



ZIGBEE TECHNOLOGY BASED DAIRY INDUSTRY PROCESS

R.Vanitha M.E.¹, B.Sivasarathi B.E.², G.Praveen Kumar B.E.³, Vayaluru Sudheer B.E.⁴

¹Assistant Professor, Department of EEE, RMD Engineering College, Chennai.

^{2,3,4}Student, Department of EEE, RMD Engineering College, Chennai.

Abstract

The key objective of the project is to supervise and to control the industrial automation wirelessly using SCADA system. In current scenario all the industry process are automatically controlled. The wireless control networks in industries continue to grow because of the attributes inherent to wireless communication, such as flexibility, straight forward installation, and low labor costs. Visual Basic is a type of HMI and it provides the instruction to microcontroller for controlling whole industrial plant. In this project the industry is considered as the dairy industry. The dairy industry process is controlled through PC using wireless network like zigbee technology. Through PC we can observe the dairy process that is how the milk is stored, circulated and how the stored milk is used for cheese preparation. Therefore, processes at dangerous places can be controlled with good accuracy and enhanced safety using SCADA.

Keywords: HMI: Visual Basic, Micro Controller, Zigbee Module.

1. INTRODUCTION

In the existing project they supervise and control the industry process using wired network. In the proposed system one can supervise and control the industrial automation wirelessly. This process is referred as wireless SCADA. In this project, the dairy plant process flow is controlled and monitored wirelessly with the help of HMI (Human Machine Interface). In Visual Basic software, the layout of the small scale dairy industry is designed which act as the HMI while controlling and monitoring the physical parameters. The physical parameters such as control valves, pumps, sensors etc. are converted

from analog to digital; this digital input is fed to the microcontroller. The zigbee module is used to transfer the data from PC to Microcontroller and vice-versa

2. ROLE OF SCADA

A Supervisory Control and Data Acquisition (SCADA) system usually a distributed computerized system used to control and monitor the field devices from a centralized location. Field devices pump, heater, alarms, control valves etc. through SCADA system the exchange of data from the field devices as well as with other control systems and plant information system. The SCADA system is divided into three major units, they are master terminal unit (MTU), remote terminal unit (RTU) and communication unit. The remote terminal unit involves the process in microcontroller, sensors, valves and other IC's. The mater terminal unit includes personal computer or the centralized location from where the process can be controlled. Here SCADA is used in control system of dairy plant and to check how milk flow is circulated through various process and finally production of cheese is done. Now-a-days all the industries prefers SCADA system. Usually, SCADA system is used in PLC's because SCADA system has number of protocols to enumerate the industrial process

3. GENERAL BLOCK DIAGRAM

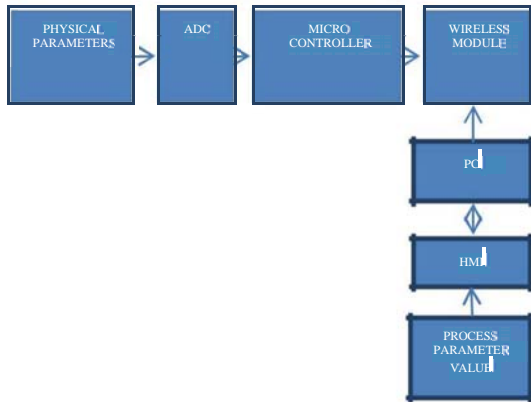


Figure 3.1 General Block Diagram

The block diagram describes about the overall flow and control of the industry process. First of all the physical parameters such as level sensors, control valves, motor pumps etc. are fed to microcontroller after converting from analog to digital. The wireless module is also connected to the microcontroller; the information from the microcontroller is transferred through this wireless module. Another wireless module connected with PC helps to communicate the data. Through PC the controlling and monitoring of the flow in industry is done with the help of HMI designed in visual basic software.

4. PROCESS FLOW OF DAIRY PLANT

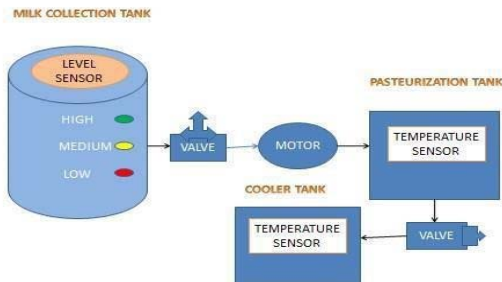


Figure 4.1 Process Flow of Dairy Plant Dairy

Process

The most representative production processes for the main groups of dairy products and subsidiary operations:

- Fresh milk;
- Products obtained from milk fat (cream and butter);
- Fermented milks (yogurt);
- Cheeses (ripened and soft);
- Secondary operations.

Processing Of Fresh Milk

Raw milk containing fats and other impurities are stored in the storage tank.

Milk Collection Tank Details

The amount of fresh milk is stored in big tank and the volume of the tank is 1000 liters per day. Then the stored milk is used for any secondary process of milk production.

Pasteurization Tank

After milk is stored in a tank it moves on to another tank for heating to remove all the impurities present in the milk. Generally they heat the milk in the range of 71.7 degree Celsius up to 35 minutes. The milk pumped from heater tank by using motor and the dairy industry use generally gear pump and its pressure range is 210 bars. The pipe dimension is 0.7 inch.

Cooler Tank

The heating process is over then the milk move on to cooler tank where the milk has been cooled in the range of 4 degree Celsius up to 8 hours. Then the cooled milk is used for secondary process of milk production.

Cheese Making Process

The preparation of cheese is one of the oldest forms for processing milk, and it is carried out traditionally within each family, village or district. Cheese is a product that is prepared from whole milk, cream, skim milk or buttermilk or with combinations of these products. In general, cheese is produced by the coagulation of milk proteins, using lactic ferments and/or rennet. The addition of enzymes, acidification or heat can accelerate this process. After coagulation, it is molded, salted, pressed and, for some types of cheese, it is treated with fungi or bacterial cultures. In some cases, special coloring or other non-lactic ingredients are also added. It is consumed as soft cheese or as cheese with different degrees of curing. There are more than

2,000 different types of cheeses throughout the world with very distinct characteristics that require a series of more or less distinct procedures for preparation. Milk should be treated and prepared by conditioning its physical, chemical and biological characteristics (filtering, clarification, standardization) to the final product desired before being used in the operations for producing cheese. Once ready for the stage of coagulation, the milk is raised to an appropriate temperature and ferments and enzymes are added that produce the formation of the gel or coagulate. After coagulation, the curds are cut into small cubes in order to promote the draining of the whey. After separation of the whey, the curds are placed in molds and in some cases are pressed. Once the form of the cheese is stabilized, it is salted and curing begins. For some cheeses, the process ends with the draining of the whey and packaging without curing (fresh cheeses).

Coagulation

Coagulation causes an alteration in the casein and its precipitation, creating a gelatinous mass that covers all the components of the milk. The nature of the gel that forms upon co-prevention of pollution in the dairy industry coagulation is carried out in vats where the curds are formed. These tubs must remain stationary and not be moved during the coagulation in order to avoid alteration of the coagulation processes with the resulting loss of casein with the wastewater.

There are three types of coagulation:

- Acidic coagulation.
- Enzymatic coagulation.
- Mixed coagulation.

Acidic coagulation it is produced by acids, usually lactic bacterial action, transforming the lactose into lactic acid. The formation of lactic acid reduces the pH of the milk, producing changes in the caseincalcium compound, gradually releasing calcium from this compound. The pH reaches 4.6; the remaining casein is precipitated into a liquid state (whey), which contains the dissolved calcium from the casein. The gel resulting from this process is formed by more or less polymerized protein chains in a network without rigidity or compactness.

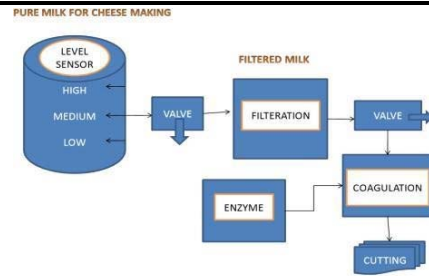


Figure 4.2 Cheese Making Process

Enzymatic coagulation it is the system of coagulation most widely used for the preparation of cheese and is produced by the addition of protein enzymes. The rennet obtained from the dry stomachs of lactating calves contains these enzymes and have traditionally been used in cheese production. Enzymatic coagulation transforms the casein-calcium compound in colloidal dissolution into a network of casein calcium, forming the gel or coagulate that covers the rest of the cheese components. The minerals in the micelles of the coagulate thus formed give it rigidity and compactness. An important part of the liquid state (whey) is thus retained in this structure. The amount of enzyme coagulant to add to the milk depends on its pH, the coagulating strength of the enzyme and the concentration and characteristics of the milk to be coagulated. Another important factor to take into account in coagulation is the temperature of the rennet or coagulant enzymes to be added. The time required for coagulation depends on the temperature of the added rennet. Temperature also influences the capacity of the rennet to link with water, retraction of the curds and acidification. Normally, temperature is between 28 and 34 °C, except for cheeses that are not cured that are worked at lower temperatures.

Mixed coagulation it is the result of the joint action of rennet and lactic acidification. A mixed gel can be obtained by adding rennet to acidic milk or by acidifying an enzymatic gel.

Cutting and draining

The gel formed during coagulation, whichever method is used, is in an unstable physical state. Depending on the conditions, the liquid state or the whey that impregnates it separates more or less quickly. This phenomenon is known as draining of the whey. The draining of the curds obtained by acidic coagulation is difficult and creates very moist rennet that is poorly drained.

This is because dispersion of the casein agglomerates the slight contraction of the curds and the absence of minerals from the casein that forms a pliable mass containing whey. Draining produces runoff from the mass of coagulate.

The coagulation obtained through enzymatic coagulation does not drain out the whey by leaving it at rest. To drain the whey, it is necessary to apply mechanical action. In order to promote the draining of the whey, the curds are cut in order to multiply the surface for draining. The conditions under which the gel is cut up influence the final product and varies depending on the type of cheese sought. There are two main methods for draining the whey. During the draining of the whey in vats, the coagulation is divided into cubes, which remain floating in the whey that they exude. During the draining of whey in molds, the cut-up coagulate is maintained in a mass from which the whey is separated as it forms. For some types of very acidic and demineralized coagulates, the whey is separated by centrifugation. Separation of the whey from curds left at rest is weak and slow and in most cases the cheese does not have the desired final composition. For this reason, other operations are carried out that facilitate the draining of the curds. There are two types of treatment: heat and mechanical.

Curing

Cheeses, once salted and dried, are taken to storage rooms for aging, in which the temperature and humidity are controlled. The curing of cheese includes physical, microbiological and enzymatic processes, creating a finished product with certain characteristics of aroma, taste and texture. Like in the previous stage, electricity is consumed during the curing of cheese as a result of the use of aging chambers with controlled temperature and humidity.

5. MODE 1 BLOCK DIAGRAM

Mode 1 block diagram explains the port connection. In this block diagram explains about the controller part. In this project PIC16F877A microcontroller is used for controlling purpose. In PIC16F877A the Port B, Port C and Port D are used for LED's connection and the serial communication is done through the RC6 and RC7.

Based on the instruction fetched from the PC the microcontroller make a control process .The microcontroller process time must be matched with VB process time. To achieve this process the proper crystal oscillating frequency in the range of 10.5MHz is set up. The important setting is baud rate value 9600 bps.

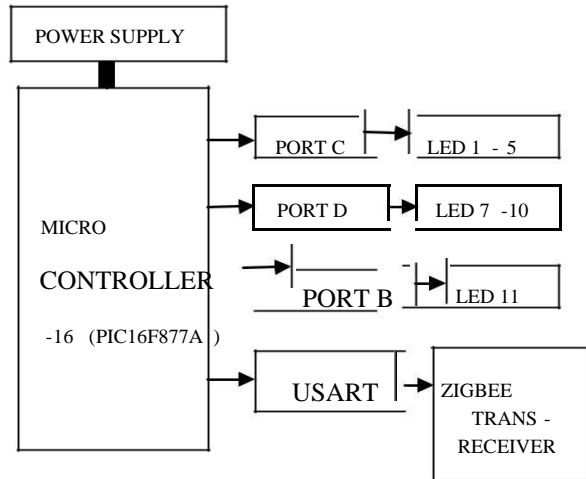


Figure 5.1 Mode 1 Block Diagram

6. MODE 2 BLOCK DIAGRAM

The mode2 Block Diagram includes the PC part where the HMI is created for setting the instructions. The Visual Basic is act as a HMI that make an interaction with user. In our project we VB version 6.0 and it is a convenient for making a process.

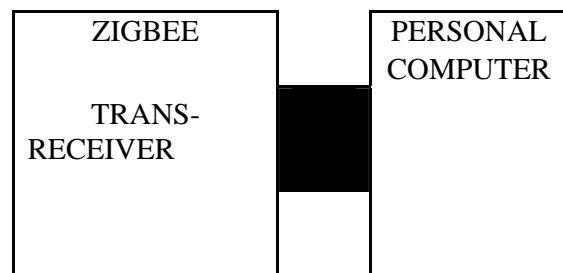


Figure 6.1 Mode 2 Block Diagram

7. PROCESSING OF DAIRY INDUSTRY IN VISUAL BASIC

Open the Visual Basic 6.0 on window then create a new project. Once the project window has opened set all the user interface elements required for dairy process. Then type a proper code and attain the absolute output by changing

the properties of interface elements. Then run the program by pressing F5 in the window if any bug occurs, press debug mode and check the error by using the help file. In this dairy process we use 25 shapes, 8 labels, 2 text box, 12 command buttons and 8 lines. Timer is used to set the delay and MS comport is used to transfer the information to any controller to control the process.

Form Window of Dairy Process

In the form window of Visual Basic, one can create a user interface elements. In this project, dairy industry the equipment’s such as storage tank, heater tank, cooler tank, pump motors, control valves, pipelines etc. are designed using the shapes available in the toolbox of visual basic software. The code for indicating the flow of the dairy process is written accordingly.

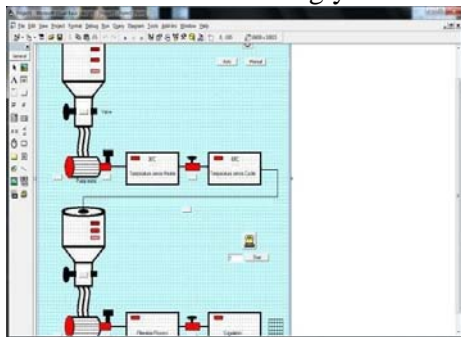


Figure 7.1 Form Window Of Dairy Process

Project window of dairy process

In project window one can write a code to compile the process. Code can be written based on the user interface elements placed on the form window. the dairy plant operation is controlled in two modes; they are automatic mode and manual mode. The code for automatic mode is written such that the flow process through various blocks takes places continuously. In manual mode, as the user gives command the particular part of the whole process is controlled and monitored.

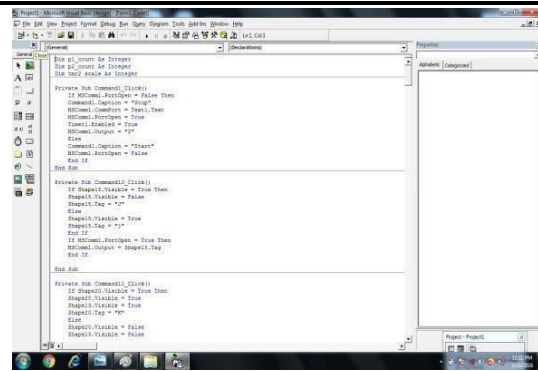


Figure 7.2 Visual Basic Code Window

8. MPLAB COMPILER

MPLAB Compiler is a software tool to build the code and detect the bugs for PIC microcontroller

Basic Steps

- Select Device: open the new project wizard and select the used microcontroller type.
- Create Project: select the hi tech compiler and create the project.
- Select Language Tools: In the Project Wizard the language tools will be selected..
- Put Files in Project: After creating the project, save the file.
- Create Code: in code editor window one can write the code for the project.
- Build Project: after creating and configuring the project code is tested and errors are rectified.
- Test Code with Simulation: Finally, the code will be tested with the simulator.

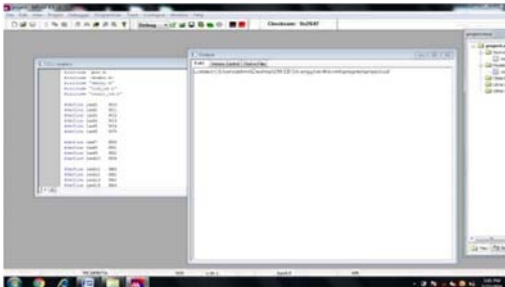


Figure 8.1 Editor Window of MPLAB



Figure 8.2 Output Window 9.

ZIGBEE MODULE

Zigbee is a wireless network module of IEEE 802.15.4. It cost low and provides high level communication. Generally, its coverage distance is about 10-100m. In this project RFM75 zigbee module is used. Its practical coverage distance is about 2-5m and its modulation type is GFSK Modulation. Data communication takes place in halfduplex mode. CC2500 modem is used in RFM75. RFM75 works in the band range 2.4 GHz and it receives and transmits the serial data with adjustable baud rate of 9600bps, 4800bps, and 38400bps at RS232 level.

10. PROPOSED SYSTEM DESIGN

In the proposed system, using SCADA system we control and access the whole dairy process. The HMI used is visual basic software which helps to monitor the process. We design the dairy process in visual basic. The controlling part has two modes of operation automatic control and manual control.

In automatic control part once if we start the process according to the milk filling content the low, medium and high led glows then when the tank status is high, the first valve opens and led glows. Next the milk is supposed to go to heater tank where heating takes place at 71 degree Celsius for 30 minutes, the led at the heater glows to indicate start of heating process. After completion of heating, the second valve opens the milk moves to cooling tank where it is refrigerated at 4 degree Celsius for 8 hours. Then next section is the cheese preparation process, the pasteurized milk proceeds to limited tank the level of the milk indicated by led. If the status of tank is high then the valve opens. The milk is transferred to filtration tank and then coagulation tank the flow is indicated by led glowing.

In manual the same process takes place but only thing is we can switch on or off specific equipment as per our need. This information from visual basic layout is transmitted through wireless network. Here in our project we use zigbee to convey the information to microcontroller and the output is viewed simultaneously as per instructions in visual basic layout of dairy process.

PROPOSED SYSTEM OUTPUT

The below simulation explain the dairy flow process where flow can be run in the automatic manner. Then one can run the flow with manual control process.

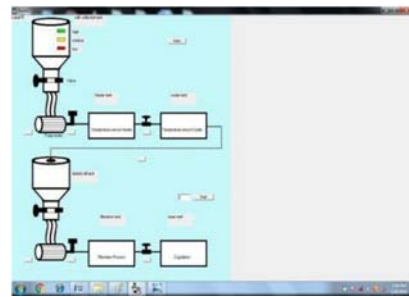


Figure 10.1 Simulation Window of Dairy Process

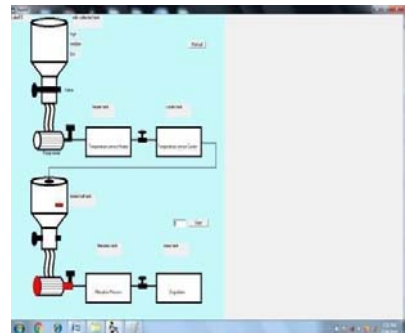


Figure 10.2 Simulation Window of Cheese Making Process

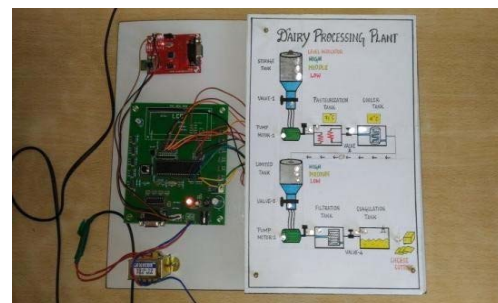


Figure 10.3 Prototype of Dairy Process Control System



Figure 10.4 Prototype of Wireless SCADA

International Journal of Emerging Science and Engineering (IJESE) ISSN:2319-6378, Volume-1.

[5]. Singh, R. (2011). India Dairy and Products Annual Report 2010. USDA Foreign Agricultural Service: Global Agricultural Information Network. Retrieved 16 June 2011.

CONCLUSION

In this project a prototype has been designed to represent the industrial automation for dairy plant. The whole industry process can be controlled and monitored using PC through PIC. The zigbee module is used to transfer the data from PC to microcontroller and vice-versa. It is cost effective technique.

FUTUREWORK

The proposed model can be further extended to a mobile app which will help us to control and supervise any industry plant through an android mobile. Since the visual basic requires a PC it's not portable. So the mobile app can be better way to monitor and control the industry status by an engineer anywhere at any time far from the plant field.

REFERENCES

- [1]. Aung Naing Myint, Hla Soe Theinigi and Win Khaing Moe, (2013), "Implementation of Control Unit using SCADA System for Filling System", World Academy of Science, Engineering and Technology 46.
- [2]. Aung Soe Phyo, Zaw Myo Tunand, Hla Myo Tun , (June 2015), "Wireless Patient Monitoring System Using Point to Multi Point Zigbee Technology", International Journal Of Scientific & Technology Research, Volume 4, Issue -6.
- [3]. Engin Ozdemir, Melt Karacor, "Mobile Phone Based SCADA for Industrial Automation". ISA Transactions Volume 45, Number 1, January 2006.
- [4]. Mada Yaswanth Manikanta, Bandarupalli Pavan Kumar, P.E.S.K.Sharan, M.V.D.Prasad, (2013) " Optimum Zigbee based Wireless Control of Industrial Automation Processes",