

The IMC / MTI[®] - Process

PRACTICAL TIPS

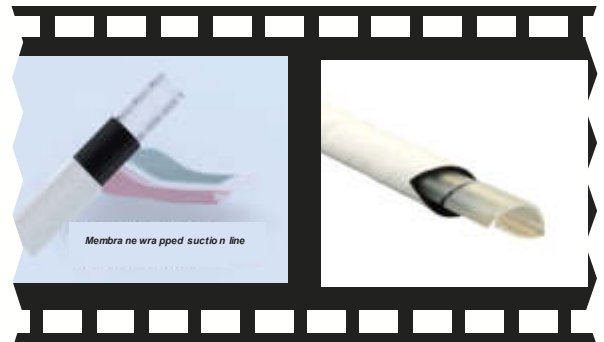
*... next generation
vacuum infusion*

- The manual attached to the animation -



In-Mould Coating

+



MTI[®]-hose

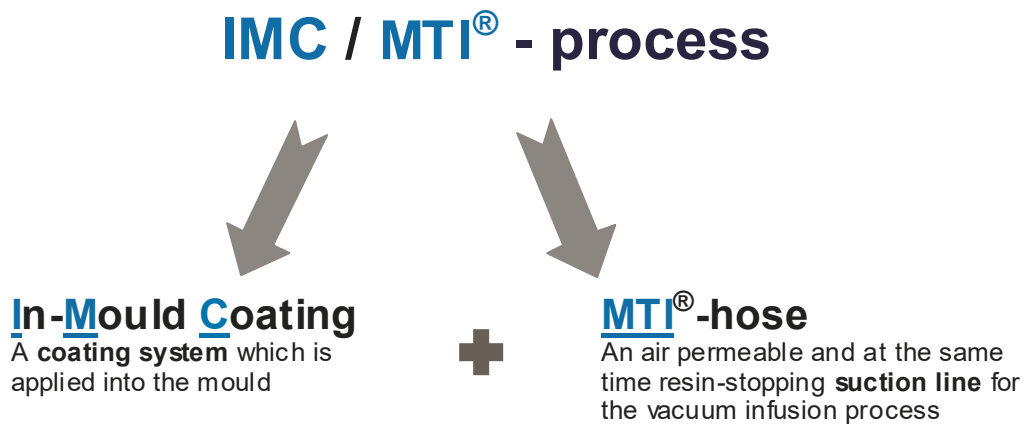
=



Cost savings coupled with high process safety

1. BACKGROUND - what does „IMC / MTI®“ stand for?

The **IMC/MTI®-process** combines the advantages of the **In-Mould Coating** and the advantages of the **Membrane Tube Infusion** in component manufacturing by using the infusion process.



At the **IMC/MTI®-process** the painting of the moulded part is already made in the tool or negative form. Instead of grinding and painting fiber-reinforced components very work-intensive afterwards,

= time and cost savings
ready painted components of highest quality

the varnish is already applied in the mould on the visible side of the moulded part.

Thanks to its specially developed composition, a PU-varnish which is applied by this method is able to establish a chemical bond to the FRP even after several weeks. Particularly productions by means of vacuum infusion or vacuum compression processes benefit from this principle.

The **MTI®-hose** is a membrane-wrapped suction line → permeable for air and gases → impermeable for the resin system. This hose is placed at the edge of the mould and serves as a ring main in the vacuum construction. In the process of vacuum infusion it provides an evenly distribution of the resin without exhausting the resin out of the component.

Besides low investment costs and flexible fields of application, the **IMC/MTI®-process** provides a high degree of process safety with a simultaneous optimization of the component's quality.

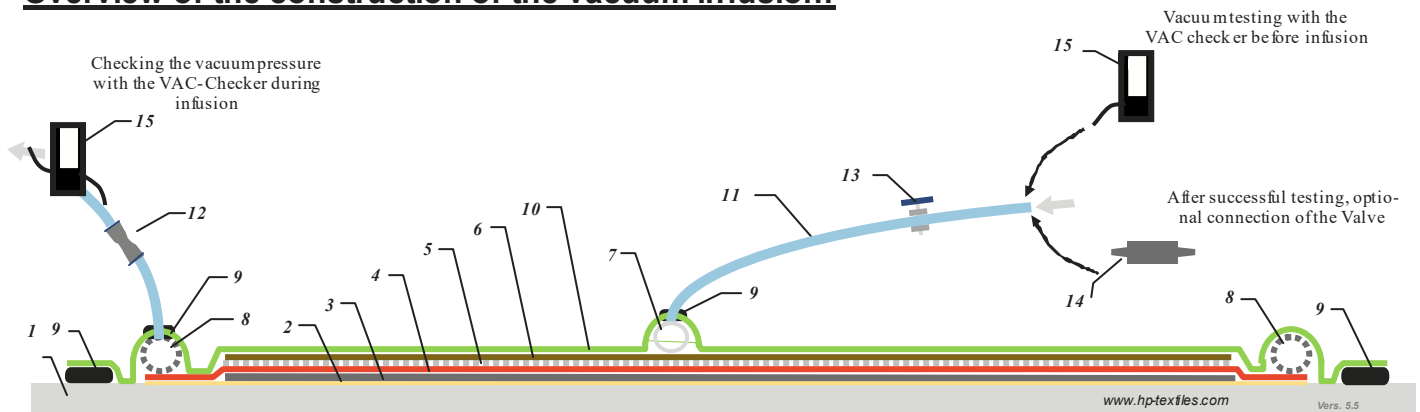
The **IMC/MTI®-process** has already been used successfully for years by several large and well known manufacturers in the wind power and automotive industries but also at aeromodelling.

What started as a modified infusion process quickly established itself as a synonym for a totally new whole package for the production of fiber reinforced structures.

The **IMC/MTI®-process** and its components are already known thanks to several international trade fairs:



Overview of the construction of the vacuum infusion:



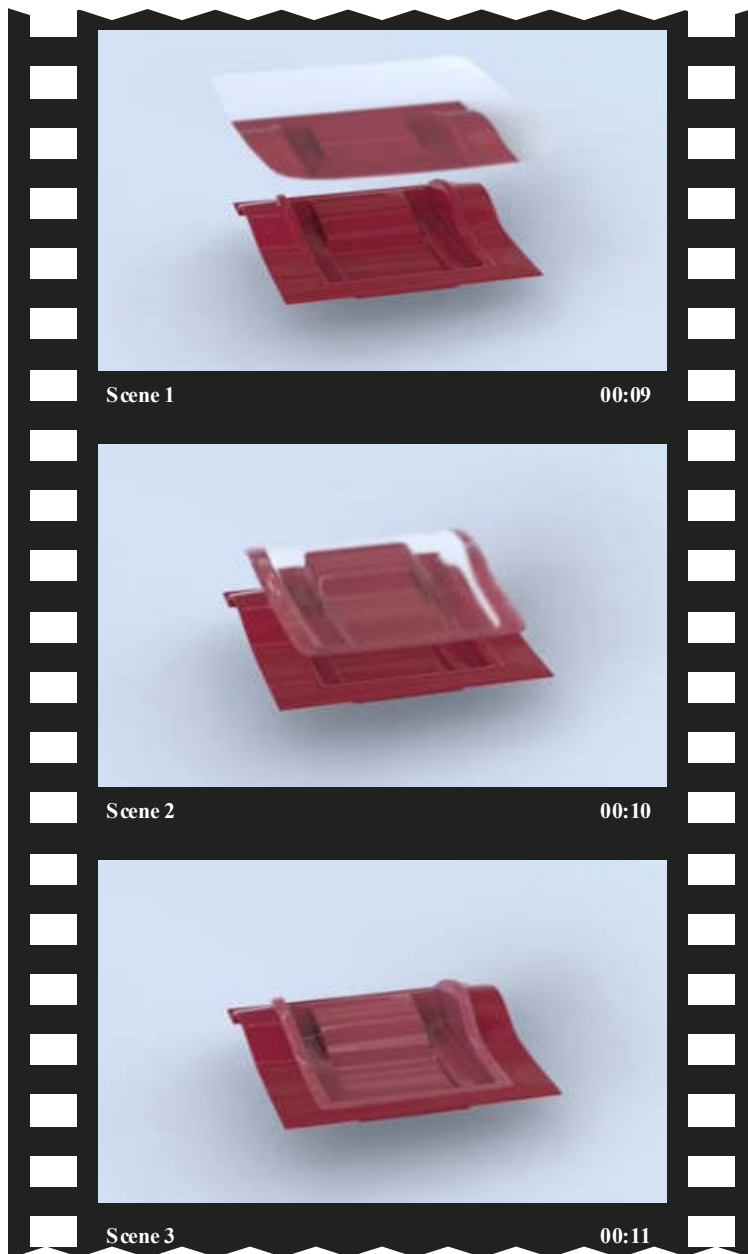
Description	Material / Notes	Item
1 - Mould		
2 - Release agent	aqueous, up to 150°C (briefly up to 200°C) Priming wax and PVA, up to 100°C Carnauba wax, up to 80°C	HP-HGR5 HP-G and HP-PVA HP-CX7
3 - Reinforcement fibres	various types	
4 - Peel ply	Polyamide, twill / plain, var. width	HP-P83P or HP-T105P
5 - Perforated film	HDPE, 30g/m² or 44g/m²	HP-RF30/130, HP-RF44
6 - Flow aid	PE 145g/m² oder 200g/m²	HP-IM145/100 or HP-IM230/120
7 - Flow channel	PE spiral hose / Blade Runner®	HP-ST060, HP-ST080 or HP-ST100 HP-VZ1475
8 - Vacuum ring line	MTI®-hose	HP-MTI-08
9 - Vacuum sealing tape	Butyl rubber, use up to 80°C, black synth. rubber, use up to 210°C, yellow	HP-ST12X3/80 HP-ST10X3/210
10 - Vacuum bagging film	PA/PE/PA, width 2,60m PA/PE/PA, width up to 8,00m, very clear PA/PE/PA as hose, width 1,50m PA as hose, width 20, 30, 60, 90cm	HP-VF60/260 HP-VF70/260 HP-VFT75/150 HP-VFT50
11 - Vacuum hoses	PE (esp. inexpensive), 10 or 12mm PUR (esp. flexible), 10 or 12mm	HP-VZ1010 or HP-VZ1020 HP-VZ1030 or HP-VZ1040
12 - Plug connectors	various types, manometer, valves, etc...	
13 - Squeeze® / Squeezer® hose clamp		HP-VZ1400 or HP-VZ1425
14 - MTI® Valve	Automatic valve for vacuum infusion	HP-VZ1450
15 - VAC Checker	Digital vacuum gauge	HP-VZ1440
16 - Vacuum pump	Rotary vane pump, oil-lubricated, 4m³/h (further types available)	HP-VZ1200, HP-VZ2000

NEW:
Vakuum bagging films
available up to 8m width!

2. The IMC/MTI[®]-process step by step ...

... further details to the animation

STEP 1: ... construction of a separating layer



First, the surface of the negative form has to be cleaned.

Forms which were created with the mould making resin **HP-E30FB** can be cleaned with solvents like **acetone** or **thinner XB**.

After that, the release agent **HP-HGR5** has to be applied in at least 2-3 layers with each 20-25g/m².

If required, it is possible to polish it after a few minutes to high gloss.

After the last layer, the entire construction should harden for at least 30 minutes.

The layer of release agent is suitable for multiple de-moulding processes. However, it should be renewed with a layer of **HP-HGR5** from time to time.

further TIPS

Do you need assistance in processing fiber composites? Do you want to build a negative form made of fiber composites and do you need information regarding material selection?

You can find practical assistance step-by-step in our Online-Shop at www.hp-tex.com and also short videos regarding diverse topics... just take a look!

Selection of release agents:

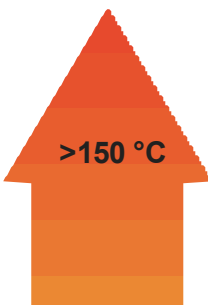
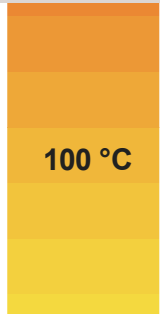
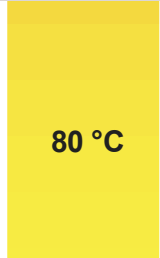
The optimal release agent is selected according to the existing process temperatures.

The high adhesive force of the **In-Mould Coating** requires the use of the most effective release agents to avoid 'unpleasant surprises'.

In addition to well known products based on carnauba wax or PVA (see table below) we also offer a special high gloss water-based release agent: **HP-HGR5**.

This product is suitable for a permanent processing temperature up to approx. 150°C (briefly up to nearly 200°C).

Overview of possible release agents:

Type	Short info	Temperature
HP-HGR5 (high gloss release agent)	Aqueous high gloss release agent HP-HGR5 . Application by wiping or spray gun. Creates a polymer-release-film. Residues can be cleaned with water. Polishable to high gloss Semi-permanent polymer-release agent Suitable for multiple de-moulding processes.	 >150 °C
HP-G (priming wax) with HP-PVA (film release agent)	Priming wax HP-G in combination with film release agent HP-PVA . Reliable separation effect and simple to apply. Not polishable. Combination of release agents Has to be applied after each de-moulding process.	 100 °C
HP-CX7 (Carnauba wax)	Carnauba wax HP-CX7 . Single-release wax, polishable to high gloss. Release wax Limited suitability for multiple de-moulding processes. If necessary renewable with a new layer!	 80 °C

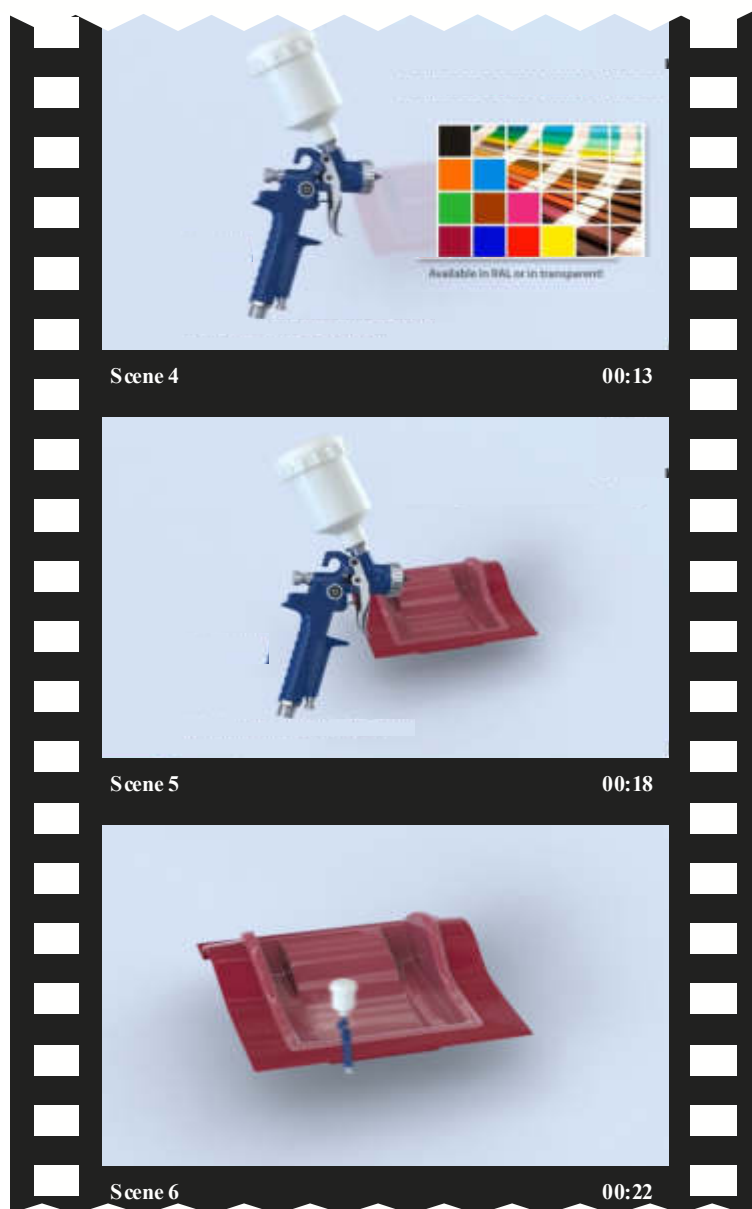


Pic. 1: Carnauba wax **HP-CX7**



Pic. 2: Release agent **HP-HGR5**

STEP 2: ... processing the In-Mould Coating



Chose the desired RAL-colour of the **In-Mould Coating**.

The next step is to mix the **In-Mould Coating** in a mixing ratio of 100:50 (by weight).

Apply the **In-Mould Coating** within the processing time of approx. 30 minutes at 20°C.

INFO

A high-quality 2-component PUR varnish forms the basis of the **In-Mould Coating HP-IMC**.

Advantages of the **In-Mould Coating**:

- elimination of subsequent grinding or painting work
- high adhesion properties
- maximum protection for the fiber composite
- available in RAL colour range or in transparent



Pic. 3+4: The In-Mould Coating **HP-IMC**

To mix the **In-Mould Coating**, proceed as follows:

First, insert the resin component into the mixing container and then add the required amount of hardener (mixing ratio = 100:50 proportions of weight).

Then mix everything carefully. Avoid already at this step the formation of air bubbles.

After mixing, the mixture can be processed within a pot life of approx. 30 minutes.

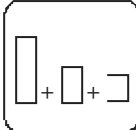

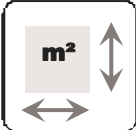
Our recommendation is the application by spraying for an optimum quality.

(Processing by varnish roller / varnish brush is also possible, but the result will normally be a barely homogeneous layer thickness.)

Space out evenly, apply crosswise and avoid the formation of air bubbles.

It is not necessary to whet the surface before applying the second **In-Mould Coating** if the second coating takes place within 24 h (at 20°C).




Processing parameters:

		
Mixture	Processing	Consumption
100 parts (resin) 50 parts (hardener)	nozzle: 1,2 - 1,4mm	40-50 µm (per spraying process)
when required: 5-10 parts thinner	pressure: ca. 4bar	2-3 spraying processes recommended
Consumption: 1 litre mixture = approx. 7m² at 50µm		

Is the **In-Mould Coating** painted into the mould, the coating with epoxy resin (or the infusion) can be done **without** another coupling layer!

Therefore, the **In-Mould Coating** only has to reach a sufficient degree of cross-linking prior to further processing (pre-hardening up to a tack-free phase).

Hardening parameters:

		
Temperature	Pre-hardening time (before coating with epoxy)	
80°C	A few minutes	
60°C	40-80 minutes	
40°C	4-6 h	
20°C	24 h	

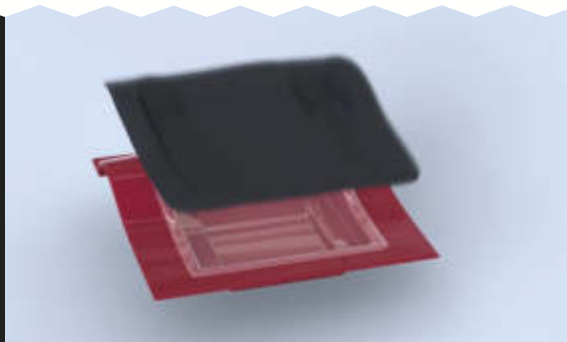
The duration of the pre-hardening process largely depends on the temperature.

At 20°C it will take approx. 24h → at a mould temperature of 80°C this time is shortened to a few minutes!

IMPORTANT: Do not coat the **In-Mould Coating HP-IMC** with epoxy if it is still sticky. This has the advantage that the laminate construction can be made even after almost 4 weeks (at 20°C).

Depending on the process, reference values can deviate . We recommend pre-tests.

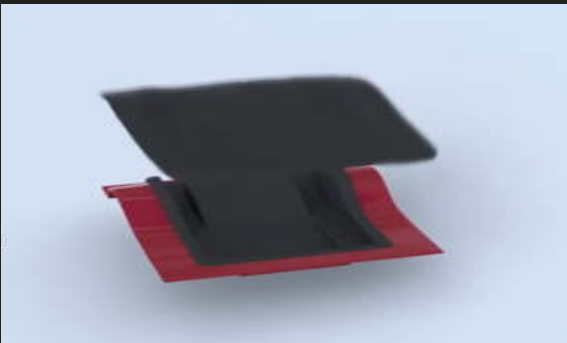
STEP 3: ... layer construction and vacuum materials



Scene 7

00:49

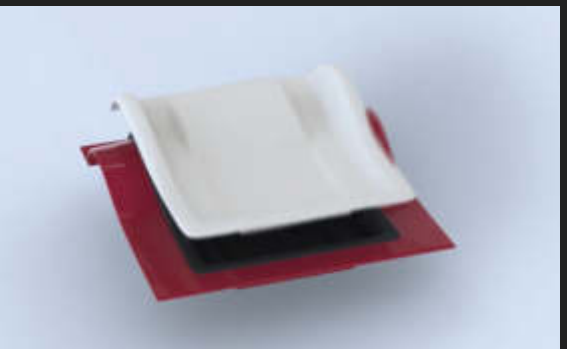
Place dry reinforcement fibers (fabrics, multiaxial fabrics...) in the mould. Fix the single layers with adhesive spray or with the self-adhesive glass fiber mesh tape [HP-AM075/050](#).



Scene 8

00:50

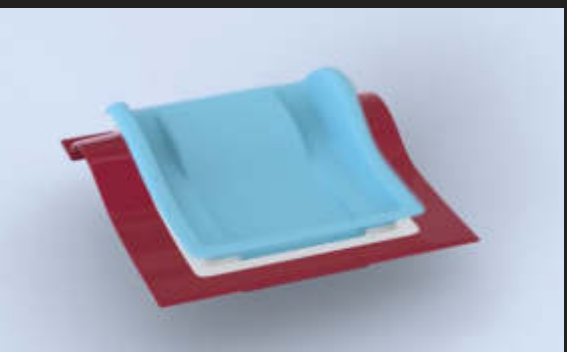
A major advantage for the [IMC/MTI®-process](#) over e.g. pre-impregnated fibers: High investments for autoclaves and cooling equipments are eliminated. Furthermore, a greater choice of fabrics / multi-axial fabrics is directly available.



Scene 9

00:53

To provide an optimal infusion, the vacuum bagging materials need to be placed now. This includes first a peel ply (e.g. [HP-T105P](#)). It absorbs a surplus of resin and leaves an evenly abrasive surface behind.

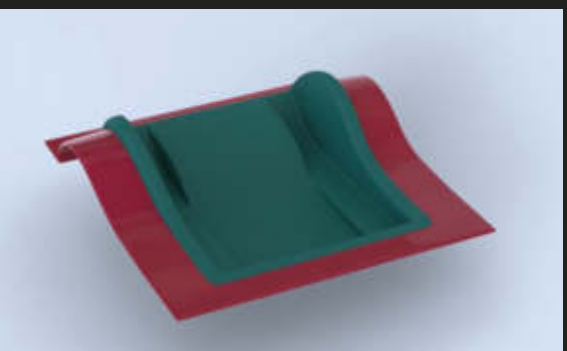


Scene 10

00:55

This is followed by the perforated release film [HP-RF25/110](#).

TIP: Fix this film with a small piece masking tape at the corners.



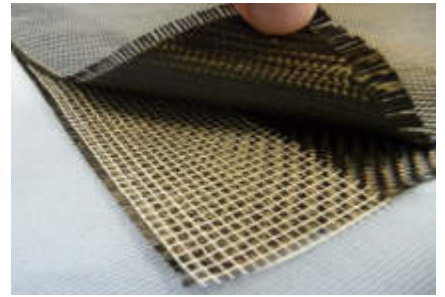
Scene 11

00:59

To enable a quick flow of resin, the vacuum mesh [HP-IM145/100](#) is added as a flow aid and is also fixed with a small piece of masking tape.

Fixation of fiber layers:

Instead of using adhesive spray it is also possible to fix the fiber layers with the glass fiber mesh tape **HP-AM075/050**. This product is not only self-adhesive but also consists of glass fibers and is therefore suitable to stay in the laminate.



Pic. 5: The glass fiber mesh tape **HP-AM075/050** (between two layers).

Construction of vacuum bagging materials:

1. The peel ply, e.g. **HP-T105P**

→ leaves an evenly and abrasive surface behind and absorbs a surplus of resin.



Pic. 6: The surface after removing the peel ply.

2. The perforated release film **HP-RF25/110**

→ makes it easier to separate the flow aid and the peel ply from each other



Pic. 7: The perforated release film **HP-RF25/110** in a close-up view.

3. The vacuum mesh **HP-IM145/100**

→ provides an evenly vacuum and a good flow of the resin even into contorted areas



Pic. 8: Adjusting the vacuum mesh **HP-IM145/100**.

All vacuum bagging materials can be cut to size with our scissors **HP-L1054**.

Creating flow channels for the infusion resin:

If you have components with a greater flow-distance, it is useful to build up „resin-channels“.

Therefore, you can use our spiral hose and fix it with adhesive tape onto the vacuum mesh to ensure here the flow of a greater amount of resin.

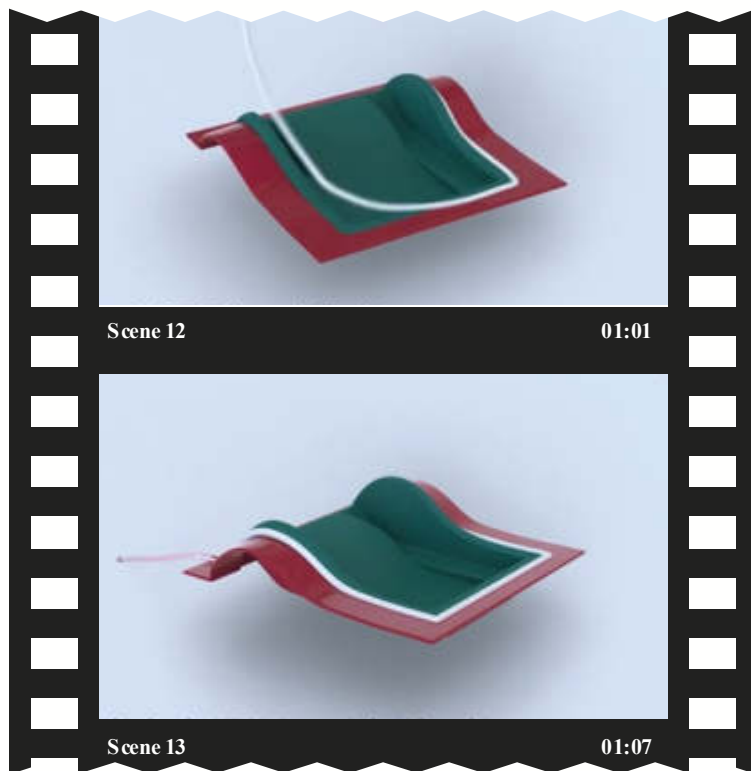
Those spiral hoses are available in different sizes:

HP-ST060 (diameter 6mm)
HP-ST080 (diameter 8mm)
HP-ST100 (diameter 10mm)



Pic. 9: A spiral hose.

STEP 4: ... attaching the MTI® - hose

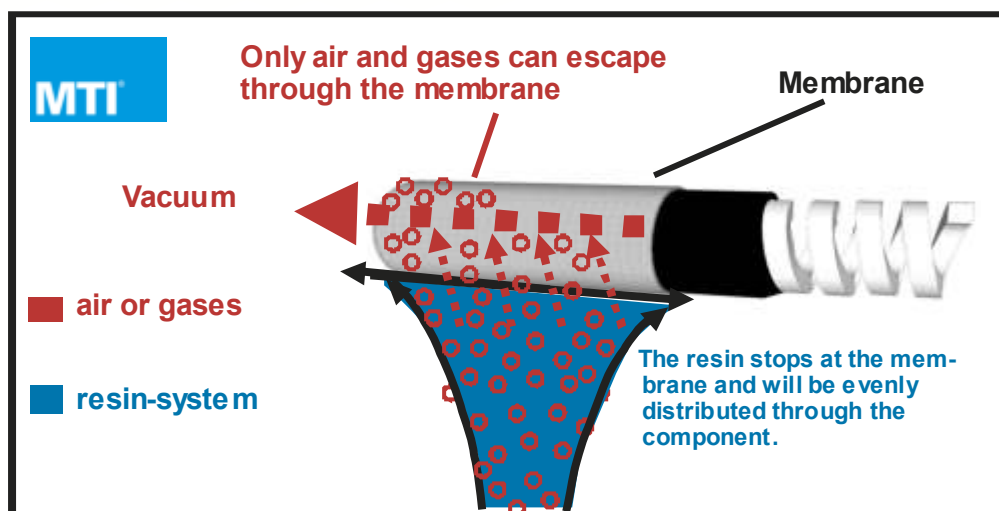


The **MTI®-hose** is fixed at the edge of the mould using our vacuum sealing tape **HP-ST12X3**.

Alternatively, it is possible to prevent the hose from moving with the help of adhesive tape.

After that, the **MTI®-hose** is connected with the vacuum line.

Therefore, it is also possible to use the vacuum sealing tape **HP-ST12X3**.



Pic. 10: The functionality of the **MTI®-hose** in an overview.

INFO

The **MTI® - hose** consist of a spiral hose which is surrounded by a functional membrane. Therefore, the resin is not unnecessarily sucked out of the component.

Advantages of the **MTI® - hose**:

- complete impregnation of the fiber layers
- minimisation of air pockets
- reduced consumption of resin
- high fiber volume ratio
- optimisation of the component's quality



Pic. 11: The **MTI® - hose**.

The all-rounder for gluing and sealing work:

Our vacuum sealing tape **HP-ST12X3** consists of butyl rubber and distinguishes itself by a very high adhesion on diverse materials and surfaces.

The vacuum sealing tape is about 3mm thick and 12mm wide to achieve a highly effective sealing and slightly uneven spots or bends can be sealed easily.

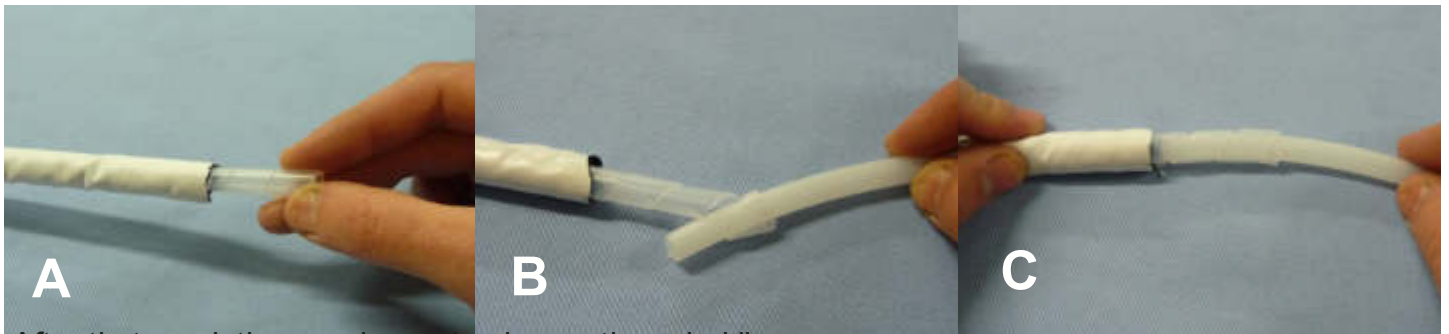


*Pic. 12: The vacuum sealing tape **HP-ST12X3**.*

Connecting the **MTI**®-hose with the vacuum line:

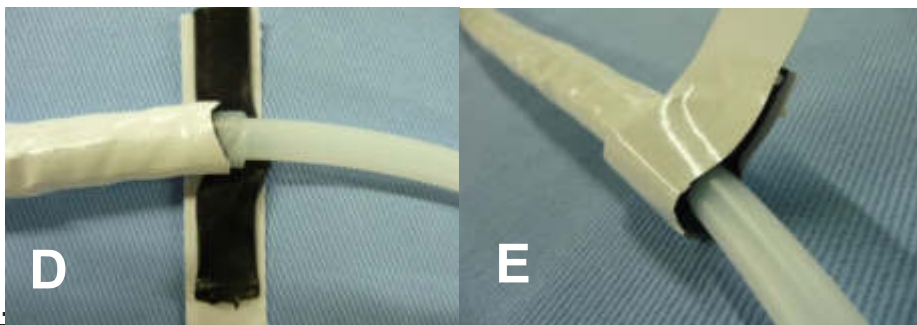
First, pull a few centimetres of the inner spiral out of the membrane. (*Pic. 13, A*)

Then wrap this spiral line around the hose which leads to the vacuum pump. (*Pic. 13, B-C*)



After that, push the membrane back over the spiral line.

Now wrap the vacuum sealing tape around the connection so that the transitional area is completely surrounded with the vacuum sealing tape. (*Pic. 13, D-E*)



Closing the end:

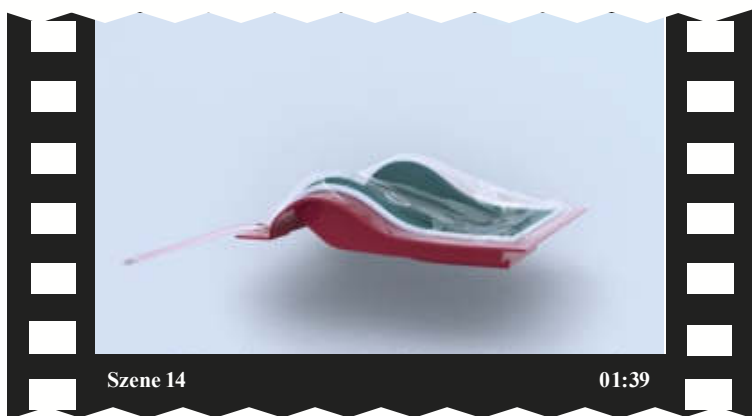
*Pic. 13 D-E: connecting the **MTI**®-hose (continuation).*

Just release a piece of the sealing tape from its carrier film and put it into the end of the hose. After that, press the opening carefully together and fold the end over. Close this end again with a piece of the vacuum sealing tape. (*Pic. 14, A-C*)



*Pic. 14, A-C: **MTI**®-hose. Sealing the ends.*

... STEP 5: ... sealing with vacuum film



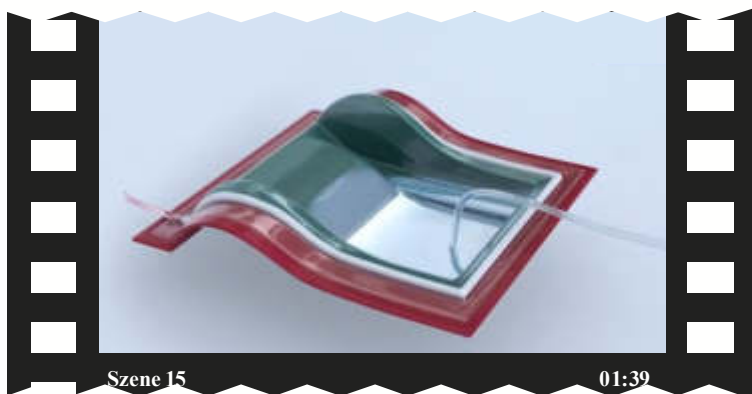
Fix the vacuum film with the help of our vacuum sealing tape **HP-ST12X3** at the edge of the mould.

Include darts (pleats) so that the film does not stretch.

Alternatively, it is possible to use the film hose **HP-VFT75/150**. So you can put the entire component together with the mould into the film. After that, you just have to close the small sides (cut surface) of the film with vacuum sealing tape.

It is necessary to perform a sealing test prior to the infusion!
Thereby, possible leakages can be detected early and eliminated if necessary .

... STEP 6: ... preparing and leading the infusion resin into the mould



Before leading the infusion resin (e.g. **HP-E3000GL**) into the component it is necessary to degas the resin.

Directly after mixing (mixing ratio = 100:30) the resin is placed into a desiccator to degas it and to evacuate air. Depending on the strength of the vacuum, first air bubbles will burst within a few seconds.

The degased infusion resin can be “soaked” into the component.

INFO

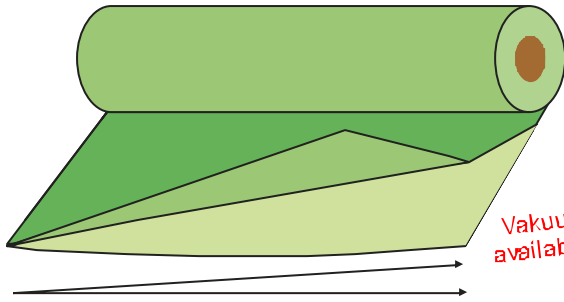
Epoxy-infusion system of the series **HP-E3000GL** High-Tech System for the production of components.

Characteristics:

- basic resin with three different hardeners and therefore the pot life is variably adjustable (15 - 300 minutes).
- increased temperature resistance , (T_G MAX) approx. **107°C**
- high degree of static and dynamic strength
- especially high beginning- T_G already during hardening at room temperature
- visual applications even at elevated temperatures as carbon visual parts.

Vacuum film or film hose?

As flat film: **HP-VF60/260**
(folded once)

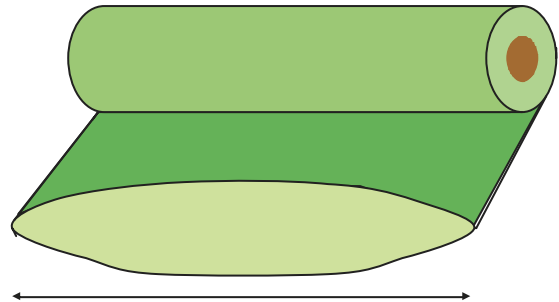


width (total): 260cm
(folded once to approx. 130cm)

Temperature resistance: 125°C
Material: PA/PE/PA coextruded
Thickness: 60µm

NEW:
Vakuum bagging films
available up to 8m width!

As film hose: **HP-VFT75/150**
(both sides closed)



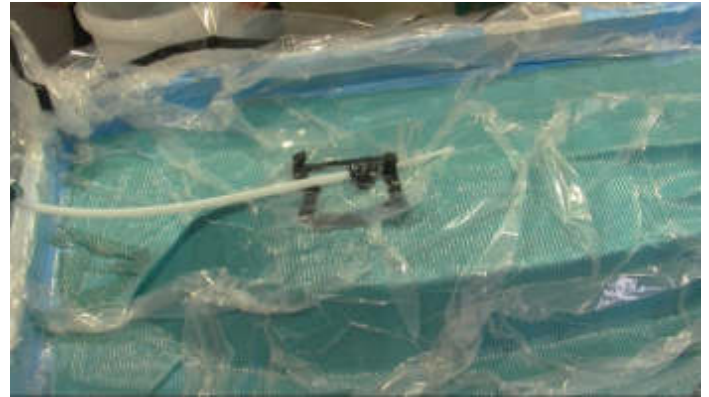
width (flat): 150cm
(diameter as hose approx. 95,94cm)

Temperature resistance: 180°C
Material: PA/PE/PA coextruded
Thickness: 75µm

Pic. 15: Vacuum film compared with film hose.

Connection point for the supply of resin (infusion line):

Connection points for the supply of resin should be added at a point in the vacuum construction from where the resin can infuse evenly into the component. Normally, central points are chosen for this. So the resin can impregnate the fibers and displace air outward (in the direction of the suction line at the edge of the component). Connection points can be added before sealing as well as subsequently but it often makes sense to add the suction line before sealing.



Pic. 16: Central connection point of infusion line.

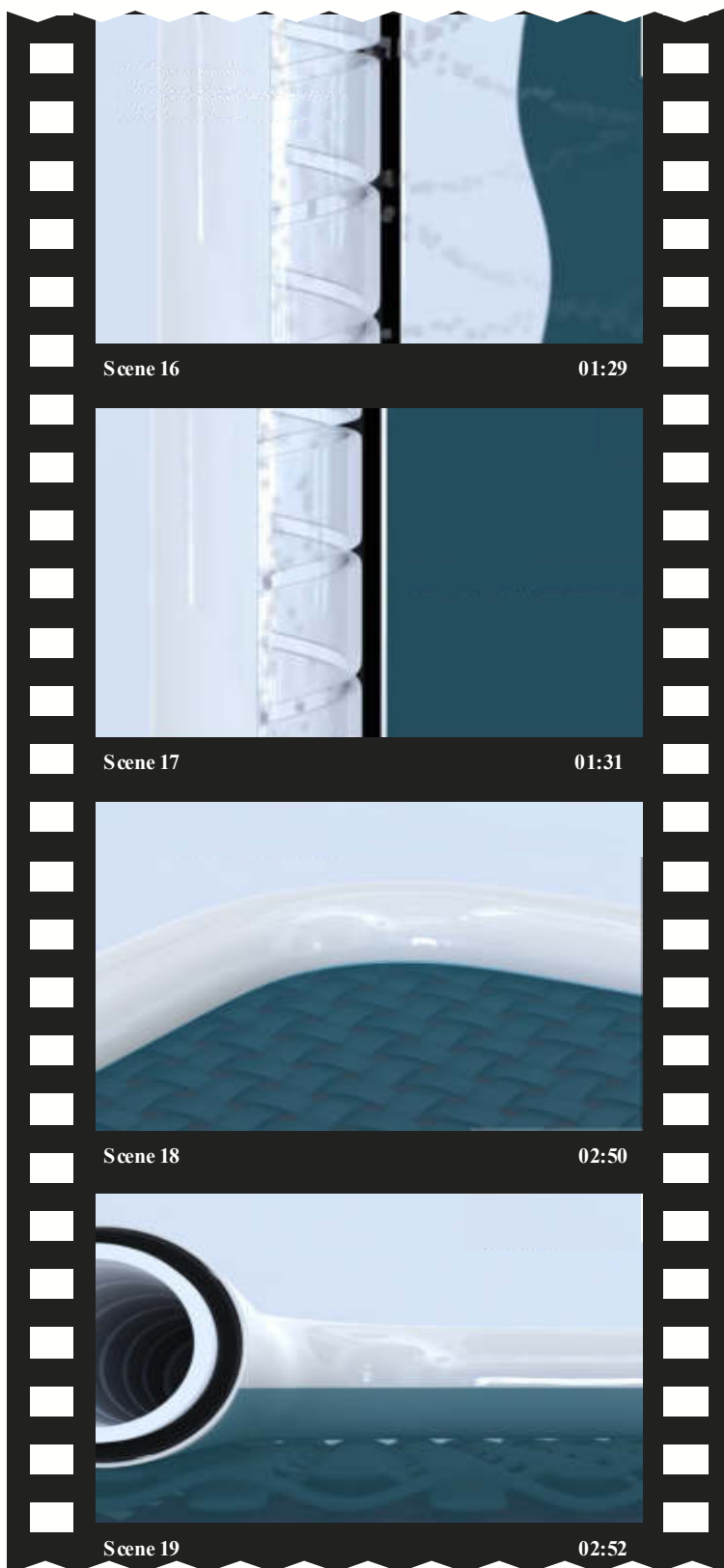
Adding the infusion line directly:

First, wrap the vacuum sealing tape **HP-ST12X3** around the supply line (Pic. 17, A)
After that, cut a piece of foil to the size of about 10 x 10 cm. Add a little hole to the piece and seal the foil at the edges. Now you can feed the hose through the opening of the foil, so that the opening is closed by the vacuum sealing tape which is wrapped around the hose.
The vacuum sealing tape at the hose (in the middle) and at the edge should be located at the same side of the piece of foil. (Pic. 17, B)

Now insert the protruding end of the supply line through a cut under the vacuum film (into the component). After that, seal this point by pressing the vacuum sealing tape on the vacuum film - at first press on the tape in the middle onto the film of the component and after that press on the tape which is at the edges of the piece. (Pic. 17, C)



Pic. 17, A-C: Connecting the line for resin infusion.



Top view onto the **MTI®-hose** from above, partly without membrane:

The infusion resin flows with air bubbles from the right towards the **MTI®-hose**...

... and meets the membrane.

This membrane enables the suction of air bubbles out of the resin and the risk that the infusion resin can be sucked into the suction line is eliminated.

When the infusion resin (with micro-bubbles) meets the **MTI®-hose** at the components edge, it is stopped by the membrane.

However, air bubbles are still sucked out of the resin.

By using the **MTI®-hose** the laminate is completely impregnated. At the same time the membrane prevents the resin from suction (as it would be the case by using a conventional spiral line).

Process parameters vacuum infusion (as benchmarks):

- optimal processing temperature = from 20 to 25°C - *higher temperatures are also possible!*
- optimal process pressure = <20mbar (absolute)

A pressure of <20mbar (absolute) is recommended for infusions with a minimum of air bubbles
Therefore, you should use a powerful vacuum pump (see *right*).

IMPORTANT:

It is important to have a constant vacuum level! This means that this level has to be constant even after the gel-phase of the resin system!

Everything from a single source -

from fibers to manometers:

We offer you a variety of plug and quick connectors for your vacuum construction. Furthermore, we provide the most popular manometers and valves.

The quick connectors are easy to apply and also easy to disconnect by pulling back the blue ring.



Pic. 18: Extract from our product range of vacuum accessories and quick connectors.

Vacuum accessories with quick connectors (extract):

	System 10mm Art.-No.	System 12mm Art.-No.
PE-hose, <i>standard</i>	HP-VZ1010	HP-VZ1020
PU-hose, <i>esp. flexible</i>	HP-VZ1030	HP-VZ1040
Plug connection	HP-VZ1050	HP-VZ1060
T-type plug connection	HP-VZ1070	HP-VZ1080
Plug connection (reducing)	HP-VZ1090	
Plug connector with internal thread, G 1/4"	HP-VZ1100	HP-VZ1110
Y-type plug connector	HP-VZ1120	HP-VZ1130
Sealing plug	HP-VZ1160	HP-VZ1170
Stopcock	HP-VZ1140	HP-VZ1150
Manometer	HP-VZ1180 (vertical)	
	HP-VZ1190 (horizontal)	
Squeeze [®] / Squeezer [®]	HP-VZ1400 or HP-VZ1450	

We also offer simple hose connectors with spouts as an alternative to quick connectors. These hose connectors are placed in the hoses and they are mainly used as disposables in lines carrying resin.

Vacuum pump for continuous operation:

The quality of the manufactured parts depends also on the built up vacuum!

Therefore we offer a compact rotary vane vacuum pump, lubricated with circulating oil (suitable for the continuous operation). With a pump capacity of 4m³/h (approx. 67 litres/min) and a maximal vacuum of 2mbar _(absolute) this model reaches a contact pressure of more than 10t/m².



Pic. 19: Our rotary vane vacuum pump **HP-VZ1200**.

© **This work and its parts are protected by copyright.**

Any use in other than legally authorised cases requires the written approval of HP-Textiles GmbH.

The data of this practical guide have been compiled to the best of our knowledge and belief and correspond to our current state of knowledge.

—> Due to market dynamics we reserve the right to make short-term changes if we regard them as necessary.

We cannot give any warranty for the processing results in individual cases because of the variety of applications. Also storage and processing conditions of our products are beyond our sphere of influence.

When using and processing our products the current product data sheet must always be observed. Furthermore, our general terms of business and delivery will apply. We generally recommend pre-tests.

With the publication of a new revision of this practical guide or new product data sheets all earlier versions and resulting data are no longer valid.

Please follow this QR-code to the corresponding animation of the **IMC / MTI® - process ...**



... and please have a look at the video
right on your Smartphone/Tablet.

HP-TeXtiles

...light up your future!!!

Otto-Hahn-Str 22
48480 Schapen
-Germany-

Tel: +49 (0) 5905 945 98 70
Fax: +49 (0) 5905 945 98 74

www.hp-textiles.com
info@hp-textiles.com

The HP-Textiles GmbH is **certified according to DIN EN ISO 9001:2008** by



Rev. 2.6

Vehicle of the 'Formula Student Series' of the 'Ignition Racing Team' of the University of Osnabrück.
Production with the help of the **IMC / MTI® - process** and products from HP-Textiles