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Predicting Mechanical Properties of Polymer Films after Extrusion Coating using Supervised Machine Learning Algorithms

The polymer layer of the packaging material acts as a barrier against moisture and thus a break in the polymer can lead to food contamination. A common knowledge is that extrusion coating affects the mechanical properties of the polymer film which compromises the integrity of the material. Predicting and determining the mechanical properties after processing is therefore important. In this thesis, the relationship between process settings and mechanical properties have been identified and a predictive model has been built.

The thesis was performed in collaboration with Tetra Pak AB in Lund. Tetra Pak is a global leading company in providing innovative packaging solutions and processing technologies that can be used for a broad range of products. In a typical carton package, paperboard is the main constituent. The paper is then coated with different layers and grades of polyethylene which is the polymer studied in this thesis.

The process by which the polymer layers are applied on the paperboard is called extrusion coating. Polyethylene films were created to investigate how different process settings in the laminator affects the mechanical properties of the polymer films. The mechanical properties were measured using tensile tests, which is one of the most widely used testing standards for measuring the mechanical properties of a polymeric material when under tension load.

To identify the relationship between the process settings and the final mechanical properties, classical statistical analysis was applied. The purpose of the thesis was also to investigate if a predictive model using supervised machine learning algorithms could be built and used to predict the mechanical properties solely by knowing the conditions from the processing. The primary tool for data processing used in this thesis is Python. The results showed that such models could be built providing with high accuracy. This shows that it is possible to use machine learning to predict mechanical properties of extruded polymer films. The ability to predict the mechanical behaviour makes it possible to improve the development process and the packaging material. In the future this could also lead to the ability of creating new designs of the polymer films with better mechanical properties.

The mechanical properties are largely dependent on the process settings in the coating line. The polymer films were created by varying two process parameters; line speed and melt temperature of the molten polymer. Due to a narrower process window, effect from melt temperature on the mechanical properties was less distinguishable. Effect from line speed on the mechanical properties was however clear. Depending on the line speed used, the properties of the polymer can be either brittle or ductile. The mechanical properties of an extruded polymer film are thus dependent on the processing conditions.