Concepts for Optimizing Manufacturing Processes of Coated Products submitted to the European Coating Symposium ECS2015

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Abstract

Manufacturing coated products involves several processes including

- formulation design
- fluid preparation, i.e. mixing and dispersing
- fluid conditioning, i.e. filtering, degassing and tempering
- fluid delivery, i.e. pumping and metering
- fluid distribution
- coating
- drying or curing
- laminating
- substrate conditioning, i.e. cleaning and surface treating
- substrate moving, guiding and controlling its tension
- un-winding and re-winding

Some of these processes are optional, most of them are sequential as described above, and some of them influence processes further downstream. Coating is the core process.

Optimizing this complex process configuration requires optimizing each sub-process. It also implies minimizing the product unit costs and maximizing the product uniformity. The cost aspect is of particular importance, because a product with fancy and desirable features will not be a commercial success if the price is not right. The relationship between product features, manufacturing technology and resulting product costs is of great significance, especially now with regard to renewable energies, and in particular with regard to lithium-ion batteries and roll-to-roll coated photo-voltaic cells. Both products are currently being developed worldwide, and they are at the beginning of their life cycle. Therefore, technological choices being made today will have important consequences on the cost of these products. The costs, however, must be low enough so as to allow these products to become mass products in the sense of a lithium-ion battery in every car, and a solar cell in combination with a lithium-ion battery in every house. Moreover, the costs of these products must be low from the beginning of their life cycle and not only at some undefined later time. This is particularly important for Germany and Switzerland, because the governments of these countries have decided to focus on renewable energies and to shut off their nuclear power plants in only a few years.

Therefore, the purpose of this presentation is to raise the awareness of the relationship between technological decisions and resulting product costs, and to provide guidelines to the R&D community, that may help to design product features and manufacturing processes, resulting in low product costs from the very beginning [1, 2].

The focus of the discussion is on the coating process. Firstly, an economic model is presented, which relates technological features implemented in a production environment to the resulting product unit costs [2].

Moreover, the model allows one also to play "what if" games in order to answer questions such as: how would the product costs change, if a

- particular raw material, such as the solvent
- technical aspect, such as the coating method
- particular operating parameter, such as the coating speed

would change?

Secondly, the question of which of the more than fifty coating methods known in the converting industry is the best for a given application is addressed. The first answer is typically obtained by comparing the wet film thickness of the application with the respective capability of each method. In addition, several technological concepts are presented here, that have already proven helpful and reliable in further refining the choice of coating process. These concepts allow us to design product formulations and manufacturing processes that avoid undesirable features and hence allow optimization with regard to product quality and cost. The concepts include

- Parallel engineering between product and process design
- Flow fields with a minimum wall shear stress
- Hydrodynamic assist in dynamic wetting
- Rheology profiling
- Simultaneous multilayer coating

These concepts are explained and illustrated by many good and bad examples. It becomes obvious that the concepts can best be implemented in pre-metered coating methods. This is why they are the methods of choice as long as a particular application fits into the boundaries of their respective operating window.

References

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