

Additional Questionnaire : Manual Methods - Answers

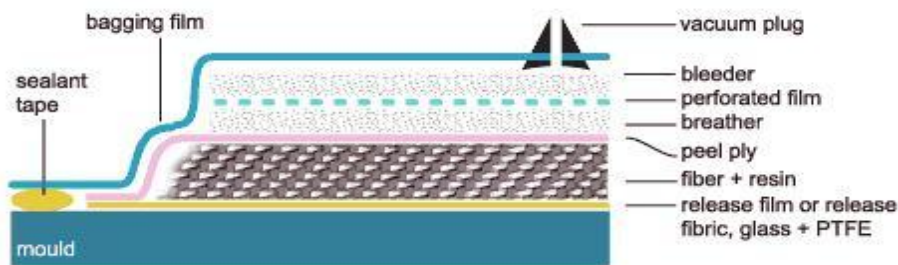
Question 1 : Classify the following techniques according to the Technique.

- Manual
 - Pressure bag molding
 - Resin injection molding (RTM = Resin Transfer Molding with mold and casting mold and RTM light)
 - Simultaneous projection molding
 - Vacuum molding and autoclave.
 - Contact molding
- Automatic or Semi-Automatic
 - Centrifugation
 - Low-pressure compression molding
 - Stamping Thermoplastics (RTF)
 - Compression of BMC and SMC
 - Pultrusion
 - Filament winding
 - Reaction molding (RIM)

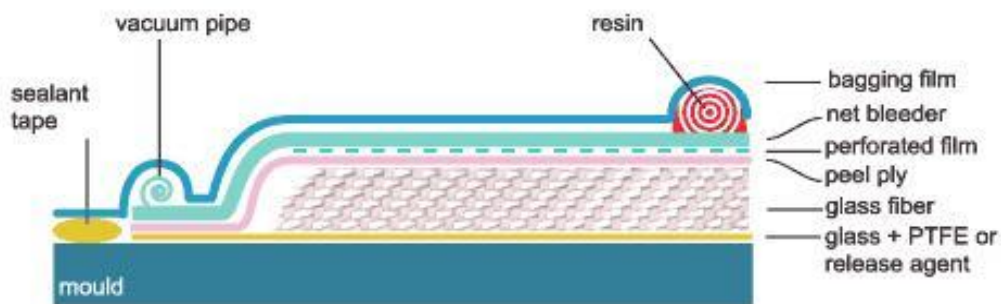
Method	Series	Cadences kg/h/day P/j/mold Pace (m/min)	Mold Type Life	Molding Conditions Pressure (kg/sqm) Temperature (°C)	Type of reinforcement for the resin	% of reinforce- ment
Contact	1 to 1000	50 to 200 1 to 4 -	PA 800 p	- -	Mat, fabric, Stratifil	25/30
Projection	1 to 1000	50 to 600 1 à 4 -	PA 800 p	- -	Stratifil	25/30
Low Pressure	500 to 5000	50 to 300 1 to 50 -	PA 1500 p	1 to 4 20 to 80	Mat, fabric, filament yarn	20/30
BMC	> 10000	1000 80 to 200 -	Steel -	10 to 40 120	Compound	25/50
SMC	> 10000	1000 120 to 200 -	Steel -	70 140	Prepreg fabric	25/40
Filament Winding	-	500 - -	Metal / PA / wood -	- -	Stratifil	35/75
Centrifugation	-	500 - -	Steel -	- -	Mat, fabric, Stratifil	35/45
Pultrusion	> 5000 m	- - 1 to 15	Metal / PA / wood -	- 100	Stratifil	25

Question 2 :

Vacuum Molding



Infusion Molding



What do we lay?
Order of

implementation of the consumables for infusion and vacuum molding
Number of pieces per hour
Advantage infusion and contact
Simultaneous projection
Degassing
Put the operations in the right order

Question 3 : What is of interest in infusion compared to vacuum molding ?

- | | | |
|--------------------------------|-------------|--------------|
| • Saves time | True | False |
| • Saves resin | True | False |
| • Limits VOC | True | False |
| • Better mechanical properties | True | False |
| • Savings on consumables | True | False |
| • Two smooth surfaces | True | False |

Question 4 : Degassing

Degassing consists in removing air pockets with a spiked roller. It is necessary for the following techniques :

- | | | |
|-----------------------------------|--------------------|-----------|
| ➤ Vacuum bag molding | Recommended | |
| ➤ Stamping thermoplastics (RTF) | Yes | No |
| ➤ Resin injection molding | Yes | No |
| ➤ Simultaneous projection molding | Yes | No |
| ➤ Vacuum molding | Recommended | |
| ➤ Autoclave molding for prepregs | Yes | No |
| ➤ Contact molding | Yes | No |

Question 5 :

Technique : Contact molding at room temperature 15 to 25 ° C

Material : Gel Coat applied by hand + Pre-accelerated polyester resin + fiberglass + MEKP*

* Methyléthylketone Peroxyde

Preparing the work :

Tools :

- Wax
- Pieces of Cloth
- Brush
- Container (basin)
- Scales (to the gram)
- Catalyst Measure (pipette)
- Spiked roller
- Solvent (acetone) to clean up the tools

Preparing the piece :

N°	Opérations à effectuer
1	Cleaning the mold (the surface quality depends on it)
2	Laying a mold release agent (wax or polyvinyl alcohol)
3	Laying catalyzed « Gel Coat » (finishing layer)
4	POLYMERIZATION switching from a liquid state to a gel phase (45mins)
5	Cleaning tools with acetone
6	Preparing the reinforcements
7	In gel phase, laying the surface mat (100g/sqm), then the different reinforcements (4 at a time max.)
8	POLYMERIZATION 1H30, cut into Gel after 45mins
9	Removing from the mold 2 hours after the end of lamination
10	Machining, cutting according to the client's requests

Preparing the material :

Gel Coat :

- By hand:

Ratio from 600 to 800 g/sqm Thickness = 0,6 to 0,8 mm

- With a gun :

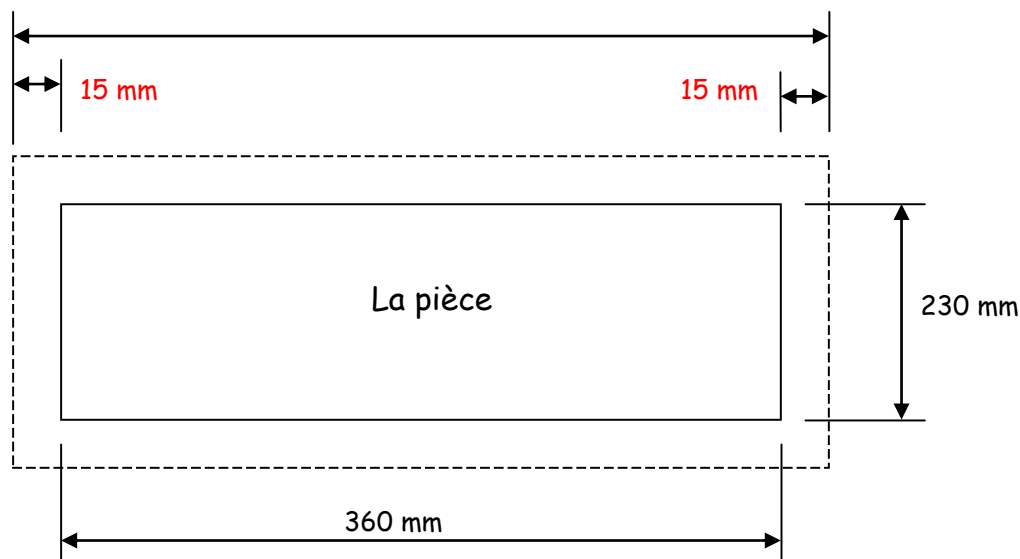
Ratio from 400 to 600 g/sqm Thickness = 0,4 to 0,8 mm

Example.

Find the surface of the following piece : you need to obtain a 360mm*230mm rectangle but the gel coat and the resin do not spread uniformly.

We will lay : 1 mat 100, 1 mat 300, 1 roving 450

Cutting out the piece :



The dimensions of the Inscribed Rectangle (IR) and therefore the reinforcement flows will be :

$$IR = [360 + (2 \times 15)] \times [230 + (2 \times 15)] \quad \text{which equals to :}$$

$$IR = (\text{width} + 30 \text{ mm}) \times (\text{length} + 30 \text{ mm})$$

$$IR = 101400 \text{ sqmm} \quad \text{we convert it into sqm because the basis weight is given in g/sqm}$$

$$IR = 0,1014 \text{ sqm}$$

➤ Calculation of the Gel Coat mass :

800 g/sqm by hand

Gel coat mass = Surface of the Inscribed Rectangle × Ratio to the sqm

600 g/sqm with a gun

Therefore gel coat mass = $0,1014 \times 800 = 81,12 \text{ g}$ Thus **81 g**

Polymerization time :

- 45 minutes for the Gel phase
 - 1 hour for the setting
 - 1 H 30 for the full setting
 - 2 H 00 to unmold
 - 21 days for a complete polymerization
- Clean tools during polymerization.

Preparing the reinforcements (Mats – Roving – Core Mat)

Mats : We lay the surface mat (basis weight 100 g/sqm) during the Gel phase

Nomination	Basis weight (g/sqm)	Thickness (mm)
Mat 100 (surface)	100	0,2
Mat 300	300	0,6

Roving : in order to obtain a mechanical resistance

Nomination	Basis weight (g/sqm)	Thickness (mm)
Roving 450	450	0,45

Calculation of the reinforcement mass :

Reinforcement mass = Surface of the Inscribed Rectangle (in sqm) × Basis Weight of the Reinforcement (in g/sqm)

So for our example :

Mass of the Mat 100 = $0,1014 \times 100 = 10,14$ g

Mass of the Mat 300 = $0,1014 \times 300 = 30,42$ g

Mass of the Roving 450 = $0,1014 \times 450 = 45,63$ g

Preparing the resin :

Type of reinforcement	Relation	Ratio (no unit)
Mats	$\frac{1}{4}$ Reinforcement $\frac{3}{4}$ Resin	3
Roving	$\frac{1}{3}$ Reinforcement $\frac{2}{3}$ Resin	2

Calculation of the resin mass :

Resin mass = Reinforcement Weight x Resin Ratio

3 for the mats

2 for the roving

Our example :

Resin mass for the Mat 100	= 10,14 x 3 = 30,42 g
Resin mass for the Mat 300	= 30,42 x 3 = 91,26 g
Resin mass for the Roving 450	= 45,63 x 2 = 91,26 g

Preparing the catalyst (To use when utilizing the Gel coat and resin. It allows to start and accelerate the polymerization)

Gel Coat and resin are also called matrixes

Type of Matrix	Percentage
Gel Coat	2 %
Polyester resin	1,5 %

Calculation of the catalyst mass : MEKP = Methylethyketone Peroxyde

MEKP mass = Mass of the matrix utilized x Percentage

2% for gel coat
1,5% for resin

With our example :

Mass of the catalyst to be put into the Gel coat = $(81 \times 2) / 100 = 1,62$ g

Mass of the catalyst to be put into the resin to « set » the Mat 100 :

Catalyst mass = $(30,42 \times 1,5) / 100 = 0,456$ g

Mass of the catalyst to be put into the resin to « set » the Mat 300 :

Catalyst mass = $(91,26 \times 1,5) / 100 = 1,369$ g

Mass of the catalyst to be put into the resin to « set » the Roving 450 :

Catalyst mass = $(91,26 \times 1,5) / 100 = 1,369$ g

Lamination :

Lamination requires a lot of technique to obtain good-quality composites with excellent mechanical features.

Lamination Technique :

Spread $2/3$ of resin (catalyzed) in a uniform layer on gel coat in gel phase.

Apply surface mat.

Impregnate with $1/3$ of the remaining resin.

Degas with the brush at a right angle to the workspace starting from the center and spiralling around.

Repeat for the next reinforcements.

According to the chosen example, here is the order of the tasks to be performed.

Lay the 100 g/sqm surface mat

Lay the 300 g/sqm Mat

Lay the 450 g/sqm roving

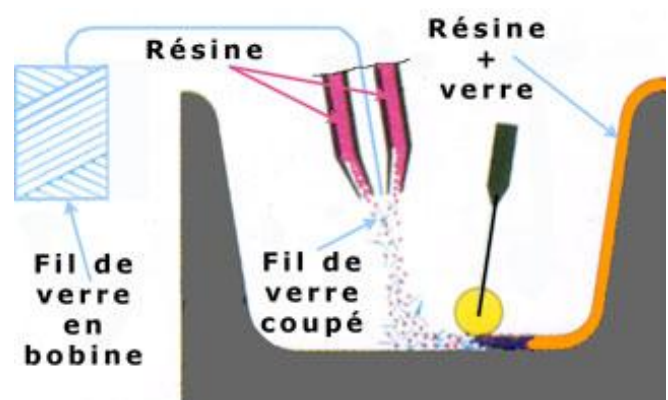
Clean tool with acetone (Beware of projections)

Wait 45 minutes to **cut in gel**

Wait 2 hours to remove from the mold



Projection gun



Simultaneous projection

Question 6: Simultaneous Projection Molding

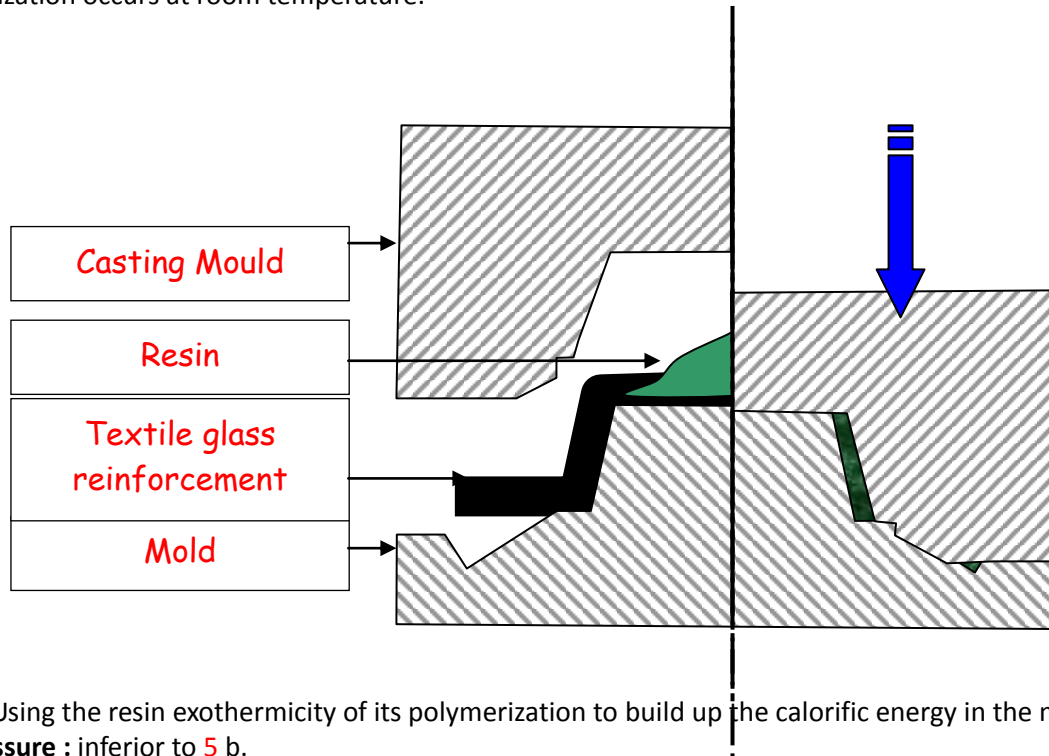
- Explain the principle and fill the blanks.

In this process, derived from contact molding, we lay material with a **projection gun** that cuts the glass roving and **projects** it on the mold at the same time as the resin. The degassing operation is processed **manually** like contact molding. This technique also requires a meticulous preparation of the mold surface (**wax**) and the application of a **gel-coat**

Question 7: Low-Pressure Molding

- Principle

Molding made by cold compression of a reinforcement between a **mold** and a **casting mold**. Polymerization occurs at room temperature.



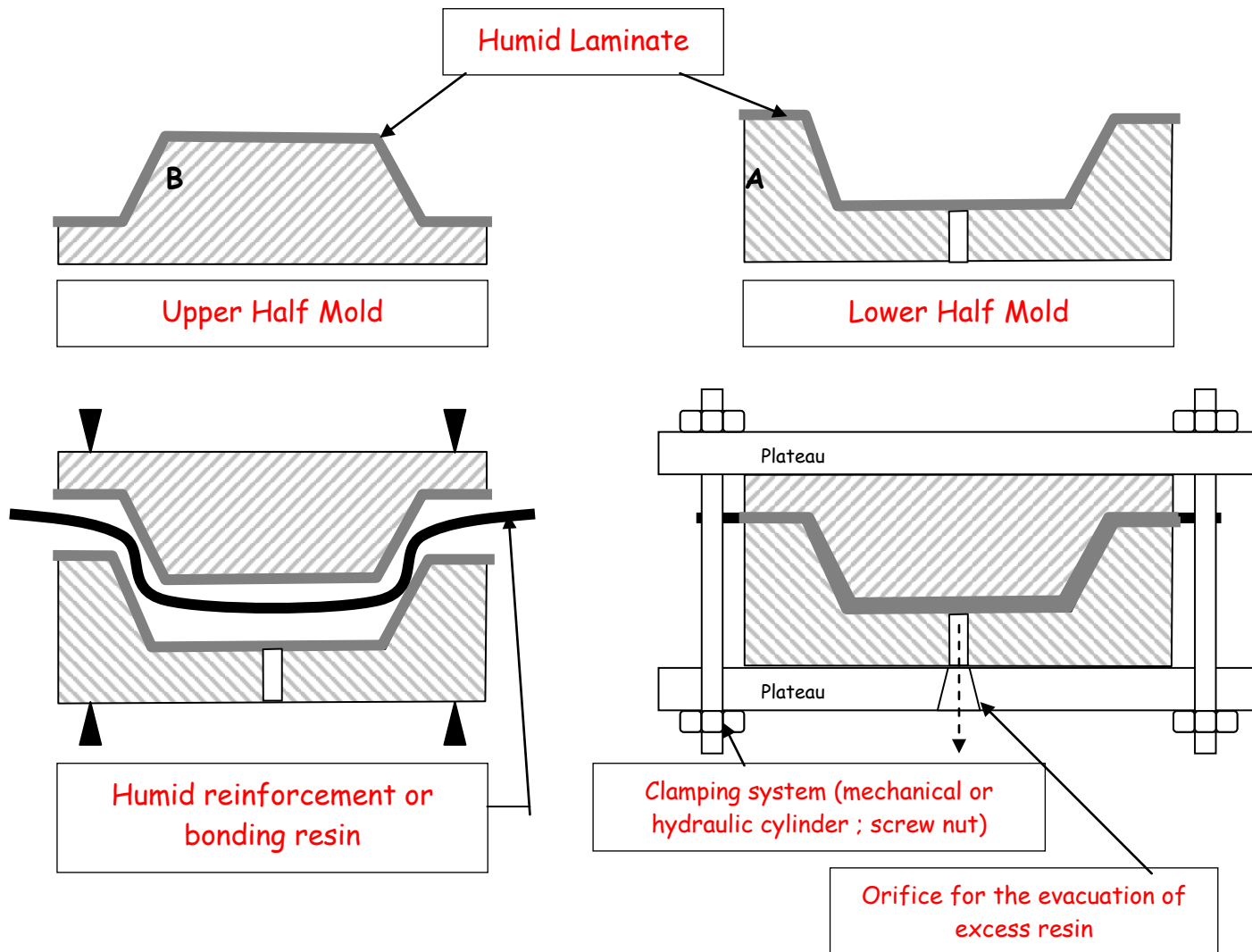
Cold press : Using the resin exothermicity of its polymerization to build up the calorific energy in the mold.

Molding pressure : inferior to 5 b.

Pace : 4 to 12 pieces per hour.

Question 8: Press Contact Molding

- Principle.



Advantage	Inconvenient
<ul style="list-style-type: none"> • Two smooth faces 	<ul style="list-style-type: none"> • Manual draping