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"A STUDY ON HEAT ENHANCEMENT OF PLATE HEAT EXCHANGER IMPROVED EFFICIENCY BY USING TURBULATOR ON PASTEURIZATION SYSTEM IN DAIRY PLANT"

***Abhishek Kumar* [1], *Yogesh Tembhurne* [2]**

[1] *P.G. Scholar, Dept. of Mechanical Engineering, B.E.R.I., Bhopal, MP, India*

[2] *Assistant Professor, Dept of Mechanical Engineering, B.E.R.I., Indore, MP, India*

ABSTRACT

The heat exchangers are generally used to transfer heat from one medium to another medium. The heat exchanger are generally used for space heating, refrigeration, air conditioning, power plants, chemical plants, petrochemical plants, petroleum refineries, natural gas processing, and sewage treatment. A Plate Heat Exchanger is a type of heat exchanger that uses metal plates to transfer heat between two fluids. An experimental was conducted in Bihar SahakariDugdhSangh (BSDS) on Plate Heat Exchanger. Plate Heat Exchangers are used to pasteurize milk in BSDS, in which the hot water is used to transfer heat towards milk by which milk is pasteurized. The temperature of pasteurization milk is set on 78°C in Bihar SahakariDugdhSangh plant for milk properties, when the temperature of pasteurized milk become below 78°C the milk come in raw milk tank to again pasteurize. By which we got the working plate heat exchanger efficiency of Bhopal SahakariDugdhSangh is 55.05%. We enhance the working plate heat exchanger efficiency of Bihar SahakariDugdhSanghby placing different turbulators (Twist tape turbulator, Brock turbulator and Wire turbulator). in inlet hot water pipe. We got the working efficiency of Plate Heat Exchanger in these turbulators are 71.01%, 62.64% and 63.31. The experiments proposed for counter flow models of the fluids. After modification by turbulators in Plate Heat exchanger set up we got that Twist turbulators is better turbulators than other turbulator. Then we again find working efficiency on different pitches of better turbulator. The working efficiency become on different piches are 71.9%, 63.26%, and 62.97%. We compared these modified working efficiency to without modified working efficiency of plate heat exchanger which used in Bihar SahakariDugdhSangh. We got that the working efficiency of Bihar SahakariDugdhSangh plant is increased by placing twist-tape tabulator in inlet hot water pipe, and it is also depended on the pitches.

Key Words: *heat exchangers, turbulators, space heating, refrigeration, air conditioning,Plate Heat Exchanger*

I. INTRODUCTION

1.1 What is Heat exchanger

A heat exchanger is a contraption by which warm vitality or enthalpy is exchanged between in any occasion two fluids having various temperatures and which are in like way in warm contact with one another. The enthalpy can exchange between at any rate two fluids, among fluid and strong particulates and among fluid and a strong surface which are in warm contact with one another. When in doubt in heat exchangers there is no work correspondence. The heat exchangers are in like way adiabatically verified, so no heat exchange happens. The cooling and warming of a fluid, advancement of a singular or multi-compound fluid, dissipation of a single or multi-compound fluid are the crucial uses of the heat exchanger. Everything considered, high sufficiency heat exchangers are utilized in cryogenic applications. The sufficiency of heat exchangers utilized in liquefiers is of the solicitation of .at any rate 96. There will be no fluid yield if the common sense of the heat exchangers falls underneath the course of action respect. In any case, if there

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should be an occurrence of the use of heat exchangers in flying machines, high sufficiency and execution isn't so required rather the truth of the matter is to keep the weight and volume of the heat exchanger least. These necessities of low volume and weight of the heat exchanger lead to the time of immaterial heat exchangers.

Heat exchangers are normally utilized in system control to advance or extinguish made responses (by warming or cooling, autonomously). The sustenance business uses warming to murder pathogen microorganisms (disinfection), either coming about to canning, or before bundling; the last is most steadily made for fluid stuff in heat exchangers. Cleansing, for example the inactivation everything considered, requires hightemperature dealing with, for the most part at 120 ºC or more (for example under strain, for watery stuff); to execute even the most secured spores. In the cleansing philosophy, in any case, a fast warming to 60 ºC or 70 ºC is associated with homicide most living beings without protein denaturising, yet different microorganisms remain, what determines that snappy cooling after purification is required (what makes heat siphons so strong), and that vacuum or refrigeration is required a short range later. The ideal open entryway for-disinfection (or for cleansing) relies on the microorganisms and the holding temperature.

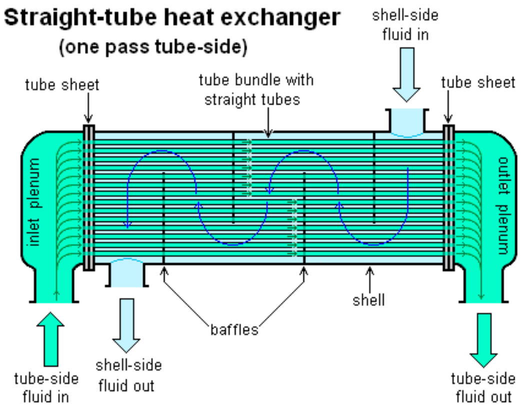

Fig.1.1 Heat exchanger

1.2 Classification of Heat Exchanger:

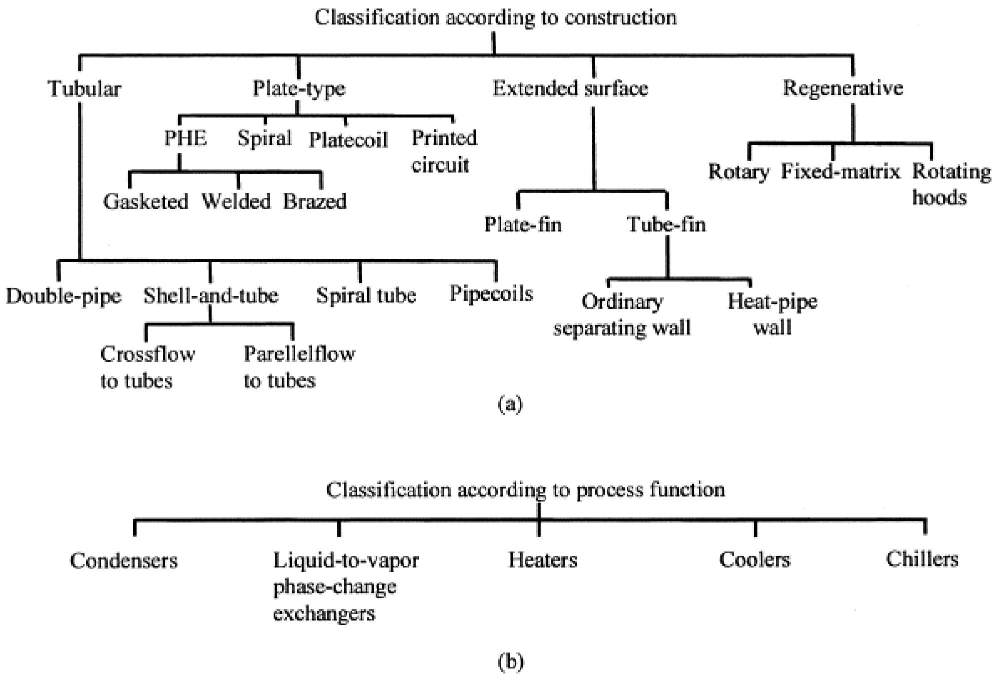

Fig.1.2 Classification of Heat Exchanger Chart

1.2.1 Plate heat exchangers

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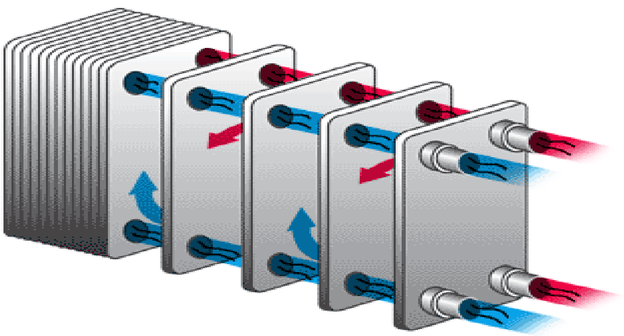
A plate heat exchanger, PHE, is a littler heat exchanger where thin furrowed plates (some 0.5 mm thick, contorted 1 or 2 mm) are stacked in contact with each other, and the two fluids made to stream freely along adjoining coordinates in the wrinkle. The conclusion of the staked plates may be by cinched gaskets, brazing (generally copper-brazed tempered steel), or welding (solidified steel, copper, titanium), the most broadly perceived sort being the first, for simplicity of survey and cleaning. Besides, a casing (end-plates and fixing bars) checks together the plate stack and connectors (once in a while PFHE, speaking to plate-and-edge heat exchanger, is used instead of PHE). Plate get together is illustrated in underneath fig. Suitable channels, every so often helped by the gaskets, control the progression of the two fluids, and grant parallel stream or cross stream, in any perfect number of passes, one pass being commonly used. They have gigantic conductance coefficients (up to K=6000 W/(m2•K) for fluid to-fluid use), are ideally proper for low-thickness fluids, the amount of plates can be adjusted to the necessities, and the trade surface open to cleaning (the last two great circumstances only for gasket gatherings; in any case, the gaskets should be changed at whatever point got off). The anticipated zone of plates is ordinarily taken as ostensible heat trade zone, in spite of the certified twisted surfaces and lost space in gaskets and ports.



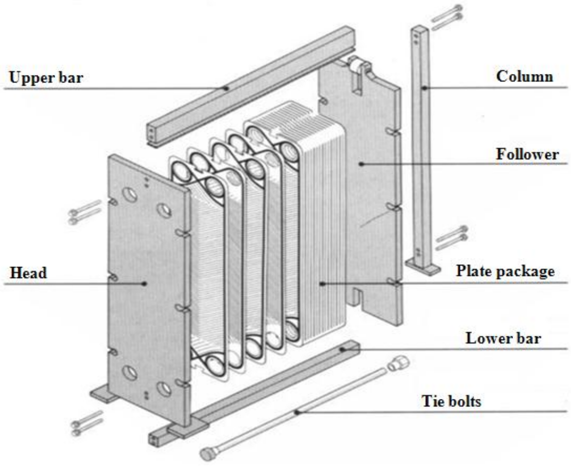


Fig.1.3 Heat exchanger's Plate

Fig.1.4 Flow design in arrangement Plate Heat exchanger)

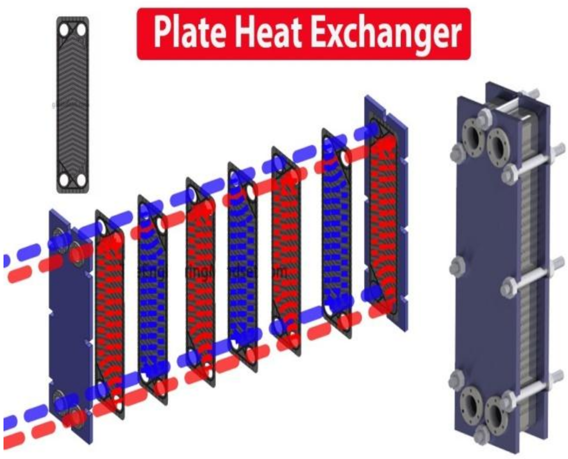


Fig.1.5 Plate heat exchanger

Civic chairman restrictions in PHEs are: most extreme permitted weight (typically underneath 1 MPa, despite the fact that there are plans with 4 MPa), temperature run (normally constrained to 150 ºC by the gasket material, in spite of the fact that there are structures permitting 400 ºC), and prize (however brazed PHEs are about half prize of workable PHEs). Albeit run of the mill PHE application is in fluid to-fluid heat trade, outstanding plate plans have been created for stage change applications. Higher working loads and still goof warm execution can be practiced with creamer plate-shell heat exchangers, where a plate stack is welded inside a shell (for instance a kind of STHE with plates instead of cylinders). The PHE was made during the 1920s in the sustenance business (for the sterilization of milk), yet they are

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expecting power over all business areas presently in light of its minimization and adequacy (3 to different occasions more than STHE). They are used for methodology warming, cooling, in each cryogenic application, and as a widely appealing endeavor in neighborhood water radiators, where consumable bubbling water (hot spigot water) is conveyed in a midway heat exchanger from shut circle fuel-ended bubbling water, to restrain solid declarations. PHE are as often as possible named CHE (littler heat exchangers), in spite of the way that the word limited can be added to a heat or mass trade unit with explicit locale $>10^3$ m^2/m^3.

II. COMPOUND TECHNIQUES

A compound increase method is where more than one of the previously mentioned systems is utilized in mix with the end goal of further improving the thermo-pressure driven execution of a heat exchanger.
Twisted Tape Turbulators are an economical means of enhancing heat transfer in new and existing equipment. It is common knowledge that enhancement is achieved by inducing a swirling and mixing action of tube side fluid causing higher near wall velocities which eliminates thermal boundary layer and the corresponding insulating effect. Using state of the art, high speed equipment our seasoned staff fabricate to your specification. A turbulator is a swirl flow device that turns a laminar flow into a turbulent flow. Swirl flow devices causes swirl flow or secondary flow in the fluid .A variety of devices can be employed to cause this effect which includes tube inserts, altered tube flow arrangements, and duct geometry modifications. Dimples, ribs, helically twisted tubes are examples of duct geometry modifications. Tube inserts include twisted-tape inserts, helical strip or cored screw–type inserts and wire coils. Periodic tangential fluid injection is type of altered tube flow arrangement. Among the swirl flow devices, twisted- tape inserts had been very popular owing to their better thermal hydraulic performance in single phase, boiling and condensation forced convection, as well as design and application issues, which is shown in below fig.

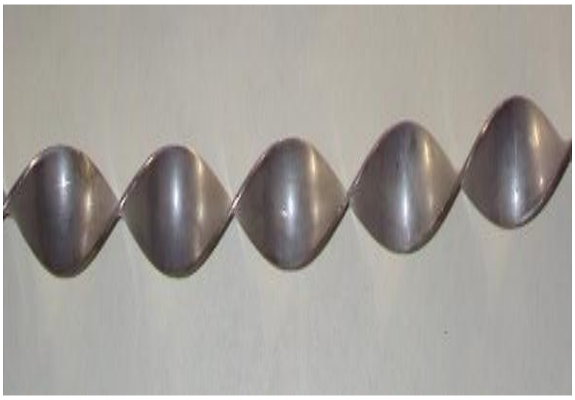

Fig.1.8 Twist tapeTurbulator

III. OBJECTIVE OF WORK

We have found some basic problem in Plate Heat Exchanger in Bihar SahakariDugdhSangh at the time of pasteurization of milk in Plate Heat Exchanger. In Plate Heat Exchanger the milk pasteurization temperature is fixed 78°C to pasteurize. When the pasteurization temperature become below the 78°C the raw milk will not pasteurize and return to raw milk tank and again it goes to Plate Heat Exchanger to pasteurize. We observed this type of problem become five or six round of pasteurization. Then the rate of pasteurization of milk is decrease and also the efficiency of Plate Heat Exchanger islow.

The main objective to the evaluation of performance parameters of a counter flow plate heat exchangers are:

- To find working efficiency, overall heat transfer coefficient, Reynolds number and Nusselt number of plate heat exchanger by without using and with using different turbulators in hot water inlet pipe.

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- Compare the working efficiency of plate heat exchanger before using and after using turbulators (Twist tape turbulator, Brock turbulator, Wire Turbulator).
- After getting better turbulator find again all those parameters at different pitches of turbulators.

IV. EXPERIMENTAL APPARATUS AND INSTRUMENTATION

Fig. 4.1 Plate Heat Exchanger set up in BiharSahakariDugdhSangh

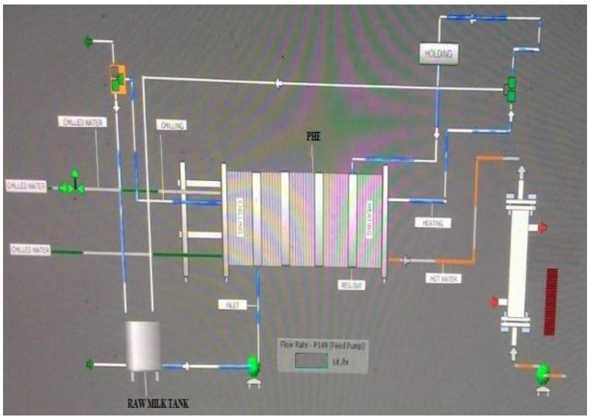

Fig. 4.2 Line Diagram of Plate Heat Exchanger used in BSDS before modified

Shows over the schematic outline of the exploratory set up Plate Heat Exchanger utilized in BiharSahakariDugdhSangh. The Plate Heat Exchanger set up shows in fig.3.2. The Plates of Plate Heat Exchanger are comprised of Aluminum material. All the geometrical dimensions are in term of channel tallness while the heat move coefficients are exhibited in term of channel water driven breadth. Steam is conveyed from the steam kettle. This steam is utilized to heat water which in turns heats the item to sanitization temperature. The 228 plates are utilized in above Plate Heat Exchanger set up of and the plate dimensions are: length of plate is 1.22m and width is 0.34m. The measurement of pipe is 0.63cm by which boiling water and milk stream in to PHE. The turn turbulator of various pitches are encased inside the heated water bay pipe one by one to recognize the variety of temperature of sanitization milk. The turbulator encased in 50cm of high temp water cylinder appeared in fig.3.3, and plainly turbulator zone are clarify by line graph with thermocouples appeared in fig.4.4. T2 thermocouple at a separation of 30cm from the cause of the gulf of high temp water pipe is introduced on the dividers of thepipe

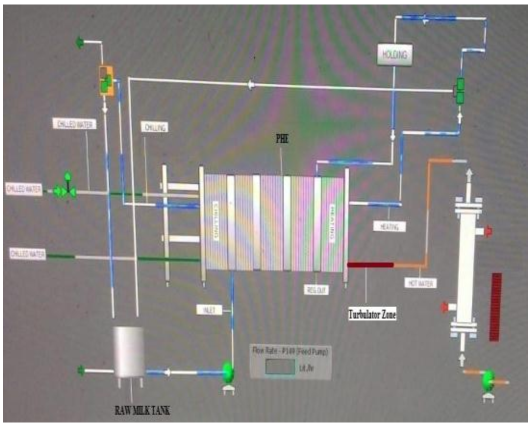

Fig.4.3 Line diagram of modified Plate Heat Exchanger used in BSDS

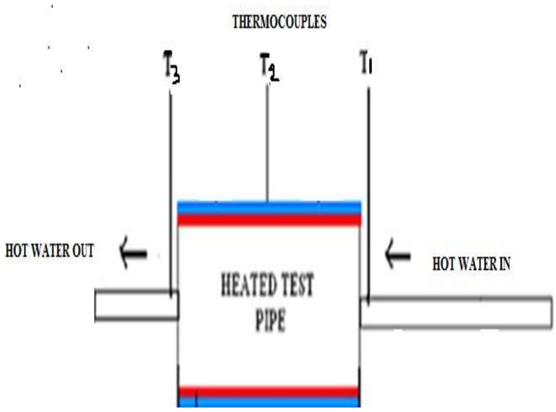

Fig.4.4 Thermocouples set up in hot water pipe

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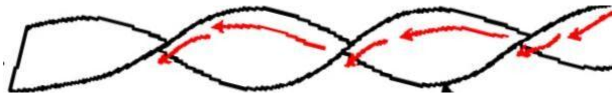

Fig.4.5 Twist Turbulator line diagram

4.1 Constructional Features

The material chose for the plate is Aluminum since it is light in weight, have high conductivity, easily accessible and less expensive in contrast with copper. Furthermore, the turbulators material is copper.
The trial setup consists of following segments

1. **Control Valve: -** Control valve is stream redirected set in the stream way of milk and is given the handle having graduations in degrees. By changing the controller we increment the temperature of high temp water by turbulators encased in hot waterpipe
2. **Thermocouples: -** Thermocouples are utilized to detect the temperature. Thermocouples are broadly utilized kind of temperature sensor and can likewise be utilized as a way to change over thermal potential distinction into electric potential contrast. There are assortment of thermocouples accessible, contingent on the applications the specific thermocouple is chosen. In our undertaking we are using eight copper-constantan thermocouples having scope of – 50 to 12000C.
3. **Twist turbulator: -** One turbulator of 1cm pitch, second turbulator of 2cm pitch and third turbulator of 3cmpitch.

V. EXPERIMENTAL PROCEDURE

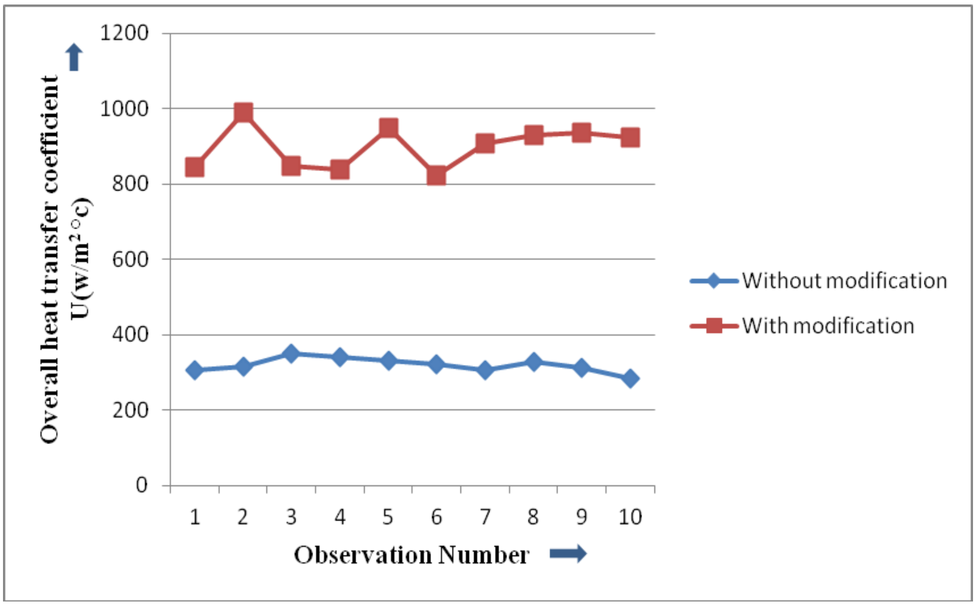

Fig.5.1. Overall heat transfer coefficient (U) Vs Observations Number

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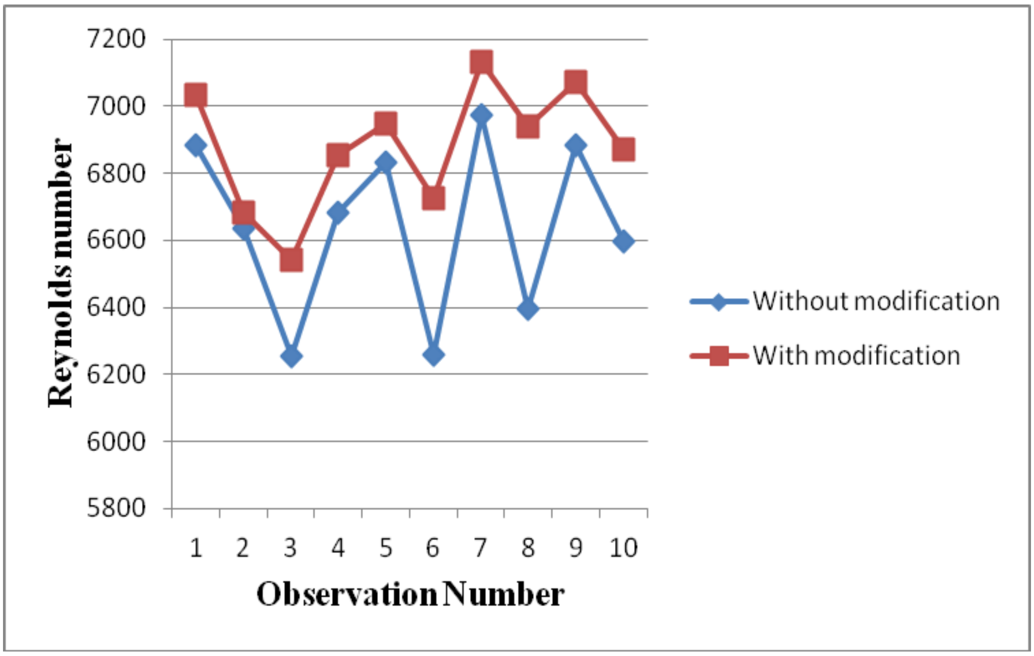

Fig.5.2 Reynolds Number (Re) Vs Observations

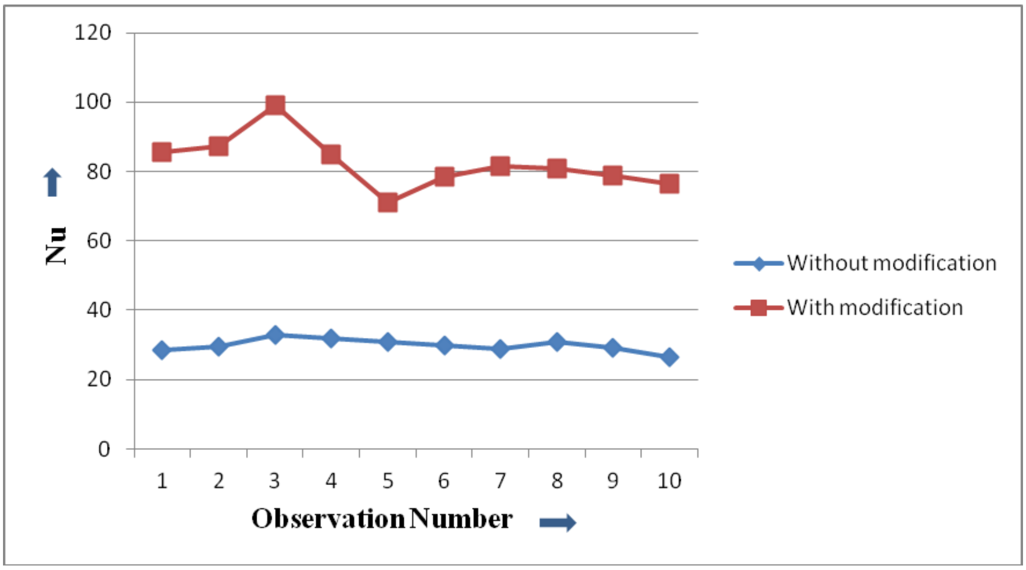

Fig.5.3 Nusselt Number (Nu) Vs Observation Number

The experimentation was carried out with the inlet hot water pipe of plate heat exchanger without and with using Passive heat transfer enhancement methods by using twist turbulators. Overall heat transfer coefficient and Nusselt number are calculated for modification with pitch 1cm and without modification. Parameters were plotted for number of observation, these all graphs are plotted to compare the performance of with and without turbulators of different pitches used in inlet hot water pipe.

VI. CONCLUSION

After the successful achievement of a task of the planned modification and introduction of the Plate Heat Exchanger used in BiharSahakariDugdhSangh to pasteurize the milk. We achieved that pasteurize milk temperature become above 78°C. This is done when we used Twist tape turbulator of pitch 1cm. We got 78% working efficiency of Plate Heat Exchanger by modification which is more than without modification of Plate Heat Exchanger. By the help of this experiment approx 20% working efficiency of Plate Heat Exchanger is increased. We did not consider those values of

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outlet milk temperature which is below 78°C. It is because the pasteurize milk temperature is set at 78°C for its chemicalprocess.

In this project thermal energy worked as energy to transfer heat towards cold fluid. The temperature of primary fluid is increased by passive modification in inlet pipe by which the time interval of heat flow towards primary fluid is increased in BiharSahakariDoogdhSangh. If the time interval is increased then the fuel consumption decreased. And most important thing of this project is that an attempt is made to recover the pasteurize milk did not pass through flow diversion valve in to raw material tank by an experimentation, so the rate of pasteurized milk increased on same inlet energy. The following conclusions of this experiment:
The experiment showed that there is definite improvement in the rate of pasteurized milk by 71%. Thus the system efficiency isimproved.
The experimentation has indicated that the heat transfer is increased.
The additional time for the milk pasteurization in Plate Heat Exchanger can be recovered by using the turbulators in thesystem.

VII. FUTURE SCOPE

Heat transfer augmentation techniques (passive, active or a combination of passive and active methods) are commonly used in areas such as process industries, heating and cooling in evaporators, thermal power plants, air-conditioning equipment, refrigerators, radiators for space vehicles, automobiles, etc. This project work analyze the possibilities of using different turbulators in Plate Heat Exchanger to promoted better heat transfer analysis and increase heating and cooling performance. There is lot of scope for advancement in the experimentations. Following are the most prominent ways below:

- Experimental work may be done at low Reynolds number using ribs on surface of plate.
- Experiment work may be done at high Reynolds number using ribs on surface of plate.
- Experiment work may be done by using dimension change of diameter of inlet pipe and length of plates.

Experiment work may be done by increasing the number of plates inPlate Heat Exchanger by which working area increase.
We used the Plates of Plate Heat Exchanger material Aluminum and if we use any other material having high thermal conductivity we can achieve high enhancement in heat transfer rate.

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