# 平膜物理發泡製程之衣架型模具：流動模擬及最佳化設計

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## 摘　　要

衣架型模具已廣泛地應用於薄膜及板材押出製程之中，在許多製程中甚至必須添加發泡劑以因應產品需求。本研究針對押出物理發泡製程提出兩種不同型式的衣架型模頭，並採用二維控制體積法之流動模式去模擬非等溫、非牛頓型流體於兩種物理發泡衣架型模具內之流動。其中包括以數學模式直接預測含有溶解氣體但不發泡的膠料其剪切黏度$\eta$，及在某溫度及某氣體溶解度下之發泡臨界壓力值，並以此為依據，利用上述控制體積法搭配田口法，建立膠料在模頭內之流動模式，成功地建立供以使用物理發泡劑做為高發泡倍率用之一套衣架型模具設計及分析軟體，以便對模具幾何形狀進行最佳化設計。並以LDPE/$CO_2$之系統為例，模擬預測不同模具幾何下模具內之預發泡位置、壓力分佈、流量均勻度與溫度均勻度，以進行模具最佳化設計。

Coat-Hanger Die for the Flat Film Extrusion with Physical Foaming Agent：
Flow Simulation and Optimal Design

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## ABSTRACT

Coat-hanger dies were widely used in the production of films and sheets. In many cases, foam extrusion was necessary to be utilized. In this thesis, two different types of coat hanger die was proposed for the extrusion foaming process with a physical blowing agent. A flow model of two-dimensional control volume method was utilized to simulate the non- isothermal and non-Newtonian flow behavior in a coat-hanger die used for the extrusion foaming process. The research works included the development of mathematical models for the direct prediction of shear viscosity of a molten polymer containing a dissolved gas and of the critical pressure under a certain temperature and solubility of gas in the melt. Based on this prediction, the aforementioned control volume method is then used to establish the flow model of a coat hanger die. In addition, a Taguchi method was coordinated to establish a software for the analysis and optimal design of a coat-hanger die for the foam extrusion which requires a high foaming ratio with a physical blowing agent. Finally, in this thesis, an optimal design of coat-hanger die used for the LDPE/$CO_2$ system will be also investigated to predict the position of pre-foaming, pressure distribution, flow homogeneity and temperature homogeneity.