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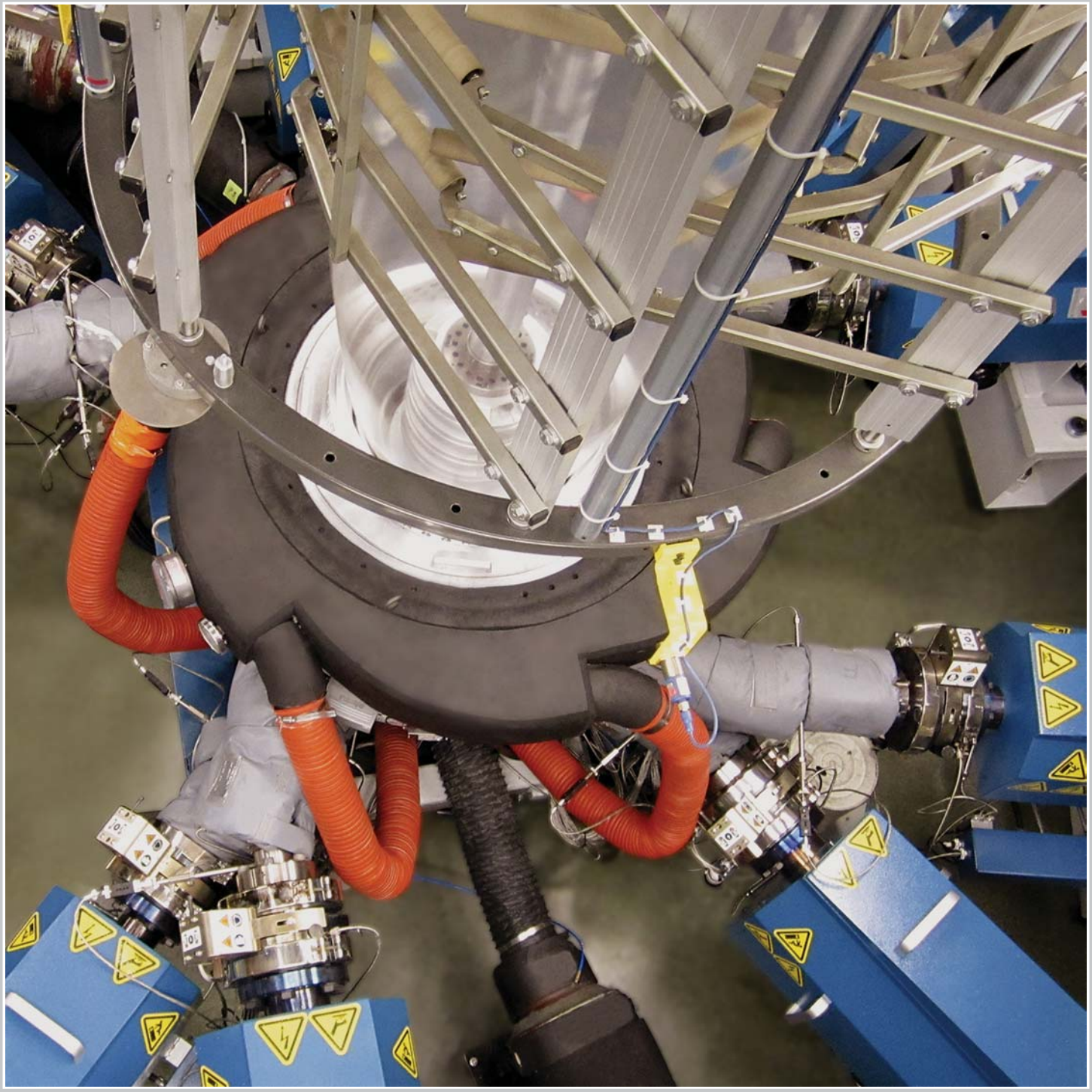

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A promising future for whey-coated films

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Research into sustainable packaging materials which maintain the performance of their composite structures is intensifying. A European funded study into whey protein coated films and laminates tested on a semi-industrial scale is evaluating the potential of novel, recyclable food packaging materials to replace synthetic oxygen-barrier layers such as EVOH in multilayer films.

A new approach to the manufacture of multilayer films has revealed a commercially feasible use for the 50% discarded whey by product of cheese production that could help towards replacing petroleum-based plastics with bioplastics while safeguarding the performance and enhancing the recyclability of multilayer films.

A biopolymer-coating for plastic films has been formulated based on whey protein to replace current synthetic oxygen barrier layers used in food packaging such as Ethylene vinyl alcohol copolymers (EVOH). Tests done at a semi-industrial scale have confirmed its potential as a very good barrier to oxygen and humidity and to outperform existing biopolymers for storing various food products, claim its developers. Findings indicate that the whey-based coating can maintain shelf-life and sensory attributes at a level comparable to existing commercial packaging films and fulfil food safety regulations in terms of migration.

The whey-coating can be removed by enzyme activity within two hours, making it compatible with plastics recycling operations by allowing multilayer films to become recyclable by separating the other combined layers. A life cycle assessment showed »a massive reduction« in the environmental impact of the packaging due to the possibility of recycling materials as opposed to incinerating those containing EVOH or Polyamide (PA), and also the use of sustainable raw materials. As such it adds »huge value« for the European packaging and food industries.

The whey by-product of cheese manufacturing contains some 7% dry matter, made up of proteins, lactose, minerals, organic acids and less than 1% fat. Whey proteins are used as additives in the agro-food industry but around half of the 50 million tonnes (110.2 billion lbs) of whey produced annually in Europe is still unprocessed.

The coating solution used for testing mainly comprised of whey protein isolate (WPI). Plasticisers in the form of Sorbitol and/or Glycerol were added to prevent brittleness of the protein coatings and other natural additives were also comprised in the tunable formulations.

Thermo-mechanical and optical measurements of the films showed an excellent gloss and high transparency of coated PET. There was very good adhesion between the coating and the PET substrate.

The most promising formulations among those evaluated at a pilot scale were selected for scaling up. The substrate used was mainly Polyethylene Terephtalate (PET) of

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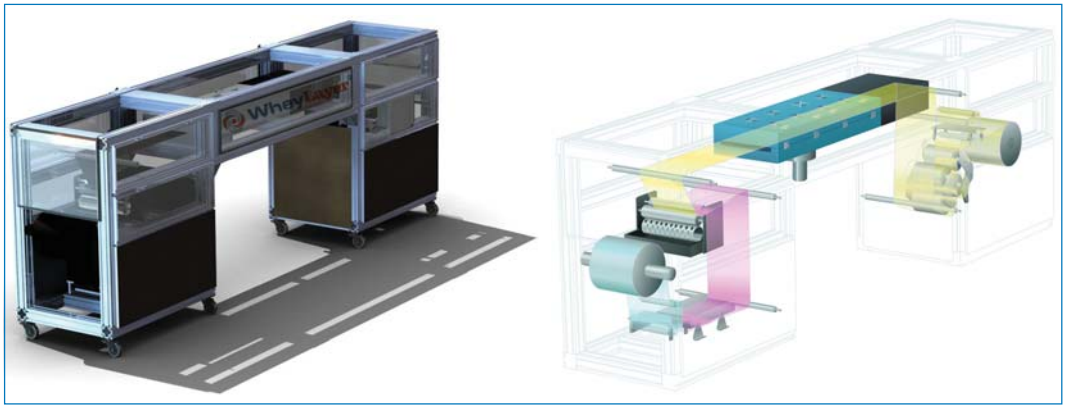

Figure 1:
Prototype unit for the production of whey-coated films and laminates.

200 mm (7.9") width, 12 microns thick, but others were also tested such as PVC.

Figure 1 shows that the process prototype for whey-coating application allowed film unwinding, corona pre-treatment of the film, coating application, drying and stabilisation, winding of the coated film.

A corona pre-treatment was performed to obtain sufficient wettability adhesion of the coating layer on the substrate.

Resulting coated films were laminated with Polyethylene (PE, 20 microns) as a sealing layer using *Liofol UK 3640/UK 6800* (*Henkel KGaA*) as an adhesive.

Oxygen permeability was measured with the coated side of the films exposed to flowing oxygen gas and the other side to flowing nitrogen gas. Resulting oxygen permeability of multilayer films was deduced in terms of $cm^3/m^2 \cdot d \cdot bar$ and used for further calculations regarding permeability of the single whey protein layer.

Whey-coated films achieved much superior barrier properties compared to other bioplastics (*figure 2*). Results confirmed that the whey-based coating indeed has potential to substitute other synthetic barrier layers while getting close to the range of OTR of EVOH with high Ethylene content, and being better than polyamide.

Enzymatic detergents based on enzymes protease dissolved in water at various concentrations were used for the removal of the whey-coating from coated film and laminates.

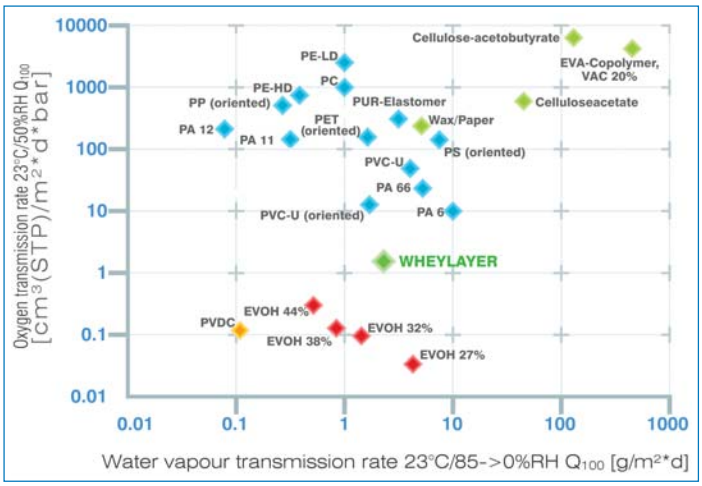

Figure 2: ***Permeability values of typical plastics, bioplastics and whey-layer.***

Buttercheese, which was used to fully test the sensory and chemical effects of whey-coated film and laminates, presented no obvious off-flavour.

Overall, the use of whey-based coating could reduce CO_2 emissions and consumption of resources in packaging production. Data obtained by standard LCA methodology showed a potential 15% reduction of environmental impact versus synthetic counterparts such as EVOH or PA at a similar weight. Furthermore, huge advantages can be seen at end of life for the full multilayer laminates that will be recyclable and not be incinerated.

The main conclusion of this European funded study is that whey-coating offers environmental advantages with no loss of technical performance in films when used to pack sensitive food products.

Secondly, the eco-efficient application and drying of the coating, by combining hot air and infrared, carried out at semi-industrial production speeds showed the ability of the process to control the structure of the whey proteins and the resulting properties of the coating.

Finally, the enzymatic cleaning is compatible with current plastics recycling operations, which would offer key cost and emission savings in terms of raw materials and end of life. ■

➜ *www.wheylayer.eu*

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