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A Review on Temperature Control for Dryer

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ABSTRACT: Drying is one of the most common and important unit operation in Process industries. The aim this paper is to promote the cooperation between drying and control communities. From the review of 13 relevant publications all related to control operation in drying, this paper explains about the usage of control tools in drying applications had startedsince 1979. In other hand which is started around 1998, new trends based on more advanced concepts have also implemented in drying control. In this paper it is shown that control of drying is important and many opportunities are there to improve the performance of industrial dryers through efficient control operations.

I.INTRODUCTION

Drying technology is one of the major energy consumer used in many industries which includesagriculture, textile, mineral, pharmaceutical, pulp and paper, polymer, biotechnology, food, wood and others. The main aim of Drying is to reduce the moisture content inside a product by application of thermal energy to make dried products of desired attributes. Once the Control of dryers was mostly manual; automatic control appeared in industries was more recently in industrial drying equipment, especially when the PID controller is introduced (the first paradigm in control) by Ziegler and Nichols in 1942. But the control techniques have been widely used during the middle of the 1970's in the chemical industry and other industries. Indeed, with 60,000 products dried and 100 dryer types commonly used worldwide (1, 2), and with the problems of transport phenomena involved in drying process, no single controller can be applied to all dryers. Then, most of the research is focused on the understanding of the drying mechanisms and product quality and also on control of the operation of dryers. Therefore, it is not surprising to see that about few published works deal with the control aspects in drying technology. In these time, one has to note that the cost of dryers is not in the initial investment but in the operation carried out in the drying process, where control is most sufficient to save energy and obtain product quality. From this it is clear that dryer control is very sufficient and that with deeper inspection of the drying, new "smart" dryers can be designed with more reliability and cost efficient than the classical dryers(1). This paper is made as follows: first, some promotions for the use of control tools regarding drying are shown, also includes some the financial benefits. In the second part, some concepts of control engineering tools needed for this paper are reviewed briefly. It shows how control tools can be used to control industrial drying process and reviews the recent trends in the control dryers, mainly in terms of advanced control techniques and modelling.

II.METHODS OF DRYING TECHNOLOGY

Drying methods and processes can be differentiated in several different ways. It can be classified as batch, here the material is inserted into the dryer and drying happens for a given time, or as continuous, here the material is continuously added to the dryer and the dryer dries the material continuously removed.Drying processes can also be classified according to the physical conditions uses addition of heat and removal of water vapour:

1) In this first category, heat is added by making direct contact with heated air at atmospheric pressure, and then the water vapour formed is removed by using the air.

2) In vacuum drying, the water evaporation proceeds more fleetly at low pressures, and the heat is added by indirect contact with a metal wall.

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3) In freeze drying, water is supressed from the frozen material. Dryers, whichreveals the solids to a hot surfaces with which the solid is in contact. Dryers, which reveals the solids to hot gasses, are called as adiabatic and are also called as direct dryers; in this the heat is transferred from an external medium called as non-adiabatic dryers or indirect dryers. Dryer is heated by using radiant or microwave energy which is also non-adiabatic. Some commonly used industrial dryers are:

- Bin Dryer
- Rotary Dryer
- Conveyor Dryer
- Fluidized bed Dryer
- Spray Dryer
- Drum Dryer
- Pneumatic Dryer
- Vacuum band Dryer

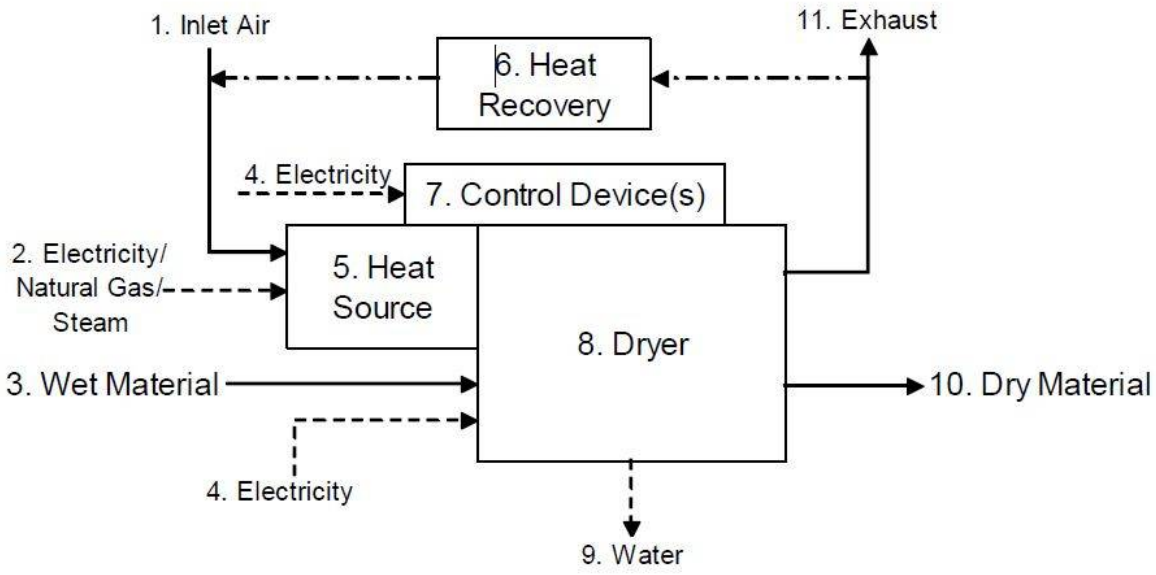

Fig.1DIAGRAM FOR BASIC DRYING SYSTEM

III.USE OF CONTROL IN INDUSTRIAL DRYING

During drying, the most important objective is to adjust some of the drying conditions [6]hale achieving the main final overall performances required.

- Increases the yield when obtaining the specified properties and desired quality of the dried products needed. This includes:visual appeal, porosity, stability, size, colour, and texture, stress resistance, etc. [7].

- Decrease the cost of production due to: the consumption of energy, the cost for maintenance and the drying time. Considering the energy consumption, drying is one of the highly energy intensiveprocess and it consumes from 10% to 25% of the national industrial energy in the world [1]. Moreover, it is also known that many industrial dryers operate at very low energy efficiency, from 10% to 60% only .Therefore, due to the more energy costs and more intensive global competition, the performances of drying process have to be improved and which can be only done using the control tools. For example, improved properties of the

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products and quality of the productoften demand which increases the cost of production and also decreases the time of drying which leads to decrease the quality.

IV. USE OF CONTROL TOOLS IN DRYING

The control algorithm is fully based on a model which is used to represent the process inside the control strategy. The controller model can have various representations. In drying, only the black-box models are used classically because they are quiet easy to obtain, simple and basic to use in a control strategy. Since 1998, if they are still usually more complex to obtain, first principle models are more used because they are more accurate to show the complex behaviours in drying. Recent development of optimal control and first principle model is not at all a surprise, since 1998.

V. CONTROLLER DESIGN

The controlling techniques for the drying machine were first designed by using a PID (proportional Integral Derivative) control algorithm. Then it later upgraded to FLC (fuzzy logic controller) for the purpose of improving the performance drying section in process industries and also some of the controlling techniques are fuzzy tuned PID, PSO, ANFIS, etc. are applied. Let us discuss briefly about some controllers using in industries by the help of MATLAB Simulink in process industries.

VI.PID CONTROLLER

PID controller is one of the control loop feedback mechanism which is mostly used in industrial control system. PID controller will also be represented as PI, PD, P or I controller in the absence of any respective control actions. PID control algorithm is mostly used in process control industries. Because it contains simple control structure. Due to its flexibility and reliability it can be chosen in many applications.

$$u(t)=kp\ e(t)+ki\int e(t)dt+kdt+de(t)/dt$$

The above equation represents the general form PID control algorithm, Where

- Kprepresents the Proportional constant or gain.
- Ki represents the Integral constant or gain.
- Kdrepresents the Derivative constant or gain.

VII.FUZZY LOGIC CONTROLLER

FLC controller is an intelligent and which is more popular also widely used in process control applications. FLC system is derived from fuzzy set theory introduced by zadeh in 1965. The purpose of fuzzy controller is to influence in the behavior of a system by changing an input to that system according to a rule or set of rules that model how the system operates. By applying fuzzy logic control algorithm, which improves the response behavior and also efficiency of the process. The system being controlled may be mechanical, electrical, and chemical or any combination of this. The main application of the fuzzy logic in engineering is in the area of control system. The input variables in the fuzzy control system are mapped by set of membership functions, also known as fuzzy sets. The process of converting crisp quantity into fuzzy value is called as fuzzification and its vice versa is called as de-fuzzification. The MATLAB Simulink contains fuzzy logic tool box which is used to design the controller.

VIII.MANUAL CONTROL vs AUTOMATIC CONTROL

Manual control is the most common way used to tune the manipulated variables: The manipulated variables are adjusted by the operator by sensing the overall process behaviour (e.g.:heating power flow rate). This type of control is very simple. The main drawback is this can be uneasy, because of some complex multivariable behaviours which occurs when drying process is carried out. Some disturbances (e.g.: change in feed characteristics) which occur are

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usually not negligible during the drying. The new adjustments required by the new uncontrolled drying conditions may not be implemented, because the frequency of this tuning is unknown, which leads to decrease of drying performance.

On the other side, the advanced automatic controllers refers intelligent hard and soft devices that aim to tune the manipulated variables (e.g.: the thermostat in your house) automatically. The manipulated actions are therefore adjusted at each time, or at a fixed sampling time. From the introduction of PID control by Ziegler and Nichols in 1942, the automatic controllers are very common in industries and used in many control actions today. The overall performance and efficiencyof the process system can be improved very much by introduction of those controllers and its implementation is very easy that of manual controllers. Multivariable controllers can be easily operated than the manual controllers. This paper focuses on the better performance of dryers while approaching the automatic controllers over manual controllers.

IX.CONCLUSION

The idea in this paper is about the implementation of some basic principles of standard control tools and to explain about their role in drying.Indeed, though drying is a very old technology, the implementation of control techniques in drying is recent: the first real application of drying control technique was published in 1979 and the mean publication rate of papers about drying has increased by 3.7 from 1998. In this paper, to explain the advantages of the implementations of those control techniques in drying some methods are present. It allows to get a better controlof the dryers and to improve the drying yield regarding drying time, consumptionof external energy needed during the drying process, production cost and cost of may be decreased. In terms of application domain of control, drying of food is considered important (66% of the papers). Because, the food quality is considered important and which has the direct impact on humans day to day life. In the meantime, the use of such controllers requires the development of more accurate models.

With collaboration between both the control and drying communities, it is to be expected that the industrial drying control operation is to be continued to improve the energy efficiency which enhances the product quality and also reduces the negative environmental impact on dryers. Advances in control section could be applied inorder to decrease cost of drying systems.

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