wind

Decreasing the cost of energy from wind



Sandwich composite solutions and high-performing core materials for the wind industry



We know what matters

Application development within the wind industry is driven by the need to decrease costs and increase efficiency. These two objectives are challenging to combine, but necessary to make wind energy a viable alternative to fossil fuels. Quality requirements within the wind industry leave no room for errors, further increasing the challenges for wind turbine suppliers and manufacturers. DIAB looks at these challenges from a holistic point of view. By combining design, manufacturing and quality with the right core materials, we achieve significant results together with our customers. DIAB offers invaluable solutions because **we know what matters**.

WTG (Wind Turbine Generator) manufacturers' ability to provide competitive cost per megawatt relates to:

- Provision of high performing WTG
- Manufacturing efficiency
- Security of supply
- Six Sigma quality levels
- Continuous innovation and product development
- Sustainable products

Partnering with DIAB leads to improvements in all areas. DIAB is an expert in sandwich composite solutions and has extensive experience working with the wind industry. Because we understand our wind customers' unique needs and challenges, we focus on one clear objective: helping you decrease the cost of energy from wind.



Power more with DIAB



DIAB has every important strategic capability for wind, qualifying us as a leading supplier of core materials and sandwich composite solutions for the wind industry.

DIAB – a strategic partner

Competence gained through experience

DIAB probably has the highest competence level in the industry. Our decades of experience serving the wind industry give us invaluable insight into our customers' unique products and processes, which enables us to develop solutions adapted to your specific needs.

Our forward-thinking research and innovation are coupled with the knowledge and wisdom that only experience can bring. With that winning combination, we help you develop applications with the right performance to boost your productivity and increase your competitiveness.

From our work with all major turbine manufacturers, there are now approximately 200,000 DIAB cored blades in service around the world.

Most valuable offering in the industry

DIAB serves a wide range of markets with diverse needs and challenges. To meet the wind industry's needs, DIAB provides one of the widest offerings in the sandwich composite industry. Combining our five high-performing product lines of core materials and numerous finishing and kit options with our top-level engineering services and experience, DIAB presents the most valuable offering available.

Security of supply

We have positioned ourselves to serve our customers locally while offering all the benefits of working with a global company. With eight manufacturing plants in strategic locations around the world, all offering our full range of materials, DIAB ensures high efficiency, quality and an optimal supply chain – giving you security and flexibility.

Innovation and quality

At DIAB, we are continuously developing and expanding our portfolio of core materials and valueadded services. Our development department and our dedicated R&D function ensure we keep our customers in the forefront of the industry.

Working closely with DIAB gives you continuous access to innovation and continuous product development in core and composite technology.

All of DIAB's factories work according to the highest quality standards and we are constantly improving the quality and efficiency of our products.

Commitment

DIAB is a long-established, stable company. We take our customers' trust very seriously and we honor our commitment by focusing on what is needed to make our customers' products stronger, lighter and more competitive. Partnering with DIAB gives you access to our full value now and in the future, allowing you to continuously develop your business.



Define your optimal solution

Needs in the wind industry are diverse, and we know every customer is different. Yet we also know the importance of quickly and effectively zeroing in on the right solution, which is why DIAB has predefined concepts for each application – from infusion and prepreg blades to nacelles and cones.

We have a set of core materials, finishing and type kits specifically suited to each one, which DIAB's skilled staff combine in order to provide a tailored solution that fits each customer's needs. In every step of the process, we work closely together with our customers to deliver top results – optimizing performance, weight, quality and cost. Here you gain an overview of our composite concepts, as well as a quick run-through of the various parts of our solutions: cores, finishing, kits and engineering. You can find detailed information at www.diabgroup.com and in our "Knowledge Series" for kits, finishing and core.

DIAB Core Materials

DIAB provides a wide range of materials suitable for the wind industry – available in plain sheets with a variety of finishes and in pre-cut kits. All of our materials are good environmental choices with high performance over time.

Divinycell[®] MatriX

Divinycell Matrix is our most high-performing product range, which has started to replace our existing Divincell H range. The Matrix series builds on our long experience with the H line and makes it even better. Our concept of High, Right and Optimized enables our customers to use a core that:

- Has very high mechanical properties per weight
- Has mechanical properties positioned on relevant requirements
- Enables manufacturers to optimize applications from a weight and cost perspective



Matrix provides excellent mechanical properties per weight – complementing our existing H range perfectly. It is compatible with most low temperature pre-pregs as well as wet resin systems.

Divinycell[®] H

Divinycell H needs no introduction. This all-purpose grade has set the standards for decades. Its long-term, proven performance and wide range of mechanical properties has made it the first choice of marine designers and manufacturers.

Divinycell[®] HP

Divinycell HP is a structural, all-purpose grade appropriate for various applications within the wind industry. Divinycell HP is suitable for most pre-pregs and, thus, is high-temperature resistant. It is available in a wide range of mechanical properties as well as product characteristics, and has excellent strengthto-weight performance.

ProBalsa[®]

ProBalsa is an organic core material mainly suitable for blade production. Some circumstances allow for 100% ProBalsa, otherwise it can be mixed in hybrid kits consisting of both foam and ProBalsa.

> Sandwich composites and core materials How they work and why you should use them

For more information, download the DIAB Core Guide at **www.diabgroup.com** or contact us for a printed copy.



All of DIAB's materials can be delivered in ready-made construction kits to optimize weight, cost and efficiency throughout the manufacturing cycle. By eliminating the on-site shaping and cutting of flat sheets, customers can substantially reduce build times, save labor cost, decrease inventory and improve the quality of their products.

In order to meet our customers' various needs, we offer four levels within our kit offering, each taking into account individual requirements for various wind applications.



BIAB



Finishing

Selecting the optimal finishing has a distinct and profound impact on your application's success – directly influencing weight, cost and quality. DIAB helps you choose from a wide range of cuts, grooves, perforations, kerfs, etc. in different patterns, each serving a specific purpose to optimize your application.





DIAB Core Infusion

When manufacturing a wind application part, the end result is highly dependent on the process you use. We have developed DIAB core infusion to ensure our customers reach optimal results. In simplest terms, DIAB core infusion uses a vacuum bag over the mold and core. The resin is transferred with pressure through multiple inlets, and complete wet out is achieved by using grooves, cuts and perforations in the core. By taking a holistic view – using expertise in core, kits and finishing – we have refined vacuum-infused composite application manufacturing for optimum results. That means you can make significant improvements in weight, quality and cost when you work closely with DIAB.

Engineering

DIAB's integrated range of solutions and services can serve you in every part of the composite design and manufacturing process. Many of our customers take advantage of our engineering expertise to ensure each element fits together for optimal performance.

Our Technical Service team and the Composites Consulting Group (CCG) have a unique combination of practical and theoretical experience ensuring that solutions are valuable from both a design and a manufacturing perspective. Our competence in wind includes:

- Structural calculations
- Core material selection
- Finishing selection
- Kit optimization
- Set up and training of manufacturing processes.



Wind composite solution concepts

We use composite concepts as starting points to quickly zero in on your needs. The concepts are a strategic combination of cores, finishing and kits that optimize your application for sustainable improvement in weight, cost and quality.



Infusion blades

The infusion concept includes multiple PVC core materials covering a wide range of mechanical properties. Below we illustrate what we believe are suitable core concepts for blades manufactured with infusion process. Using DIAB kits enables you to select an optimal core for your loading requirements, keeping cost and weight down. Further, you can also significantly improve lay-up time and blade quality using the DIAB kit process (see DIAB Kits on the previous page). The cores are available in a number of different finishing options particularly suited for wind blades. Using the appropriate finishing for curvature and resin consumption can also provide a considerable weight and cost reduction.

For optimal results, we recommend using the DIAB Core Infusion process.

Core material concept: infused blades

Core Materials	Comp. 0.7 - 7.2 MPa Shear 0.4 - 4.5 MPa	
Divinycell [®] Matrix	7-7, 10-8 and 11-9	
Divinycell [®] H	(H60*), H80, H100 and H130	
Geometry and process solution		
Finishing	Wind: GST, GSC, ODC, GRS, GPC, PFC	
Kits	Kit type: wind energy	140
DIAB Core Infusion	Wind optimized	% ()
Development and implementatio	n	Maria
DIAB Technical Services	Product, application and process development	× *
Composites Consulting Group	in close cooperation with customer	

* Will be replaced by Matrix 10-8



Full manufacturing solution

- Kit: materials optimized according to loading
- Kit: finishing optimized according to geometry and resin consumption/weight
- DIAB Core Infusion for optimized cycle times, quality and weight

Please note: These suggestions and data are provided for informational purposes only. Thorough analysis of loading requirements and consideration of relevant regulations are needed before selecting a solution. For these reasons, we always recommend obtaining an expert consultation before choosing or implementing any solution.

PrePreg blades

The PrePreg concept includes both PET cores as well as PVC high-temperature resistant core materials covering a wide range of mechanical properties. Below we illustrate what we believe are suitable core concepts for blades manufactured with infusion process. Using DIAB kits enables you to select an optimal core for your loading requirements, keeping cost and weight down. A wide range of finishing is available to ensure the ideal surface finish and curvatures.

For the best possible results, DIAB can take a holistic approach, enhancing the application from structural design to manufacturing process implementation.

Core material concept: PrePreg

Core Materials	Comp. 0.6-3.0 Mpa Shear 0.45-2.2 MPa	
Divinycell [®] HP	HP60, HP80, HP130	
Divinycell® P	P100, P150	
Geometry and process solution		
Finishing	Wind: ODC, GSC, GST, PFC	
Kits	Kit type: wind energy	
Development and implementation		
DIAB Technical Services	Product, application and process development	
Composites Consulting Group	in close cooperation with customer	



Full manufacturing solution

- Kit: materials optimized according to loading
- Kit: finishing optimized according to geometry

Please note: These suggestions and data are provided for informational purposes only. Thorough analysis of loading requirements and consideration of relevant regulations are needed before selecting a solution. For these reasons, we always recommend obtaining an expert consultation before choosing or implementing any solution.

Nacelles and spinners

Nacelles and spinners are normally manufactured using infusion process. DIAB provides PVC with sufficient mechanical properties at low weight suitable for nacelle roofs, floors and walls. Here, just as in blades, using kits with multiple cores according to loading requirements and choosing the right finishing related to curvature saves both weight and cost. For optimal results, we recommend using the DIAB Core Infusion process. The holistic approach ensures blade enhancement from structural design to manufacturing process implementation. Numerous blades have been produced with DIAB Core infusion, providing an unmatched proof of concept.

Core material concept: nacelles and spinners

Core Materials	Comp. 0.5-7.2 Mpa Shear 0.4-4.5 MPa	
Divinycell [®] Matrix	7-7, 10-8 and 11-9	
Divinycell [®] H	H45, (H60*), H80, H100 and H130	
Geometry and process solution		
Finishing	Wind: GST, GSC, ODC, GRV2, GPC	
Kits	Kit type: Nacelles	
DIAB Core Infusion	Wind/nacelle optimized	And the second
Development and implementation		
DIAB Technical Services Composites Consulting Group	Product, application and process development in close cooperation with customer	

* Will be replaced by Matrix 10-8



Full manufacturing solution

- Kit: materials optimized according to loading
- Kit: finishing optimized according to geometry and resin consumption/weight
- DIAB Core Infusion for optimized cycle times, quality and weight

Please note: These suggestions and data are provided for informational purposes only. Thorough analysis of loading requirements and consideration of relevant regulations are needed before selecting a solution. For these reasons, we always recommend obtaining an expert consultation before choosing or implementing any solution.

Making you more competitive

DIAB is a world-leading supplier of sandwich composite solutions that make our customers' products stronger, lighter and more competitive. Our extensive experience in providing sandwich composite solutions to customers has made DIAB a leading partner in the sandwich composite industry. DIAB's solutions combine high-performance core materials, valueadded kits, engineering and process services.

Core materials | Knowledge | Kits | Processing | Engineering | Training | Global presence – local service

DIAB Group

Box 201 SE-312 22 Laholm, Sweden

Phone: +46 (0)430 163 00 Fax: +46 (0)430 163 96 E-mail: info@se.diabgroup.com



DIAB, Divinycell, Matrix and ProBalsa are registered trademarks in countries all over the world.

www.diabgroup.com