VAP® Vaccum Assisted Process

Air and reaction gases that are trapped during closed infusion processes can cause weaknesses in lightweight components. In conventional infusion processes, the entire assembly – subjected to low pressure – must be extensively flushed with the infusion medium until it can be safely assumed that there is no more trapped air and gas inside the component. The vacuum has to be reduced towards the end of the infiltration process in order to avoid the matrix boiling effect.

The EADS-patented Vacuum Assisted Process (VAP®) uses the properties of modern, semi-permeable membrane systems in highly developed textile composites to apply the effect of a vacuum to the entire surface of a component. In this way, trapped air and gas can be reliably and efficiently removed (porosity lower than 0,3%, accuracy of fibre volume content up to 1%).

Membrane-assisted low-pressure infiltration

In the VAP®assembly, the flexible membrane system – which is permeable to gas but impermeable to the resin – is superficially contacted with the component. When the resin is infiltrated, it separates the matrix from the vacuum duct. With the aid of low-pressure, trapped air and gas can then escape through micro-permeability and are purged via the textile layer.

The vacuum acts uniformly, so trapped air and gas can be evacuated across the entire contact surface during and after infiltration.

Key features of the Vacuum Assisted Process VAP® process:

- Low initial investment: possibility to use tools that are already available
- Air and gas removal during and after infiltration
- Uniform vacuum across entire contact surface
- Membrane systems tested and approved for different resins and processes
- Fast infiltration process through higher vacuum = shorter cycle times
- Higher process reliability due to simple process control
- Instruction and training by VAP® experts

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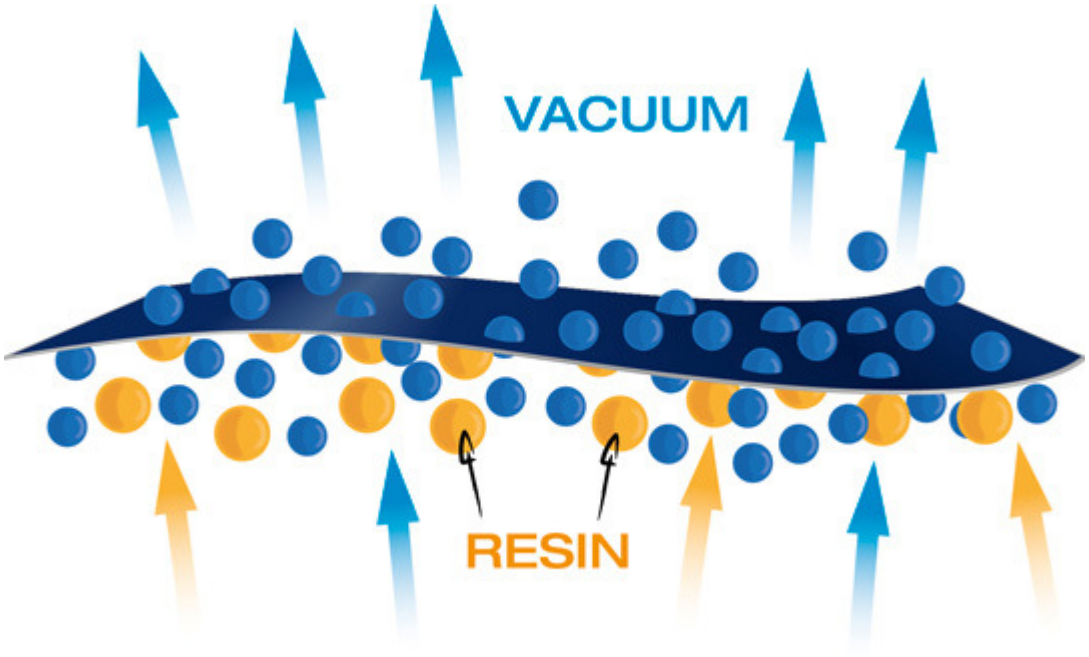
How the membrane system works

Semi-permeable VAP® membrane systems are full of tiny pores. Under vacuum conditions, small molecules of trapped air and gas can be reliably removed, while the large-molecule resin stays stable in the mould.

In the VAP® membrane system, barrier layers are connected (laminated) to a textile substrate. By the optimal combination of components and processing technologies during manufacture, it is possible to accurately control the essential process parameters: air permeability and the resin barrier.

Trans-Textil´s quality-assured VAP® membrane systems have been tested for various different resin types and process variants, and the company is continuously developing the technology in close cooperation with EADS.



The results for lightweight components are:

- No trapped air or reaction gases
- High quality standards
- Homogeneous fibre volume content
- No resin loss caused by extensive flushing
- Compatibility with all components

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Improved flow front management

Conventional techniques

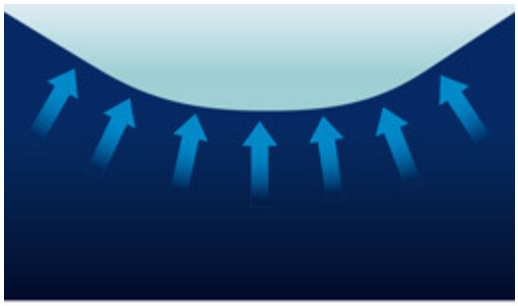
In all conventional vacuum infiltration processes, the difficulty in successfully infiltrating the component lies in determining, or predicting, the flow fronts in order to avoid undesirable areas of occluded air (‚dry spots'). If the vacuum then also has to be reduced due to the risk of matrix boiling, it becomes almost impossible to eliminate these imperfections. The reduced vacuum also causes substantial fluctuation in the fibre volume content and material thickness, and leads to greater porosity in the components.

Irregular flow fronts cause dry spots

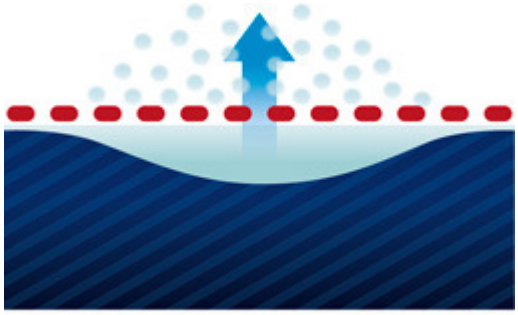
Irregular fibre volume content, fluctuations in thickness and porosity cannot be remedied.

Vacuum Assisted Process VAP®

The matrix´s flow behaviour is much more consistent in the Vacuum Assisted Process (VAP®) process because of the uniform vacuum. The low pressure's extensive effect on all of the membrane system´s contact surfaces reliably removes dry spots, even after infiltration, without the vacuum having to be reduced.



Uniform flow fronts make the process controllable.



The vacuum effect works both during and after infiltration.

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VAP® advantages

VAP® advantages in the production process:

- Easy implementation
- Usage of existing tools
- Training by qualified experts
- Improved worker protection and low emissions due to closed process
- Uniform flow rates in the resin
- High process reliability
- Achievement of an exact and constant fibre volume content

"A homogeneous fibre volume content and low porosity in the laminate are proven to result in better component characteristics than those produced in any other known injection process." CCM University of Delaware

VAP® advantages in the end product

The VAP® process proves its strength especially when it comes to the series production of large complex components with a high degree of integration.

- Excellent component quality without dry spots
- Consistently stable and controlled process results
- High reproducibility
- Production of complex 3-dimensional shapes
- Maximum economy compared to other existing infusion processes
- VAP® in practice

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Functional textile solutions for VAP®

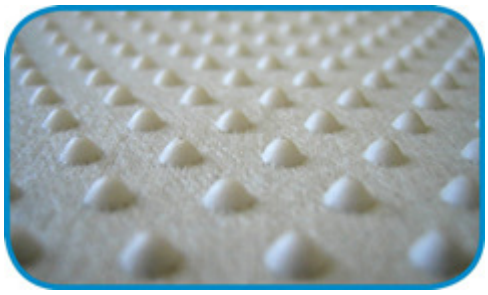
Trans-Textil's work as a functional fabric specialist involves the development and production of sophisticated textile systems for use in VAP® membrane-assisted low pressure infiltration. Our VAP® membrane systems – the central component in the VAP® approach – are continuously adapted and optimized according to differing process variables and practical requirements, whereby our broad portfolio of semi-permeable barrier layers, the choice of a suitable textile carrier and precise production control enables us to develop flexible solutions tailored to the resin system and process variants involved. Along with adaptations according to specific requirements, these special solutions broaden the range of possible uses for our VAP® membrane systems still further.

VAP® strips

Our broad portfolio offers not only membrane systems designed for efficient implementation of various VAP® applications but also solutions tailored to specific customer requirements. The edges and corners on complex integrated structural components are no problem for flexible membrane systems thanks to our VAP® strips, which we deliver in widths adapted to design specifications.

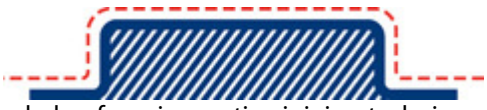
VAP® multilayer

Integrating several VAP® stack layers into one facilitates handling quite considerably. Our multifunctional membrane systems do this already, as evidenced by the breather layer they incorporate. The small raised nubs involved (see right) act as spacers for optimum vacuum distribution and faster removal of trapped air and gas as well as lower likelihood of handling mistakes. In other words, VAP® multilayer not only saves significantly on time but also improves results.



VAP® 3D

The development of three-dimensional VAP® membrane systems shaped to fit the lines of specific structural components is the goal of the AZIMUT Project. Such customised solutions are achieved with the help of our innovative joining techniques and not only facilitate handling in the production of complex integrated components but also deliver significant savings in terms of time and costs.



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VAP® integral

As an expert in the production of textile systems, Trans-Textil is involved in the CFK Integral Aviation Project, working with other partners on finding further means of combining as many flexible VAP® stack layers into one.

VAP® membrane qualified for aviation applications

Trans-Textil GmbH, EADS-licensed manufacturer of central components for the patented VAP® method, has qualified its C2003 VAP® membrane system for aviation applications together with its partners Airbus Deutschland GmbH and Premium Aerotec GmbH. This places a new high-temperature-resistant and practically transparent material on the market for membrane-assisted vacuum infusion in the aerospace sector. The C2003 membrane system, a complete new development by Trans-Textil, acts as a reliable resin barrier for vacuum infusion processes and ensures dependable air and gas evacuation over the entire component surface. Specifically developed for use with certain resin systems at defined temperatures (up to 190°), it is already proving of value in the fabrication of aviation components.

Service & Support

VAP® licensees enjoy extensive services concerning the Vacuum Assisted Process, from evaluation of the method's suitability for a given application in comparison to other lightweight construction methods to advice at the implementation stage and on-going production support. In particular the partners in the VAP® Support network offer assistance in the development of fibre composite plastic components (FCP). Engineering services in this respect include formulation of individual specifications, conceptual design and detail engineering, production planning, testing and component qualification. When implementing the Vacuum Assisted Process in production work, VAP® users benefit from the long experience of VAP® Support partners in the formulation of manufacturing instructions and work schedules and in design-to-cost calculation for economical prototype and serial production on the basis of the membrane-assisted resin infusion process. In addition, VAP® Support partners provide training at every level ranging from shop-floor worker to manager. As an interface to those with necessary know-how they also enable further developments and adaptations in need with specific requirements.

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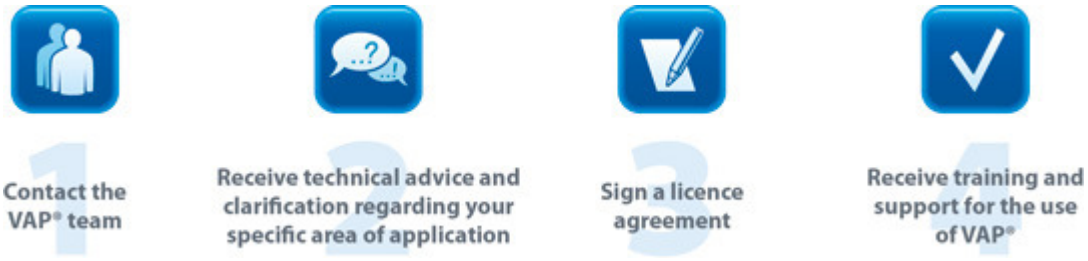
Protected know-how

Knowledge is the only commodity in the world that grows when it is shared. Achieving quality, efficiency and success in lightweight construction requires leading-edge knowledge and experience. VAP® users and their customers are guaranteed this competitive edge with the system's processes, membrane systems and other components – all of which are internationally patent-protected by EADS and Trans-Textil for all areas of application.

By acquiring licences for the implementation of Vacuum Assisted Process VAP®, users are ensured that the technique can be further developed and that their own technological know-how is protected from competitors.

Four steps towards a VAP® licence:



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