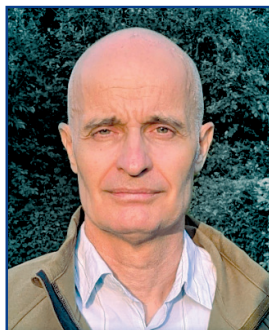


SUSTAINABLE BARRIERS FOR PACKAGING - OPPORTUNITIES & CHALLENGES



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Abstract:

Current packaging regulations and consumer sensibility to environmental impact are pushing the packaging market to reduce the utilization of plastic. In a lot of cases, paper packaging is the alternative of choice, however, there are some limitations of traditional paper packaging as a replacement for plastic. It is important to provide effective barrier solutions in striking a balance between sustainability and functionality.

The key requirements for paper barrier solutions in packaging are recyclability, compostability, food compliance, and performance in end application such as water, oil and grease barrier for food packaging. Understanding these requirements is crucial in developing sustainable and effective packaging solutions.

The most performing coatings on the market are based on per fluorinated compounds (PFCs) or are solvent based - there is an imperative to develop sustainable chemistries.

As a key supplier of the paper industry, the company has naturally been working on new chemistries safer and more sustainable as described in the next pages.

Keywords: Sustainable packaging, Paper barriers, water-based coatings, bio based coatings

Introduction:

While being biodegradable and easily recyclable, paper has some limitations when it comes to resistance to grease, oil, water and

oxygen. For many years the solution chosen by packaging producers has been to apply a laminated film usually polyethylene based to solve this issue. The problem of this solution is that it limits the possibility to recycle the packaging and is not biodegradable.

For oil and grease resistance, PFC based coatings have been commonly used. But multiple studies have shown that they contain potentially carcinogenic molecules and need to be replaced by safer solution in a short term wherever possible.. Therefore, the packaging industry needs to focus on a barrier that meets technical performance requirements as well as health and environmental safety.

This paper will introduce the groundbreaking water-based non fluoro based alternative developed by the company as an exemplary solution that balances enhanced functionality with reduced environmental impact.

Furthermore, we will introduce the company's commitment to developing safer

solutions based on bio-based raw materials and highlight the potential of customized barriers for specific packaging requirements.

Materials, Methodology and Results

The research is done in-house using various chemistries and substrates and identifying the best suited solutions to meet the requirements of a sustainable barrier for food packaging and other purposes.

1. Transitioning to water-based alternatives for oil and grease resistance:

The most efficient coating solution available today for oil and grease resistance are based on per fluorinated compounds (PFC) and the transition towards more environmentally friendly water-based alternatives is needed.

The grease resistance is usually measured by doing a KIT test according to TAPPI Test Method T559, which consists in testing the degree of repellency and/or the anti-wicking characteristics of paper or paperboard.

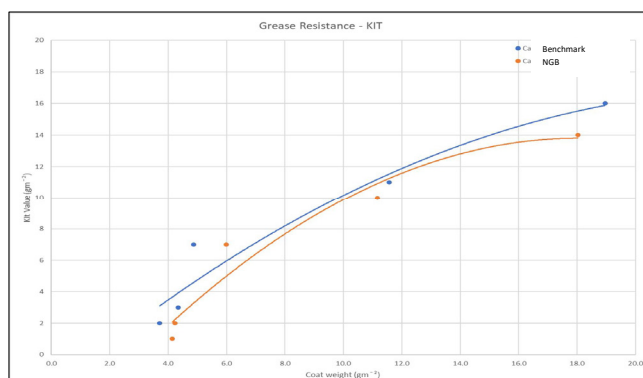


Fig. 1: Comparative performance of NGB with the Benchmark chemical for oil & grease resistance

KIT value above 6 can easily be achieved with only 2 gsm of PFC based- coating, it is a high challenge to replace those chemicals in high demanding applications.

The company has been working on improving the performance of their benchmark water based barrier (“Benchmark”) in Fig. 1 and has launched a new solution providing better oil and grease resistance (New Grease Barrier = NGB in the documents below) as well as moisture resistance as shown in Fig. 2.

The new water-based solution is providing better grease resistance and we will see in section 2 of the study that we can even boost it.

It is also known that for some applications such as wrap paper for fast food, the moisture resistance is critical. The test shows that the performance of the new water-based coating is also better than the incumbent solution (Fig. 3).

Conclusion 1: The new water-based coating solution developed for oil and grease application is providing superior performance and is a solution of choice for customers willing to move towards sustainable alternative.

However, in some cases some specific properties and performances are required, in the next part we will see if we can provide customized solution based on the interaction of multiple chemistries.

2. Customized barriers barrier solutions: studying the combination of multiple coatings to improve specific properties:

Heat-sealing: As we have seen before, the performances of the new water-based coating are superior to existing market solution. However, the high-water repellency of the coating affects its sealing capabilities. Sealing is a needed property for application such Ice-cream boxes.

The current coating, developed by the company for heat-sealing application, has been one of the eight solutions winning the next-gen cup challenge.

Based on this, the company’s R&D team has decided to test the combination of both products in order to check if this approach

could improve heat sealing properties of the new grease resistance coating. In Table 1, we show the results of the sealing tests done with various ratios of the new grease barrier solution (NGB) combined with this heat-sealing coating (HSC). The evaluation was done on 110 g/m² board. The equipment is RDM hot Tack Tester (Model is HT-IXS).

Table 1: Sealing tests with various ratios of NGB and HSC

% NGB	% HSC	Pressure (in bars) Variable Sealing temperatures 200 °C					
		0,5	1	1,6	2,3	2,6	3
60	40	NO	NO	NO	NO	NO	4,0 N
50	50	NO	NO	NO	3,8 N	4,2 N	4,6 N
45	55	2,7 N	3 N	4,9 N	4,4 N	4,6 N	4,6 N
40	60	2,9 N	3 N	4,3 N	4,4 N	4,5 N	4,5 N

Conclusion 2a: For the 110 g/m² board, the mix 45 % NGB + 55 % HSC can provide the sealing with 0.5 bars (we were not able to test below 0.5 bars), ideally 1 bar. KIT test has also been conducted and showed that mixing the 2 products have a limited impact on the performance.

Moisture Resistance - Cobb

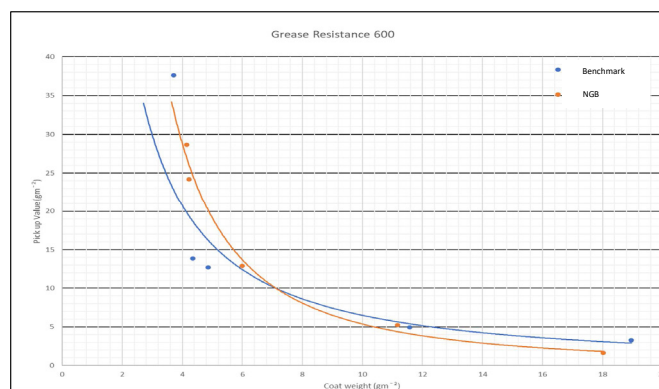


Fig. 2: Comparative performance of NGB with Benchmark chemical for moisture resistance

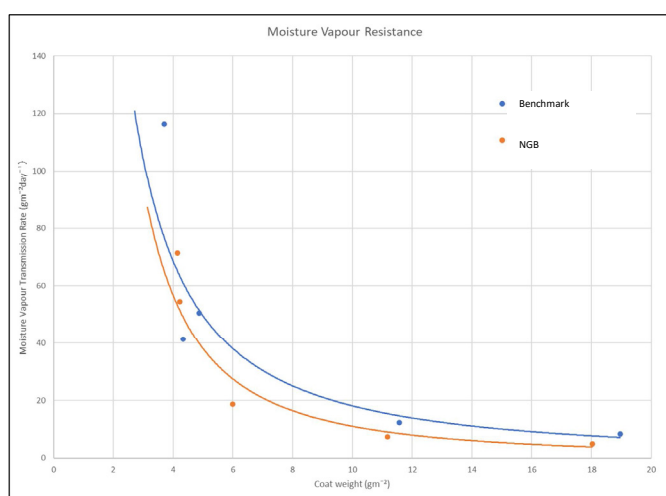


Fig. 3: Comparative performance of NGB with Benchmark chemical for moisture vapour transmission rate

Superior barrier performance: The company is also producing water based cross-linkers which are commonly used in the paper industry as highly effective surface strength improvers. They crosslink with a wide variety of natural and synthetic binders to improve the surface structure of the sheet to reduce dusting, picking and linting at the paper surface because the amount of weakly bonded particles and fibers have been reduced.

We conducted the experiment in order to evaluate the interaction between the new grease barrier solution (NGB) and a crosslinker (CLK) and measured the effect on barrier performance (Tables 2-4).

Table 2: Cobb test with different ratio of crosslinker (CLK)

Products	Coat weight (g/m ²)	Cobb 30 min (g/m ²)
NGB	4.3	30
	9	2
NGB + 1% of CLK	4.7	11
	9	3
NGB + 2% of CLK	4.7	12
	9.2	2
NGB + 3% of CLK	4.7	13
	9	2

At the highest coat weight, all samples have the same good results. For Cobb test, the best product is NGB + 1% of CLK.

Table 3: Corn oil test results

Products	Coat weight (g/m ²)	Corn oil test 10 min (g/m ²)
NGB	4.3	10
	9	2
NGB + 1% of CLK	4.7	2
	9	1
NGB + 2% of CLK	4.7	2
	9	0
NGB + 3% of CLK	4.7	2
	9	0

At the highest coat weight, all samples have good results. At low coat weight, papers treated with NGB and CLK show better results compared to the reference (NGB only).

Table 4: KIT test results

Products	Coat weight (g/m ²)	KIT
NGB	4.3	8
	9.7	12
NGB + 1% of CLK	4.7	9
	9.2	13
NGB + 2% of CLK	4.7	8
	9.2	16
NGB + 3% of CLK	4.7	8
	9.3	16

At highest coat weight, the difference between each product is more visible. Papers treated with NGB and CLK are more resistant than NGB alone.

At low coat weight, the gap between the products tested is less important, although the results are slightly better when we add more crosslinker (CLK).

For all coat weights, when we add CLK, grease and solvent resistance increase.

Conclusion 2b: The experiments show that adding a small percentage of crosslinker to

the grease barrier coating has a positive effect on the barrier performance. Therefore, we recommend the addition of 1 to 2% of crosslinker into the formulation depending on the final application.

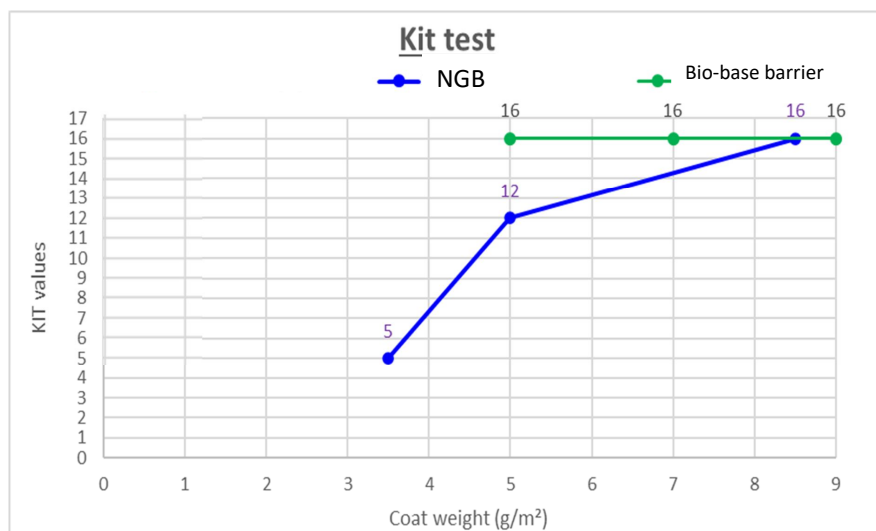
3. Commitment to safer solutions with bio-based raw materials:

While the recent water-based coatings developed by the company are already a more sustainable solution than PFC compounds or solvent based barriers, we are convinced that it is important to develop safer solution which won't be based on non-renewable material. The company has been working on developing coatings using bio-based raw materials for many years and have always considered a fully sustainable approach: the raw material should not enter in conflict with resources used for food, it should be available in the long term and also be sustainable from an economic standpoint.

A commercial solution containing up to 30% bio-sourced raw material is already available on the market. Resistant to oil, grease and water for general food packaging used with a short contact time, ideally suited for burger or sandwich paper wraps. It is compliant with the food contact regulations of BfR, FDA & China (GB9685-2016).

A solution under development containing up to 40% bio-based raw material is expected to be commercially available by the end of 2023. The goal is to propose a competitive alternative to water-based coating using 100% fossil based raw materials.

The graph (Fig. 5) provides the KIT value comparison between our NGB and the bio-



combination with crosslinkers.

Fig. 5: KIT value comparison between NGB and the bio-based barrier under development

based barrier under development. As we see the biobased coating is providing very good KIT performance at 5g/m² and higher. the next evaluation will be done with lower coat weight and also in combination with crosslinkers.

Conclusions:

While the most performing solutions on the market are either based on PE film or PFC based coatings, it is crucial to develop safer and sustainable solution in the short term.

The study we shared showed that water-based solution providing excellent barrier to oil and grease are available. Based on the long experience acquired with many

customers, it is difficult to develop a one fits all solution and the ideal approach is to combine chemistries based on the application and performance requirements.

It is also important to think ahead and continue to work on products with minimal environmental footprint. The company is committed to come up with barrier solution based on renewable raw material. The consumer push for this type of solution is growing all over the world. That is why we will intensify the development effort in this direction and will introduce a new high performance bio-based barrier solution by the end of 2023.

“This article only provides general information about probable solutions, for barrier coatings being developed by Archroma, for the packaging industry. The information in this article is not intended to be comprehensive. For more details you may contact jyotsana.shrivastava@archroma.com”