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Research area: Process aims

Paper and paperboard production // Surface treatment

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Key words:

Barrier, extrusion, coating, starch

Title: Natural raw materials for specific barrier applications in paper and board (NATUBAR)**Background/Problem area**

In many applications, paper and board needs a barrier film on its surface to prevent migration of substances towards the paper bulk. This is the case in photo paper where a polyethylene barrier is extruded on the paper in order to prevent penetration of photographic developer solutions into the paper. This is also the case in folding box board used in food packaging, where a barrier is meant to prevent board staining with oils and fats from foods stuff or water vapour permeation through the board. At present, the most efficient barrier materials are of synthetic origin (polyethylene and other synthetic polymers, fluorinated resins, etc.). Synthetic barrier materials present a number of drawbacks when recyclability and environmental impact are considered. There is therefore a strong interest to replace those barrier materials by natural, renewable products. To date, many works have investigated the potential of starch and its derivatives, however with a limited success.

Objectives/Research results

In the first approach, extruded starch based films can be prepared and applied onto paper, much in the same way as polyethylene films. The main challenge in this approach was to produce the starch-based films under proper conditions that are suitable for the film converter and the papermaker customer, the processing conditions for preparation of the films must be economically feasible. In earlier work starch based films were seen to possess exceptional oxygen barrier properties, and could be prepared in such a manner to make films capable of holding water for several days to weeks. Nevertheless the transfer of this work to extruded starch based films on paper was not successful. The single screw extruder in the paper mill was not able to form a uniform starch melt for paper coating in contrast to the twin screw extruder used in earlier lab work.

In the second approach, starch derivatives were converted in such a manner as to facilitate their application in water-based coating dispersions. These coatings were applied directly onto the paper in a coating or size press station. The formulation of these coatings was such that upon drying the coated paper in the paper machine, a continuous barrier was formed. As a barrier, the integrity of the coating had to be very high in order to prevent the migration of substances throughout the sheet. The modified starch coatings showed very good barrier properties against fats and oil and had no negative influence on recyclability. Especially the migration of the catalyst used for starch oxidation was focused on (Tenax test), as the final product can be in contact with food. It was found that the migration barrier properties of the modified starch films was acceptable.

Application/Economic benefits

Replacing polyolefins based on petrochemistry by renewable starch based materials will reduce crude oil consumption. The raw material for the replacement will be provided by local agriculture, giving small and medium-sized companies additional business opportunities.

Replacing polyolefin by starch based materials will result in an easily bio-degradable product and will present many environmental advantages. Used imaging paper and folding box board, when present in recovered paper, even in small quantities significantly disturb the recycling process. The barrier coatings, made of plastic, may be separated and eliminated as coarse rejects. These have to be either dumped or incinerated. If dumped, as plastic is not biodegradable, they will remain buried for centuries. If incinerated, they will cause pollution and corrosion of the incineration units, and necessitate costly chemical treatment of exhaust gases. The synthetic barrier coating may also be split into very fine particles which are not easily separated with cleaning technologies. They may then agglomerate and create very problematic deposits on all paper machine parts (forming wire, drying wire, felts, drying cylinders etc.) known as stickies. This is particular due to their chemical nature, mainly based on hydrocarbons, which melt or become sticky at medium temperature.

In contrast, the barrier products developed in NATUBAR are based on modified starch. They are easily biodegradable or burn without either pollution or production of corrosive gases. They may be dealt with in paper recycling technologies with existing enzymatic techniques (e.g. based on amylase). Starch is a cheap, abundant, natural and quickly renewable product, available all over in Europe. It does not need to be imported from politically instable regions like oil as base for polymer-based barrier materials.

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Remarks

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