SE REGISTRÓ UN PROYECTO "SEMILLA" CON LA INFORMACIÓN SIGUIENTE:

Universidad Autónoma de Coahuila
Dirección de Investigación y Posgrado
Subdirección de investigación

Proyecto "Semilla" 2020
Registro No. 62

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DATOS GENERALES

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Participación: *SNI, Perfil PRODEP*
Área del conocimiento: *Ingenierías*
LGAC: *Ingeniería de control y automatización*
Sector que beneficia: *Privado*

PROYECTO **Design and implementation of an IoT based controller for a solid-state fermentation packed-bed column**

Antecedentes:

Solid-state fermentation (SSF) is a microbial process over the surface of solid materials with the property to absorb water with or without nutrients (Viniegra-González, 1997). Even on laboratory scale (grams of solid dry weight material) a bioreactor design is used to develop an SSF. Different bioreactors have been designed to use in SSF (Durand, 2003) but tray bioreactor and packed-bed bioreactor are the most used. However, one relevant disadvantage of the packed-bed bioreactor is the high temperatures reached at the center of the column (Mitchell et al., 2000), as long as the high increased. The same problem occurs for the majority of the bioreactors design; in general, Petri dishes and

Erlenmeyer flasks are the bioreactors with advantages in controlling the process with external equipment as the use of incubators to control fermentation temperature trough fermentation time. However, there are variables that cannot be controlled using external and robust equipment, as the airflow. Packed bed bioreactors, tray bioreactors, drum bioreactors, among others, include accessories for monitoring and controlling variables like temperature, airflow, pH, humidity and CO2 and O2 concentration. For these reasons, to develop studies in those bioreactors to produce a wide variety of metabolites can generate useful data to make fermentation in higher scales.

High temperatures reached in column bioreactors by metabolic heat are difficult to remove just with forced aerated because the unidirectional way of air through the bed (Ashley et al., 1999), and the geometric modifications and are principally based in the length size limited, because by making the column wider the heat elimination, is not significantly improved. Even if it is accompanied by a jacked, radial heat transfer would not be enough to dissipate metabolic heat if the radium is greater than the optimum. For scale-up purposes, the elimination of the heat produced by the metabolic action of the microorganism is an area of opportunity (Asgher et al. 2016a).

Automating the bioreactor control is advantageous in implementing an algorithm that maximizes the yield (Efe et al., 1999, Hu et al., 2008, and Kumar et al., 2008). The development of internet technologies allows us to apply the Internet of Things (IoT) to industrial processes (Fantana et al., 2013).

Justificación:

Solid-state fermentation has been used since ancient times to produce several metabolites by-using many different microorganisms. Several bioreactor configurations have reported for SSF. Packed-bed columns are widely used; however, some drawbacks have been observed during its implementation at larger volumes, mainly to the rise temperature within the substrate due to metabolic heat. Then heat removal is critical in order to maintain the optimal temperature, thus the monitoring and control strategies in order to solve this problem will allow to increase process performance and yield. Also, the use of low-cost biosensors for measuring SSF variables (temperature, humidity, O2 and CO2) and universal interface for bioprocess variables monitoring anywhere will allow us to monitor and manipulate strategies focused on process improvement.

Objetivo general:

The present investigation proposal arises to design and implement of an IoT based controller to monitoring and control a solid-state bioprocess carried out in a packed-bed column for biosynthesis of enzymes for food industry.

Objetivo (s) específico (s):

1. To design and implement of an IoT based controller to monitoring and control a solid-state bioprocess.

2. To validate the performance of the IoT controller in a packed-bed bioreactor for the biosynthesis of enzymes.

Metas:

1. A mobile application to remotely monitored and control a packed-bed bioreactor for the biosynthesis of enzymes.

2. Impact on the obtainment of professional human resources.

METODOLOGÍA

Tipo de metodología: *Cuantitativa*

Clase de metodología: *Multidisciplinaria*

Disciplinas involucradas en metodología multidisciplinaria: *The areas involved will be electronics, sensors and biological engineering.*

Descripción de la metodología: *The development of this research project will be carried out in two different stages. In the first stage, an IoT controller to monitoring a bioprocess will be implemented. During the second stage, the IoT controller will be validated under a real bioprocess to produce enzymes for food industry.*

Stage 1. IoT controller.
Acquiring data from all the sensors, controlling the actuators, and processing the data to provide useful information is accomplished by a bio-reactor controller. In this stage, we acquire the sensors, actuators, and processors, which precedes the implementation of hardware communication protocols on Arduino and raspberry pi to establish a connection with the sensors and the actuators. A software is developed in the raspberry pi to communicate with the internet to complete the Internet of things (IoT) device.

Stage 2. Validation of the IoT controller in a solid-state bioreactor.
The microorganism and substrate selected for the solid-state process validations will be selected based on internal results from the Department of Chemical Engineering (UAdeC, Saltillo, Coahuila).
The packed-bed column will consist of a cylindrical glass vessel (500 mL) connected to an air humidifier, to supply air (relative humidity of 95 – 100 %) at the bottom of the column to maintain the desired moisture content. The column will be filled with enough agroindustrial waste to achieve a desired packed density, and it will be moistened with optimal conditions. Humidity and temperature gradients will be evaluated and controlled through the column at different airflow rates and air inlet positions by implementing online sensors and actuators through the IoT controller developed in stage 1.

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CALENDARIZACIÓN

ACTIVIDAD	**INICIO**	**TÉRMINO**

IoT controller	01-09-2020	28-02-2021
Validation of IoT controller for monitoring packed-bed bioreactor	01-03-2021	30-08-2021

DESGLOSE FINANCIERO

RUBRO	**MONTO**
MATERIALES Y REACTIVOS	$50,000.00
TOTAL	**$50,000**

PRODUCTOS COMPROMETIDOS

- Artículos: *1*
- Libros: *0*
- Capítulos de libro: *0*
- Tesis: *2 (1 Borrador tesis de licenciatura y 1 Borrador/Avances tesis de posgrado (Programa de Doctorado en Ciencia y Tecnología de Alimentos, Unidad Saltillo))*
- Patente: *0*
- Ponencias: 0
- Registro en derechos de autor: *0*
- Formación de recursos humanos:

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