Selection of force creation method for press forming machinery

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Abstract

Environmental aspects have become increasingly important in today's business. In packaging industry this has created an increased demand for fibre-based packaging solutions which present a renewable and environmentally friendly alternative for oil based materials. One of such materials is paperboard, and for example trays made of paperboard can be an alternative for traditionally used plastic trays in food packaging. Nowadays there is a need for cost-effective small scale machinery. In this study the objective was to define the best method to produce the force needed in the compact paperboard tray pressing machine. Two different force creation methods were studied in this article using Score Table -analysis and SWOT-analysis. Results indicate that the electric actuator system had several key features compared to the hydraulic system that gave it a clear advantage, including high force production, accuracy and cost efficiency.

Keywords: Press Forming methods, Paperboard tray, Hydraulic System, Electric actuator, SWOT-analysis, Score Table

1. Introduction

The need for paperboard packaging machines are nowadays more and more important due to increased demand of environmentally sustainable products. Especially in the food packaging industry paperboard is the most widely used material when it comes to environmentally sustainable and recyclable products. [1] Because of its material properties it can be used as primary, secondary or tertiary packages. The packages can come in many different...
shapes and forms like bags, boxes, cans, cartons, composite cups, folding cartons and wrappings. [2] The combined usage of flexible paper and board in 2016 is estimated worth 290,085.00 Million $. [3]

Generally the most common method for producing paperboard trays is press forming. Other methods include deep drawing and hydroforming which are not as widely utilized as press forming. Earlier it has been stated that the press forming process must be controlled accurately to achieve satisfactory quality for the formed products [4 - 7]. Currently the machinery used in industry to manufacture paperboard trays lacks the desired level of adjustability. Therefore there is a high demand for machinery that at the same time is cost efficient and fulfills all the required properties to produce end products that meet the desired quality.

In the deep drawing process the paperboard is formed with rigid tools and compression. [8]. According to Hauptmann et al. (2016) to obtain better distribution and controllability of wrinkles it was found that the blank holder force and the thermal energy have the most important influence to the material.

In the hydroforming process the paperboard is pressed against the female mould with membrane that is pushed by expanding fluids. The benefits of this process is that the end product has good surface properties and high visual quality [9].

According to previous studies [5, 10] it has been found that in order to achieve satisfactory quality for the formed products the pressing force has to be over 100 kN while the temperature is above 130 degrees of Celsius. This force/temperature combination allows the paperboard to stretch and gain the needed formation. In press forming, a pre-cut and creased possibly polymer coated, paperboard blank is placed between forming moulds that are pressed together to form a tray of a desired shape, as shown in Fig. 1. The folding of the tray corners is controlled with the blank holding force applied by a rim tool (blank holder). The male mould is held at the bottom end of the stroke for a set time (dwell time) while the possible polymer coating softens, and creases in the corners of the tray are sealed together. Simultaneously the flange of the tray is flattened by the larger force (max. 150 kN) also applied by the rim tool. Finally the formed tray is removed, and a new blank can be fed into the tray press. [11]

The benefits of paperboard compared to plastic are various but most important ones are the ability to be disposed without a major effort or effect to nature. On the other hand the appearance of the package has an important role on the customers’ decision to select a product in the retail stores. Paperboard trays can have various different graphical designs on it. In the Figure 2 below some various different shapes and graphical designs of paperboard trays are presented.
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