay time. That segment keeps the target temperature of previous segment, temperature value can be changed.
- Step: Setting of target temperature. That segment allows setting of target temperature with automatic transition to the next segment.

The screenshot shows the 'Writing recipe' interface. At the top, there is a header with the date '22/01/2013', time '08:08:44', and the 'sat' logo. The main title is 'Writing recipe'. On the right, there are buttons for 'Language' (with a US flag) and 'Log'. Below the title, there are buttons for 'Load recipe', 'Saving', 'Save as', and 'Delete'. The main area contains a form with 'Name recipe: Test INEATEC V01', 'Check type: Piece', and 'Part check type: Coldest thermocouples'. Below the form is a table with 10 segments, each with various parameters like air gap type, air gap, piece/air gap, piece gap, cooling, operator validation, segment type, target, speed, duration, and vacuum. Below the table is a graph showing the temperature profile over 10 segments. At the bottom, there is a navigation bar with buttons F1 HOME, F2 RECIPES, F3 START CYCLE, F4 CYCLE FOLLOW UP, F5 OVERVIEW DIAGRAM, F6 INJECTION, F7 MAINTENANCE, F8 HISTORICAL, F9 CURVES, and F10 ALARMS.

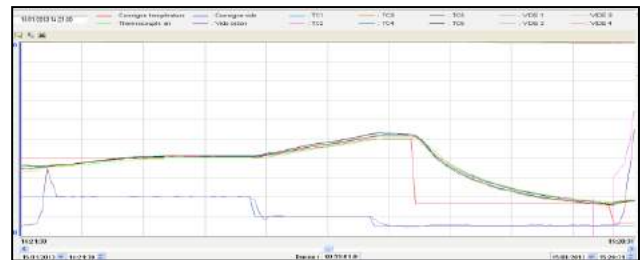
Segment	Air gap type	Air gap	Piece/air gap	Piece gap	Cooling	Operator validation	Segment type	Target	Speed	Duration	Vacuum
1	Without		2.0 °C	3.0 °C	<input type="checkbox"/>	<input type="checkbox"/>	Ramp by speed	100.0 °C	3.0 °C/min		- 980 mb
2	Bottom	3.0 °C	2.0 °C	3.0 °C	<input type="checkbox"/>	<input type="checkbox"/>	Ramp by time	150.0 °C		10 min	- 980 mb
3	Top	4.0 °C	2.0 °C	3.0 °C	<input type="checkbox"/>	<input type="checkbox"/>	Steady line			0 min	- 980 mb
4	Band	4.0 °C	2.0 °C	3.0 °C	<input type="checkbox"/>	<input type="checkbox"/>	Step	200.0 °C			- 980 mb
5	Without		5.0 °C	3.0 °C	<input type="checkbox"/>	<input type="checkbox"/>	Ramp by speed	200.0 °C	5.0 °C/min		- 980 mb
6	Bottom	0.0 °C	0.0 °C	3.0 °C	<input type="checkbox"/>	<input type="checkbox"/>	Ramp by time	100.0 °C		10 min	- 980 mb
7	Top	2.0 °C	2.0 °C	3.0 °C	<input type="checkbox"/>	<input type="checkbox"/>	Steady line			0 min	- 980 mb
8	Band	0.0 °C	0.0 °C	0.0 °C	<input type="checkbox"/>	<input type="checkbox"/>	Step	100.0 °C			- 980 mb
9	Without		0.0 °C	0.0 °C	<input type="checkbox"/>	<input type="checkbox"/>	Ramp by speed	50.0 °C	0.0 °C/min		- 980 mb
10	Without		0.0 °C	0.0 °C	<input type="checkbox"/>	<input type="checkbox"/>	End				0 mb

Example of creating of cycle recipe

The function «CURVES» allows entire visualization of realized cycle and creating a report of accomplished process, with the further printing.

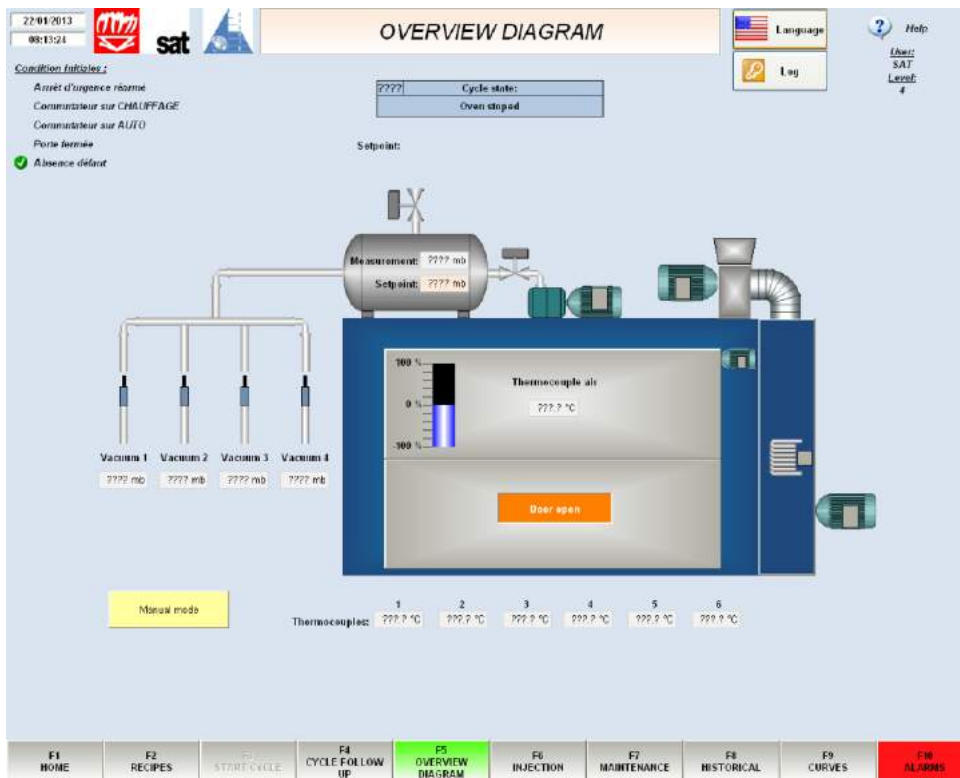
That data is automatically saved on a computer hard disk each 30 seconds:

- Set temperature value
- Value of air thermocouple
- Set vacuum value
- Vacuum value in storage tank
- Value of selected thermocouple of each part
- Values of selected vacuum lines



Example of obtained curve

State survey of actuating and construction units is displayed in animated diagram of heating module and vacuum lines.



Animated diagram

Software function «HISTORY» permits to overlook the information on the performed cycle at any time. At the end of each cycle the batch information (batch n °, recipe name, ...) is saved in database, and following files are automatically saved on computer hard disk:



- File «Date» (contains entire cycle data)
- File «Alarm » (contains alarms and cycle events)
- File «Report» (shows the link and cycle diagram).

Please contact us for more detailed information as well as for system development according to your technical specification.

Advantages of heating module:

- Energy saving due to high heat insulation of oven's body and floors – high efficiency of equipment.
- Controlled heating temperature till 270°C with speed change increment of 0, 2°C.
- Temperature homogeneity +/- 2°C during operation at oven working volume.
- Different configurations of heating modules: for laboratories or production chain, single or many chambers, with fixed or changeable chamber volume.
- Possibility of visual control of production cycle inside the oven by use of CAMELIA system.
- Vacuum control systems and forced cooling systems.
- Correspondence to standards BAC 5621, AMS 2750, Nadcap.

► INJECTION MODULE DESCRIPTION

Injection unit with vacuum tank(s) and programmable interface for operation with high temperature one component or premixed multicomponent resins. The system is composed of a tank and its peripherals, which can be installed in several stages based around the injection tank.

The constituent parts are as follows:

- the injection tanks and options;
- the electronic measurement apparatus (measurement of injected weights);
- the vacuum pump (degassing of the resins and/or the tooling);
- the electronic data processor and supervision of the machine (direct management by the PC of the injection machine, if connected with a PLC).

► INJECTION UNIT ELEMENTS

Injection tank

- Each steel tank mounted on three feet
- Max. dimensions: diam. 400 mm - height 450 mm, overall height 1000mm.
- Material: stainless steel.
- Tank capacity: min. 0,5l. - max. 50 l of resin.



- Tank characteristics:
- Pressure: 10 bar (or 2 bar)
- Pressure (tested pressure): 15 bar (or 3 bar)
- Vacuum: up to 1 mbar.
- Approx. weight of each tank: up to 140 kg.
- The tank cover is closed by screw action and it is composed of:
 - a vacuum /pressure gauge
 - a nitrogen connection with spherical valve;
 - an air/vacuum connection with 3 way valve for inversion;
 - an auxiliary connection for other functions;
 - two control points for temperature measurement
 - two resin outlet connections ;
 - a viewing window diam. 80 mm ;

1. Illumination of window

24V / 20watt illumination.

2. T/C K Temperature probe

Temperature probe with length 650 mm (direct measurement of resin temperature with display).

3. Electric agitation of resins

Electric motor, slow agitation, controllable speed, sealed unit, shaft and blade in steel, removable.

4. Heating of resin tank from bottom side

Heated volume in the tank must be between 0.5 - 50 l. Caution: during degasation process resin volume is increasing, that is why the container 90-l tank can be used for maximum of 50 l of resin. External heating device for tanks. Heated elements are placed outside of the tank. 230V\250W. Temperature regulation is based on PT 100 probe values in resin. Manipulation with control panel. Digital input / output.

5. Heated sole-plate

Plate for placement of peripheral equipment and tank shell.

6. Pneumatic tank-cover removal



Tank top cover may be opened using pneumatic system using air-pressure limiter. The cover is column-mounted and gives free access to the tank. Draining of the agitator is facilitated by an adjustable temporary stop device. Safety lock fitted for operator security.

7. Electronic pressure measurement instrument

Connected to an optional data processor, the electronic pressure measurement instrument operates at 24 V.

8. Mobile platform

The useful item incorporates the tank, control cubicle and accessories.
Dimensions: 1500 x 750 mm

9. Pinching valve

Pneumatic pinching valve adapted for silicon tube 7 (ID) X 13 (ED). The valve is actuated by a pneumatic piston. Switch on /off on control panel. This valve is heated.

10. Heated connection between tank and tooling

In order to avoid loss of heat, the flexible connection between the tank and the tooling can be heated to maintain the most efficient temperature. The preset and measured temperature of heated connection is displayed. The one-use silicon tube SK2RIM260-1 is placed in the tube, which is changed after each operation. Length 2,5m ID:10, 230V 50 Hz 375 W.

11. Electronic weighting device

- Operating voltage : 230 V 50Hz,
- Max. capacity: 150 kg,
- precision: 10 gr, digital display,
- 4\20mA signal for data recording, delivered with cables and connections,
- Attached using 3 screws to tank.

12. Vacuum pump

Power: 16 or 25 m³/hour, max. vacuum level 1mbar (no vacuum control)



Vacuum gauge with digital display. Value in mbars.

13. Pirani gauge

Compact and durable vacuum gauge for vacuum level measurement – is a key point of the unit, as it is important to use measuring equipment resistant for volatile resins, and pollution resistant. The signal has a high quality and can be easily detected by control system PLC Schneider

14. Full automated system, including PLC on 2 languages (Russian/English)

- Heating the resin up to a set point;
- Degassing the resin during a certain time and with control of level of temperature
- Injection of the resin with an applied pressure and up to a set point volume or duration
- Compaction after injection with a pressure level (can be different from the injection pressure)
- It is possible to memorize cycles in the PLC and this is possible with adjunction of a display. There is a possibility of message during the process and the operator knows exactly the phasis in progress and set points for the phasis.

The PLC is a SCHNEIDER/TELEMECANIQUE system. Software on 2 languages: English and Russian is included in price.

15. Data processor

(Can be added only with PLC) it is possible to work without PC if PLC is present

Description: The system consists of a means of continuous measurement of the different parameters of the injection process

- Pressure conditions (vacuum and pressurization of the tank).
- Temperature conditions (temperature of resin and mould).
- Weight injected into the tooling (weighing scales).

These data are managed by an IBM compatible personal computer. Windows XP / WIN 7. The machine is equipped with a tactile monitor 17 inches. USB ports and integration in control board

- weight4/20 Ma signal;
- vacuum level;
- pressure levels in tank;



- pressure on mould;
- temperature of resin within the tank
- temperatures in the tooling (5 T/C)

All incoming data are treated by the hard-disk loaded program, which can be set using the parameters in use by the operator. This provides the advantage of having available at all times a usable record of all parameters used in each application.

Software is included in the packages based on DASYPAB 9.0. The application is included with input data recording and reports with automatic printing after injection. Data storage of materials and parts (resin reference, tool references, operator's name). All data is also automatically stored on Hard disk each second and a saving of ASCII file is on the disk. Possible to work with EXCEL software.

Software on English and Russian languages. The system manages injection cycle:

- name of the file;
- name of the part;
- reference of resin and fabrics;
- name of saving files;
- injection flow or injection pressure selection
- cycle data (pressure , flow , injected quantity, to temperature for starting injection , resin temperature for starting injection, degassing duration, degassing resin temperature)

All the files are saved in the system; they can be opened and renamed. The system stores automatically data and it is possible to manage directly the machine by the PLC.

16. Installation, Customer's training in Russian language

Installation and training are made by qualified specialists of our company and by engineer of ISOJET. Start-up and Customer's training is in Russian language.

17. Filling system (Option)

The system consists of device for resin preparation, filling of a tank, track, heating housing and heated filling line. (Option)

Equipment set is mounted on a track in a special box, which has two cells (thermo insulated blocks) for placing of original containers with resin.



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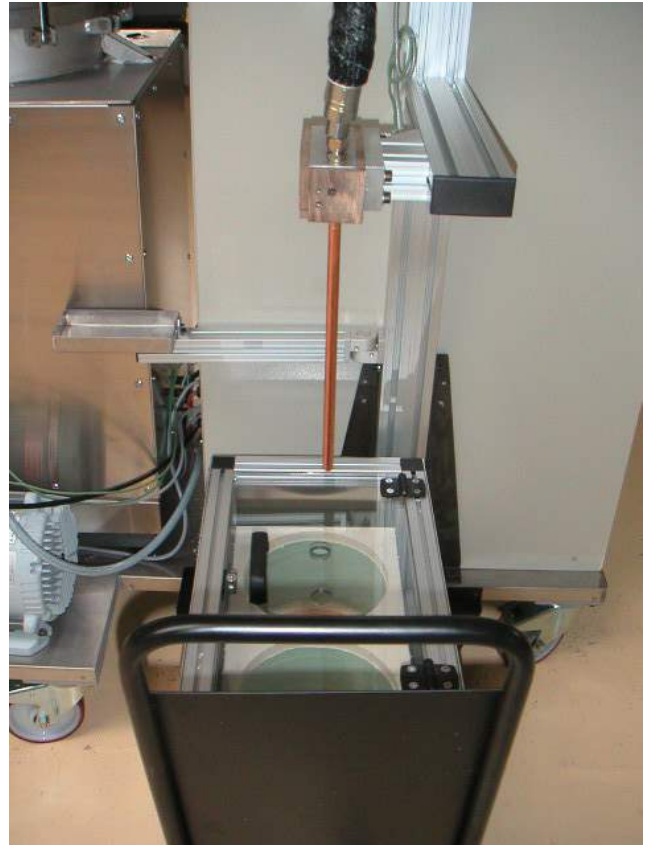
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Original containers heating is made by an electrical heater, specially designed for that purpose, in the form of a band, encircling container.

For heating temperature control, and heating uniformity of resin in the original container, the set include a temperature sensor, plunged in the container with resin and electric mixer, placed on the container head. Resin constantly stirred is heated till the fixed temperature. Supply of heated resin in the tank is realized by creating of vacuum in infusion unit tank with a vacuum pump, which is included in the infusion unit set (the pump is not included in delivery).

Heated resin from original containers is transferred at infusion unit tank by a silicone tube, one end is placed in the container, and other is switched to the filling valve, placed on the head of a tank of injection unit. Supply of heated resin in the tank is realized by creating of vacuum in infusion unit tank with a vacuum pump, which is included in the infusion unit set



Equipment control is made by control console of infusion unit, when hardware and software are totally integrated into PLC system.



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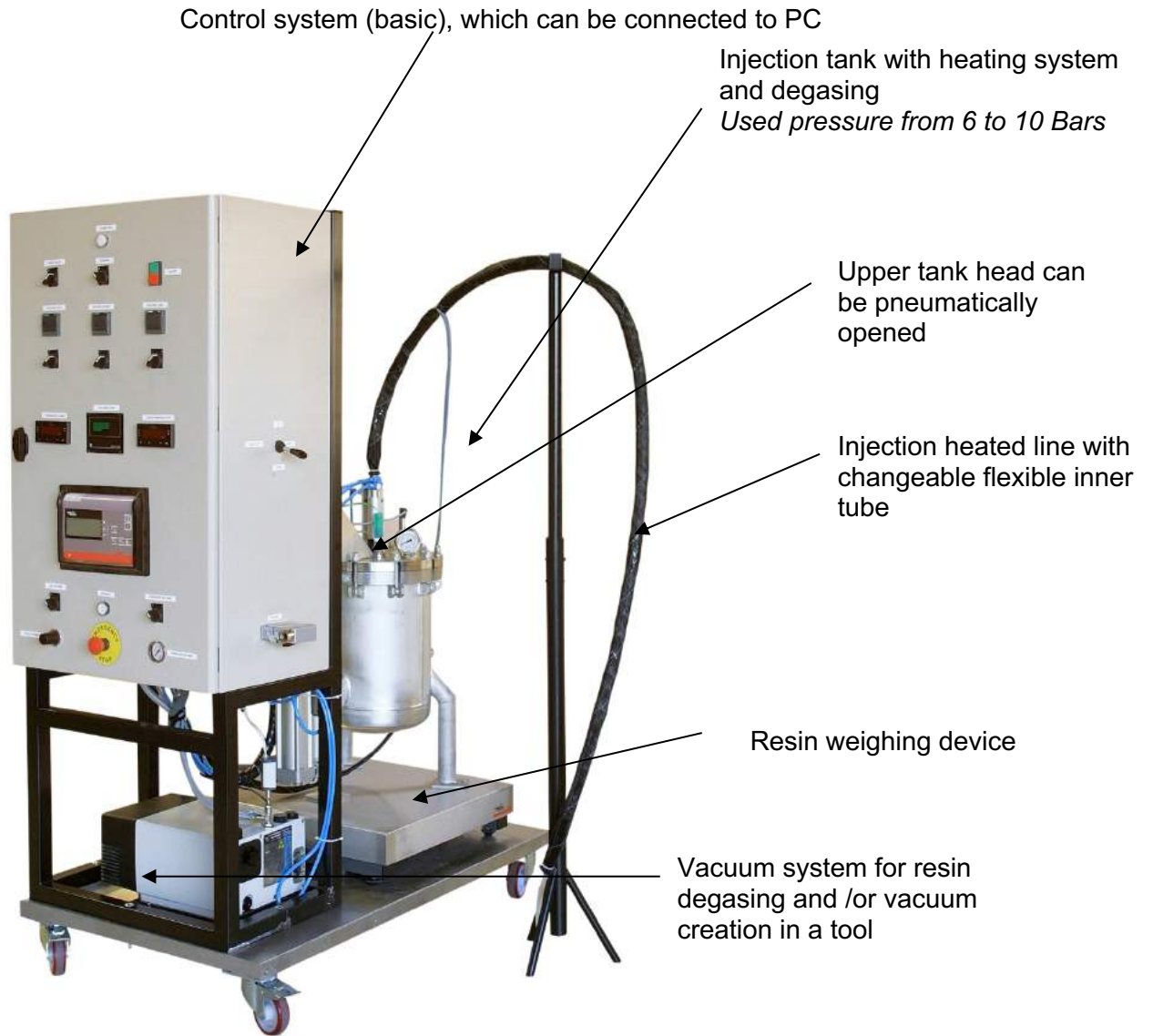


Photo 1: Basic configuration without PLC and PC.



Photo 2: Heating system

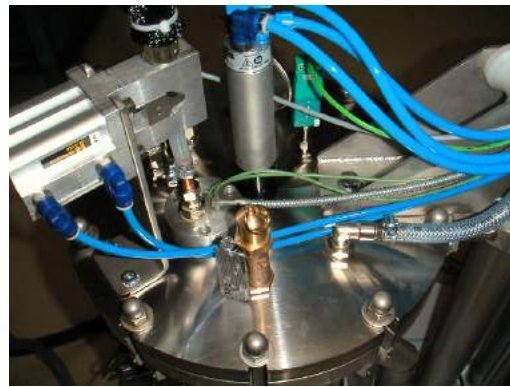


Photo 3: Pinching valve for silicone tube

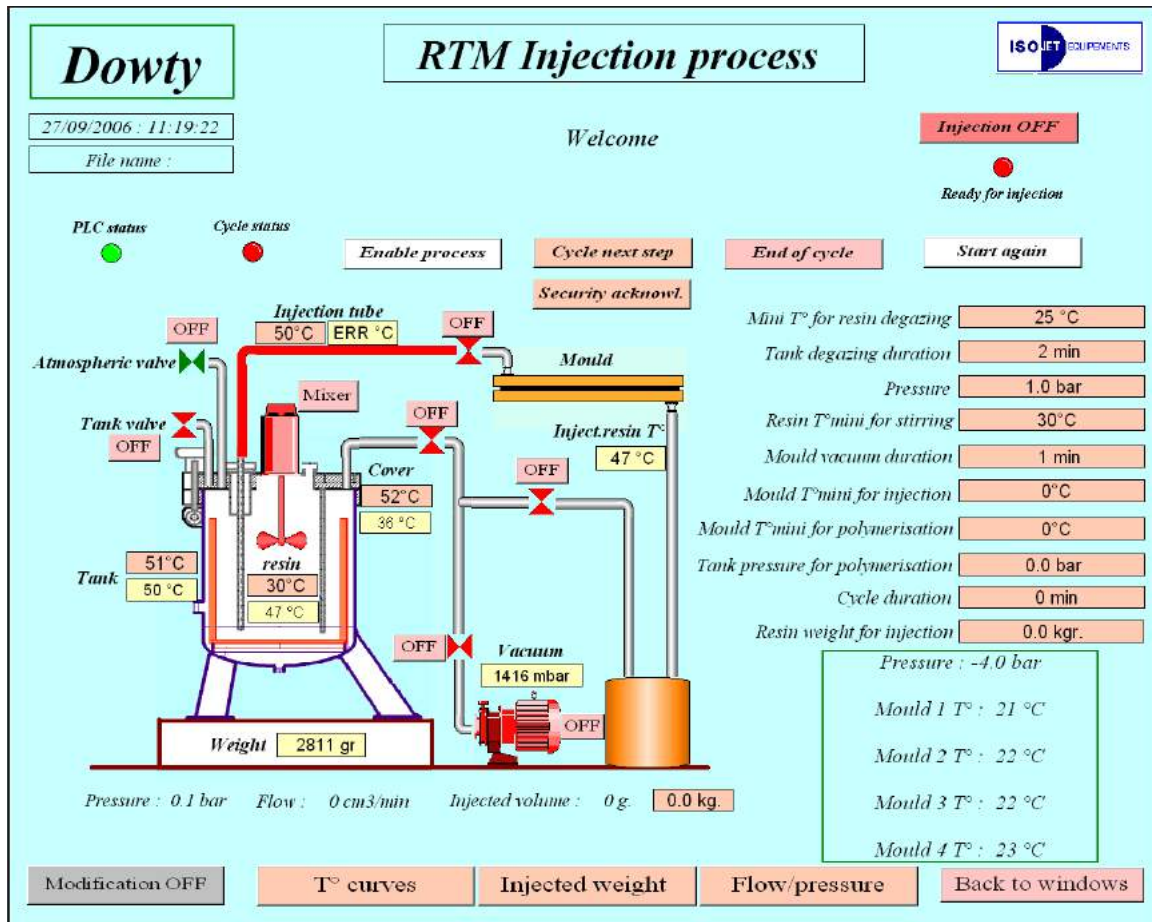


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▶ AUTOMATIC CYCLE REVIEW





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► INFORMATION PAGE FOR CREATING OF TECH. MAP

Dowty

Data initialization

Order number opi	Tool reference lk13	Piece number 56
Texture 1 rtm1	Texture 2 rtm2	Injection resin reference dert
Tool 1 by4	by5	Tool 2
Operator name hph	TRIAL4	Data file name

Process data

Injection tube T° <input type="text" value="50"/>	Degazing resin mini T° <input type="text" value="25"/>	Mini T° for injection <input type="text" value="30"/>
Tank T° <input type="text" value="51"/>	Degazing duration (min) <input type="text" value="2"/>	Injection pressure <input type="text" value="1.0"/>
Cover T° <input type="text" value="52"/>	T°mini for resin stirring <input type="text" value="30"/>	Mould vacuum duration <input type="text" value="1"/>
Mould T° mini for enable injection <input type="text" value="0"/>	Tank pressure for polymerisation <input type="text" value="0.0"/>	Mould T° mini for enable polymer. <input type="text" value="0"/>
Cycle duration (min) <input type="text" value="0"/>	Resin weight for injection (kg) <input type="text" value="0.0"/>	

Initialize process

Back to windows

File recall

C:\data_dowty\hph.INI

*All data are saved under :
TRIAL4*



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► UNIT WITH CONTROL CONSOLE PLC



▶ AUTMATED UNIT FOR RTM INFUSION PROCESS WITH PC OR PLC



Avantages of injection unit:

- Possibility of resin heating before process start 140°C
- Different configuration of injection modules with resin volumes from 0,5l to 200l.
- Electronic system of weighing control with measurement control ± 10 g during all the process.
- Control of input weight in real time mode.



- ▶ **MAIN ADVANTAGES OF TIAC (Thermo Infusion Automated Center)**



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- Heating module produced by the European leader in the oven manufacturing
- Injection module produced by the European leader in the injection and RTM process
- Software developed internally and allowing all customization that may be required by customer
- Guaranty of process repeatability
- Minimizing of man factor in the process
- Both way communication between units allows to fully automatized the process
- Quality reporting for keeping the traceability of production

► NOTE

Please contact us to get further information, as well as to make an equipment design according to your technical specification.

Standard warranty period: 12 months.