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"Design of Cooling System to Control the Temperature of Domestic Flour Mill"

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Abstract:-*Flour mills are used to crushing and grinding of whole grains, into powder and fine pieces that are called flour. Due to crushing and grinding the temperature of flour increases up to 60 to 70 degree Celsius. For the reduction of temperature of flour mill grinding section, air cooling system is used. The main part of the system is Air Handling Unit (AHU). In air handling unit fresh air comes in through fan and then passes through the filtration unit. Then after filtering air it goes through the cooling coil where it will be cooled. Then air will goes to the blower. After that dehumidified air will pass on the casing of the grinder. After that the expected temperature of the grinder and flour is below 43 degree Celsius will be achieved. Below this temperature wheat flour does not loses its nutrients. The material is selected for the systems are aluminum, copper, steel, etc. Refrigerant will be used in the system is R134a. This system is used to reduce the temperature of the flour mill grinder/flour. This work is dealing with experimentations of cooling system for small flour mill used in the home.*

Key Words*: *Flour mill, AHU, Cooling, Nutrients, etc.

1. INTRODUCTION

Flour mills are devices used to crush, grind, whole grains into smaller, powdery pieces are called flour. In flour milling process when we start the milling by pouring the grains into the hopper of the flour mill it goes to the grinder which is grind the granule into powder form. And after completing this process we get flour. In normal flour mill working time is more hence due to more working time the temperature of the grinder increases after an hour usually. Because of high temperature of the grinder flour temperature will also increases. This high temperature causes the losses in nutrients and quality of the flour and also life of the flour and grinder.

The study suggests that by reducing the heat of the grinder we can controls the temperature of the flour and grinder also. In the searching of this it is observed that the temperature of the flour is usually above the 70-80 Degree Celsius. And the nutrients like protein, starch, carbohydrates, etc. of the wheat flour are losses above the 40 Degree Celsius temperature. Hence we are designing the air cooling system to control the temperature of the grinder of mill.

In the air cooling system Air Handling Unit consist of a fan, blower, refrigerant cooling coil and circular duct etc. Air Handling Unit is device used to regulate and circulate air as part of a heating, ventilating and air-conditioning system. An air handler is usually a large metal box containing a blower, heating or cooling coil, filter rack or chambers, sound attenuators and dampers. Air Handling Unit usually connects to ductwork ventilation system that distributes the conditioned air through the next system and after cooling effect returns it to the Air Handling Unit.

2. OBJECTIVE

The main objective of project work is to design and develop the air cooling system to reduce the temperature of grinder and flour while grinding. We have to reduce the temperature of the grinder below the 40 degree Celsius. This helps to keep the nutritional values of wheat flour stable and also helps to reduce the temperature of grinder and due to this reduces the maintenance. To keep the flour nutrients constant, to keep the healthy qualities of flour constant we design this system.

3. Scope:

We can install this system at different commercial flour mills so that flour quality can be maintain at different commercial flour mills.

4. LITERATURE RESEARCH

Min Jeong Kang, Mi Jeong Kim, Han Sub Kwak, Sang Sook Kim:- The aim of the study was to investigate the effect of milling method and hammer mill and wheat cultivars on physiochemical and dough properties of the whole wheat flour. Colors, particle size, starch damage, falling number, water absorption index, water solubility index, pasting and mixolab properties, dough extensibility of whole wheat flour were measured. Significant differences were observed in the proximate compositions. The particle size of each cultivar milled with hammer mill was larger than those milled with jet mill. The final viscosity of the whole wheat flour milled with a hammer mill was higher than that of milled with the jet mill. Overall result from principal showed that among the two to three cultivars, keumkang whole wheat flour was the most affected by the milling methd.

Raffaella Di Silvestro, Alessandro Di Loreto, Ilaria Marotti, Sara Bosi, Valeria Bregola, Andria Gianotti, Robert Quinn, Giovanni Dinelli:- In the perspective cereal based functional food development, research compared to the watermill and the stonemill which is differ in heat generate during grinding. Effect of storage on preservation of phytochemicals, after six months storage of flour, reduced in soluble dietary fibre, bound polyphenols were observed. Other wheat grain components are unvaried. By comparison of milling methods stoneground wheat grains indicated highest amylose and resist starch amount which lowering the glycaemic Index. Stoneground KAMUT starch had higher tendency to be converted into resistant starch, it also indicated the highest damage to the starch, by comparing with the durum wheat variety Claudio. This provides the suggestions to the modulating the chain of production with the target of supplying added value to the wheat products.

Iuliana Aprodu, Iuliana Banu, Georgeta Stonescue, Violeta Ionescue:- In the process of milling streams are obtained. In this work different flour was studied and extraction level of flours were analyzed and studied by using Mixolab and Alveograph devices. Results shows that rate of the extraction are an important factor affecting rheological behaviour. The objective of the milling is to separate endosperm from the kernel, and gradually grinding the endosperm into the high no. of milling streams flour. The Mixolab characterizes the flour completely as: (1) Quality Of the protein by showing their water absorption and the weakening properties. (2) Starch behaviour during gelatinization and retrogradation. (3) Consistency change when using additives. (4) Enzymatic activity of the proteases, amylases.

Gregory D. Williams, Kurt A. Rosentrater:- Flour milling facilities are more important for the agriculture process for more times. They needed no. of unique designs needs. By this paper engineer gets more used to with the specific design consideration for the milling facilities and develops right reference to improve their information and knowledge. This gives the procedures of designs for the construction, planning, and the operations of flour milling facilities. It also gives the standard and procedures which are helping to the design considerations.

C.Nuntadusit, M. Wae-hayee, N. Kaewchoothong:- Heat transfer and flow characteristics of impacting jet from the nozzles with air augmented duct were experimentally investigate. The geometry of air augmented duct affects the heat transfer. The regular impacting jet method was also studied for doing improvement in this method. The temperature distribution of the affected impacting surface was observed and measured by the use of thermal infrared camera. The hot wire anemometer was used to measure the profile of velocity and the turbulence intensity of jet. This type of duct is used to increases the heat transfer on affected surface. The target of this work is to find the flow and heat transfer characteristic of an impacting jet from pipe nozzles with the air augmented duct experimentally and using numeric calculations. This study gives the knowledge about designing and analysis of duct for heat transfer.

5. METHODOLOGY

For achieving above objective we are going to design the air cooling system (ACS).In the air cooling system Air Handling Unit consist of a fan, blower, refrigerant cooling coil and circular duct etc. Air Handling Unit is device used to regulate and circulate air as part of a heating, ventilating and air-conditioning system. An air handler is usually a large metal box containing a blower, heating or cooling coil, filter rack or chambers, sound attenuators and dampers. Air Handling Unit usually connects to ductwork ventilation system that distributes the conditioned air through the next system and after cooling effect return it to the Air Handling Unit.

5.1 Calculations

The flour mill (domestic),

Milling rate of small flour mill min 6 kg/ hr

For wheat flour the CP of wheat is varies between1.0792 to 5.533

Take average of CP of heat

CP = (1.0792+5.533) ÷ 2

CP of wheat = 3.3064 Kj/kg °C

The heat generation inside the flour mill

$q= mC_p\Delta T$

Where,

M= mass of flour per second

Cp= specific heat of wheat

ΔT= temperature difference

Therefore,

q = (0.001666*3.3064* ΔT)

The temperature of wheat flour after milling is generally 60°C and the temperature of wheat before milling 25 °C.

But, have to reduce the temperature of wheat up to 16°C for better quality of flour

q= ((0.00166*3.306 4)*(60-16))

= 0.241499kw

We have to remove 0.241499kw heat from the mill so

For air cooling,

The temperature of air after blower is generally 50 °C

Let us consider we reduce the air temperature up to 4°C

Then, mass flow rate of air is,

q = m*Cp air*(50-4)

0.241499=m*1*46

m = 0.005249kg/s

And density of air is 1.22kg/m^2.

m= 0.004302 m^3/s

Design of duct system:

Pressure drop in circular duct is less than pressure drop in square duct hence the circular duct having 0.0127m diameter is selected;

Duct length:- 2m

Duct diameter:- 0.0127m

Friction factor:- 0.005

Density of air:-1.2 kg/m^3

1) Pressure drop in circular duct;

Velocity of air= Flow ÷ Area

= ((0.01717*4)÷(60*π*0.0127^2)

=2.2590 m/s

Hydraulic mean depth = d/4 = 0.0127÷4

= 0.003175m

Frictional pressure drop=(FLρV^2)÷2m

= (0.005*2*1.21*2.2590)÷(2*0.003175)

9.7239N/m^2

For square duct side 0.0127m

Velocity= (Flow÷ Area) = 17.74m/s

Frictional Pressure Drop = (FLρV^2)÷2m

= (0.005*2*1.21*17.74^2)÷(2*0.003175)

= 599.67 N/m^2

Convective heat transfer coefficient (h):-

h = 10.45-V+10V^(1/2)

Where, V= relative speed between object surface and air

V= 2.2590m/s

h = 10.45-2.2590+ 10*2.2590^0.5

h = 23.22 w/m^2°C

Extra cooling load on the system:

Heat loss from 1 H.P motor

Efficiency of motor =75%

The heat loss from an electric motor supplied with 10 Kw with the heat loss 150w/Kw

(10kw)*(150w/Kw) = 1500watt=1.5kw

Therefore, heat loss per Kw of motor

For 1 H.P motor

Heat loss =250watt/Kw

6. EXPECTED RESULT

In the air cooling system that we were design in that we have calculated Pressure, Velocity, Temperature drop, convective heat transfer coefficient. These parameters we have calculated on that we are designing a system which will use to decrease the temperature of flour mill.

So the parameters are,

Pressure drop in the duct:- 9.7239N/m^2

Velocity of air: - 2.2590m/s

Convective heat transfer: - 23.22 W/m^2°C

So from the following parameters we have designing air cooling system which was used in flour mill. From that we can reduce the temperature of flour so their nutritional value cannot be decreases.

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