A METHOD OF MODELING SLAB

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ABSTRACT

Heating is a common machining method in engineering processes. In which, the problem of heating slab is a very typical problem. The requirement of the slab heating problem is that the slab temperature must reach the desired temperature. This paper introduces a method to model the heat transfer process in the slab as a transfer function. By using the transfer function, we can determine the temperature of each layer in the slab, from which we can design a controller to control the slab temperature to meet the technological requirements.

Keywords: *Heating problem, slab, transfer function model.*

1. INTRODUCTION

The heating problem is a technical problem that is applied in many different fields. Heating for materials can be the process for further processing or it can be the final step to produce the product. The requirement of the heating process is to control the temperature and temperature distribution of the product during the heating process. In this paper, we are mainly interested in the problem of metal heating with the main workpiece being slab. In the problem of heating slab, the necessary requirement is to control the temperature of the heating furnace according to the temperature requirements of the slab, thus ensuring the technological requirements set forth with the slab. To meet the above requirements, we need to determine the temperature of the slab. There are two ways to determine the temperature of the slab.

- Direct measurement of the temperature of the slab by sensor: This option, if possible, has high control accuracy. However, in order to know the surface temperature and heat distribution in the slab, it is necessary to place many sensors in the slab, which is difficult to do in practice.

- Indirect measurement of slab temperature: In this option, we calculate the slab temperature according to the heat transfer equations, that is, build a mathematical model of the heat transfer process. Based on this computational model, we can determine the temperature of the slab surface and the temperature distribution of the inner layers of the slab from the furnace temperature. This option has high applicability in practice

The model can be built by two methods that are numerical method [1-3] and transfer function model method [4-6]. Numerical methods [1-3] often has high complexity, so it is not suitable for the design of real control systems. The method of modeling slab as transfer function [3-7] is very suitable for controller design. Therefore, in this paper, we introduce the slab model as a transfer function. From the transfer function model of the slab we can design the controller to control the temperature of the slab.

2. MAINT CONTENTS

Consider the model of 1-side heating furnace [3-7] as follows

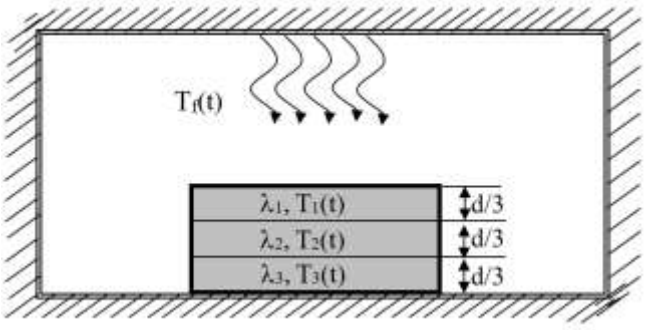

Figure 1. Heat transfer model of furnace

In the above model, the heat source for the slab $T_f(t)$ comes from one side of the furnace. In order to calculate and build the transfer function model of the furnace to be convenient, we have the following assumptions: The volume of the furnace chamber is small, considering the temperature in the furnace is the same; Neglect the heat transfer through the tip and edge of the slab. According to Figure 1, we divide the slab into 3 layers. Heat transfer from the furnace heat to the first layer of the plate workpiece is mainly through radiant heat transfer. With this outer layer: The input of the model is the temperature in the furnace space, the output of the model is the temperature of the outermost layer. Heat transfer between the layers of the slab is carried out by conduction. For inner layers of the workpiece: The input of the model is the temperature of the front layer, the output of the model is the temperature of the layer under consideration.

Consider a case of slab steel with the following parameters:

The thermal conductivity of the plate k = 55.8 w/m.K (Here, the thermal conductivity of the slab is considered constant); Density: ρ = 7800kg/m^3 ; Specific heat c = 460 j/kg.K; Heat transfer coefficient h = 335 w/m^2. Slab length l = 0.6m ; Slab width w=0.3m; Slab thickness d = 0.06m

According to [3-7], we have the layer-by-layer transfer function of the slab as:

$$W_3(s) = \frac{1}{25.7s+1}$$

$$W_2(s) = \frac{25.7s+1}{660.49s^2+77.1s+1}$$

$$W_1(s) = \frac{660.49s^2+77.1s+1}{141622.26s^3+22106.76s^2+720.2s+1}$$

Modeling of slabs in Matlab – Simulink is as follows

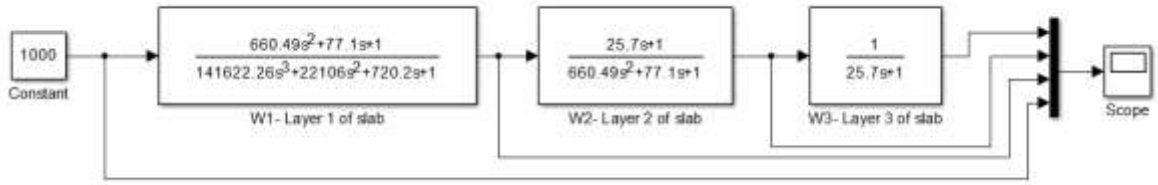

Figure 2. Simulink diagram showing 3-layer slab

The results of observing the temperature of the layers of the slab are as follows

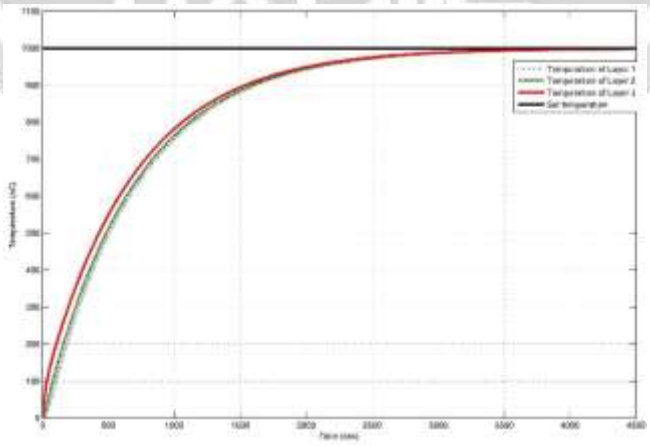

Figure 3. Temperature of the layers in the slab

3. CONCLUSIONS

The article has introduced a mathematical model for 3-layer slab in the form of transfer function. This transfer function model will allow us to determine the temperature of the layers in the slab. This is also the basis for controlling the temperature field in the slab to satisfy technological requirements.

4. REFERENCES

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