THE PREDICTION OF DRYING TIME OF EXPANDED POLYSTYRENE BLOCKS

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FOR MY MOTHER

Abstract

A study of methods to predict the drying time of expanded polystyrene was made with the aim of optimizing the drying conditions of the drying kiln at Lanwood Industries.

Experiments were carried out in both a laboratory and Lanwood Industries factory. The drying rate was found to decrease with increasing product thickness and to increase with increasing drying temperature. Drying temperature between 50 and 60 °C has a stronger influence on the EPS drying process than between 40 and 50 °C.

A simplified theoretical method can be used to predict the drying time in the industrial environment when quick computation is needed. Newton's model can fit the full-scale drying process, but it did not fit the laboratory drying processes well. Page's model has an excellent fit to the three dimensional EPS drying process and it is also able to scale up the laboratory drying results. It supplies a powerful tool to describe the drying process and predict the drying time of the EPS product.

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Chapter 1 Introduction

This project, which has been done in conjunction with Lanwood Industries of Palmerston North, was supervised by Mr. Phil Collins from the Production Technology Department at Massey University. The research intends to improve the drying quality of expanded polystyrene (EPS) blocks used as insulation by the construction industry.

The processing of the EPS product employs a pre-expansion stage where steam is blown through raw polystyrene beads which contain a small amount of pentane. The partly expanded beads from this stage are called "prefoam". Before moulding the prefoamed beads are put into large hoppers to dry. After drying, the material is then blown into a mould and treated again with steam to soften the prefoamed bead for final fusing. Blocks of EPS leaving the moulder contain both pentane (the expanding agent) and up to 10 % moisture from the steam injected during moulding. Before hot wires cut the blocks into slabs, the blocks are dried in warm air chambers to allow the pentane and moisture to disperse. Residual pentane can cause a fire hazard during cutting. If too much moisture remains in the block, the cutting wires cool down which causes an uneven cut surface, drag marks or "picture framing". Moisture also has other adverse effects, such as detaching the outer layer of composite panels and reducing the insulation efficiency.

The purpose of this project is to determine the optimum conditions for drying moisture from moulded EPS, in order to minimise the drying time while also maintaining acceptable product surface quality during the hot-wire cutting. Both laboratory drying tests and full-scale drying tests were carried out to study the drying process of the EPS product.

In EPS block (3.6m×1.2m×0.65m) drying, moisture movement occurs along the length, width and height of the block which involves three dimensional drying. In order to simulate the full-scale drying process, drying samples were cut into a cubic shape from fresh moulded EPS blocks and dried in a laboratory drying cabinet. These results together with drying theory were used to scale up the laboratory experimental data to the full-scale drying operation. The capillary theoretical method, Newton's model and Page's model were used for the drying time calculation.

Some limitations encountered during the data collection and analysis were: the varying drying conditions during the full-scale tests, the limited experimental data, and the large gap in dimensions of drying materials between the laboratory tests and the full-scale tests. The scale-up procedures are by no means straight forward. However, Page's equation was found to give a better fit for the experimental data of both the laboratory and the full-scale tests. Page's model is able to describe the three dimensional drying process of the EPS product. It also provides a method to scale up the laboratory results for the optimization of the drying conditions.