Heat Enhancement of Plate heat exchanger Working Efficiency by Using Tabulators in Dairy Milk Pasteurization system- A Review

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Abstract- *The heat exchangers are generally used to transfer heat from one medium to another medium. The heat exchanger is 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 experiment was conducted in Bihar Sahakari Dugdh Sangh (BSDS) on Plate Heat Exchanger. Plate Heat Exchangers are used to pasteurize milk in BSDS, in which the hot water is used to transfer the heat towards milk by which milk is pasteurized. The temperature of pasteurization milk is set at 78°C in Bihar Sahakari Dugdh Sangh 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 Sahakari Dugdh Sangh is 55.05%.*

Keywords:- *heat exchangers, turbulators, space heating, refrigeration, air conditioning, Plate Heat Exchanger*

1. Introduction - A warmth exchanger is a gadget by which warm vitality or enthalpy is exchanged between at least two liquids having various temperatures and which are likewise in warm contact with one another. The enthalpy can exchange between at least two liquids, among liquid and strong particulates and among liquid and a strong surface which are in warm contact with one another. More often than not in warmth exchangers, there is no work communication. The warmth exchangers are likewise adiabatically protected, so no warmth exchange happens. The cooling and warming of a liquid, buildup of a solitary or multi-compound liquid, dissipation of a solitary, or multi-compound liquid are the fundamental utilizations of the warmth exchanger. By and large, high adequacy heat exchangers are utilized in cryogenic applications. The adequacy of warmth exchangers utilized in liquefiers is of the request of .96 or more. There will be no fluid yield if the viability of the warmth exchangers falls beneath the plan esteem. In any case, in the event of the utilization of warmth exchangers in flying machines, high adequacy and execution aren't so required rather the point is to keep the weight and volume of the warmth exchanger least. These necessities of low volume and weight of the warmth exchanger lead to the age of minimal warmth exchangers.

2. Literature Review- Many types of research were carried out by many scholars and professors of mechanical engineering in this field, to find the ways and heat exchanger Working Efficiency by Using Turbulators in Dairy Milk Pasteurization system.

Tabish Alam et al [1] The objective of this paper is to review the different techniques, which have been used to enhance the heat transfer rate in heat exchanger devices such as solar air heater, cooling blades of turbine and so on using single phase heat transfer fluids. The results of recently published articles with the development of new technologies such as as Electro hydrodynamic (EHD) and Magneto hydro dynamics (MHD) are also included. Enhancement of heat transfer in heat exchanger can achieved by means of several techniques.

Chirag Maradiya, Jeetendra Vadher et al [2] Heat transfer devices have been used for conversion and recovery of heat in many industrial and domestic applications. Over five decades, there has been concerted effort to develop design of heat exchanger that can result in reduction in energy requirement as well as material and other cost saving. Heat transfer enhancement techniques generally reduce the thermal resistance either by increasing the effective heat transfer surface area or by generating turbulence effective heat transfer surface area or by generating turbulence.

Zhe Wang, Zan Wu et al [3] As a novel coolant, the ethylene glycol-water (50 wt.%:50 wt.%) with graph nano platelets nano fluids (GnPEGW) were prepared at four weight concentrations (0.01, 0.1 0.5 and 1.0 wt.%), and heat transfer and pressure drop characteristics in a miniature plate heat exchanger (MPHE) were investigated. All nano fluid samples were prepared and diluted by ultrasonic vibration, and their thermal conductivity and dynamic viscosity were measured by a transient plane source method and a rotational rheometer, respectively.

M.Thirumarimurugan et al [5] A plate type heat exchanger consists of plates instead of tubes to separate the hot and cold fluids. Because each of the plate has very large surface area, the plates provide each of the fluids with an extremely large heat transfer area. Due to the high heat transfer efficiency of the plates, plate type heat exchanger is very compact when compared to a shell and tube heat exchanger with the same heat transfer capacity. In this paper efforts have been made to study the performance of Plate type heat exchanger with miscible and immiscible systems.

. **Abhishek Nandan et al [6]** Plate heat exchanger has found a wide range of application in various industries like food industries, chemical industries, power plants, etc. It reduces the wastage of energy and improves the overall efficiency of the system. Hence, it must be designed to obtain the maximum heat transfer possible. This paper is presented to study the various theories and results given over the improvement of heat transfer performance in a plate heat exchanger. However, there is still a lack in data and generalized equations for the calculation of different parameters in the heat exchanger.

M. Faizal et al [7] Experimental studies were performed on a corrugated plate heat exchanger for small temperature difference applications. Experiments were performed on a single corrugation pattern on 20 plates arranged parallelly, with a total heat transfer area of 1.16298 m2. The spacing, DX, between the plates was varied (DX = 6 mm, 9 mm, and 12 mm) to experimentally determine the configuration that gives the optimum heat transfer.

Dnyaneshwar B.Sapkal et al [8] An industrial application of plate heat exchangers is demonstrating a large dominance over the shell and tube heat exchangers. In this paper focus on the modeling a copper plate heat exchanger for milk pasteurization in a food industry using high temperature for a short time. The efficiency of the plate heat exchange depends on numerous factors like space requirement, material required for construction, pressure drop and energy requirement for circulation of milk and water by using a pump.

Oana Giurgiu et al [9] The study presents a Computational Fluid Dynamics (CFD) numerical study for two different models of mini channels, included in plate heat exchangers structure. The influence of geometric characteristics of the two studied plates on the intensification process of heat transfer was studied comparatively. For this purpose, it was examined the distribution of velocity, temperatures fields and distribution of convection coefficient along the active mini channel.

Koen Grijspeerdt et al [10] A detailed calculation of the flow pattern of milk between two corrugated plates was carried out using 2Dand 3Dcomputational fluid dynamics (CFD). The 2Dcalculation shows the influence of the corrugations shape, but the 3Dcalculations are necessary to assess the importance of the corrugation orientation. The influence of the inlet flow extends only up to three corrugations.

Chandan Kumar Sethi [11] There is a wide utilization of Plate heat exchanger in the field of marine, dairy and other modern applications for its improved heat exchange attributes and conservative structure. Compact heat exchangers are most broadly utilized for heat transfer applications in ventures. Plate type heat exchangers are generally utilized for liquid-to-liquid heat transfer applications with high-density working fluids.

T.S. Khan et al [12] Corrugated plate heat exchangers have larger heat transfer surface area and increased turbulence level due to the corrugations. In this study, experimental heat transfer data are obtained for single phase flow (water-to-water) configurations in a commercial plate heat exchanger for symmetric 30/30, 60/60, and mixed 30/60 chevron angle plates. Experiments were carried out for Reynolds number ranging from 500 to 2500 and Prandtl number from 3.5 to 6.5.

Vikas Kumar et al [13] This paper presents details of an experimental investigation into the effect of different spacing (DX ¼ 2.5 mm, 5.0 mm, 7.5 mm and 10.0 mm) in plate heat exchanger (PHE) on the basis of its combined energetic and exergetic performance by using various nano fluids, i.e., TiO_2, Al_2O_3, ZnO, CeO_2, hybrid ($CuþAl_2O_3$), graphene nano plate (GNP) and multi-walled carbon nano tube (MWCNT).

M. Rossato et al [15] This paper presents new experimental results of heat transfer coefficient and pressure drop measured during condensation of R1234ze(E) and R32 in a brazed aluminum multi channels test section with 1.6 mm hydraulic diameter at 40 ^oC saturation temperature, mass velocity from 55 to 275 kg m^2 /s, heat flux up to 35 kW m^2 and a complete range of vapor quality.

Kifah Sarraf et al [16] This article presents a detailed analysis of the thermo-hydraulic transfers for single-phase flow in brazed plate heat exchangers (BPHE) using numerical simulations. The comparison of the simulation and experimental results show similar trends on the variations of the global thermo-hydraulic quantities, as the friction and convective heat transfer coefficients, with respect to Reynolds number.

Caner Turk et al [17] In this study, experiments are performed to test the thermal and hydraulic performance of gasketed plate heat exchangers (GPHE). A heat exchanger composed of two different plate types is used for the experiments, for a Reynolds number range of 500 to 5000. The results are compared to the experimental results obtained for plate heat exchangers which are composed of plates that have the same geometry instead of mixing two different plates.

Jan Waj et al [18] The experimental analysis of passive heat transfer intensification in the case of plate heat exchanger has been carried out. The metallic porous layer was created on the heat transfer surface of analyzed unit. The experiment was accomplished in two stages. In the first stage the commercial stainless steel gasketed plate heat exchanger was investigated, while in the second one – the identical heat exchanger but with the modified heat transfer surface. The direct comparison of thermal and flow characteristics between both devices were possible due to the assurance of equivalent conditions during the experiment.

Ya-Nan Wang et al [19] Generally, heat exchanger is a thermodynamic system which has been employed to transfer thermal energy between two or more fluids, between a solid surface and a fluid, or between solid particulates and a fluid, at different temperatures and in thermal contact. Recently, the growing requirements to save energy and reduce overall environmental impacts has placed greater emphasis on the use of heat exchangers with better thermal efficiency.

Tang Xinyi et al [20] Experimental and numerical investigations have been conducted to study turbulent flow of water and heat transfer characteristics in a rectangular channel with discontinuous crossed ribs and grooves. The tests investigated the overall heat transfer performance and friction factor in ribbed and ribbed-grooved channels with rib angle of 30°.

Xiao-Hong Han et al [21] In this work, the widely used chevron corrugated-plate heat exchanger was simulated, and the three dimensional temperature, pressure, and velocity

fields were obtained. From the temperature field, we can see that, in the first zone, the temperature gradient increases gradually and get the maximum; in the central of the flow, the temperature gradient becomes smaller again.

3. Manufacturing of the plate heat exchangers

In the assembling procedure of the plate heat exchangers, the fundamental standard is the same for all materials and all sizes. Initial various level sheets are set one above other and the folded plates are amassed like a sandwich development. The separating sheets (the isolating plates) are the essential warmth exchange surface. To shape a limitation between each layer, the separating sheets are put in an elective way with the layers of the plates framing a stack. Every one of the components for example the partings sheets, sidebars, the foldings, and the top sheets are held together by a dance under a foreordained burden. At that point, for shaping a warmth exchanger square it is put in a brazing heater. At that point during the welding procedure to guarantee the brazed joints stay in contact or not, the spouts and the header tanks are welded to the square.

4. Applications of plate heat exchangers

The utilization of plate heat exchanger is wide because it works over an exceptionally enormous scope of weight and temperature for gas-to-gas, gas-to-fluid, and in multiphase applications. There is a wide assortment of uses. In the cryogenic field, for the liquefaction of air, for the division of air, the plate heat exchangers are generally utilized. In the petrochemical businesses and enormous refrigerating frameworks for the preparation of gaseous petrol, and their liquefaction, it is likewise broadly utilized. The plate and complex units with enormous measurements. In aviation enterprises, aluminum brazed PFHEs are broadly utilized due to their smallness and low weight-to-volume proportion. These plate blade heat exchangers are essentially utilized in charge arrangement of the flying machine, cooling arrangement of the airship, water driven cooling of oil and fuel warming.

4.1 Flow plans

4.2 Flow game plans

There can be at least two streams in the plate 0heat exchangers and the stream heading of these liquids streams influence the viability of the warmth exchanger. The plan of stream in the plate heat exchanger can be of three kinds:

(a) Cross stream

(b) Counter stream

(c) Parallel stream

Based on the thermodynamics perspective, the counter stream course of action of stream gives the chilliest/heat recuperation through the parallel stream that conveys the least. The cross-stream game plan conveys the middle of the road activity by providing a simpler mechanical yield and warmth stream. Therefore, there are predominantly three sorts of plate heat exchangers.

(a)Cross-stream heat exchangers: In these kinds of warmth exchangers, the hot and the cool liquids stream the opposite way to one another. The viability of cross-stream frameworks lies in the middle of the parallel stream and the counter-stream course of action. In cross-stream heat exchangers, just two liquid streams can be dealt with that is the reason it wipes out the need of wholesalers. The header tanks are put on each of the four sides of the center of the cross-stream heat exchanger. This makes it shoddy and basic. So just more adequacy is certifiably not a noteworthy prerequisite. On the off chance that the two liquid streams have very unique volume stream rates or if any, either of the two liquid streams has consistent temperature, at that point, the cross-stream game plan is a decent decision to be actualized. The radiators need in cars,

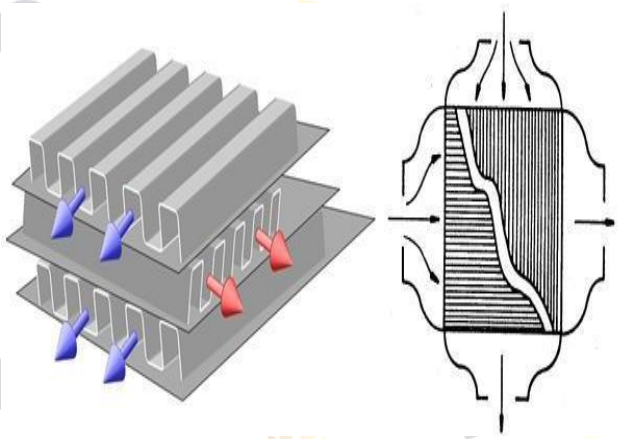

Fig.4.1 Flow game plan in the cross-stream heat exchanger

plane warmth motors are some run of the mill utilization of this kind of warmth exchanger.

(b)Counter stream heat exchangers: Here the two liquid streams stream in inverse ways yet the liquid streams stream parallel to the next one. These warmth exchangers give the most astounding productivity and are best in recuperation frameworks, for a steady by and large warm conductivity (UA), the bay temperature of the liquid, and rate of the liquid stream. The uses of these warmth exchangers are huge in cryogenic refrigeration and liquefaction hardware. Because of

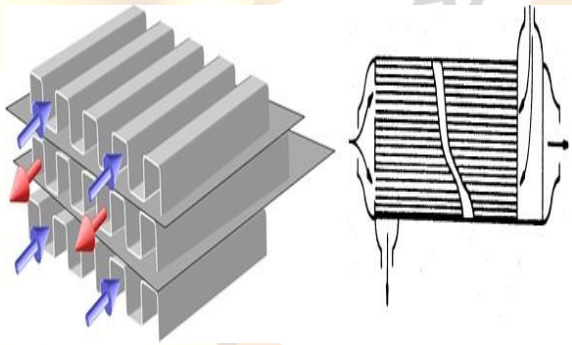

Fig.4.2 Flow plan in the counter stream heat exchanger

the muddled geometries of headers, these warmth exchangers are extremely intricate in structure.

5. Turbulator

A turbulator is a twirl stream gadget that transforms a laminar stream into a violent stream. Twirl stream gadgets cause a whirling stream or auxiliary stream in the liquid. An assortment of gadgets can be utilized to cause this impact which incorporates cylinder embeds, changed cylinder stream courses of action, and conduit geometry adjustments.

Dimples, ribs, helically wound cylinders are instances of channel geometry changes. Cylinder supplements incorporate wound tape embeds, helical strip or cored screw-type embeds, and wire curls. Intermittent distracting liquid infusion is a kind of modified cylinder stream game plan. Among the twirl stream gadgets, curved tape additions had been extremely prominent attributable to their better warm water driven execution in single-stage, bubbling and buildup constrained convection, just as structure and application issues. Fig.1.2.1.shows a run of the mill setup of contorted tape which is utilized ordinarily.

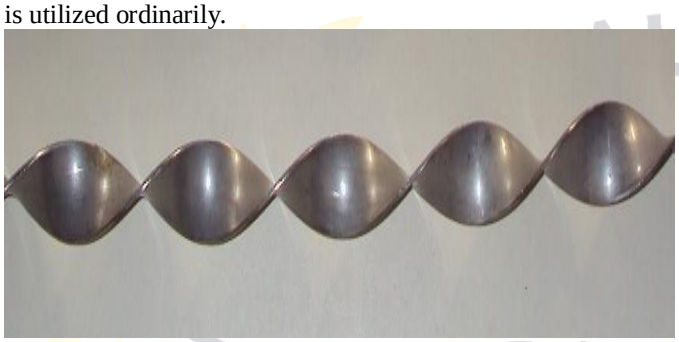

Fig.5.1 Twist tapeTurbulator

obligations of the current shell and cylinder Turned tape additions expand the warmth exchange coefficients with generally little increment in the weight drop. They are known to be one of the most punctual whirl stream gadgets utilized in the single-stage warmth exchange forms. Due to the structure and application comfort, they have been generally utilized over decades to create the whirling stream in the liquid. The size of the new warmth exchanger can be decreased altogether by utilizing curved tapes in the new warmth exchanger for a predefined warmth load. Consequently, it gives a monetary favorable position over the fixed expense of the gear. Turned tapes can be likewise utilized for retrofitting reasons. It can expand the warm heat exchangers. Contorted tapes with multi-cylinder groups are anything but difficult to fit and expel, in this manner empowers cylinder side cleaning in fouling circumstances. Embeds, for example, bent tape, wire curls, ribs, and dimples for the most part hinder the stream and separate the essential stream from the auxiliary streams. This

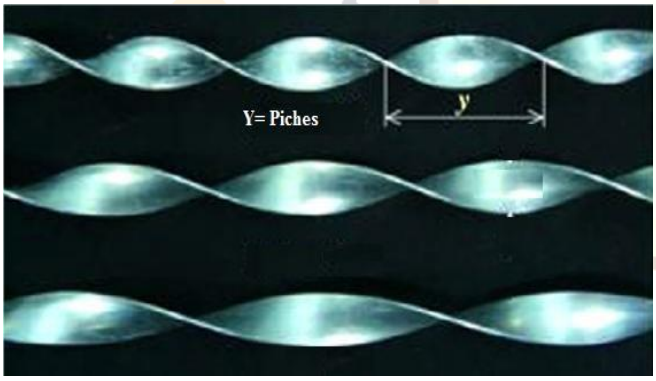

Fig.1.5 Different Pitches of Twist Tape Turbulator

causes the improvement of the warmth move in the cylinder stream. Supplements diminish the compelling stream territory subsequently expanding the stream speed. This additionally prompts increment in the weight drop and at times causes' huge optional stream. The optional stream makes whirl and the blending of the liquid components and consequently improves the temperature inclination, which eventually prompts a high warmth exchange coefficient.

The diverse pitches of wind turbulator are utilized in this task which is appeared in fig.1.6.

Wire Turbulators is a turbulators which is utilized for warmth exchanger. Adding turbulators to a cylindrical warmth exchanger will improve warmth exchange.

The turbulators we offer are fabricated from the wire as a circled winding as showed, and we consider they have numerous focal points over Fin or Spiral sheet metal sorts.

Fig.5.2 Wire Turbulator

6. Conclusion

In this review paper, 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 Bihar Sahakari Doogdh Sangh. 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 into raw material tank by an experimentation, so the rate of pasteurized milk increased on same inlet energy.

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