

Graphene in glue recipes: A new solution for high weight corrugated board

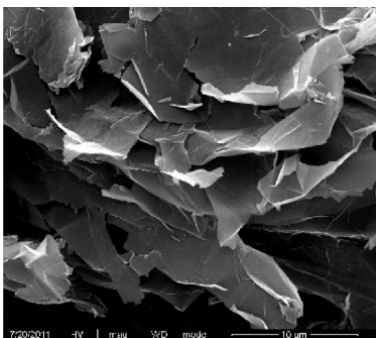
Graphene: Background

Although its existence had been theorized for decades, graphene was first observed under an electron microscope in 1962 and obtained in a laboratory in 2004, its properties led to the application of this particular form of graphite in various fields of production.

Graphene is a carbon atom arranged in a single, thin, two-dimensional layer, like a graph. The properties of the carbon atom, in combination with the physical effects that occur in the layer, give rise to a number of unique properties. The graph can be presented as either flakes or films, forms which can provide different advantages depending on application. It is also flexible and can be stretched about 20 percent without residual deformation.

The extremely powerful arrangement of the carbon atoms makes graphene about 200 times stronger than steel. In addition, its electron mobility is about 100 times faster than in silicon, which provides very good conductivity. Graphene has a high reactivity to other molecules, a property that can be used in many different applications. Flakes of graphene can be mixed with other substances for new functions.

Thanks to its exceptional thermal conductivity and functional reactivity, graphene can make important contributions to corrugated board production.



Starch glues bond the liner and fluting.

Once glues are applied to the top of the flute, the energy provided by the machine raises its temperature. Depending on the type of starch used and the amount of caustic soda added, when the glue reaches between 48 and 56°C the secondary starch transforms into a colloidal solution, increasing the viscosity of the glue at a rate of over 2 million mPa*s at peak development in the cooking phase. For comparison, this is a viscosity comparable to that of solid glass.

Electronic microscope image of graphene

This rapid development of viscosity in the initial bonding phase is important because it ensures that the glue bonds have sufficient strength to withstand the stresses to which the cardboard is subjected during production. Reducing the rate of bonding will cause a subsequent decrease in quality.

The more rapidly the glue line can absorb the heat supplied by the machine, the more quickly viscosity will develop. In medium- and low-weight cardboard production, heat distribution is not particularly limited. However, in double- and triple-wave heavy cardboard, the weight of the papers used, the mass of the matter through which heat is conducted and the distance of the glue line from the Double Facer plates may make it difficult to reach the temperatures necessary for proper bonding.

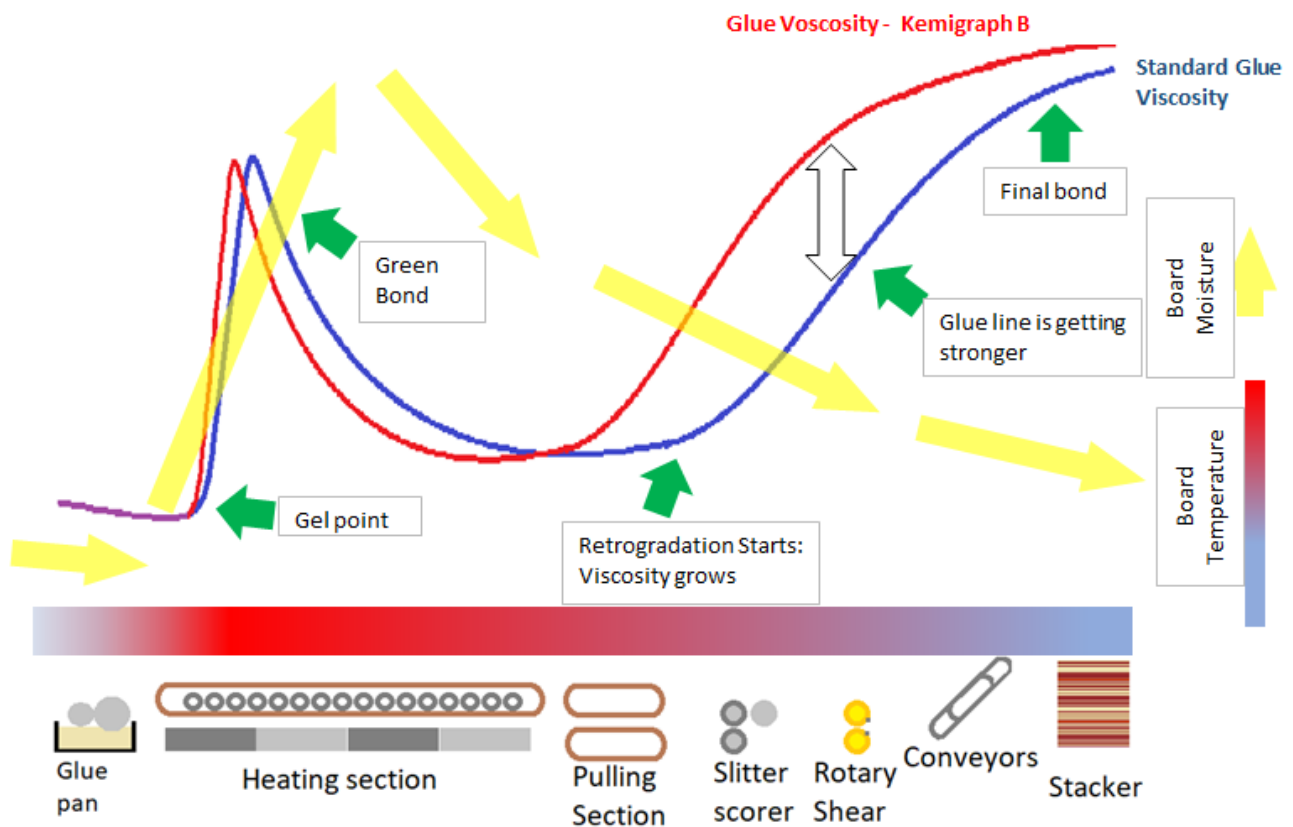
Additionally, high-weight cartons often require moisture resistant properties, the achievement of which requires a higher glue gap.

Until now, the only potential tools for insuring rapid viscosity development were increasing the dry matter of the glue to 28-30% solid content in order to reduce the amount of water that needed to be evaporated, using special starches that gel at lower temperatures, and increasing running temperatures in the machine to over 14 Bar on all sections of the DF. All these solutions have a negative impact on quality and economy, of course due to the increased energy costs, but also due to increased prices for special and modified starches.

In addition, during heavy carton production, there are greater problems with dirt at the slitter-scorer knives caused by glue residue, rich in residual moisture, leaving unbonded board at the sides of the cardboard.

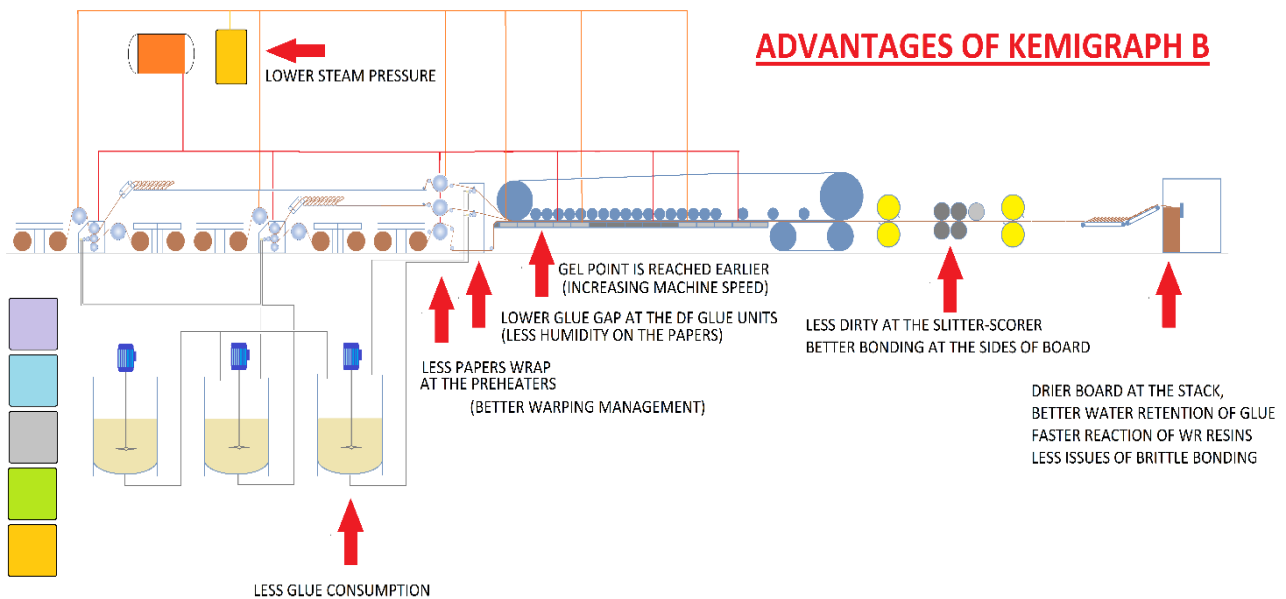
Graphene's role in board production

Thanks to its positive effect on thermal conductivity Kemind's graphene-based additive **KEMIGRAPH® B** accelerates the glue's ability to absorb heat as well as aiding secondary starch gelatinization, which enable reduction of operating temperatures and ensure higher production speed.



The improved absorption of calories accelerates Green bonding and water retention phase in the glue line (faster viscosity peak), while reducing the excessive dispersion of water inside the paper (less energy required at the DF), without altering the gel temperature of the glue. The increased heat conductivity also accelerates the cooling phase when leaving the hot plates; leading to a faster increase in the final viscosity of the glue, already at the slitter scorer.

Accelerating heat distribution in the mass of the glue leads to more marked water retention on the bonding line, even when there is a lower glue gap. The reaction of water-resistant resins is improved, ensuring increased wet strength even with lower glue gaps.



A smaller glue gap enables increased production speeds and reduces the phenomenon of knife dirt, which reduces the risk of unbonded board at the edges.

Another benefit of less extreme production settings is that it is easier to manage machine parameters as needed, for example in order to correct washboarding.

Graphene's performance in full scale trials

Recent tests performed in several plants have shown particularly positive results in terms of productivity, quality increase and cost reduction.

The case stories below show the main data from three tests carried out on double and triple flute high-weight board production.

CASE HISTORY "A"

INCREASED PRODUCTION SPEED IN TRIPLE WALL

GLUE: modified wheat starch, solid Content 27,8%, viscosity 25" Lory, gel temperature 50°C.

In the unchanged batch formula of 2100 liters, **1,5 liters of KEMIGRAPH® B** have been added.

CARDBOARD: HCB flute – K170-S175-B170-S175-K400-S175-K400

	Reference	KEMIGRAPH® B	Δ
PREHEATER EXT. LINER	100 %	80 %	-20 %
PREHEAER BOTTOM WEB	90 %	90 %	unchanged
PREHEATER MIDDLE WEB	100 %	90 %	-10 %
PREHEATER UPPER WEB	90 %	90 %	unchanged
DF STEAM SECTION 1	12,5 bar	11,0 bar	-1,5 bar
DF STEAM SECTION 2	12,5 bar	11,5 bar	-1,0 bar
DF STEAM SECTION 3	12,5 bar	12,0 bar	-0,5 bar
DF STEAM SECTION 4	12,5 bar	12,5 bar	unchanged
PRODUCTION SPEED	90 m/min	130 m/min	+40 m/min

CASE HISTORY "B"

REDUCED ENERGY CONSUMPTION IN TRIPLE WALL

GLUE: wheat starch. M.S. 29.2%, viscosity 25"lory, gel temperature 51°C.

In the unchanged formula batch of 2000 liters, **1,5 liters of KEMIGRAPH® B** have been added.

CARDBOARD: BCC – K200-S150-K150-S175-K200-S175-K300

	Reference	KEMIGRAPH® B	Δ
PREHEATER EXT. LINER	100 %	80 %	-20 %
PREHEATER BOTTOM WEB	100 %	80 %	-20 %
PREHEATER MIDDLE WEB	100 %	80 %	-20 %
PREHEATER UPPER WEB	100 %	80 %	-20 %
DF STEAM SECTION 1	14,0 bar	11,0 bar	-3,0 bar
DF STEAM SECTION 2	14,0 bar	12,0 bar	-2,0 bar
DF STEAM SECTION 3	14,0 bar	12,0 bar	-2,5 bar
DF STEAM SECTION 4	14,0 bar	13,0 bar	-1,0 bar
PRODUCTION SPEED	110 m/min	135 m/min	+25 m/min

CASE HISTORY "C"

INCREASED PRODUCTION SPEED IN WATER RESISTANT DOUBLE BOARD

GLUE: corn starch. M.S. 27,8%, viscosity 25" Lory, temperature of gel 53°C

In the unchanged formula batch of 2250 liters, **1,5 liters of KEMIGRAPH® B** have been added.

CARDBOARD: BC – K175-S150-K125-S150-K200

	Reference	KEMIGRAPH® B	Δ
PREHEATER EXT. LINER	65 %	45 %	-20 %
PREHEATER BOTTOM WEB	70 %	50 %	-20 %
PREHEATER UPPER WEB	75 %	60 %	-15 %
DF STEAM SECTION 1	7,0 bar	5,0 bar	-2,0 bar
DF STEAM SECTION 2	9,0 bar	7,0 bar	-2,0 bar
DF STEAM SECTION 3	11,0 bar	9,0 bar	-2,0 bar
GLUE GAP BOTTOM GU	0,35	0,28	-0,07 (-20 %)
GLUE GAP UPPER GU	0,37	0,28	-0,09 (-24 %)
PRODUCTION SPEED	220 m/min	265 m/min	+45 m/min
FEFCO 9 AT 22 h.	80 %	100 %	+20 %

Our 100% pure graphene additive **KEMIGRAPH® B**, developed by Kemind in cooperation with our Swedish partner **2D fab** is the result of extensive research to find the most suitable materials for the application while meeting the highest quality standards. Our product is supplied in pure water dispersion and without further chemical additives, it is easy to dose precisely in glue formulas and safe for operators to use.

Kemind's product range is fully CERTIFIED ISO 9001:2015 and provided to customers with analysis certificates, data sheets and safety sheets.

The on-site development of the application is guaranteed by the presence, in industrial trials, of our staff of technicians who provide users with the appropriate assistance in case of needs or technical problems of any kind.

Our labs provide useful technical support to customers, thanks to our qualified staff and the wide availability of analytical equipment.

Our network of agencies in Europe and in MENA area allows our customers to always have a simple, direct and fast relationship with our commercial network.

Please contact us via e-mail at info@kemind.it with any questions, our expert staff will provide you with information promptly.

Villastanza di Parabiago, November 2020