University of Science and Technology

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Modelling Simulation and Control For A Rotary Dryer

A Thesis Submitted In Fulfillment of the Requirements for the Degree of M.Sc in Chemical Engineering

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Abstract

This study investigated the modelling simulation and control of a rotary dryer. Sugar was used as material in the drying process. A control strategy was developed. The transfer functions were identified and the block diagrams were drawn with each transfer function in its block. Stability and tuning were carried out and analyzed by manual and digital control. It's observed that (ultimate gain ku and ultimate period Pu) are approximately equal using direct substitution, Routh, Root locus and Bode diagram in conventional control but not in digital control.

From the foregoing result it is recommended to use for conventional manual control any one of the tuning methods as these give equal ultimate gains and ultimate periods, which can be introduce into Z-N to obtain the adjustable parameters.

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المستخلص

هذه الدراسة عن التحكم والمحاكاة للمجفف الحراري. السكر هو المادة المستخدمة في عملية التجفيف. انشات خطة التحكم وضمنت الدوال ورسم المخطط المكعب ووضعت كل دالة في مكعبها. تحصل على الاستقرار والتعديل وتحللت عن طريق الكنترول العادي والرقمي. ولوحظ ان (Ku,Pu) متساوية او قريبة للتساوي باستخدام الحل المباشر وطريقة راوس وطريقة روت لوكس ومخطط بودي بالنسبة للكنترول العادي ولكنها ليست متساوية بالنسبة للكنترول الرقمي.

من النتائج الغريبة استوصي باستخدام الكنترول العادي لانو اعطى قيم متساوية ل (Ku,Pu) والتي عوضت في جدول زيقلر-نيكولز للحصول على قيم الضبط.

Introduction

1.1 Control:

Control means methods to force parameters in the environment to have specific value, like making the temperature in a room stay at 21°c.

1.2 Classification of control:

1.2.1 Manual control:

It happen manually like closing and opening the valve manually or decreasing and increasing temperature manually.

1.2.2 Automatic control:

1.2.2.1 Digital control:

Is a branch of control theory that uses digital computers to act as system controllers. Depending on the requirements, a digital control system can take the form of a microcomputer to an ASIC to a standard desktop computer. Since a digital computer is a discrete system, the Laplace transform is replaced with the Z-transform. Also since a digital computer has finite precision, extra care is needed to ensure the error in coefficients, A/D conservation, D/A conservation etc. are not producing undesired or unplanned effects.

The application of digital control can readily be understood in the use of feedback Since the creation of the first digital controller in the early 1940s the price of digital computers has dropped considerably, which has made them key pieces to control systems for several reasons:

- Inexpensive: under $5 for many microcontrollers
- Flexible: easy to configure and reconfigure through software
- Scalable: programs can scale to the limits of the memory or storage space without extra cost
- Adaptable: parameters of the program can change with time.
- Static operation: digital computers are much less prone to environmental conditions than capacitor, inductor, etc.

1.2.2.2 Digital Controller Implementation:

A digital controller is usually cascaded with the plant in a feedback system. The rest of the system can either be digital or analog.

Typically, a digital controller requires:

- A/D conversation to convert analog inputs to machine readable (digital) format
- D/A conversation to convert digital outputs to a form that can be input to a plant (analog)
- A program that relates the outputs to the inputs

1.3 Stability :

Although a controller may be stable when implemented as an analog controller, it could be unstable when implemented as a digital controller due to a large sampling interval. During sampling the aliasing modifies the cutoff parameters. Thus the sample rate characterizes the transient response and stability of the compensated system, and must update the values at the controller input often enough so as to not cause instability.

When substituting the frequency into the z operator, regular stability criteria still apply to discrete control systems Nyquist criteria apply to z-domain transfer functions as well as being general for complex valued functions. Bode stability criteria apply similarly. Jury criterion determines the discrete system stability about its characteristic polynomial.

1.4 Design of digital controller in s-domain:

The digital controller can also be designed in the s-domain (continuous). The Tustin transformation can transform the continuous compensator to the respective digital compensator. The digital compensator will achieve an output which approaches the output of its respective analog controller as the sampling interval is decreased.

1.5 Computer Simulation:

Digital simulation is a very useful tool for solving equations describing chemical engineering system.

1.6 Drying:

Drying is a mass transfer process consisting of the removal of water or another solvent by evaporation from a solid, semi-solid or liquid. Drying is carried out for one or more reasons :

(a) To reduce the cost of transport.
(b) To make a material more suitable for handling as, for example, maintaining the free-flowing nature of salt.
(c) To provide definite properties, such as, for example, maintaining the free-flowing nature of salt.
(d) To remove moisture which may otherwise lead to corrosion. One example is the drying of gaseous fuel or benzene prier to chlorination.

1.7 Modelling:

Models are an integral part of any kind of human activity.

Most models are qualitative in nature and are not formulated explicitly such models are not reproducible and cannot easily be verified or proven to be false.

Advantages of model :

1\ modelling improves understanding.

2\ models help in experimental design.

3\ models may be use predictively for design and control.

4\ models may be used in training and education.

5\ models may be used for process optimization.

1.8 MATLAB:

is a multi-paradigm numerical computing environment and fourth generation programming language. A proprietary programming language developed by math works. MATLAB allows matrix manipulations, plotting of function and data, implementation of algorithms creation of user interface and interfacing with programs written in other languages, including C,C++,C#, Java, fortran and Python.

1.9 objective of the study:

The objective of the study is to make a control of a rotary dryer by using routh array, root locus, bode diagram and step response by conventional and digital control.