

Paving the way towards “paperization” with Cargill™ barrier coatings

Diego Fort, Senior R&D Specialist, Cargill
Andreas Voigt, Senior Technical Account Manager, Cargill

INTRODUCTION:

Starch-based materials are increasingly being used as more sustainable alternatives for oil and grease barriers (OGR) in paper packaging. These materials offer several advantages over traditional synthetic barriers (e.g. fluorochemicals), which are commonly used but which can pose environmental and health concerns according to the European Chemical Agency. As a result, the adoption of starch-based barriers in paper packaging represents a significant step towards striving for more sustainable packaging solutions.

Cargill has been innovating in barrier coatings for some time and we are now ready to launch our new **Cargill™** Barrier Coatings product range, based on modified starch, offering medium to great resistance to oil and grease.

An innovation timeline towards barrier coatings

The constant battle against oil and grease has been ravaging for years in the food industry. Early on, food vendors used simple wax-coated papers to wrap their products. These papers did a decent job but often left customers with greasy hands and stained clothes.

Further down the line, better solutions became available. In the mid-20th century, plastic coatings were introduced, mainly based on polyethylene. These new barriers were more effective, keeping the food fresh for longer, and without the greasy hands. However, they were not perfect, as they contributed to the growing problem of plastic waste.

Then came the era of fluorochemicals, including PFAS. These chemicals provided exceptional oil and grease resistance, which made them a favourite for fast food wrappers and take-away

containers. But soon, it was discovered that PFAS materials were not as harmless as they initially seemed.

In response, innovators began exploring new, more sustainable alternatives. They developed water-based coatings, biodegradable materials, and nature derived substances like starch and proteins. These new barriers proved to not only be effective but also seem to show a better environmental profile.

Achieving these barriers varies in difficulty. Wax coatings are relatively easy and inexpensive, while biodegradable and nature derived barriers require more advanced technology and investment. However, the push for more sustainable solutions is driving innovation, making these alternative options more accessible and effective.

Image 1: KCL plant – the plant the trials took place to confirm starch performances at realistic, practise conditions.



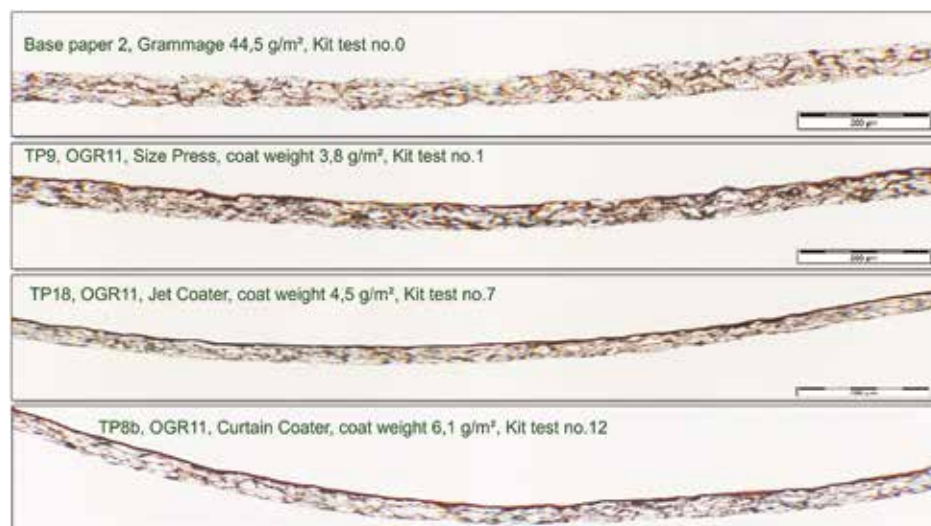


Image 2: Base paper – Microtome image of base paper 1 with 3 different methods for Cargill Barrier Coating™ OGR 11.

This can be achieved through processes such as esterification or etherification, which introduce hydrophobic groups into the starch molecules.

Film formation: When applied as a coating, starch forms a continuous film on the surface of the packaging material. This film acts as a physical barrier that prevents oil and grease from penetrating through to the food. The quality and elasticity of the film is crucial, as any

imperfection can compromise its effectiveness.

Biodegradability: One of the significant advantages of starch-based OGR barriers is their biodegradability. Unlike synthetic materials, starch-based films can break down naturally in the environment, reducing their ecological footprint.*

From lab test to pilot trial: Cargill™ Barrier Coatings

Through collaborations with universities and research institutes, Cargill was able to obtain initial data on the use of starches for barriers. Based on those, we ran lab trials to evaluate the effectiveness of different modified starches as OGR barriers when applied to various types of paper using a rod coater.

The results of the lab tests were dependent on the type of paper used. We observed that papers with smoother surfaces and a higher density tended to show better performance. The differences observed with the starches used were attributed to the hydrophobicity and film formation characteristics.

The rod coating technique used in the lab proved to be effective in achieving uniform coatings. However, we do know that the conditions at bigger scales are quite different. That's why we decided to run pilot trials to confirm starch performances at realistic, practise conditions (see image 1 preceding page).

Starch for oil and grease resistant (OGR) barriers

The OGR bio-barrier market is expected to grow as more companies invest in more sustainable packaging solutions. Innovations in material science and coating technologies will likely drive this growth and make starch-based and other biodegradable barriers more competitive when compared to traditional materials. Additionally, regulatory pressures and consumer demand for more sustainable products will continue to shape the market dynamics.

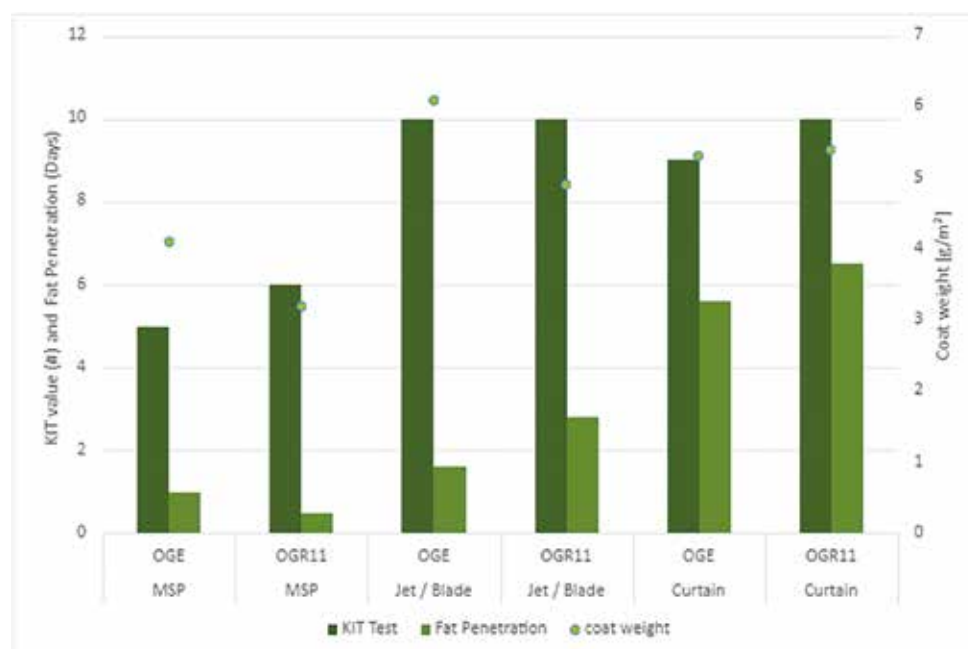
Cargill is a global leader in the production of industrial starches, offering a wide range of starch products derived from corn and wheat. These starches are used in various industries due to their versatile properties, which can be tailored through chemical and physical modifications. Cargill's portfolio is very broad, and offers native, pregelatinized and modified starches, each with specific applications and benefits for paper making, corrugating, and coatings.

For many years, Cargill provided modified starches to the paper industry to replace synthetic binders in graphic coating applications, while improving runnability and paper properties.

Starch-based OGR barriers work through several specific mechanisms that enhance their effectiveness in food packaging applications. The key advantages of using modified starches are hydrophobicity, film formation, and biodegradability:

Hydrophobicity: Starch itself is hydrophilic, meaning that it naturally attracts water. However, to make it effective as an OGR barrier, starch is often chemically modified to increase its hydrophobicity.

Graph 1: Kit test (Tappi T559). Chicken grease fat permeability Test (ASTM F119) and coat weight (GSM) results obtained for base paper 1 after coating with MSP. Jet and Curtain Coater with both products (Cargill Barrier Coating™ OGR 11 and Cargill Barrier Coating™ OGE)





(A)



(B)

Image 3 : A, B, C – different coating systems applied

- **A – Metering Size Press (MSP)**
- **B – Curtain Coater**
- **C – Blade Coater**

(C)



During pilot trials we focused on runnability of the machine while coating different base papers using various coating techniques. We selected two types of modified starches, Cargill™ Barrier Coatings OGE and OGR 11, and we tested them with metering size press (MSP), blade coater (jet) and curtain coater technologies as 3 different application devices (see image 3 ABC).

The results of the trials (see graph 1) showed that the curtain coater consistently provided the best results for both modified starches. This is likely due to its ability to create a uniform and continuous coating layer. The jet also performed well but was slightly less effective than the curtain coater. The MSP revealed some penetration of the applied barrier film which caused the least favourable results among the three techniques but might be still sufficient for wrapping grades for medium oil and grease resistance demands e.g. papers with a short contact to oily materials like wrapping burgers or French fries.

As already revealed in lab trial, the pilot trials also highlighted that the choice of base paper significantly influenced the effectiveness of the OGR barrier. Papers with smoother surfaces and higher densities generally performed better (see image 2).

In conclusion, pilot trials demonstrated that our modified starches Cargill™ Barrier Coatings, when applied using a blade or curtain coater, offers a very effective OGR barrier for paper packaging on a relatively low coat weight. The use of MSP provided good enough results for some OGR requirements. These findings also highlight the importance of selecting appropriate coating techniques and base papers to achieve optimal performance.

Visit our website www.cargill.com to learn more and get in contact with our experts.

*Source: Development of Starch-Based Materials Using Current Modification Techniques and Their Applications: A Review by Sumedha M. Amaraweera and Co.