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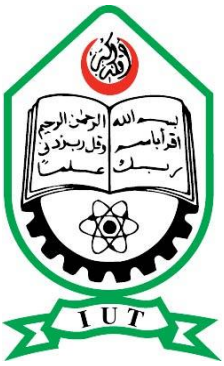

EXPERIMENTAL PERFORMANCE EVALUTION OF HEAT TRANSFER RATE IN AUTOMOTIVE RADIATOR BY ADDING NANOPARTICLES IN DIFFERENT PROPORTIONS

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DECLARATION

This is to certify that the work presented in this thesis is an outcome of the experiment and research carried out by the authors under the supervision of **Dr. Md. Dr.Md. Faisal Kader** at IUT Campus, Gazipur, Bangladesh. This is an authentic record of the study carried out as requirement for the award of degree of Bachelor of Science in Mechanical Engineering.

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ABSTRACT

CNG converted engines produces much more heat than Petrol or Diesel Engines .This is because the compression ratio of CNG is higher than other types of engines, high combustion temperature & low performance of coolants. Overheating can cause the engine failure sometimes. In our project we try to find out heat transfer rate of petrol engine & CNG engine and also compare between those engines. After comparing we find out CNG engine generate higher combustion temperature. Our goal is to find the heat transfer rate of the engine radiator using nanoparticle in different proportions. This will show that heat transfer rate increases as percentage of nanoparticle increases. From this we would be able to find that nanoparticle (Al_2O_3) with water as coolant may reduce use of materials in the radiator and reduce it's cost.

CONTENTS

CHAPTER ONE

INTRODUCTION

Our project deals with the experimentally evaluation of heat transfer rate in automotive radiators using nanoparticles as coolant in different proportions. By this we can see the heat transfer performance rate increases with using nanoparticles more. Basically this will indicate that with increasing nanoparticle percentage there's more heat transfer and the radiator can be modified using less material which will reduce the cost of making the radiator. So if we can prove that with increasing nanoparticle in water there's increase of heat transfer we can prove the fact that in the long run it will reduce radiator size and increase efficiency. As now a days for CNG the heat generation is more than the petrol engines it's also important to reduce or transfer the heat and cool the coolant used. So using nano particles can solve all these problems.

1.1 OBJECTIVE

To experimentally evaluate the Heat Transfer rate in automotive radiator using water as coolant and then adding nanoparticle (Al2o3) with water in different proportions.

1.2 WORKING PRINCIPLE OF THE PROJET

This project is about evaluation of heat transfer rate experimentally in CNG converted engines using nanoparticles as coolant in different percentages. Generally in petrol engine there's less heat generated but in CNG engines heat generation is high so heat transfer must be high and fast to make the coolant's temperature appropriate for using again and again. CNG engine's overheating is one of the biggest cause we started this project as overheating can cause the engine many troubles. The total project is carried out in IDLE speed of engine. First the setup was completed. Then adding nanoparticles with water in proportion of mass 1%, 1.5%, 2% the data's are taken and then comparison is made. Thus we get a clear view of heat transfer rate increase with the increase of nanoparticle percentage in the coolant. Which indicates that adding nanoparticle can increase radiator efficiency.

1.3 WHY NANOPARTICLE IS USED IN THE EXPERIMENT?

Nano particles are very small, nanometer-sized particles with their smallest dimensions usually less than 100nm (nanometers).The smallest nanoparticles, only a few nanometers in diameter may contain a thousand atoms .These nanoparticles may possess properties that are subsequently different from their parent materials. They may interact quite differently with their dynamic molecular structure with the base fluids, than the corresponding micro particles, and respond different within different force-flux forces accompanied with mass-energy transferred. Similarly Nano fluids may have properties that are substantially different from their base fluids like higher thermal conductivity and lower flow and heat transfer characteristics. Nanoparticle used in this experiment has the following characteristics:

Aluminum Oxide Nano powder (gamma)--	**Hydrophilic**
Nanoparticles (Al2O3) Purity	**99+%**
Nanoparticles (Al2O3) Color	**white**
Specific heat capacity	**880 J/(Kg-K)**
Density:	**3890 Kg/m3**

CHAPTER TWO

EXPERIMENTAL DETAILS

2.1 SETUP PROCEDURE

THERMOCOUPLE SETTING

Two thermocouples are connected each to radiator inlet and outlet for measuring the respective temperatures. Those thermocouples are connected and glued in a pvc which was in the middle of hose pipes.

DIGITAL TEMPERATURE METER

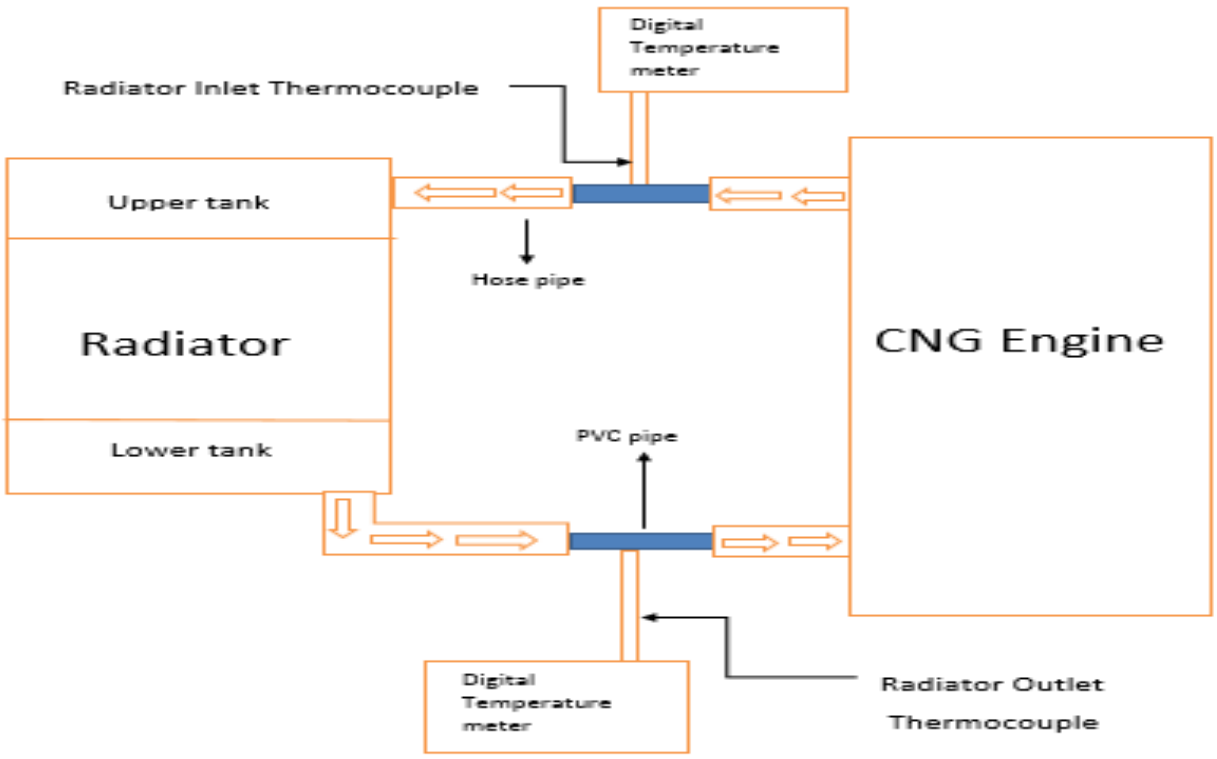
Two digital temperature meters are used to show the reading of temperature of radiator inlet and outlet. Those thermocouples are the input to the digital temperature meter.

TOTAL SETUP EQUIPMENTS

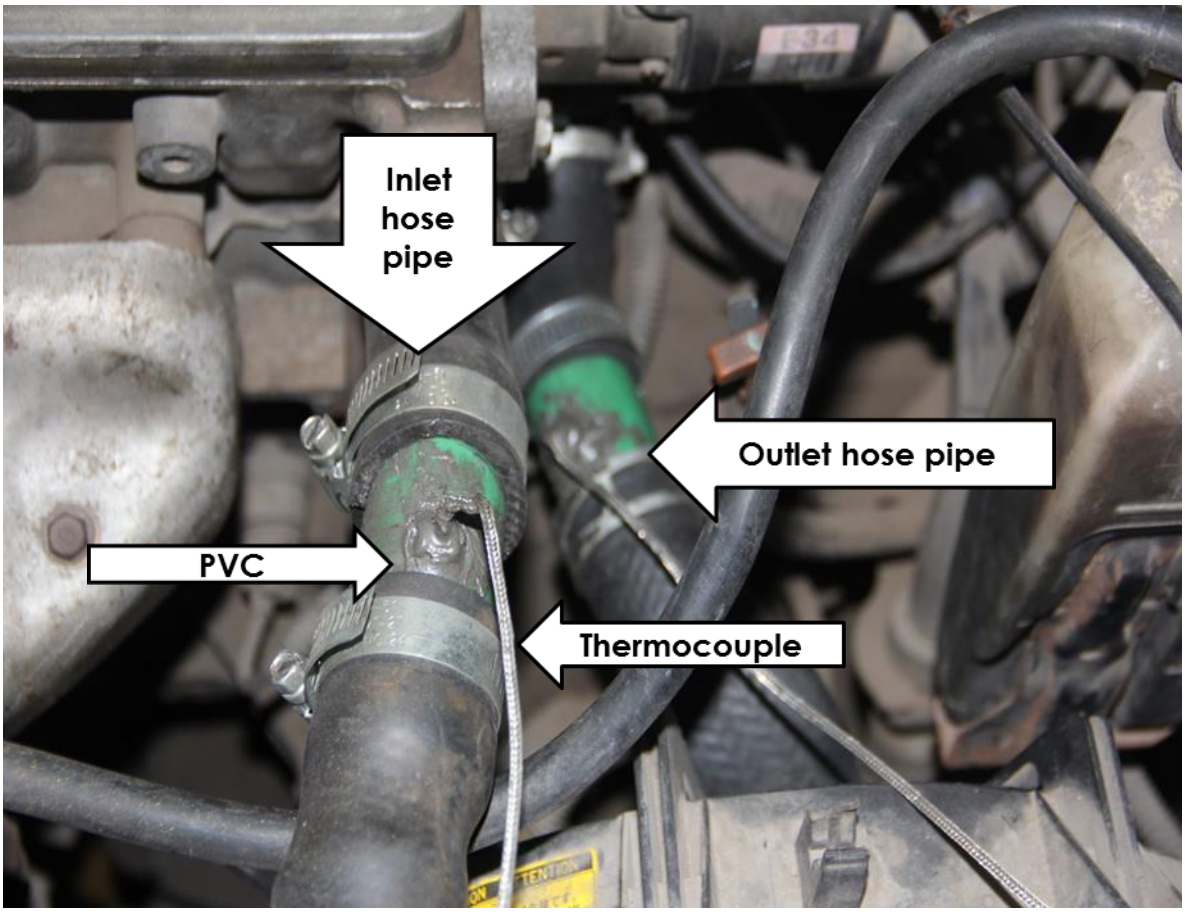
- ✓ Automotive Engine
- ✓ Radiator
- ✓ Water pump
- ✓ Measuring Instruments
- ✓ Necessary Piping and auxiliaries

MEASUREMENT AND INSTRUMENTATION

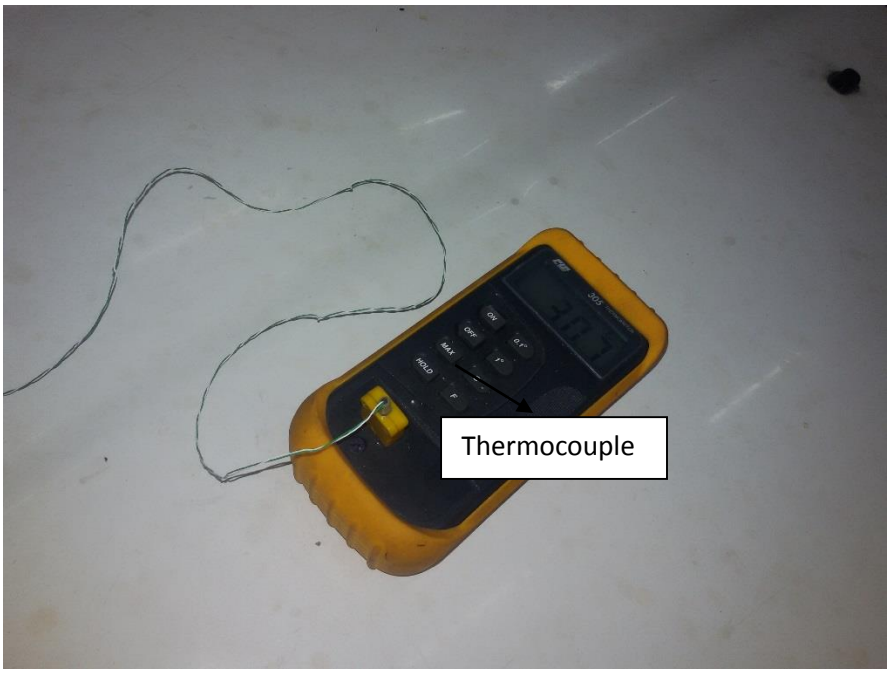
- ❑ Thermocouple
- ❑ Anemometer
- ❑ Digital Temperature Meter

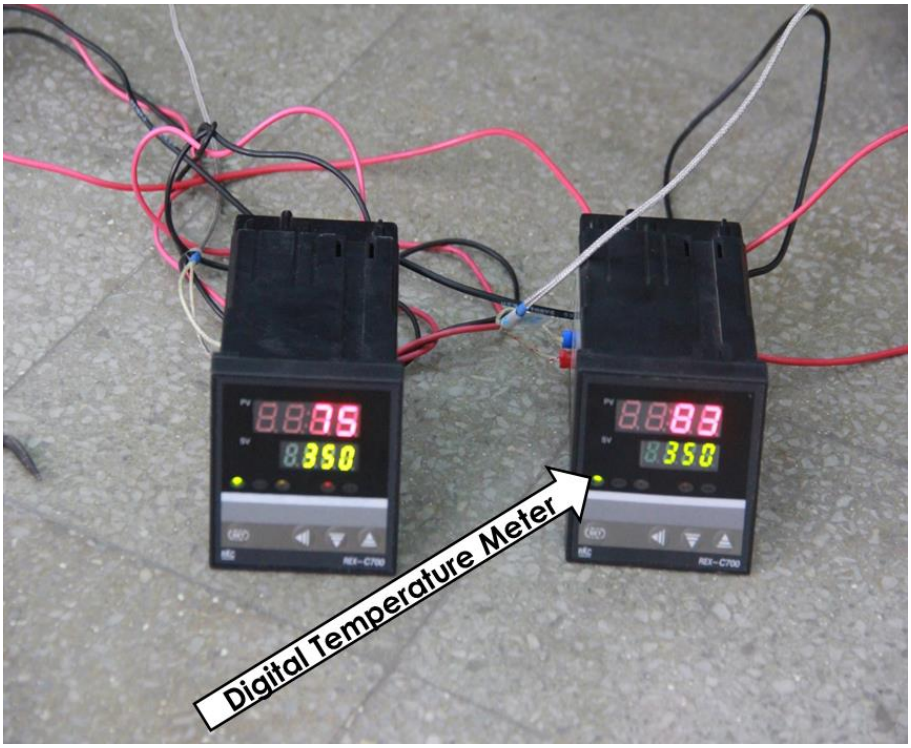


2.2 FIGURE: SETUP DIAGRAM



2.3 FIGURE: THERMOCOUPLE SETTING IN THE RADIATOR HOSE PIPES





2.4 FIGURE: TEMPERATURE MEASUREMENT DEVICES

2.5 FIGURE: TOTAL EXPERIMENTAL SETUP

2.6 EXPERIMENTAL PROCEDURE

- ✓ After completing the set up first Radiator inlet and outlet temperature with time was taken using only water as coolant when engine was running by Petrol

- ✓ Then Using CNG as engine fuel Inlet and Outlet temperature of Radiator was Taken again

- ✓ Above two reading will show the increase of engine heating in case of using CNG and heat transfer rate (Q) change.

- ✓ Then nanoparticle is added with the water first the Percentage was 1% nanoparticle with water.

- ✓ After taking the readings Heat transfer(Q) rate is calculated

- ✓ Then consecutively for 1.5%, and 2% of nanoparticle in the coolant reading were taken and comparison was made with respect to heat transfer rate (Q) of each data.

- ✓ All the data's are taken in IDLE (750 rpm) speed.

CHAPTER THREE

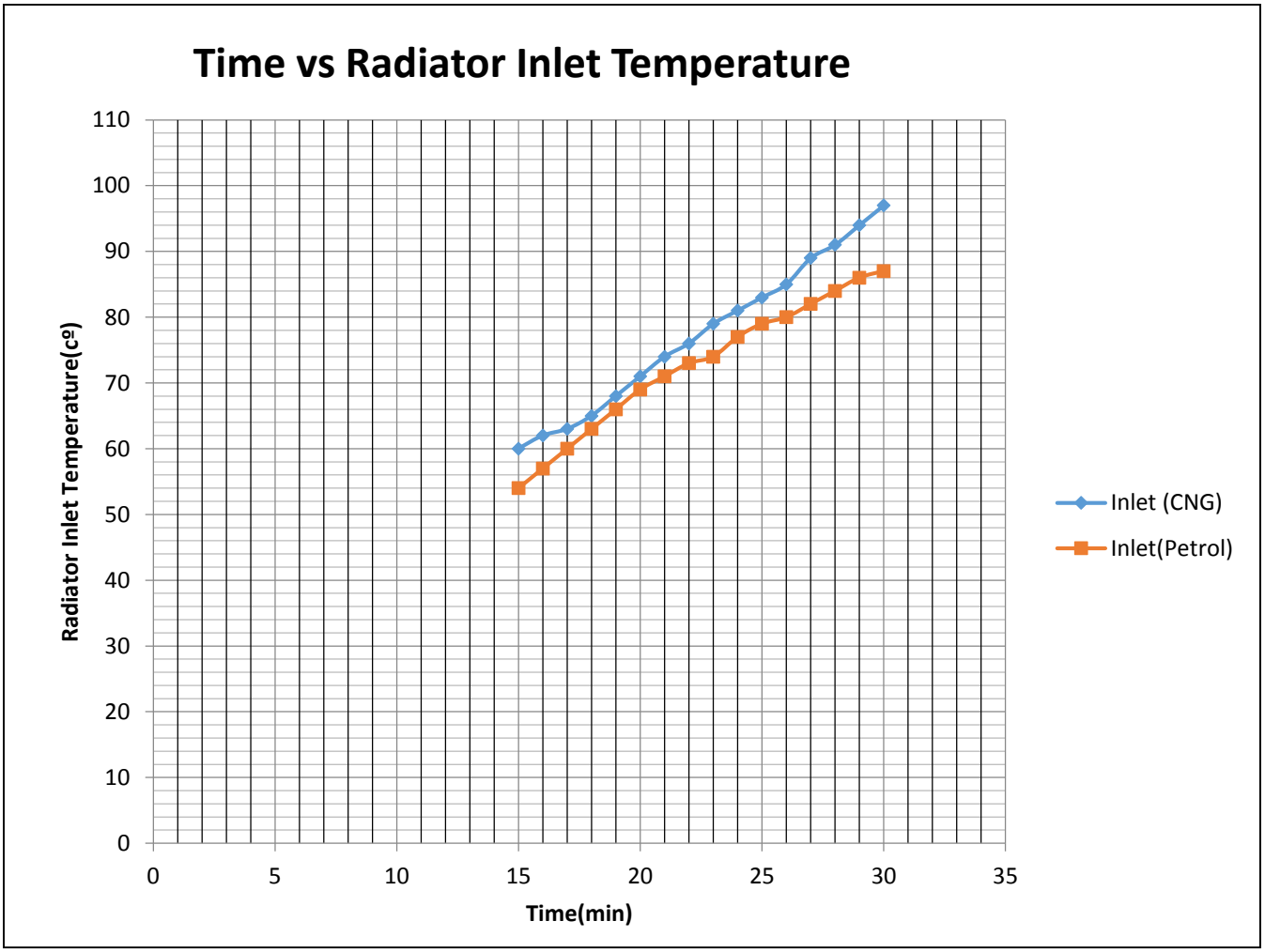
RESULTS AND CALCULATION

3.1) DATA FOR RADIATOR INLET AND OUTLET OF PETROL ENGINE USING WATER (AS COOLANT):

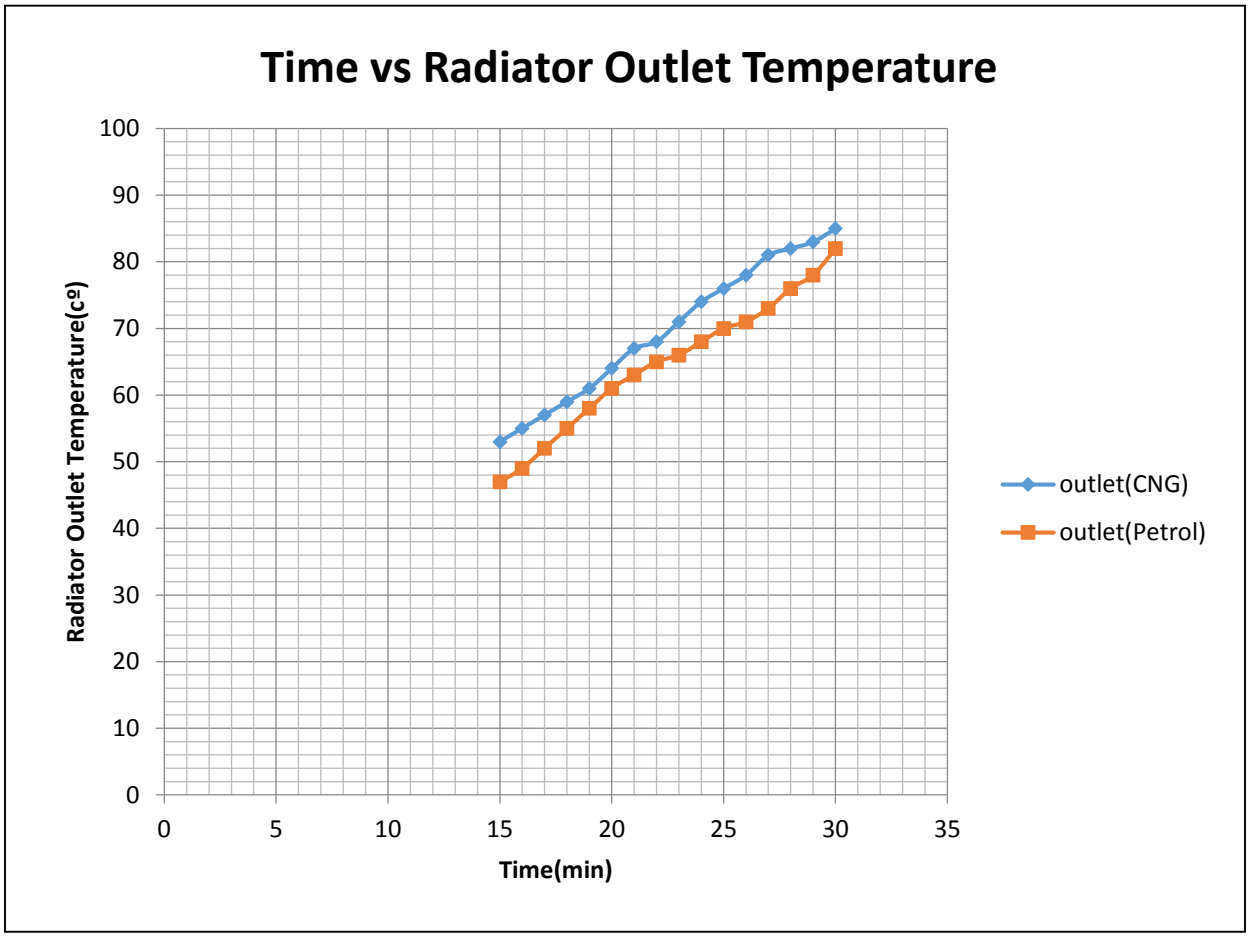
Time (min)	Radiator Inlet Temperature(c°)	Radiator Outlet Temperature(c°)
15	54	47
16	57	49
17	60	52
18	63	55
19	66	58
20	69	61
21	71	63
22	73	65
23	74	66
24	77	68
25	79	70
26	80	71
27	82	73
28	84	76
29	86	78
30	87	82

3.2) DATA FOR RADIATOR INLET AND OUTLET OF CNG ENGINE USING WATER (AS COOLANT):

Time (min)	Radiator Inlet Temperature(c°)	Radiator Outlet Temperature(c°)
15	60	53
16	62	55
17	63	57
18	65	59
19	68	61
20	71	64
21	74	67
22	76	68
23	79	71
24	81	74
25	83	76
26	85	78
27	89	81
28	91	82
29	94	83
30	97	85



3.3 FIGURE: TIME VS TEMPERATURE GRAPH (RADIATOR INLET)



3.4 FIGURE: TIME VS TEMPERATURE CURVE (FOR RADIATOR OUTLET)

CALCULATION

3.5 HEAT TRANSFER RATE OF PETROL ENGINE:

Specific heat capacity of water cpw = 4200 j/kg.k

Mass of water in radiator mw = 3 kg (approximately)

Maximum temperature at radiator inlet Ti = 87º c

Maximum temperature at radiator outlet Ti =82º c

Heat transferred by coolant Q= mwcpw (Ti- To) =63 kj

Ambient Temperature Tamb= 30.2º c

Radiator efficiency r = (Ti- To)/(Ti-Tamb)=8.80%

3.6 HEAT TRANSFER RATE OF CNG ENGINE:

Specific heat capacity of water cpw = 4200 j/kg.k

Mass of water in radiator mw = 3 kg (approximately)

Maximum temperature at radiator inlet Ti= 97º c

Maximum temperature at radiator outlet To =85º c

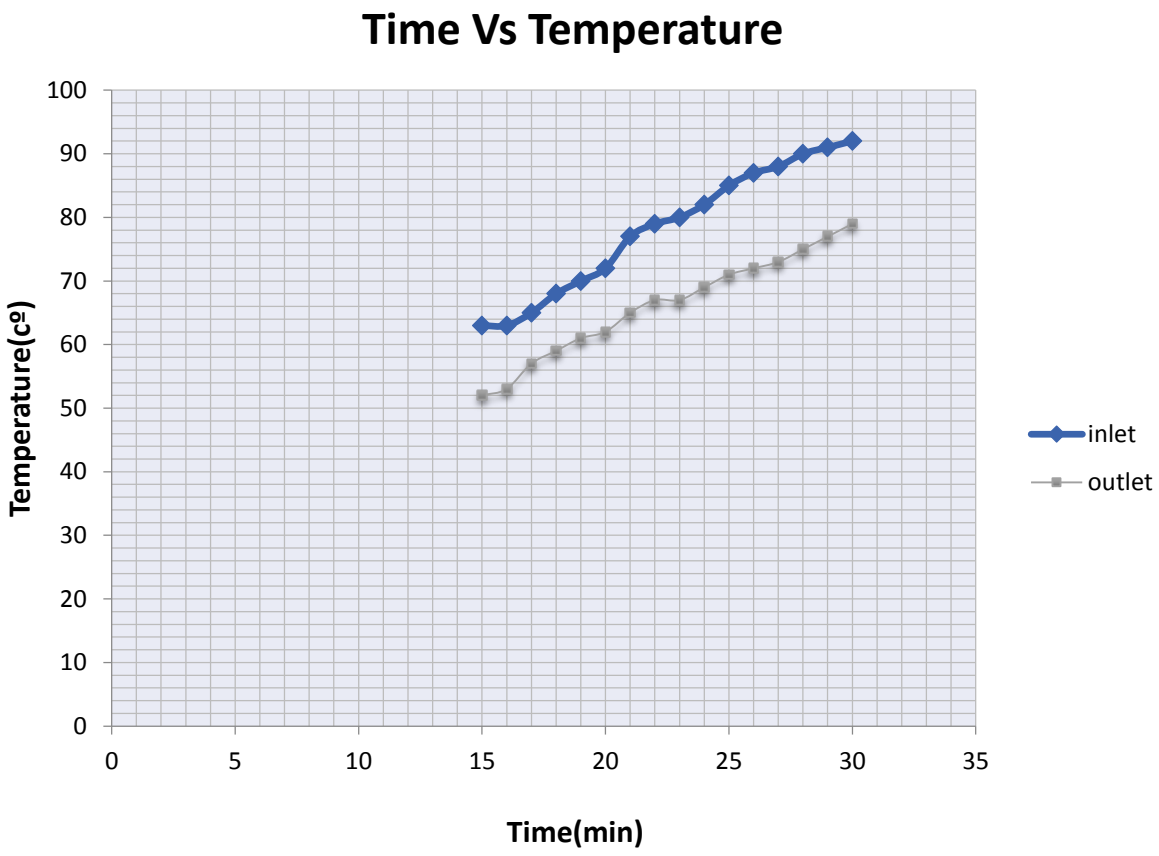
Heat transferred by coolant Q= mwcpw (Ti- To) =151.2 kj

Ambient Temperature Tamb= 30.2º c

Radiator efficiency r = (Ti- To)/(Ti-Tamb)=17.96%

3.7 DATA FOR RADIATOR INLET AND OUTLET OF CNG ENGINE USING WATER AND 1% NANOPARTICLE (AS COOLANT):

Time (min)	Radiator Inlet Temperature(c°)	Radiator Outlet Temperature(c°)
15	63	52
16	63	53
17	65	57
18	68	59
19	70	61
20	72	62
21	77	65
22	79	67
23	80	67
24	82	69
25	85	71
26	87	72
27	88	73
28	90	75
29	91	77
30	92	79



3.8 FIGURE: TIME VS TEMPERATURE CURVE (FOR RADIATOR INLET &OUTLET) USING 1% NANOPARTICLE

3.9 CALCULATION OF HEAT TRANSFER RATE OF CNG ENGINE: (USING 1% NANO PARTICLE AND WATER AS COOLANT)

Specific heat capacity of water cpw = 4166.8 j/kg.k

Mass of water in radiator mw = 3 kg (approximately)

Maximum temperature at radiator inlet Ti= 92º c

Maximum temperature at radiator outlet To=79º c

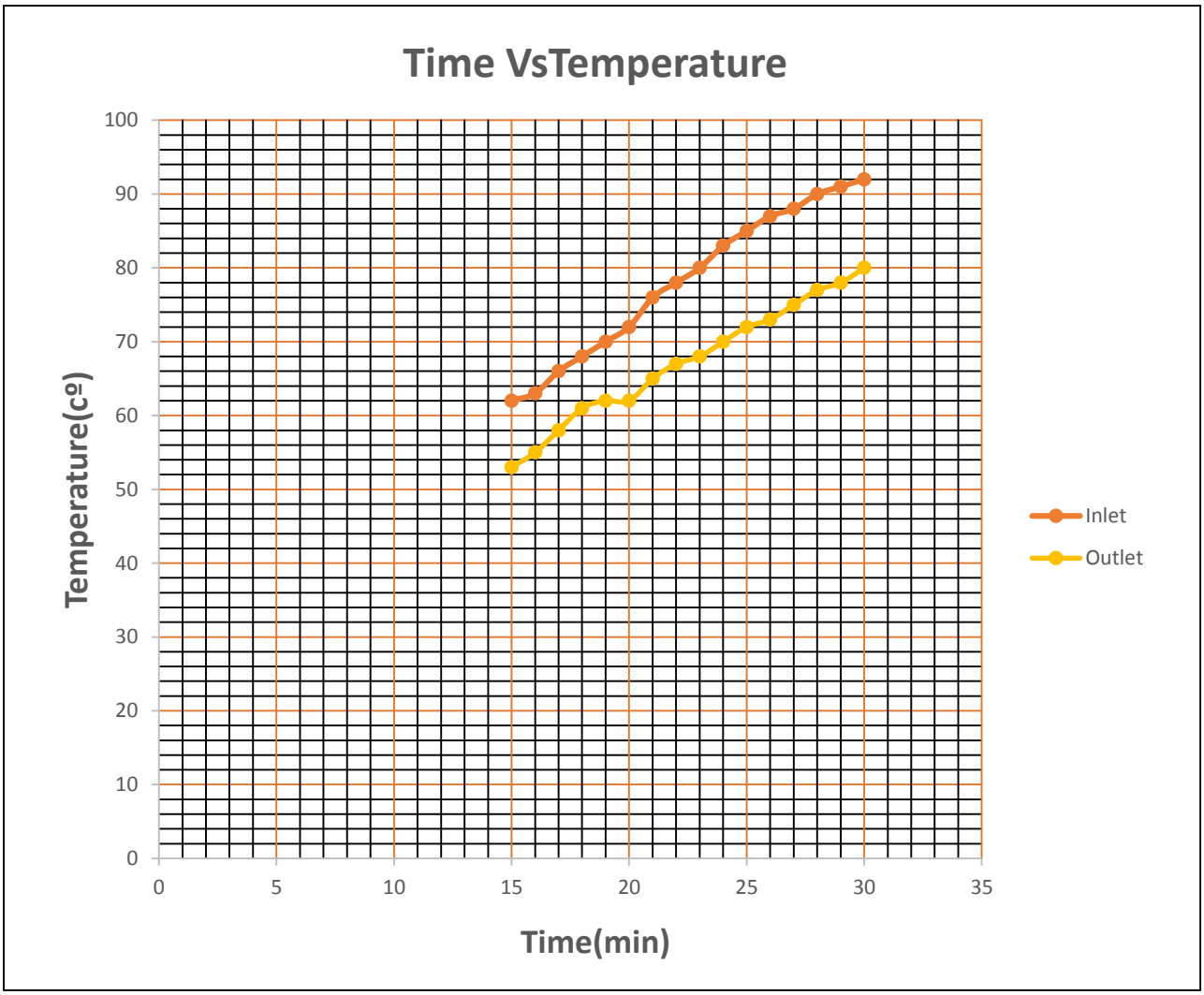
Heat transferred by coolant Q= mwcpw (Ti- To)=162.5052kj

Ambient Temperature Tamb= 30.2º c

Radiator efficiency r = (Ti- To)/(Ti-Tamb)=21.03%

3.10 DATA FOR RADIATOR INLET AND OUTLET OF CNG ENGINE USING WATER AND 1.5% NANOPARTICLE (AS COOLANT):

Time (min)	Radiator Inlet Temperature(c°)	Radiator Outlet Temperature(c°)
15	62	53
16	63	55
17	66	58
18	68	61
19	70	62
20	72	62
21	76	65
22	78	67
23	80	68
24	83	70
25	85	72
26	87	73
27	88	75
28	90	77
29	91	78
30	93	79



3.11 FIGURE: TIME VS TEMPERATURE CURVE (FOR RADIATOR INLET &OUTLET) USING 1.5% NANOPARTICLE

3.12 CALCULATION OF HEAT TRANSFER RATE OF CNG ENGINE: (USING 1.5% NANO PARTICLE AND WATER AS COOLANT)

Specific heat capacity of water cpw = 4140.4 j/kg.k

Mass of water in radiator mw = 3 kg (approximately)

Maximum temperature at radiator inlet Ti= 93º c

Maximum temperature at radiator outlet To=79º c

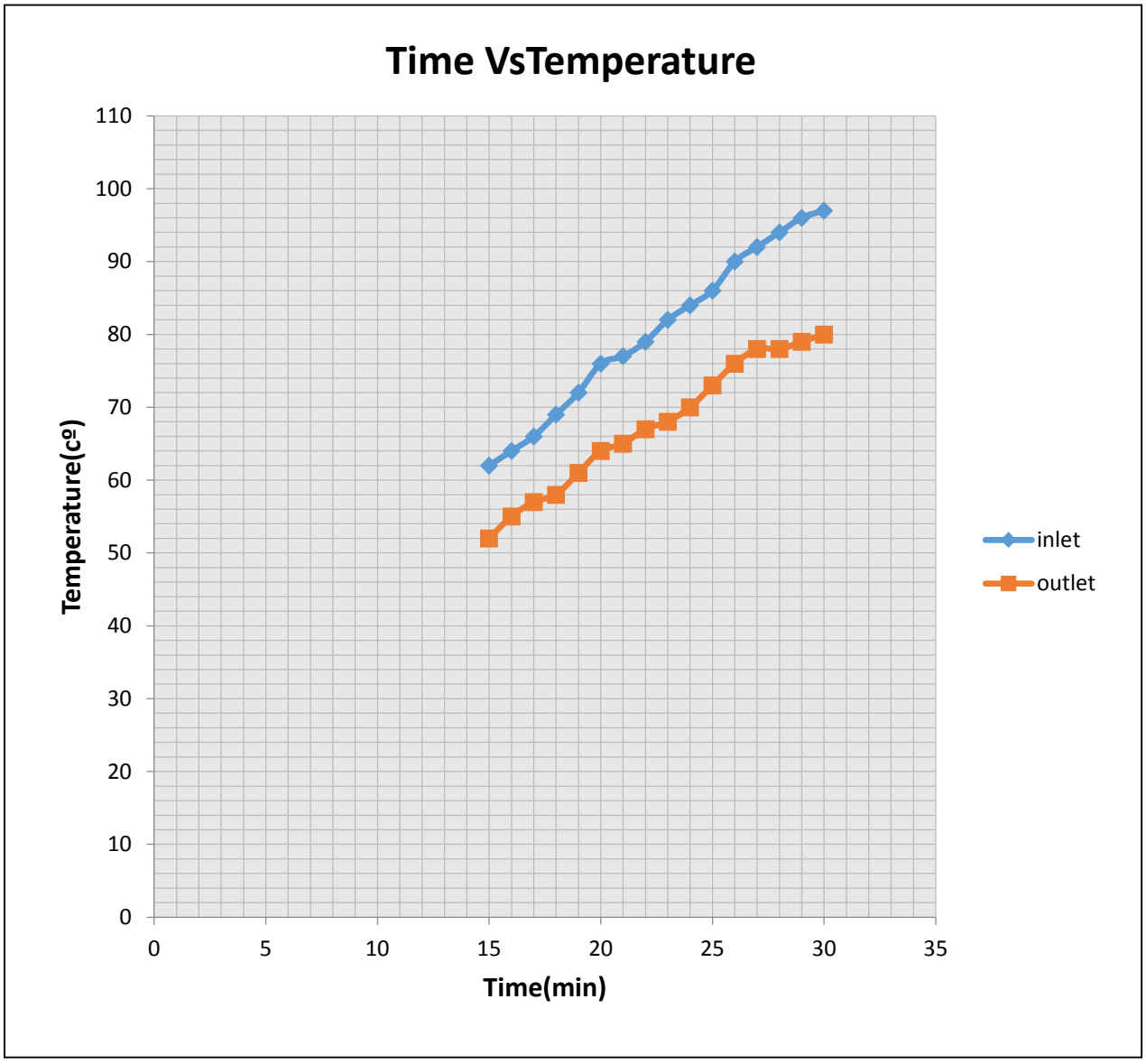
Heat transferred by coolant Q= mwcpw (Ti- To) =173.8968 Kj

Ambient Temperature Tamb= 30.2º c

Radiator efficiency r = (Ti- To)/(Ti-Tamb)=20.29%

3.13 DATA FOR RADIATOR INLET AND OUTLET OF CNG ENGINE USING WATER AND 2% NANOPARTICLE (AS COOLANT):

Time (min)	Radiator Inlet Temperature(c°)	Radiator Outlet Temperature(c°)
15	62	52
16	64	55
17	66	57
18	69	58
19	72	61
20	76	64
21	77	65
22	79	67
23	82	68
24	84	70
25	86	73
26	90	76
27	92	78
28	94	78
29	96	79
30	97	82



3.14 FIGURE: TIME VS TEMPERATURE CURVE (FOR RADIATOR INLET &OUTLET) USING 2% NANOPARTICLE

3.15 CALCULATION OF HEAT TRANSFER RATE OF CNG ENGINE: (USING 2% NANO PARTICLE AND WATER AS COOLANT)

Specific heat capacity of water cpw = 4133.6 j/kg.k

Mass of water in radiator mw = 3 kg (approximately)

Maximum temperature at radiator inlet Ti= 92º c

Maximum temperature at radiator outlet To=79º c

Heat transferred by coolant Q= mwcpw (Ti- To)=186.012kj

Ambient Temperature Tamb= 30.2º c

Radiator efficiency r = (Ti- To)/(Ti-Tamb)=21.05%

CHAPTER FOUR

RESULTS DISCUSSION AND CONCLUSION

4.1 DISCUSSION OF EXPERIMENTAL RESULT

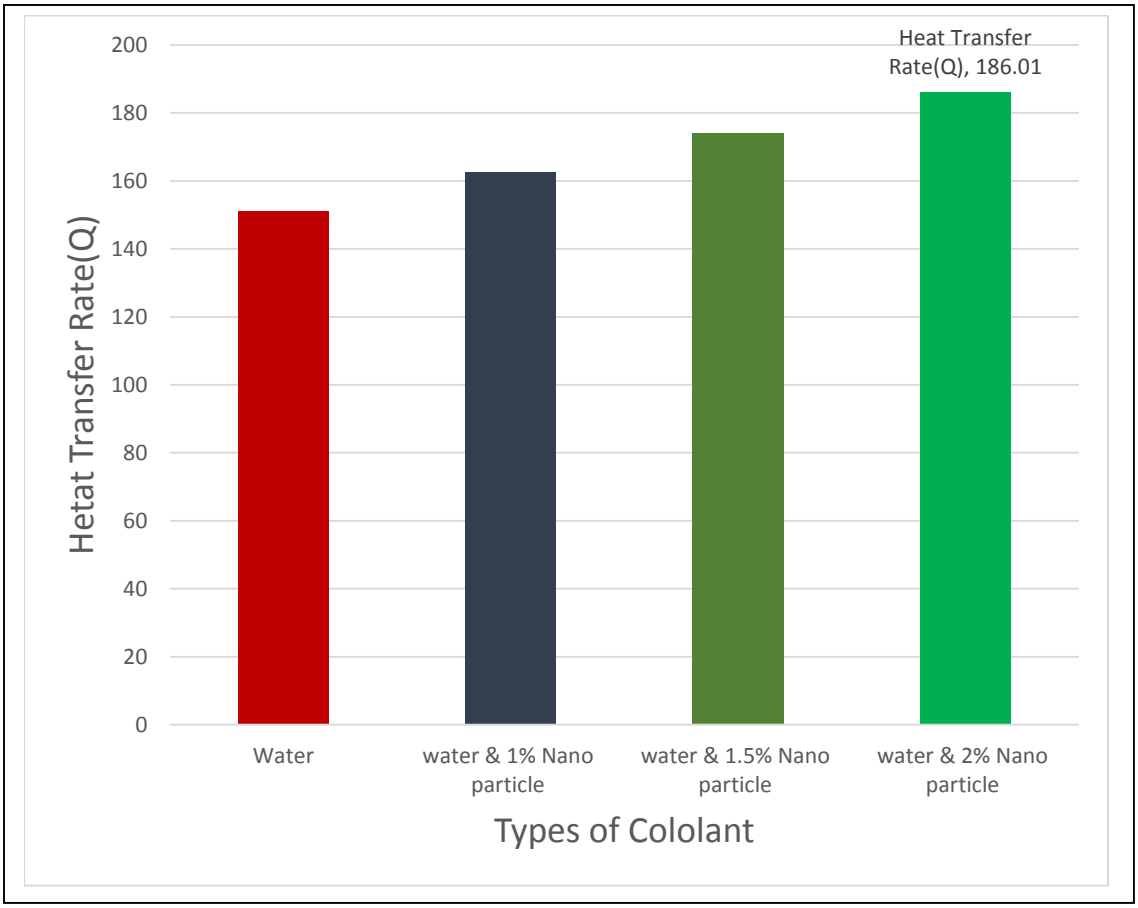
- ✓ The heat transfer rate in automobile radiator increases by adding nanoparticles of Al2O3 in water as follows:

Heat Transfer Rate			
water	1% nanoparticle	1.5% nanoparticle	2% nanoparticle
151.2 kj	162.5052kj	144.1102kj	186.012kj

- ✓ We can see there is an increase in heat transfer rate in automobile radiator compare to use water as coolant

- ✓ That means heat transfer rate as well as cooling effect can be increased in automotive radiator using nanoparticle as coolant

- ✓ The experimental Comparison of heat transfer rate as graph is given below



4.2 FIGURE: COMPARISON OF HEAT TRANSFER RATE USING NANO PARTICLES AS COOLANT IN DIFFERENT PROPORTIONS

4.3 CONCLUSION

- ✓ The Results found in the experiment might not be totally accurate as we faced some problems when doing the experiment like coolant loss and etc.
- ✓ Although we tried to minimize the error as much as possible there might be some reading error with the thermocouple.
- ✓ The Experiment was totally done in IDLE speed so in real life when car running with variable load and speed the effect of nano particle might be different.

4.4 FUTURE WORK

- ✓ By doing simulation of heat transfer in Radiator we can validate the work in future.
- ✓ If the result comes true then nanoparticle's use as coolant will decrease the material in Tubes and fins which will decrease overall cost.
- ✓ So we hope there would be continuous research regarding this topic

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