PERFORMANCE ANALYSIS OF CIRCULATION LOOP WITH HEAT EVACUATION SYSTEMS FLUIDS AS LOOP FLUID

Scholar Name Mohd. Attalique Rabbani Having Enrollment No: SSSME1508 under the faculty of PhD-ME SSSUTMS -Sehore, MP. Academic Session 2016-17. Working under the supervision of Dr. G.R Selokar

ABSTRACT

A characteristic circulation system works on the premise of common laws like gravity and buoyancy. Albeit regular circulation is a kindhearted endowment of nature for applications to a few heat evacuation systems because of their effortlessness in plan, disposal of perils identified with pumps, better stream dispersion, cost lessening, and so on notwithstanding, the potential risk of stream insecurities still evades for its wide applications. In spite of the fact that expansion of neighborhood misfortunes (orificing) may smother insecurities, notwithstanding, it is joined by critical stream diminishment which is unfavorable to the common circulation heat expulsion ability. A rectangular single-stage normal circulation loop, which comprises of two level copper tubes (heat transfer segments) and two vertical copper tubes (legs), associated by methods for four twists. The lower heating segment comprises of an electrical heating wire made of nichromel outwardly of the copper tube, the upper cooling system comprises of a coaxial round and hollow heat exchanger with water set at controlled temperature and coursing through the annulus. The parameters researched amid the trials control transferred to the liquid and viability of the heat transfer and decide the speed of the copper pipe and power raised the loop.

Key words: Natural circulation loop, heat exchanger, effectiveness.

INTRODUCTION

In this segment the theme of this examination is presented. Some foundation is given while the reason, degree and expectations of the examination are talked about. Natural circulation is a straightforward wonder which happens in a liquid in nearness of temperature and density slopes in a power field. In natural circulation systems there are a heat source and a heat sink, with the previous put lower than the last mentioned both in contact with a segment of liquid. As outcome of the heat motions, the heated piece of the liquid winds up noticeably lighter and rises, while the cooled part ends up noticeably denser and is dropped around gravity. These consolidated Impacts set up circulation. As it needn't bother with any moving mechanical part, similar to pump or fan, natural circulation is described by high reliability and low expenses of support. Then again, it is essential the plan of the systems which utilize natural circulation as essential heat transfer instrument keeping in mind the end goal to upgrade the warm exhibitions and to stay away from undesirable dynamic practices, for example, stream insecurities or stream reversals.

Different models were proposed in writing. One of the primary models was presented by in figure and comprised in a loop made by point heat source and point heat sink, both with forced divider temperature, associated by two adiabatic legs. We lender clarified the nearness of dangers and stream inversion with the "hot pocket" the not in stage, if there should arise an occurrence of particular limit conditions, the nearness of a temperature irregularity (hot pocket) may cause an underlying speed wavering, which develops in time and plentifulness, in the end creating a stream inversion.

In rectangular loops likewise the impact of the angle proportion, characterized as the tallness to width proportion, was systematically broke down. By logically found that the steadiness of the system has a base for angle proportion moving toward the solidarity (square loop). Along these lines our loops were outlined with angle proportions in the vicinity of 0.84 and 1.47, near the basic one. Likewise the impact of various materials of the pipes was broke down. Specifically it was discovered that the more conductive are the pipes the steadier is the system, in light of the fact that the temperature discontinuities are smoothed by the heat transfer amongst liquid and tube dividers as appeared in figure 1.

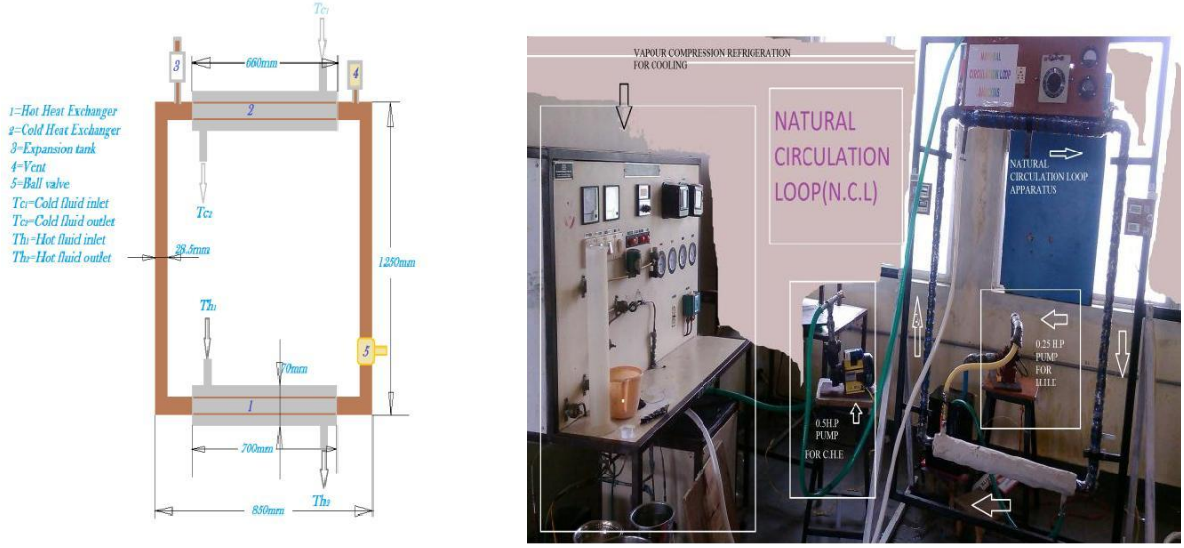

Fig.1 Experimental setup

LITERATURE SURVEY

A natural circulation system works on the premise of natural laws like gravity and buoyancy. Albeit natural circulation is a favorable endowment of nature for applications to a few heat evacuation systems because of their effortlessness in plan, end of risks identified with pumps, better stream dissemination, cost Diminishment and so on be that as it may, the potential danger of stream insecurities still evades for its wide applications. In spite of the fact that Addition of nearby misfortunes may stifle insecurities, The reason for this exploration paper is worried about the utilization of Al2O3nanofluids to stifle the hazards in a solitary stage natural circulation loop initiated by a heating–cooling system. Tests were exhibited by that with Nano liquids at various fixations.

Single-stage natural circulation inside rectangular loops is examined. The substantial scale loop exhibited distinctive dynamical practices (steady and temperamental stream with or without mass stream rate motions), while the two smaller than usual loops indicated constantly enduring state conditions at administration. Stream speeds were assessed by methods for recurrence examination or with an enthalpy adjust in the event of consistent state stream and investigated as capacity of the limit conditions. Natural circulation is a basic marvel which happens in a liquid in nearness of temperature and density angles in a power field. In natural circulation systems there are a heat source and a heat sink, with the previous put lower than the last both in contact with a bit of liquid. As outcome of the heat transitions, the heated piece of the liquid ends up plainly lighter and rises, while the cooled part winds up noticeably denser and is dropped around gravity.

A Natural circulation, shut loop thermo siphon can transfer heat over moderately vast distances with no moving parts, for example, pumps and dynamic controls. Such loops are subsequently viewed as appropriate for atomic Reactor cooling applications where wellbeing and high reliability are Paramount significance.

The examination displays a numerical examination of the dynamical conduct of a rectangular natural circulation loop with level heat trading segments. The examination has been created in a two dimensional space considering uniform divider temperatures and thermally protected vertical legs as warm limit conditions. The investigation has been performed for a settled geometry of the loop and for different Rayleigh numbers, isolating the estimations of Rayleigh for which the system shows steady and precarious dynamics.

PROPOSED WORK

Experimental Setup

Experiments were directed in a natural circulation loop with geometry. The test office takes after rectangular in geometry with roundabout stream cross-segment region. The pipes are made of Copper with inward measurement of around 26.6 mm. Imperative measurements of the loop are appeared in Figure. The loop comprises of a hot heat exchanger (tube in tube sort) at the base of the even leg through which hot water consistently streams with the assistance of a 0.25hp pump. It was cooled at the best through a tube-in-tube sort heat exchanger with tap water coursing through the annulus by the assistance of a 0.5hp pump. A development tank was given at the highest rise to oblige the volumetric extension of the liquid. It additionally guarantees that the loop stays loaded with water. Thermocouples were introduced at various positions on top of it to gauge the momentary nearby temperature. The stream rate was measured utilizing a differential weight transducer introduced in the flat leg of the loop. The instruments were associated with an information securing system which could check every one of the channels in fewer than 1s. The auxiliary side cooling water stream rate was measured with the assistance of a rotameter. The loop was protected to limit the heat losses to the surrounding.

Experimental Procedure

This investigation is finished with the assistance of a circulation of water to vapor with base to top. The examination is investigation with a functional and hypothetical esteem relies upon the distinctive parameter and demonstrating diverse inclination position.

Basic Procedure

The primary loop was loaded with tap water. To drive out the air bubbles, the filling stream was preceded for some additional time with beating. To expel the broke down gasses in the water, the loop will keep running under natural circulation condition at a little power for quite a while. This methodology will be followed in every one of the tests to drive out the broke up gasses. Prior to the examination, the optional cooling water stream rate was set at the required esteem. Adequate time was given for the test loop to balance out at room temperature without heating. At that point control was exchanged on and real account of data started.

Steady-State Test Procedure

At the point when relentless beginning conditions were achieved, the perusing was noted with zero power. At that point the heater was put on and set at the required power utilizing the DC controlled heating Variance. At the unfaltering state condition (which can be seen from the pattern of the pressure drop data and temperature variety in the graphical show mode on the data obtaining system), every one of the temperatures and pressure drop data were gathered. At that point the power was expanded in ventures of 50W and permitted to achieve the unfaltering state. A similar technique was rehashed till the power achieved 450W. Repeatability of the test outcomes was likewise checked.

Procedure for the Stability Tests

The insecurity edge was observed to be reliant on heat expansion ways. The situations for the accompanying heat expansion ways were examined:

1. start-up from stale conditions;
2. sudden power raising from an underlying stable unfaltering state conditions;
3. Instability conduct amid a power advance back process.

Amid every one of the tests the cooling water stream rate (1l/min) and its delta temperature (around 30°C) were kept steady. The change in the controlled coolant stream rate was inside ±3% of the set value. A short exploratory system is given underneath for each of the tests.

Start-Up from Stagnant Conditions

The test technique comprised of all of a sudden exchanging on the heater when the liquid was stale at uniform beginning temperature all through the loop. To accomplish uniform beginning temperature, the cooling water was valved - in any event 30 minutes before the genuine test. The system was permitted to work until the point that the stream was steady. The primary target of these tests was to get the limit control underneath which the system can be begun up without experiencing shakiness with sudden increment in control from introductory stable condition. These experiments were directed by water.

Sl no.	Time Interval at In Minutes	Hot Water Inlet	Hot Water Outlet	T1	T2	T3	T4	T5	T6	Cold Water Inlet	Cold Water Outlet	Cold Water Discharge $m^{3/}S$	Hot Water Discharge $m^{3/}S$
		Temperature in ^{o}C											
1	45	90.2	88.6	42	42	38	38	38	51	6	13	0.00023	0.00019
2	90	91.1	89	45	44	42	40	39	51	6.3	14.2	0.00022	0.00019
3	135	91.8	89.5	49	46	47	43	42	48	6.5	14.8	0.0022	0.0019
4	180	92.5	87.3	52	53	53	46	45	47	6.8	15.6	0.0022	0.0001
5	225	93	88	54	55	55	48	47	46	7	16	0.0022	0.0001

The values of cool and hot water release as appeared in table.1 w.r.to the time interims and change in temperature are acquired by led the test.

Variation of Temperature and Pressure throughout the Loop in Co2

Figures 3(a) and 3(b) demonstrate the variety of neighborhood normal temperature and aggregate pressure contrast of CO2 through the loop for various water delta temperatures of HHX. Results demonstrate that for this loop, stream inversion wonder happens at a hot fluid gulf temperature of 343 K as appeared in the figures. Because of this, at this temperature the parts of riser and down comer are switched. Because of stream inversion, the CHX and HHX wind up noticeably parallel stream heat exchangers, since the stream course of outside fluid is kept the same for all conditions. This clearly impacts the execution of the loop. Such a stream inversion wonder in NCL was additionally watched and announced by Lin Chen et al. Because of the suspicion of adiabatic condition in the riser and down comer, the variety in temperature is practically immaterial in these parts, where as varieties can be seen in CHX and HHX because of heat transfer with the outside fluid. Most extreme variety of pressure in a loop is 7 kPa which is equivalent to 0.07% of working pressure.

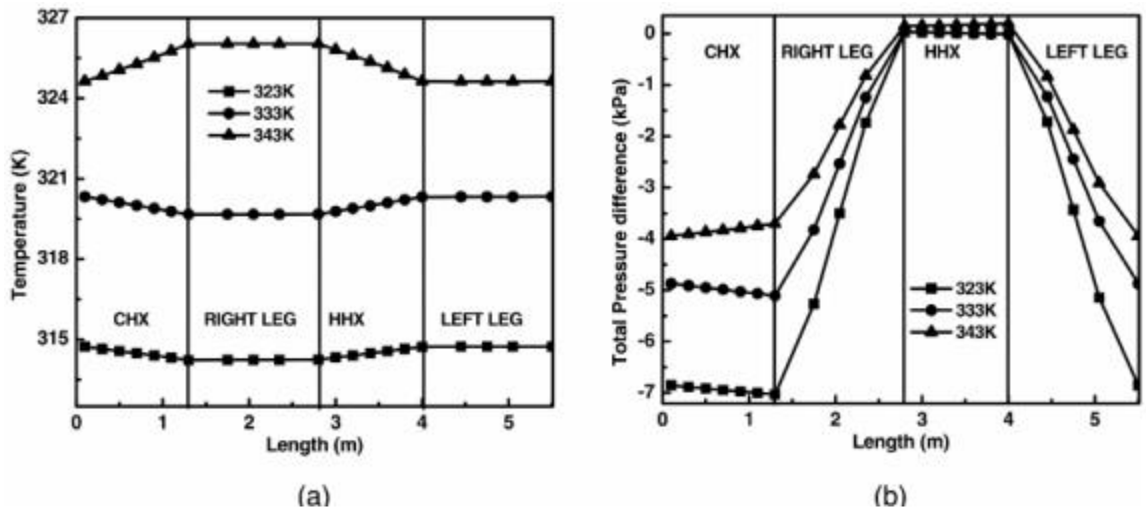

Fig.2 Variation of (a) Temperature and (b) Pressure throughout the Loop Length

PROBLEM ANALYSIS AND CALCULATIONS

The trial approach of NCLs' exhibitions and conduct is regularly wanted to CFD examination: it is difficult to play out a broad and solid numerical investigation without the assistance of trial data, because of the issue clamorous features.

The last approach gives more data about a ton of parameters which are harder to gauge, for example, stream rate, nearby fluid speed, pressure drops and prompt heat stream rate. The CFD is useful to assess the three-dimensional impacts, which can't be derived from the estimation of the temperatures. To check the legitimacy of the numerical code utilized for illuminating the full circular overseeing conditions, the numerical plan was tried on cases near the issue under thought, so as to contrast the ascertained data and the distributed data. The examinations were made for natural convection stream of air on two cases: a square pit with differentially heated vertical dividers and adiabatic even divider.

With the interest for vitality keeps on developing all inclusive, there is a need to influence heat to transfer gear more vitality efficient. At one hand, the exponential development of hardware, correspondence and PC innovation and their decision to go for scaling down has put included pressure the originator to make efficient warm administration gadgets for these systems.

Experimental discharge of .25hp pump, $Q_{discharge}=0.0001\frac{m^3}{sec}$

Experimentally calculated values:

T_{h1} in °C	T_{h2} in °C	T_{c1} in °C	T_{c2} in °C
93	**88**	**46**	**54**

We know that:

$$\Theta_1=t_{h1}-t_{c2}=93-54=39^{O}C$$

$$\Theta_2=t_{h2}-t_{c1}=88-46=42\,^{O}C$$

Therefore:

$\Theta_m = \frac{(\theta1-\theta2)}{\ln(\theta1/\theta2)} = 40.4814747^{o}C$

Mass flow rate of hot water,

$\dot{m}_h$=Density x discharge=978.1 x 0.0001=0.09781

Specific heat at constant presser:

At 90°C, $C_{ph}= 4.205\frac{KJ}{Kg\ K}$

At 50°C, $C_{pc}= 4.179\frac{KJ}{Kg\ K}$

Heat transfer rateof hot heat exchanger,

$Q=\dot{m}_h x\ C_{ph} x\ (T_{h1}-T_{h2})=2.05645525$ watt

Mass flow rate of cold water,

$\dot{m}_C=\frac{(mh\ x\ Cph) x\ (Th1-Th2)}{Cpc(Tc2-Tc1)}=0.06151158\frac{kg}{sec}$

Heat capacity:

Heat Capacity of hot fluid, $C_h=m_h x C_{ph}=0.41129105\frac{KJ}{K}$

Heat Capacity of cold fluid, $C_c=m_C x\ C_{ph}=0.257056906\frac{KJ}{K}$

$C_{min}=0.257056906\frac{KJ}{K}$

$C_{max}=0.41129105\frac{KJ}{K}$

$Q_{max}= C_{min}\ x\ (T_{h1}-T_{c1})=0.257056906\ x\ (47)=12.08167458$ w

Effectiveness:

$\mathcal{E}_h=\frac{Q}{Qmax}=\frac{2.05645525}{12.08167458}=0.17021$ or (17%)

Effectiveness calculation for cold heat exchanger:

Experimental discharge of .5hp pump, $Q_c=0.0002\ \frac{m^3}{sec}$

Experimentally calculated values:

T_{h1} in °C	T_{h2} in °C	T_{c1} in °C	T_{c2} in °C
56	48	7	16

$\Theta_1=t_{h1}-t_{c2}=56-16=40^{O}C$

$\Theta_2=t_{h2}-t_{c1}=48-7=41\ ^{O}C$

Therefore:

$\Theta_m=\frac{(\theta1-\theta2)}{\ln(\theta1/\theta2)}=\frac{(40-41)}{\ln(40/41)}=40.4979423^{o}C$

Mass flow rate of cold water,

$\dot{m}_c$=Density x discharge=978.1 x 0.0002=0.19562 $\frac{kg}{sec}$

Specific heat at constant presser

At 90°C, $C_{pc}= 4.179\frac{KJ}{Kg\ K}$

At 50°C, $C_{ph}= 4.193\frac{KJ}{Kg\ K}$

Heat transfer rate of cold heat transfer,

$Q=\dot{m}_h x\ C_{ph} x\ (T_{h1}-T_{h2})=7.357464$ watt

Mass flow rate of hot water,

$\dot{m}_h=\frac{(mh\ x\ Cph)\ x\ (Th1-Th2)}{Cpc(Tc2-Tc1)}=0.1733039\frac{kg}{sec}$

Heat capacity:

Heat Capacity of hot fluid,

$C_h = \dot{m}_h x\ C_{ph} = 0.726663093 \frac{KJ}{K}$

Heat Capacity of cold fluid, $C_c = \dot{m}_C x\ C_{ph} = 0.81749598 \frac{KJ}{K}$

$C_{min} = 0.726663093 \frac{KJ}{K}$

$C_{max} = 0.81749598 \frac{KJ}{K}$

$Q_{max} = C_{min}\ x\ (T_{h1} - T_{c1}) = 0.726663093\ x(56-7) = 35.6$

Effectiveness:

$\varepsilon_h = \frac{Q}{Qmax} = \frac{7.357464}{35.60649} = 0.20663266$

Calculation Driving Force (Change in Mass Flow Rate)

Mass flow rate in Hot Heat Exchanger section:

Experimental discharge of .25hp pump, $Q_{discharge} = 0.0001 \frac{m^3}{sec}$

Experimentally calculated values:

T_{h1} in °C	T_{h2} in °C	T_{c1} in °C	T_{c2} in °C
93	**88**	**46**	**54**

$\Theta_1 = t_{h1} - t_{c2} = 93 - 54 = 39^oC$

$\Theta_2 = t_{h2} - t_{c1} = 88 - 46 = 42\ ^oC$

Therefore:

$\Theta_m = \frac{(\theta 1 - \theta 2)}{\ln(\theta 1/\theta 2)} = 40.4814747^oC$

Mass flow rate of hot water,

$\dot{m}_h$=Density x discharge=978.1 x 0.0001=0.09781 $\frac{kg}{sec}$

Specific heat at constant presser:

At 90°C, $C_{ph} = 4.205 \frac{KJ}{Kg\ K}$

At 50°C, $C_{pc} = 4.179 \frac{KJ}{Kg\ K}$

Heat transfer rate of hot heat exchanger,

$Q = \dot{m}_h x\ C_{ph} x\ (T_{h1} - T_{h2}) = 2.05645525$ watt

Mass flow rate of cold water,

$\dot{m}_{Ch} = \frac{(mh\ x\ Cph) x\ (Th1 - Th2)}{Cpc(Tc2 - Tc1)} = 0.06151158 \frac{kg}{sec}$

Mass flow rate in Cold Heat Exchanger section:

Experimental discharge of 0.5hp pump, $Q_c = 0.0002$

Experimentally calculated values:

T_{h1} in °C	T_{h2} in °C	T_{c1} in °C	T_{c2} in °C
56	**48**	**7**	**16**

Mass stream rate of inside the loop fluid in hot heat exchanger is 0.06151158 and mass stream rate of inside the loop fluid in cool heat exchanger is 0.1733039 .The distinction of mass stream rate of these two heat exchanger is 0.11179232

As there is change in mass stream rate in the base and upper heat exchanger so it is inferred that there is fluid stream inside the loop. The variety between mass stream rate and heat transfer rate for hot and cool water can be seen as appeared in figure 2, 3 and 4.

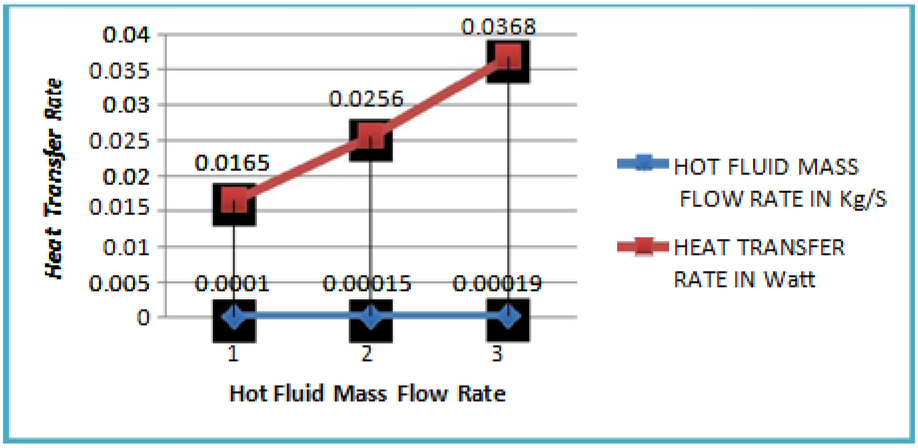

Fig.3 Hot fluid mass flow rate vs heat transfer rate

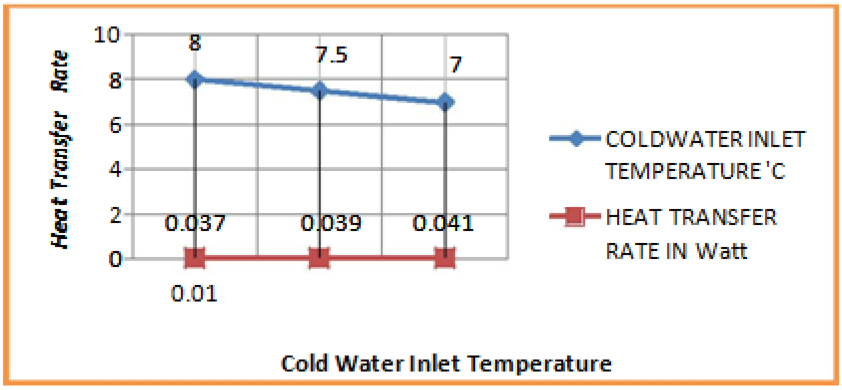

Fig.4 Cold inlet temperature vs heat transfer rate

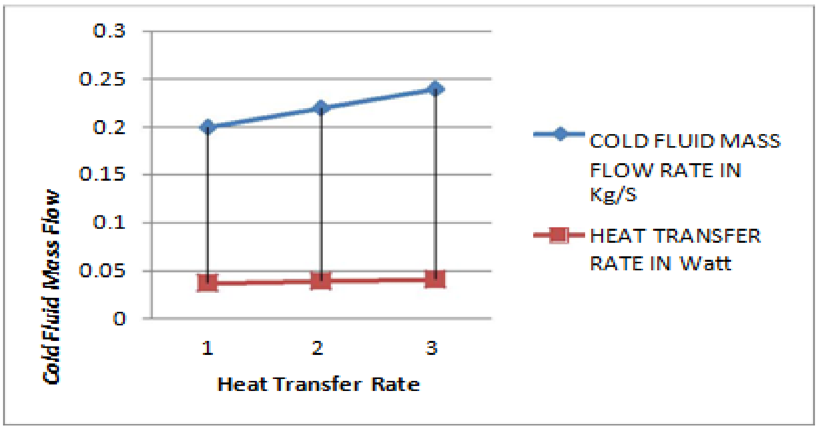

Fig.5 Cold fluid mass flow vs heat transfer rate

CONCLUSION

The Natural Circulation Loop was effectively examined and created. Experiments are directed with the refined water and after some time the temperature Contrast with on the up and up has been seen by the temperature indicator. We reason that the fluid stream has been occurring inside the loop by density distinction. Also, we plot the diagrams of heat Transfer rate to hot stream channel temperature, heat Transfer rate to Mass stream rate of hot fluid and heat Transfer rate to chilly water bay temperature. We have watched that Heat Inlet Temperature and Mass Flow rate of hot fluids specifically relative to Heat Transfer rate and icy bay temperature and Mass Flow rate of chilly fluid is straightforwardly in a roundabout way corresponding to Heat Transfer rate.

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