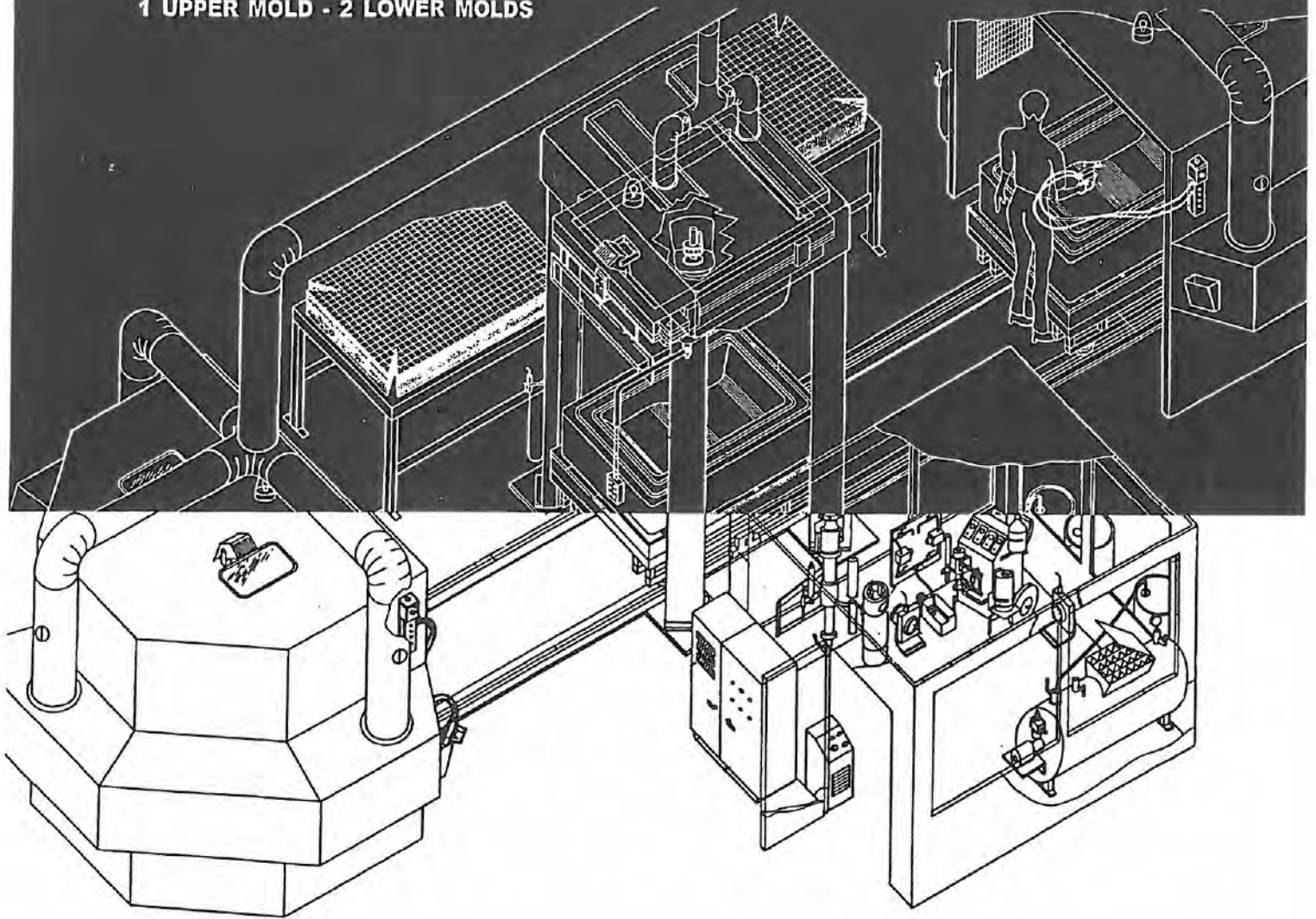


An RTM *CONCEPT*

1 UPPER MOLD - 2 LOWER MOLDS



Semi-Automated RTM Process

Presented By

Matrasur Composites

A. INTRODUCTION

B. Matrasur Composites RTM *Concept*

C. ADVANTAGES of the RTM *Concept*

D. ECONOMICS

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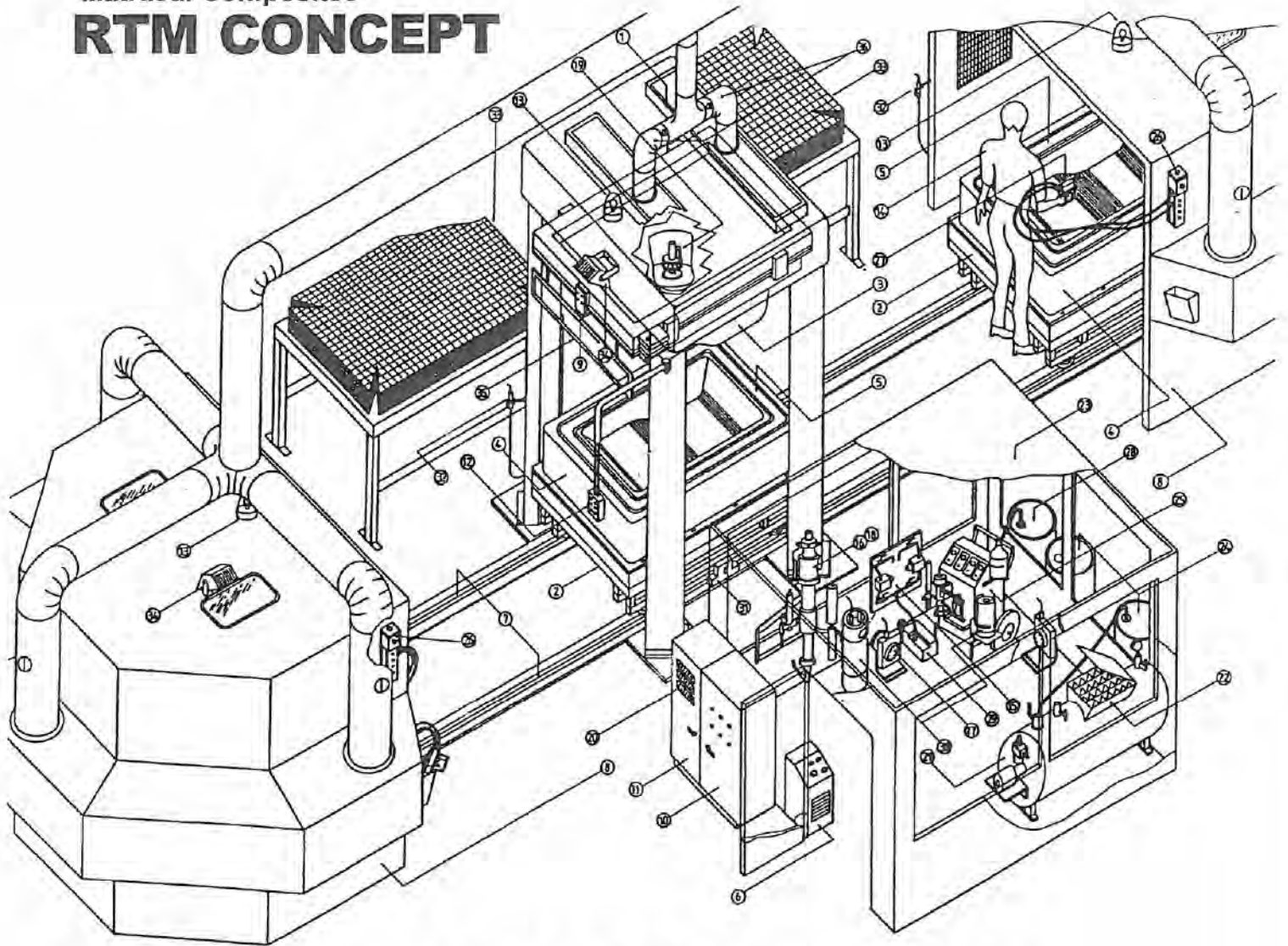
F. CONVERSION PROCESS

G. STANDARD RTM CONFIGURATION SPECIFICATIONS

- Mold handling rig
- Safety
- Automatically-locking rotating mold carriages
- Quick change of the mold
- Gelcoat ventilation booths
- General specifications
- Injection/casting process
 - Venus-Gusmer H.I.S. (Hydraulic Injection System)
 - Venus-Gusmer Automatic Pro Gun
- Catalyst detector
- Resin and gelcoat heaters
- Venus-Gusmer Gelcoat spraying machine
- Supply station and thermoregulation
- Vacuum regulation unit for mold closure, resin injection and degassing
- Molds and resin tank thermoregulation unit
- Pneumatic and electrical control panel
 - Pre-set quantity display
- Automatic resin gun
- Pressure sensor
- Injector fixed on the upper mold
- Control station
- Additional RTM *Concept* configuration

H. THE TOTAL SOLUTION

Matrasur Composites RTM CONCEPT



1 Upper Mold - 2 Lower Molds

- | | |
|---|---|
| 1. Mold manipulation and pressing system | 19. Automatic injection gun head unit |
| 2. Rotating mold carrier | 20. Material monitoring system |
| 3. Thermo-regulated male mold | 21. Mixing, holding and air bubble removal vessel |
| 4. Thermo-regulated female mold | 22. Bag slitting system |
| 5. Advanced technology mold sealing technique | 23. Equipment enclosure |
| 6. Thermo-regulation unit | 24. Resin drums |
| 7. Carriage rails | 25. Low pressure Gelcoat spraying unit |
| 8. Gelcoat booth | 26. Gelcoat heaters |
| 9. Quick change system for male mold | 27. Needle-less Gelcoat spray-gun |
| 10. Pneumatic control cabinet | 28. Gelcoat drums |
| 11. Electrical control cabinet | 29. Vacuum pump |
| 12. Easy reach control unit of the pressing | 30. Pressurized container for flushing |
| 13. Indicator light | 31. Carriage locating device |
| 14. Operator | 32. Pneumatic cleaning guns |
| 15. Vacuum regulation panel | 33. Pre-cut sheets of glass fabric |
| 16. Low pressure injection and casting unit | 34. Gelcoat booth lights |
| 17. Resin heater | 35. Personnel safety bars |
| 18. Catalyst alarm | 36. Extraction unit |

A. INTRODUCTION

*The word **composites** reflects the notion of innovation and performance. However, the sector of composite material processing is primarily made up of small to medium-sized businesses that will rapidly be confronted with problems if they don't implement technological change.*

*Businesses must comply with current air quality legislation and control staff exposure to styrene emissions with a concentration of 20 to 50 PPM. As a general rule, odor is perceived at 0.1 ppm, i.e., 0.42 mg per cubic meter. **What is currently the best method to avoid styrene escaping from resins if not the use of closed molds?***

Various types of RTM technologies including standard injection, vacuum assist, injection, impregnation, casting under vacuum, compression with vacuum and molding under vacuum may be set up with this concept.

B. Matrasur Composites RTM Concept

Developed about thirty years ago, the RTM (resin transfer molding) technique is for the production of composite material parts. The process is to inject filled or unfilled resin under low pressure into a closed mold, equipped with a pre-installed textile complex. This ensures personnel safety, minimized ventilation installations and elimination of air pre-treatment exhaust. Considering that a temperature rise of 1°F increases styrene emission by 3 lbs per sq. ft. (1°C/5g per sq. meter) of the surface in contact with air, the RTM *Concept* mixes the resin under vacuum and stores it under low pressure. The raw material is then preheated and routed towards the mold, preventing styrene evaporation.

Because of the low cost of sealed and vacuum injection molds, rapid changing of molds with the RTM *Concept* can be accommodated. A wide variety of industrial parts currently manufactured on contact molding may be efficiently converted to RTM.

C. ADVANTAGES OF THE RTM CONCEPT

With the many advantages of industrial RTM applications, it is surprising this method is only used by a handful of companies. The benefits can be applied to many different industries.

Advantages include:

- Significant styrene emission reduction in the work place
- Styrene emission is eliminated during injection
- Reduced handling of raw material
- Optimum hygiene and safety
- Depending on the item, 3 to 5 gelcoated parts per hour with only one operator
- Part repeatability
- Superior surface quality
- Smooth dual surfaces
- Monolithic and sandwich construction
- Integration of inserts
- Accurate control of raw material
- More economical process for rates of 20 to 100 parts per 24-hour day
- Ability to use fillers
- Shrinkage compensation capabilities
- No rollout
- Optimized curing for higher quality
- Reduced fire hazards
- Minimum use of solvents
- Possibility of maximum automation
- Use of any size molds and multi-cavities
- Use of the concept for polyester concrete injection
- Use of epoxy, phenolic and hybrid resin
- Use of polyester, epoxy and/or concrete epoxy molds
- Use of concrete molds on Nickel-Copper (Ni-Cu) electroplated skin
- Use of aluminum and steel molds

D. ECONOMICS

Because of the number of variables present in the RTM process it is difficult for the customer to determine final cost analysis. To assist the customer, Matrasur brings together the different variables to anticipate the final costs. By having designed a unique module for high rate production of industrial sealed molded parts sold as turnkey products, Matrasur Composites has grouped together all of the latest technologies including Venus-Gusmer's low pressure, internal mix dispensing systems into one unique system known as the Matrasur RTM *Concept*.

Businesses converting from contact molding to RTM will discover improvements in investment costs, floor space needs, cycle times, profitability, training programs and delivery deadlines. Smaller companies can afford the RTM *Concept* process because of its minimal start-up costs. The primary economic advantage of the RTM process is it can increase the maximum number of parts produced per hour.

E. FEATURES / BENEFITS

Twenty processes are incorporated into the RTM *Concept* :

1. Semi-automation allows the operator to complete multi-tasking
2. Every component is provided in one self-contained unit
3. Low-pressure, internal mix gelcoat system using an air assist nozzle—produces a consistent spray pattern and lowers styrene emissions
4. Needle-less Pro gun—provides fewer moving parts and fewer adjustments
5. Low-pressure injection of filled or unfilled resins—controls emissions
6. Gun remains permanently in place on the mold, according to the type of part—this full automation maximizes the ability to create standard parts
7. Vacuum mixing of charged resin—eliminates air pollution, minimizes porosity, creates stronger parts
8. Automatic air solvent flush on permanently installed gun—saves time by not having to remove the gun for flushing
9. Pressure feeding of dispensing unit to eliminate the possibility of pump cavitation
10. Vacuum closure of mold—is an alternative to expensive, hydraulic presses and provides a secure clamping seal
11. Automatic starting and control of vacuum—will shut down if there is too much pressure
12. Low mold closure pressure—worker safety
13. Precise indexing of molds
14. Automatic demolding of top molds—is quick and easy, eliminates damage around the entire part and requires nominal aligning
15. Seals in the upper mold maintain cleanliness and reduce the amount of de-molding time
16. Adaptable mold carriage for mold interchangeability
17. Rotating mold carriage—provides operator accessibility and saves time

F. CONVERSION PROCESS

Matrasur Composites researches your company's specific production requirements. We also provide complete specifications for parts and equipment, including the ergonomics of the operator. Matrasur Composites frequently deals with companies with a limited amount of experience with low pressure injection. To support these companies, we provide a full spectrum of expertise to ensure long-term success.

The complete system design of the RTM Concept will ensure the upgrade of your current technology to the RTM technique, mold design, production of the prototype part, chemistry of materials and staff training.

A typical conversion to the RTM *Concept* can be set up in 3-4 months and involves the following stages:

- Placement of order
- Start of mold design and fabrication
- Prototype for approval of mold by client and Matrasur
- Training in RTM technology
- Training in use of the RTM *Concept*
- System acceptance by client
- Delivery
- Installation
- Start-up
- On-site training of personnel on equipment
- Technical service support

These stages help the company achieve consistent quality in production while maintaining low production costs. The greater the company's level of technology, the easier it will be for the operators to put the process into operation.

Your company is now able to focus on your main business of productivity while continuing to receive the benefits of the RTM Concept. The company can expand its market base as a result of the highly efficient production process.

G. STANDARD RTM CONFIGURATION SPECIFICATIONS

MOLD HANDLING RIG

SPECIFICATION

- This mold handling rig has electromechanically operated columns. These columns provide different lift heights depending upon the height of the mold.
- The speed at which the upper mold is raised or lowered can be varied between 0'/min and a max of 16'/min (0 m/min-5 m/min.)
- The rig is designed to maintain a level mold as it is lowered.
- The electromechanical equipment connecting the columns ensures that the level of the plate remains stable.
- In the event of a malfunction, the machine will stop automatically due to a system of double half-shell nuts that instantly block each column.
- The plate is attached to the traveler of each of the columns. This support plate is constructed to minimize shifting. It lifts up the upper mold in the vertical axis of the lower mold, avoiding displacement of the different reinforcing pieces, or damage to the gelcoat finish.
- The underside of the support plate is equipped with an automatic vertical and horizontal alignment system. The best possible fit is made between the upper and lower molds. This technique is essential in the case of vacuum injection or casting.

SAFETY

The rig is operated by means of a two-handed suspended push-button control unit. Raising or lowering the upper mold requires the button to be held down continuously.

AUTOMATICALLY-LOCKING ROTATING MOLD CARRIAGES

The two non-motorized carriages have frames made from heavy-duty rectangular hollow tubing. Grooved wheels ensure easy maneuverability under heavy loads. The carriage is designed to allow the operator to transport the two lower molds from the gelcoat booths to the rig in line.

The carriage is automatically locked in place beneath the upper mold. This automatic locking mechanism is designed for easy mold change. The two carriages are also equipped with rollers for rapid mold removal.

QUICK CHANGE OF THE MOLD

The Matrasur RTM *Concept* provides a maximum degree of flexibility within a minimum amount of space because of the speed in which molds can be changed.

Because of the automation inherent in the system, the ability to quickly change molds does not hinder the process, resulting in maximum production.

GELCOAT VENTILATION BOOTHS

The two booths are positioned on either side of the rig, allowing background tasking. The ventilation system only operates when the operator presses the trigger of the gelcoating gun. This function ensures maximum efficiency of ventilation costs.

The ventilation system's self-stripping, separating blades allow solid particles to be trapped before they pass into the filters. This prevents the filters from becoming blocked too quickly.

GENERAL SPECIFICATIONS

Sample RTM Process: (many configurations are available)

Power

Air: 36 cfm/(60m³/hour)

Electricity: 60 kw three phase 220 Volt or three phase 380 Volt + neutral

Size {example: for a mold of 47 in x 70 in (1200 mm x 1800 mm)}

Length	40 ft (12 meters)
Width	16 ft (5 meters)
Height	12 ft (3.6 meters)

INJECTION/CASTING PROCESS

H.I.S.

The Venus-Gusmer H.I.S. (Hydraulic Injection System) meter/mix pump continuously meters and mixes resin and hardner. Resin and hardner pumps are designed for positive displacement to ensure a highly accurate metering ratio control.

In the case of polyester resin, the catalyst amount may be set between ½-3% by volume. The catalyst pump supplies catalyst through a non-pressurized, gravity fed system. Accumulators prevent pressure hesitation during pump reversal to ensure smooth delivery of composite materials.

The slave-arm design provides linked metering for precision in pumping. Pins that hold the catalyst pump in place on the slave-arm can be quickly and easily moved. Moving the catalyst pump closer or further from the pivot point allows the operator to adjust the percentage of catalyst entering the mix.

The catalyst pump and gun are constructed of high quality stainless steel compatible with MEKP and other hardners. The resin pump is constructed of aluminum and steel compatible with polyester resins, epoxy, vinyl ester and phenloyx.

This system allows uniform, uninterrupted filling of the mold without pressure variation or air inclusions. The system also makes it possible to achieve a high flow rate without generating high fluid pressure. This continuous filling of the mold at low pressure is fundamental to the success of the vacuum assisted injection technology.

Pro Gun

Resin and catalyst is mixed within the head of a Venus-Gusmer Pro Gun. The Pro Gun is an automatic, pneumatically operated, two component gun. It features a removable mix chamber and catalyst distribution system, which enables the resin and catalyst to mix completely before entering the static mixer. The Pro Gun's needle-less design eliminates the need to adjust resin and catalyst sequencing.

For maximum versatility, Matrasur Composites RTM *Concept* can incorporate any of the following approaches for injection:

- Standard injection
- Vacuum and injection
- Spray, pour and injection
- Compression and injection

CATALYST ALARM

If the catalyst becomes over-pressurized because of a blockage, bent hose, polymerization, etc. or because of lower pressure due to a lack of catalyst, the resin gun is automatically closed and a sound alarm activated. This safety system prevents partial or incomplete curing or dispensing uncatalyzed resin.

RESIN AND GELCOAT HEATERS

Resin heater - A remote controlled, high pressure, explosion proof resin heater is located adjacent to the point of injection. Because it is heat regulated, resin output will be consistent all year. This temperature control ensures that the viscosity of the mix remains constant and ensures accurate control of the gelling process.

A low resin viscosity allows for a higher reinforcement content. The digital display indicates to the operator the actual and desired temperature.

Gelcoat heater - A remote controlled, high-pressure, explosion proof gelcoat heater is installed close to the gun (depending on the operation.) The remote control prevents the heater from overheating and provides total safety.

Because of the uniformity of the gelcoat and catalyst mix, gelling begins sooner and curing times are consistent.

GELCOAT SPRAYING MACHINE

Two low-pressure gelcoat units are positioned near the gelcoat booths. Each unit includes a heater, as mentioned above.

Venus-Gusmer provides the low pressure, internal mix dispensing head. This technology avoids raw catalyst from falling on the mold and in the gelcoat, forming blisters when exposed to water. Recent experiments have shown that a uniform gelcoat and catalyst mixture produces a glossier surface. The level of polymerization is also improved and BARCOL hardness is higher than with external mixing.

Different pumping systems are available depending on the size of the mold. The size and configuration of the mold determines the appropriate pumping system. To fine tune the application of gelcoat, many gelcoat nozzles are available.

Flushing of the mix head, mix nozzle and injector requires very little solvent. The equipment can remain full of material all year, as long as production continues.

The needle-less gun allows the operator to stop frequently when spraying complex parts without risking over or under supply of catalyst. With fast gelcoat curing times, it is essential to minimize air entrapment during spraying due to the pressure drop at the spray tip. Optimum conditions are obtained with a pressure at the spray tip of approximately 217 lbs (15 bars.)

In order to achieve optimum spraying, we use a technique called "air assist." The nozzle provides air-assisted pattern shaping of internally mixed catalyst and gelcoat. It produces a clean spray without misting therefore decreasing the opportunity for porosity to occur.

Because of the inherent automation in the system, the operator can focus on the quality of the gelcoat when spraying.

SUPPLY STATION AND THERMOREGULATION

A 100 or 200 gallon (400 or 800 liters) horizontal tank with blades allows the resin and fillers to be vacuum loaded. A more uniform mix is achieved because of the even distribution of fillers into the tank. Once gas and air bubbles are removed from the resin, mixing is completed under vacuum. The tank is then pressurized to constantly supply the injection machine to prevent cavitation.

Following a prolonged stoppage, the blades, which brush against the sides of the tank, are slowly rotated, allowing the fillers to remain suspended.

This "vacuum pressure" horizontal tank is equipped with a pneumatic geared motor. The doubled walled thickness of the tank allows the resin to be maintained at the correct temperature. The combination of a uniform mixture and a preheated tank avoids the use of a high powered thermoregulated heater at the point of injection. With this highly efficient system, the operator has control of the temperature over the entire resin line.

VACUUM REGULATION UNIT FOR MOLD CLOSURE AND RESIN INJECTION

Closing of the mold - When the upper mold is lowered into place, it is automatically stopped by means of an optical fiber sensor. The peripheral vacuum is then activated, sealing the mold completely.

Injection vacuum - Injection begins once the peripheral vacuum seals the mold. With preset levels of resin pressure in the mold, the injection vacuum automatically starts once this pressure is achieved. No adjustments are necessary in the case of different molds or dimensions, because the actual pressure of the resin is detected.

Mold stripping - Before the alarm sounds for the removal of the lower mold, a unique vacuum reversal system injects air into the upper mold to release the part. For maximum efficiency, the male mold must be freed to start the next injection. This feature ensures a maximum level of operator efficiency for multi-tasking. The lower mold is immediately removed, freeing the rig for the next injection.

PRE-SET QUANTITY DISPLAY

The material monitoring system consists of digital counters that control the delivery rates, injected quantities and daily consumption.

Each counter displays automatic pre-set quantities in lbs (kg.) The second displays the actual weights of each injection to be checked. The memory of the counter is automatically reset when the operator starts a new injection. Each time the counter is reset to zero, the quantities injected beforehand are entered into the memory.

This quality control feature allows purchasing and production managers an accurate record of daily consumption.

- The display also allows any variation in the working pressures, resin viscosity, resin heater, temperatures, etc. to be adjusted.
- The flow meter allows an accurate machine delivery rate to be displayed in lbs/min (kg/min) according to the mold backpressure.
- The monitoring system operates by means of a high strength optical fiber display, eliminating the risks from electrical sparks.
- The monitoring system is pneumatically controlled only while operating.
- With this new technology, during re-circulation or in the event of a pump stall no attempts are registered by the monitor.

The system is of modular design. If a component breaks down it can be removed from the unit for repair and replaced without disturbing the other components.

MOLDS AND RESIN TANK THERMOREGULATION UNIT

The upper mold, 2 lower molds and mixing tank are maintained at different, but constant, temperatures.

The even temperature of the mold allows the maintaining of the constant gel time. Because the resin and mold are heated, thermal shock is prevented. It allows the exothermic behavior, which is the major factor influencing the future stability of the part, to be measured and controlled. Because of the constant and continuous heat, better surface tension and curing is obtained. The repeatability of the cycles is maintained regardless of the ambient temperature and humidity.

Appearance, particularly for the automotive industry, imposes very high standards. The regulation of the molds allows a low profile system to be used and class A finish to be achieved. When changing the molds, the heat regulation system can be disconnected immediately with quick release couplings. Auxiliary molds can be hooked up to the thermoregulation heating unit to maintain temperature to be heated, should they be needed for same day production.

PNEUMATIC AND ELECTRICAL CONTROL PANEL

- The control panel manages all of the machinery and guides the operator through each phase of the operation.
- This control panel is located behind the operator at the injection position, allowing the operating state of the process to be viewed at all times.
- In the event of a system anomaly, warning displays advise the operator of the origin.
- In order to allow the production day to start immediately, a program automatically pre-heats the molds and horizontal tank and pre-mixes the filler before personnel arrives.

CONTROL STATION

The control station protects and houses all of the components to the RTM *Concept* system:

- Injection / casting of the resin unit
- Thermoregulation for molds
- Pneumatic panel
- Electric panel
- Mixing tank

AUTOMATIC RESIN GUN

Once the automatic needle-less gun is positioned near the injector point. The operator can carry out other tasks during the injection cycle.

When injection is complete, the operator is informed by an alarm that will sound until the gun is flushed and air-purged.

With high production rates, an injector remains permanently on the mold. At the end of injection, the flushing and the air-purging of the static mixer is automatically carried out.

PRESSURE SENSOR

The pre-set pressure sensor is positioned at the injection. It enables the automatic injection gun to stop when it exceeds the maximum level of hydraulic pressure. This automated procedure prevents damage to the mold, avoiding costly repairs.

INJECTOR FIXED ON THE UPPER MOLD

The injection head is permanently positioned on the upper mold. This prevents the operator from climbing on the upper mold in order to maintain the gun—a risky endeavor with tall molds, molds with a deep incline, or high levels of productivity. Once the operator begins the injection cycle, the injection head opens, closes, and cleans itself automatically according to the preset cycle times of the control panel.

After injection, the injector head closes flush with the mold to ensure a smooth part. The injector port is also used to assist in demolding. The injector head may be disconnected from the mold to allow the head to be moved from part to part.

ADDITIONAL RTM CONCEPT CONFIGURATIONS

When installed in full working order, the complete production line of the RTM *Concept* accommodates a medium to high production rate. Because of its design, the operator works in a high level of comfort and efficiency.

- All elements, including air guns, scissors, mold stripping wedges and suction cups, suspended push-button control box, etc. are within easy reach of the operator as he/she works.
- Molds are removed at the mold stripping position between the gelcoat booth and the manipulator.
- The gelcoat booths and the manipulator are equipped with powerful lights.
- Two warehouse carts are located one to each side of the carriage. They serve as storage for the glass fiber sheets and demolding equipment, cloths, grease guns, etc.

The production line is self-contained, the space minimized, and each element is positioned for maximum output.

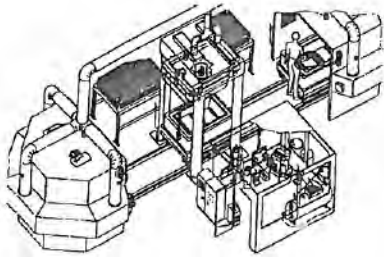
THE TOTAL SOLUTION

From start to finish, Matrasur Composites provides a complete RTM solution with a unique production line that includes advanced technologies to maximize quality, production and control of the RTM process.

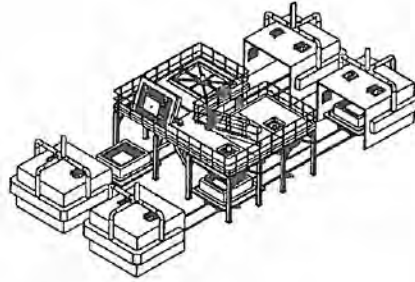
With installations in France, Canada, China and South America, the RTM Concept is currently used in the transportation and recreation industries. However, Matrasur Composites can custom design the RTM Concept process to suit the production requirements for a variety of industries. Winner of the Vinci Award for Best Innovation, Matrasur is a leader in the reinforced plastics industry, designing total system solutions, encompassing the latest in technology.

Matrasur Composites, the first system integrator in Europe, has partnered with Venus-Gusmer, a leading manufacturer of fiberglass processing equipment, to introduce the concept in the United States.

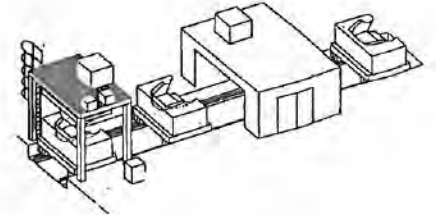
RTM Concepts



1 UPPER MOLD - 2 LOWER MOLDS

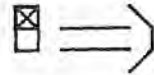


4 UPPER MOLDS - 4 LOWER MOLDS

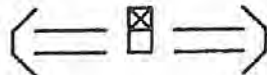


1 UPPER MOLD - 1 LOWER MOLD

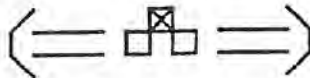
1 UPPER - 1 LOWER



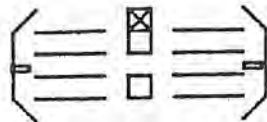
1 UPPER - 2 LOWER



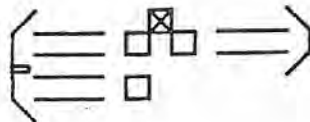
2 UPPER - 2 LOWER



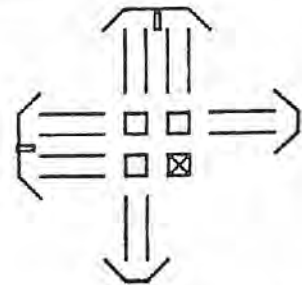
2 UPPER - 4 LOWER



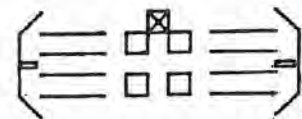
3 UPPER - 4 LOWER



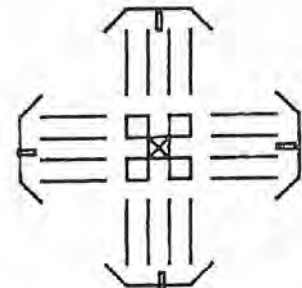
3 UPPER - 6 LOWER



4 UPPER - 6 LOWER



4 UPPER - 8 LOWER



CONTROL STATION



MANIPULATOR



RAILS



GELCOAT BOOTH

For more information contact:



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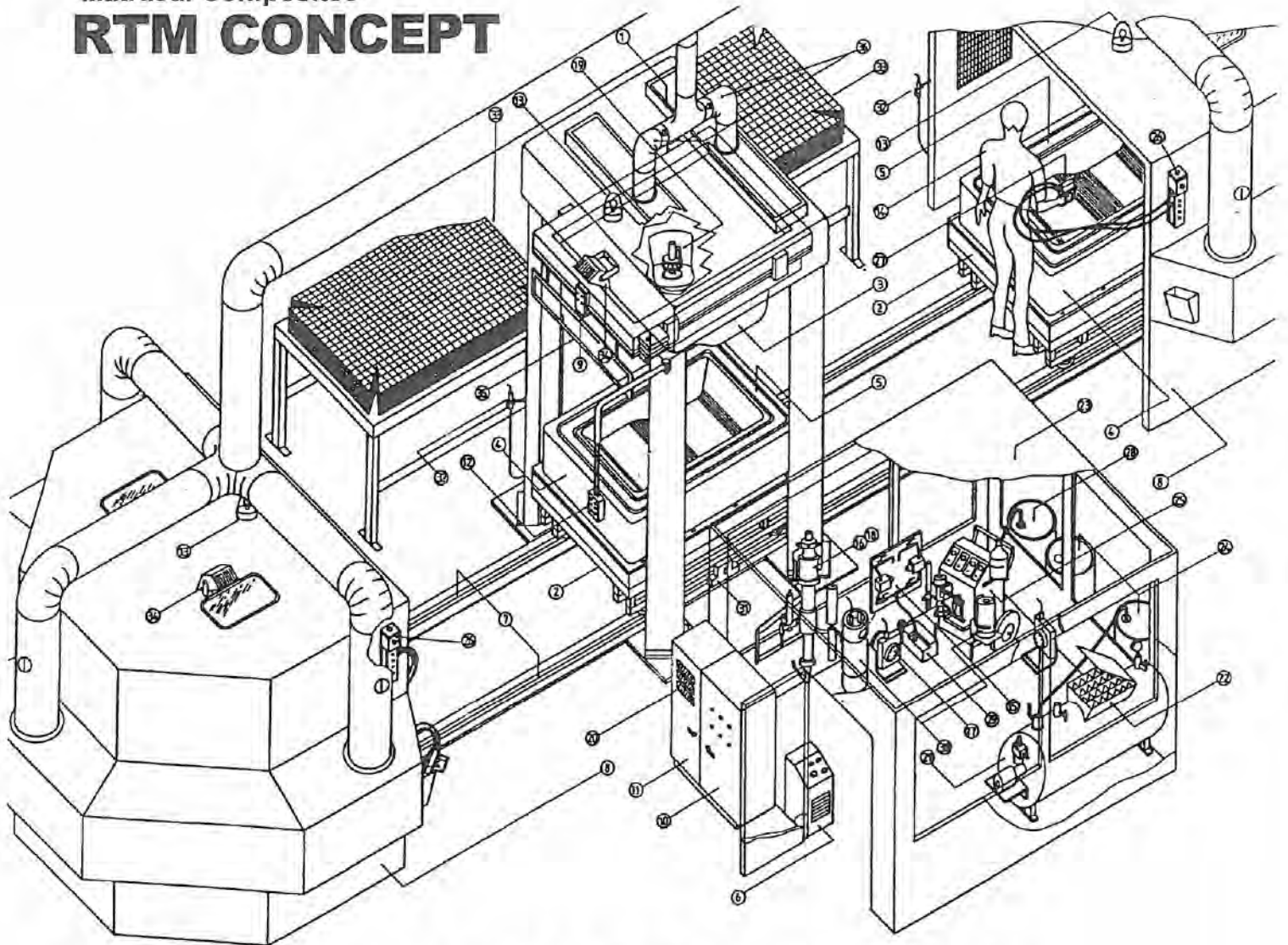
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Various types of RTM technologies including standard injection, vacuum assist, injection, impregnation, casting under vacuum, compression with vacuum and molding under vacuum may be set up with this concept.

B. Matrasur Composites RTM Concept

Developed about thirty years ago, the RTM (resin transfer molding) technique is for the production of composite material parts. The process is to inject filled or unfilled resin under low pressure into a closed mold, equipped with a pre-installed textile complex. This ensures personnel safety, minimized ventilation installations and elimination of air pre-treatment exhaust. Considering that a temperature rise of 1°F increases styrene emission by 3 lbs per sq. ft. (1°C/5g per sq. meter) of the surface in contact with air, the RTM *Concept* mixes the resin under vacuum and stores it under low pressure. The raw material is then preheated and routed towards the mold, preventing styrene evaporation.

Because of the low cost of sealed and vacuum injection molds, rapid changing of molds with the RTM *Concept* can be accommodated. A wide variety of industrial parts currently manufactured on contact molding may be efficiently converted to RTM.

C. ADVANTAGES OF THE RTM CONCEPT

With the many advantages of industrial RTM applications, it is surprising this method is only used by a handful of companies. The benefits can be applied to many different industries.

Advantages include:

- Significant styrene emission reduction in the work place
- Styrene emission is eliminated during injection
- Reduced handling of raw material
- Optimum hygiene and safety
- Depending on the item, 3 to 5 gelcoated parts per hour with only one operator
- Part repeatability
- Superior surface quality
- Smooth dual surfaces
- Monolithic and sandwich construction
- Integration of inserts
- Accurate control of raw material
- More economical process for rates of 20 to 100 parts per 24-hour day
- Ability to use fillers
- Shrinkage compensation capabilities
- No rollout
- Optimized curing for higher quality
- Reduced fire hazards
- Minimum use of solvents
- Possibility of maximum automation
- Use of any size molds and multi-cavities
- Use of the concept for polyester concrete injection
- Use of epoxy, phenolic and hybrid resin
- Use of polyester, epoxy and/or concrete epoxy molds
- Use of concrete molds on Nickel-Copper (Ni-Cu) electroplated skin
- Use of aluminum and steel molds

D. ECONOMICS

Because of the number of variables present in the RTM process it is difficult for the customer to determine final cost analysis. To assist the customer, Matrasur brings together the different variables to anticipate the final costs. By having designed a unique module for high rate production of industrial sealed molded parts sold as turnkey products, Matrasur Composites has grouped together all of the latest technologies including Venus-Gusmer's low pressure, internal mix dispensing systems into one unique system known as the Matrasur RTM *Concept*.

Businesses converting from contact molding to RTM will discover improvements in investment costs, floor space needs, cycle times, profitability, training programs and delivery deadlines. Smaller companies can afford the RTM *Concept* process because of its minimal start-up costs. The primary economic advantage of the RTM process is it can increase the maximum number of parts produced per hour.

E. FEATURES / BENEFITS

Twenty processes are incorporated into the RTM *Concept* :

1. Semi-automation allows the operator to complete multi-tasking
2. Every component is provided in one self-contained unit
3. Low-pressure, internal mix gelcoat system using an air assist nozzle—produces a consistent spray pattern and lowers styrene emissions
4. Needle-less Pro gun—provides fewer moving parts and fewer adjustments
5. Low-pressure injection of filled or unfilled resins—controls emissions
6. Gun remains permanently in place on the mold, according to the type of part—this full automation maximizes the ability to create standard parts
7. Vacuum mixing of charged resin—eliminates air pollution, minimizes porosity, creates stronger parts
8. Automatic air solvent flush on permanently installed gun—saves time by not having to remove the gun for flushing
9. Pressure feeding of dispensing unit to eliminate the possibility of pump cavitation
10. Vacuum closure of mold—is an alternative to expensive, hydraulic presses and provides a secure clamping seal
11. Automatic starting and control of vacuum—will shut down if there is too much pressure
12. Low mold closure pressure—worker safety
13. Precise indexing of molds
14. Automatic demolding of top molds—is quick and easy, eliminates damage around the entire part and requires nominal aligning
15. Seals in the upper mold maintain cleanliness and reduce the amount of de-molding time
16. Adaptable mold carriage for mold interchangeability
17. Rotating mold carriage—provides operator accessibility and saves time

F. CONVERSION PROCESS

Matrasur Composites researches your company's specific production requirements. We also provide complete specifications for parts and equipment, including the ergonomics of the operator. Matrasur Composites frequently deals with companies with a limited amount of experience with low pressure injection. To support these companies, we provide a full spectrum of expertise to ensure long-term success.

The complete system design of the RTM Concept will ensure the upgrade of your current technology to the RTM technique, mold design, production of the prototype part, chemistry of materials and staff training.

A typical conversion to the RTM *Concept* can be set up in 3-4 months and involves the following stages:

- Placement of order
- Start of mold design and fabrication
- Prototype for approval of mold by client and Matrasur
- Training in RTM technology
- Training in use of the RTM *Concept*
- System acceptance by client
- Delivery
- Installation
- Start-up
- On-site training of personnel on equipment
- Technical service support

These stages help the company achieve consistent quality in production while maintaining low production costs. The greater the company's level of technology, the easier it will be for the operators to put the process into operation.

Your company is now able to focus on your main business of productivity while continuing to receive the benefits of the RTM Concept. The company can expand its market base as a result of the highly efficient production process.

G. STANDARD RTM CONFIGURATION SPECIFICATIONS

MOLD HANDLING RIG

SPECIFICATION

- This mold handling rig has electromechanically operated columns. These columns provide different lift heights depending upon the height of the mold.
- The speed at which the upper mold is raised or lowered can be varied between 0'/min and a max of 16'/min (0 m/min-5 m/min.)
- The rig is designed to maintain a level mold as it is lowered.
- The electromechanical equipment connecting the columns ensures that the level of the plate remains stable.
- In the event of a malfunction, the machine will stop automatically due to a system of double half-shell nuts that instantly block each column.
- The plate is attached to the traveler of each of the columns. This support plate is constructed to minimize shifting. It lifts up the upper mold in the vertical axis of the lower mold, avoiding displacement of the different reinforcing pieces, or damage to the gelcoat finish.
- The underside of the support plate is equipped with an automatic vertical and horizontal alignment system. The best possible fit is made between the upper and lower molds. This technique is essential in the case of vacuum injection or casting.

SAFETY

The rig is operated by means of a two-handed suspended push-button control unit. Raising or lowering the upper mold requires the button to be held down continuously.

AUTOMATICALLY-LOCKING ROTATING MOLD CARRIAGES

The two non-motorized carriages have frames made from heavy-duty rectangular hollow tubing. Grooved wheels ensure easy maneuverability under heavy loads. The carriage is designed to allow the operator to transport the two lower molds from the gelcoat booths to the rig in line.

The carriage is automatically locked in place beneath the upper mold. This automatic locking mechanism is designed for easy mold change. The two carriages are also equipped with rollers for rapid mold removal.

QUICK CHANGE OF THE MOLD

The Matrasur RTM *Concept* provides a maximum degree of flexibility within a minimum amount of space because of the speed in which molds can be changed.

Because of the automation inherent in the system, the ability to quickly change molds does not hinder the process, resulting in maximum production.

GELCOAT VENTILATION BOOTHS

The two booths are positioned on either side of the rig, allowing background tasking. The ventilation system only operates when the operator presses the trigger of the gelcoating gun. This function ensures maximum efficiency of ventilation costs.

The ventilation system's self-stripping, separating blades allow solid particles to be trapped before they pass into the filters. This prevents the filters from becoming blocked too quickly.

GENERAL SPECIFICATIONS

Sample RTM Process: (many configurations are available)

Power

Air: 36 cfm/(60m³/hour)

Electricity: 60 kw three phase 220 Volt or three phase 380 Volt + neutral

Size {example: for a mold of 47 in x 70 in (1200 mm x 1800 mm)}

Length	40 ft (12 meters)
Width	16 ft (5 meters)
Height	12 ft (3.6 meters)

INJECTION/CASTING PROCESS

H.I.S.

The Venus-Gusmer H.I.S. (Hydraulic Injection System) meter/mix pump continuously meters and mixes resin and hardner. Resin and hardner pumps are designed for positive displacement to ensure a highly accurate metering ratio control.

In the case of polyester resin, the catalyst amount may be set between ½-3% by volume. The catalyst pump supplies catalyst through a non-pressurized, gravity fed system. Accumulators prevent pressure hesitation during pump reversal to ensure smooth delivery of composite materials.

The slave-arm design provides linked metering for precision in pumping. Pins that hold the catalyst pump in place on the slave-arm can be quickly and easily moved. Moving the catalyst pump closer or further from the pivot point allows the operator to adjust the percentage of catalyst entering the mix.

The catalyst pump and gun are constructed of high quality stainless steel compatible with MEKP and other hardners. The resin pump is constructed of aluminum and steel compatible with polyester resins, epoxy, vinyl ester and phenloyx.

This system allows uniform, uninterrupted filling of the mold without pressure variation or air inclusions. The system also makes it possible to achieve a high flow rate without generating high fluid pressure. This continuous filling of the mold at low pressure is fundamental to the success of the vacuum assisted injection technology.

Pro Gun

Resin and catalyst is mixed within the head of a Venus-Gusmer Pro Gun. The Pro Gun is an automatic, pneumatically operated, two component gun. It features a removable mix chamber and catalyst distribution system, which enables the resin and catalyst to mix completely before entering the static mixer. The Pro Gun's needle-less design eliminates the need to adjust resin and catalyst sequencing.

For maximum versatility, Matrasur Composites RTM *Concept* can incorporate any of the following approaches for injection:

- Standard injection
- Vacuum and injection
- Spray, pour and injection
- Compression and injection

CATALYST ALARM

If the catalyst becomes over-pressurized because of a blockage, bent hose, polymerization, etc. or because of lower pressure due to a lack of catalyst, the resin gun is automatically closed and a sound alarm activated. This safety system prevents partial or incomplete curing or dispensing uncatalyzed resin.

RESIN AND GELCOAT HEATERS

Resin heater - A remote controlled, high pressure, explosion proof resin heater is located adjacent to the point of injection. Because it is heat regulated, resin output will be consistent all year. This temperature control ensures that the viscosity of the mix remains constant and ensures accurate control of the gelling process.

A low resin viscosity allows for a higher reinforcement content. The digital display indicates to the operator the actual and desired temperature.

Gelcoat heater - A remote controlled, high-pressure, explosion proof gelcoat heater is installed close to the gun (depending on the operation.) The remote control prevents the heater from overheating and provides total safety.

Because of the uniformity of the gelcoat and catalyst mix, gelling begins sooner and curing times are consistent.

GELCOAT SPRAYING MACHINE

Two low-pressure gelcoat units are positioned near the gelcoat booths. Each unit includes a heater, as mentioned above.

Venus-Gusmer provides the low pressure, internal mix dispensing head. This technology avoids raw catalyst from falling on the mold and in the gelcoat, forming blisters when exposed to water. Recent experiments have shown that a uniform gelcoat and catalyst mixture produces a glossier surface. The level of polymerization is also improved and BARCOL hardness is higher than with external mixing.

Different pumping systems are available depending on the size of the mold. The size and configuration of the mold determines the appropriate pumping system. To fine tune the application of gelcoat, many gelcoat nozzles are available.

Flushing of the mix head, mix nozzle and injector requires very little solvent. The equipment can remain full of material all year, as long as production continues.

The needle-less gun allows the operator to stop frequently when spraying complex parts without risking over or under supply of catalyst. With fast gelcoat curing times, it is essential to minimize air entrapment during spraying due to the pressure drop at the spray tip. Optimum conditions are obtained with a pressure at the spray tip of approximately 217 lbs (15 bars.)

In order to achieve optimum spraying, we use a technique called "air assist." The nozzle provides air-assisted pattern shaping of internally mixed catalyst and gelcoat. It produces a clean spray without misting therefore decreasing the opportunity for porosity to occur.

Because of the inherent automation in the system, the operator can focus on the quality of the gelcoat when spraying.

SUPPLY STATION AND THERMOREGULATION

A 100 or 200 gallon (400 or 800 liters) horizontal tank with blades allows the resin and fillers to be vacuum loaded. A more uniform mix is achieved because of the even distribution of fillers into the tank. Once gas and air bubbles are removed from the resin, mixing is completed under vacuum. The tank is then pressurized to constantly supply the injection machine to prevent cavitation.

Following a prolonged stoppage, the blades, which brush against the sides of the tank, are slowly rotated, allowing the fillers to remain suspended.

This "vacuum pressure" horizontal tank is equipped with a pneumatic geared motor. The doubled walled thickness of the tank allows the resin to be maintained at the correct temperature. The combination of a uniform mixture and a preheated tank avoids the use of a high powered thermoregulated heater at the point of injection. With this highly efficient system, the operator has control of the temperature over the entire resin line.

VACUUM REGULATION UNIT FOR MOLD CLOSURE AND RESIN INJECTION

Closing of the mold - When the upper mold is lowered into place, it is automatically stopped by means of an optical fiber sensor. The peripheral vacuum is then activated, sealing the mold completely.

Injection vacuum - Injection begins once the peripheral vacuum seals the mold. With preset levels of resin pressure in the mold, the injection vacuum automatically starts once this pressure is achieved. No adjustments are necessary in the case of different molds or dimensions, because the actual pressure of the resin is detected.

Mold stripping - Before the alarm sounds for the removal of the lower mold, a unique vacuum reversal system injects air into the upper mold to release the part. For maximum efficiency, the male mold must be freed to start the next injection. This feature ensures a maximum level of operator efficiency for multi-tasking. The lower mold is immediately removed, freeing the rig for the next injection.

PRE-SET QUANTITY DISPLAY

The material monitoring system consists of digital counters that control the delivery rates, injected quantities and daily consumption.

Each counter displays automatic pre-set quantities in lbs (kg.) The second displays the actual weights of each injection to be checked. The memory of the counter is automatically reset when the operator starts a new injection. Each time the counter is reset to zero, the quantities injected beforehand are entered into the memory.

This quality control feature allows purchasing and production managers an accurate record of daily consumption.

- The display also allows any variation in the working pressures, resin viscosity, resin heater, temperatures, etc. to be adjusted.
- The flow meter allows an accurate machine delivery rate to be displayed in lbs/min (kg/min) according to the mold backpressure.
- The monitoring system operates by means of a high strength optical fiber display, eliminating the risks from electrical sparks.
- The monitoring system is pneumatically controlled only while operating.
- With this new technology, during re-circulation or in the event of a pump stall no attempts are registered by the monitor.

The system is of modular design. If a component breaks down it can be removed from the unit for repair and replaced without disturbing the other components.

MOLDS AND RESIN TANK THERMOREGULATION UNIT

The upper mold, 2 lower molds and mixing tank are maintained at different, but constant, temperatures.

The even temperature of the mold allows the maintaining of the constant gel time. Because the resin and mold are heated, thermal shock is prevented. It allows the exothermic behavior, which is the major factor influencing the future stability of the part, to be measured and controlled. Because of the constant and continuous heat, better surface tension and curing is obtained. The repeatability of the cycles is maintained regardless of the ambient temperature and humidity.

Appearance, particularly for the automotive industry, imposes very high standards. The regulation of the molds allows a low profile system to be used and class A finish to be achieved. When changing the molds, the heat regulation system can be disconnected immediately with quick release couplings. Auxiliary molds can be hooked up to the thermoregulation heating unit to maintain temperature to be heated, should they be needed for same day production.

PNEUMATIC AND ELECTRICAL CONTROL PANEL

- The control panel manages all of the machinery and guides the operator through each phase of the operation.
- This control panel is located behind the operator at the injection position, allowing the operating state of the process to be viewed at all times.
- In the event of a system anomaly, warning displays advise the operator of the origin.
- In order to allow the production day to start immediately, a program automatically pre-heats the molds and horizontal tank and pre-mixes the filler before personnel arrives.

CONTROL STATION

The control station protects and houses all of the components to the RTM *Concept* system:

- Injection / casting of the resin unit
- Thermoregulation for molds
- Pneumatic panel
- Electric panel
- Mixing tank

AUTOMATIC RESIN GUN

Once the automatic needle-less gun is positioned near the injector point. The operator can carry out other tasks during the injection cycle.

When injection is complete, the operator is informed by an alarm that will sound until the gun is flushed and air-purged.

With high production rates, an injector remains permanently on the mold. At the end of injection, the flushing and the air-purging of the static mixer is automatically carried out.

PRESSURE SENSOR

The pre-set pressure sensor is positioned at the injection. It enables the automatic injection gun to stop when it exceeds the maximum level of hydraulic pressure. This automated procedure prevents damage to the mold, avoiding costly repairs.

INJECTOR FIXED ON THE UPPER MOLD

The injection head is permanently positioned on the upper mold. This prevents the operator from climbing on the upper mold in order to maintain the gun—a risky endeavor with tall molds, molds with a deep incline, or high levels of productivity. Once the operator begins the injection cycle, the injection head opens, closes, and cleans itself automatically according to the preset cycle times of the control panel.

After injection, the injector head closes flush with the mold to ensure a smooth part. The injector port is also used to assist in demolding. The injector head may be disconnected from the mold to allow the head to be moved from part to part.

ADDITIONAL RTM CONCEPT CONFIGURATIONS

When installed in full working order, the complete production line of the RTM *Concept* accommodates a medium to high production rate. Because of its design, the operator works in a high level of comfort and efficiency.

- All elements, including air guns, scissors, mold stripping wedges and suction cups, suspended push-button control box, etc. are within easy reach of the operator as he/she works.
- Molds are removed at the mold stripping position between the gelcoat booth and the manipulator.
- The gelcoat booths and the manipulator are equipped with powerful lights.
- Two warehouse carts are located one to each side of the carriage. They serve as storage for the glass fiber sheets and demolding equipment, cloths, grease guns, etc.

The production line is self-contained, the space minimized, and each element is positioned for maximum output.

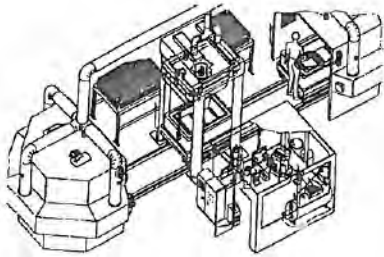
THE TOTAL SOLUTION

From start to finish, Matrasur Composites provides a complete RTM solution with a unique production line that includes advanced technologies to maximize quality, production and control of the RTM process.

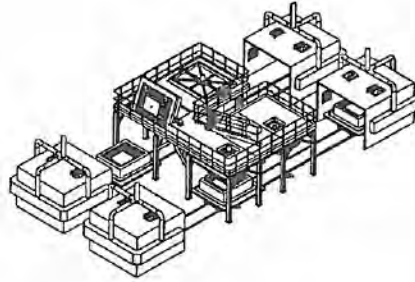
With installations in France, Canada, China and South America, the RTM Concept is currently used in the transportation and recreation industries. However, Matrasur Composites can custom design the RTM Concept process to suit the production requirements for a variety of industries. Winner of the Vinci Award for Best Innovation, Matrasur is a leader in the reinforced plastics industry, designing total system solutions, encompassing the latest in technology.

Matrasur Composites, the first system integrator in Europe, has partnered with Venus-Gusmer, a leading manufacturer of fiberglass processing equipment, to introduce the concept in the United States.

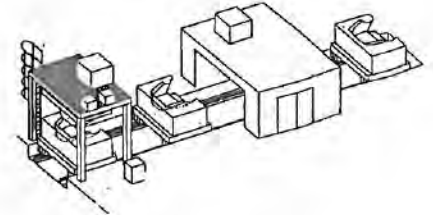
RTM Concepts



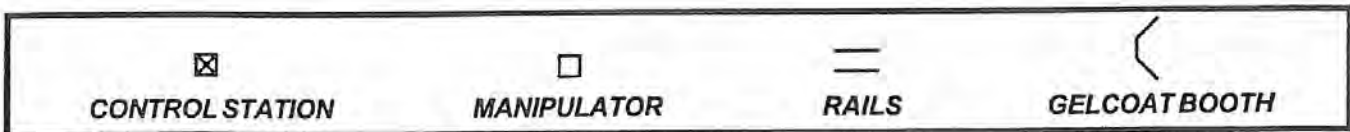
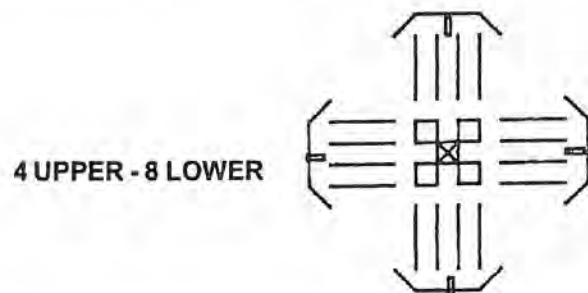
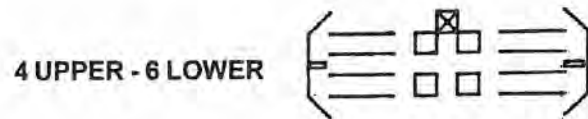
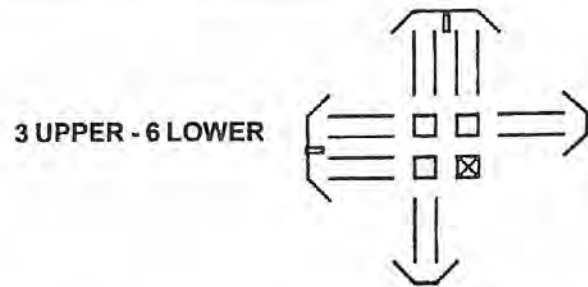
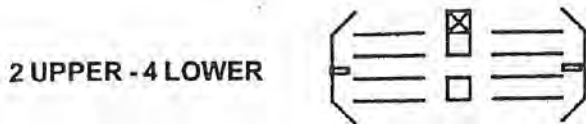
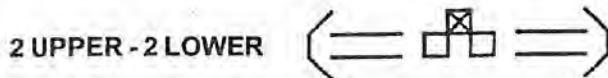
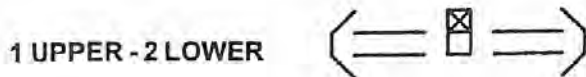
1 UPPER MOLD - 2 LOWER MOLDS



4 UPPER MOLDS - 4 LOWER MOLDS



1 UPPER MOLD - 1 LOWER MOLD



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