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Performance Investigation of the Influence of Ambient Temperature on a 1.5HP Air – Conditioner

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Abstract

The influence of ambient temperature on the performance on a 1.5HP Air – Conditioner that is connected to office of size 6830mmx248mmm has been investigated experimentally. The data collection was conducted for thirteen (13) working days for every degree interval as it is well enunciated in the dashboard of the air – conditioner by the manufacturer: LG Nig. LTD. Periodically, the collection of data was performed as follows: morning period: 7:00am – 9:00am; afternoon period: 12:00pm – 2:00pm and evening period: 4:00pm – 6:00pm respectively and it commences with the least temperature 16^0C and ends with 25^0C. The results revealed that as the ambient temperature increases to 38^oC, the cooling temperature increases to 25^0C while the time of cooling during morning, afternoon and evening periods increases to 24mins, 24mins and, 22.5mins respectively. It is recommended that keeping the air – conditioner at a cooling temperature of 22^0C is advisable during usage

1. Introduction

The air – conditioning systems were manufactured to assimilate heat at a lower temperature and dissipate heat at higher temperature coupled with the vital role it plays in the industries, domestics and the commercial spheres for cooling and heating applications [1]. Meanwhile, the heat that was dissipated may immediately take place to the surrounding as in the case of most conventional air – conditioning systems [2][3][4][5].

The air – conditioning systems are mostly utilize in offices, domestic buildings and shopping malls and it imbibes heat from the living domestic places and interchanges it by cool air while the heat energy that it assimilated is dissipated to the atmospheric environmental air [6]. This machine called air conditioning system, has two important modes of operation which includes the liquid absorbed heat when it transforms from liquid into gas and gas emit heat when it transforms from gas into liquid. Also, the water absorbs heat from the flame as it boils and changes into gas. When the gas condenses into liquid there is a radiation of heat [7]. The air - conditioner is made up of four

equipment which include the compressor, evaporator, condenser and expander. The compressor and the condenser are normally situated on the exterior part of the air – conditioning unit while the evaporator is situated on the interior of the apartment – house.

The refrigerant gets at the compressor and raises the pressure of the fluid and this compacts the molecules of the fluid closer together. Precisely, the closer the molecules, the higher the energy and its temperature. And the refrigerant departs from the compressor as a high pressure gas; high temperature and flows into the condenser [8][9][10][11].

The performance of air – conditioning of water heat with trombone coil type as dummy condenser at different cooling loads was done by [12]. The work analyzed the effects of the system performance parameters – compressor power test chamber, test chamber temperature, condenser temperature, hot water temperature and COP. The result obtained revealed that the larger the cooling load that is generated to the test chamber, the larger the heat that is assimilated in the evaporator and the greater the temperature of the hot water in the tank.

The appraisal of determining the waste water heat from a 1.5HP air – conditioner attached to an office was conducted by [9]. The result obtained revealed that 145.81KJ heat was rejected and it was also found that there is possibility of recycling the heat for commercial utilization.

The performance assessment of real time of cooling of a 1.5HP window air – conditioner utilizing thermometric apparatus like thermometer and stopwatch was performed by [13][14]. The study engulfed fifteen (15) days during which the collations of data were made and it was done. The study shows that for every 1^0C increment, the following will happen: 1.207%, 1.119% and 1.186% time taken increase during these periods; 7:00am – 9:00am, 1.119%, 12:00pm – 2:00pm and 1.186% 4:00pm – 6:00pm respectively and it was discovered that the relative humidity affects the time of cooling adversely thereby causing fluctuation in the certainty of time.

The performance assessment of a rooftop air – conditioning unit at high ambient temperatures was done by [15]. Their work encompasses several experimental tests conducted in the laboratory aimed at measuring the effect of high ambient temperature on the energy standard and high efficiency of about 5tons rooftop unit. A comparative performance appraisal of the units at 85^0F, 85^0F, 95^0F, 105^0F, 115^0F, 120^0F, 125^0F and 130^0F air temperature measurement was performed at the condenser air inlet and the results obtained revealed that each rooftop unit's cooling ability degenerated as the ambient temperature increases, and the rate of cooling ability degeneration differs between individual units.

Furthermore, the present study will conduct an performance investigation of the influence of ambient temperature on a 1.5hp air – conditioning unit utilizing basic thermodynamic principles and concept.

2. **Methodology**

The experiment which was performed for Thirteen (13) working days was done on a 1.5HP Air – Conditioner that is connected to office of size 6830mmx248mmm. The data collection were performed by painstakingly taken time for every degree interval as it is well enunciated in the dashboard of the air – conditioner by the manufacturer: LG Nig. LTD. Periodically, the collection of data was performed as follows: morning period: 7:00am – 9:00am; afternoon period: 12:00pm – 2:00pm and evening period: 4:00pm – 6:00pm respectively and it commences with the least

temperature 16^0C and ends with 25^0C and the average of the respective time taken for each degree and each section was computed and compared to [13][14][16].

Thermodynamically, useful equations and principles were utilized in the determination of the coefficient of performance and refrigerating effects doubled with the psychometric chart (See Figures 1 and 6) [7][17][18][19].

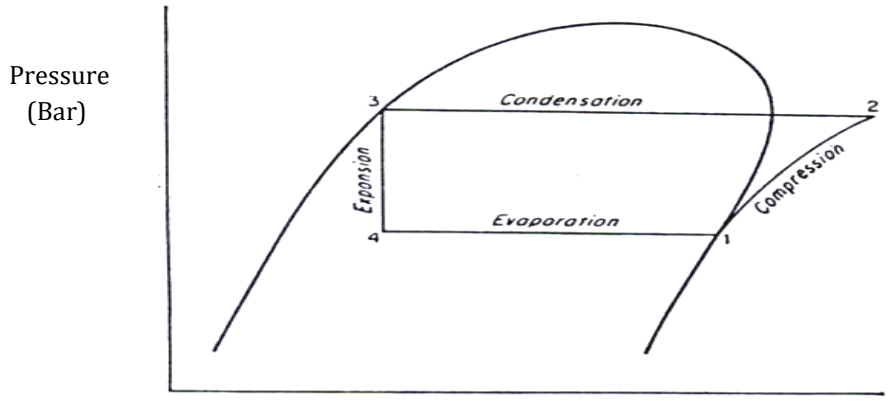

Figure 1. Pressure – Enthalpy Diagram [8][16]

From Figure 1 the coefficient of Performance and the refrigerating effect can be deduced[13][18][19].

$$COP_{ref} = \frac{Q_{41}}{W} = \frac{h_1 - h_4}{h_2 - h_1} \quad (1)$$

$$Q_{41} = h_1 - h_4 \quad (2)$$

3. Results and Discussion

3.1 Results

Table 1 comprises of the reading from the stopwatch after conscious monitoring of the exact time of the thermometer when it reaches the comparable temperature. The reading commences with 16^0C and stops with 26^0C and the mean values computed and tabulated. Meanwhile, Excel Software was utilized to ascertain the effects of ambient temperature on the cooling temperature and the effect of ambient temperature on the time of cooling at the respective section that the experiment was conducted (See Figures 2 – 5).

Table 1: Values of Time Taken at Different Degrees Levels

S/N	Temperature (^{0}C)	Average Ambient Temperature (^{0}C)	7am -9am (Mins.)	12 pm – 2pm (Mins.)	4pm – 6pm (Mins.)
1	16.00	32.00	11.03	13.04	11.00
2	17.00	33.00	12.58	14.02	12.55
3	18.00	32.00	13.05	15.07	14.48
4	19.00	34.20	15.07	15.23	15.00
5	20.00	32.00	16.30	17.00	16.48
6	21.00	37.00	18.05	19.03	18.05

7	22.00	36.00	19.10	20.50	19.30
8	23.00	33.30	19.50	20.58	20.01
9	24.00	35.50	20.10	21.00	20.00
10	25.00	37.40	22.30	22.00	21.02
11	26.00	38.00	22.50	23.50	23.00
12	27.00	39.20	24.00	24.00	24.00
13	28.00	37.00	25.00	26.00	25.50

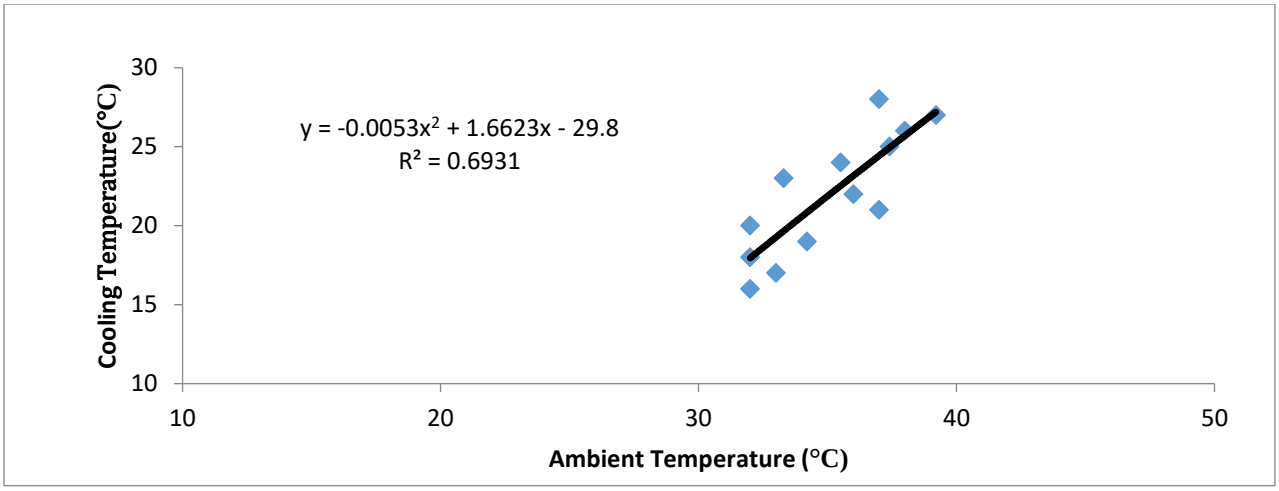

Figure 2. Influence of Ambient Temperature on the Cooling of Temperature

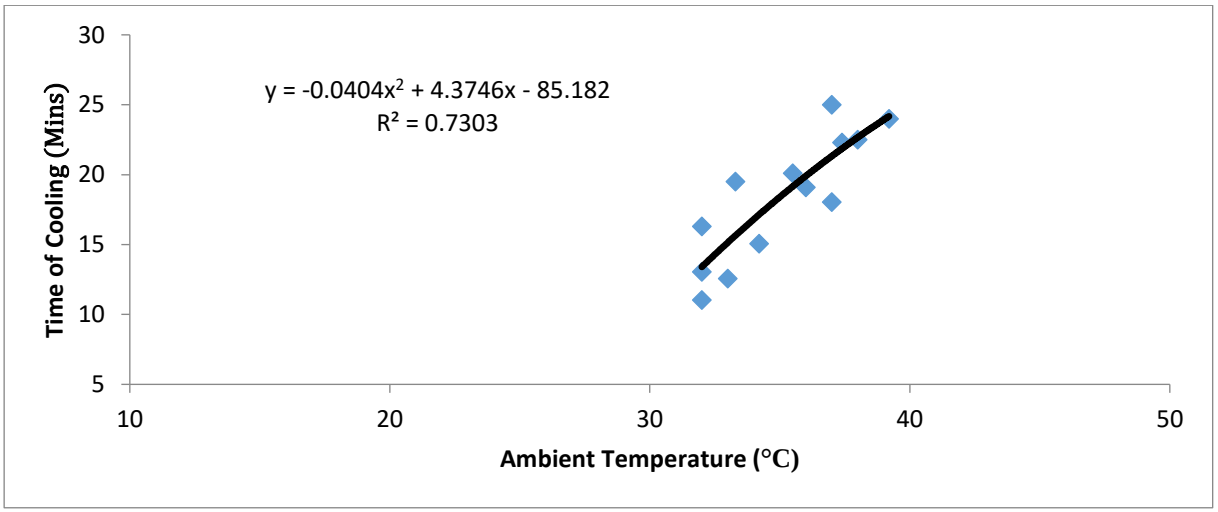

Figure 3**.** Influence of Ambient Temperature on the Time of Cooling during Morning Period: 7am – 9am

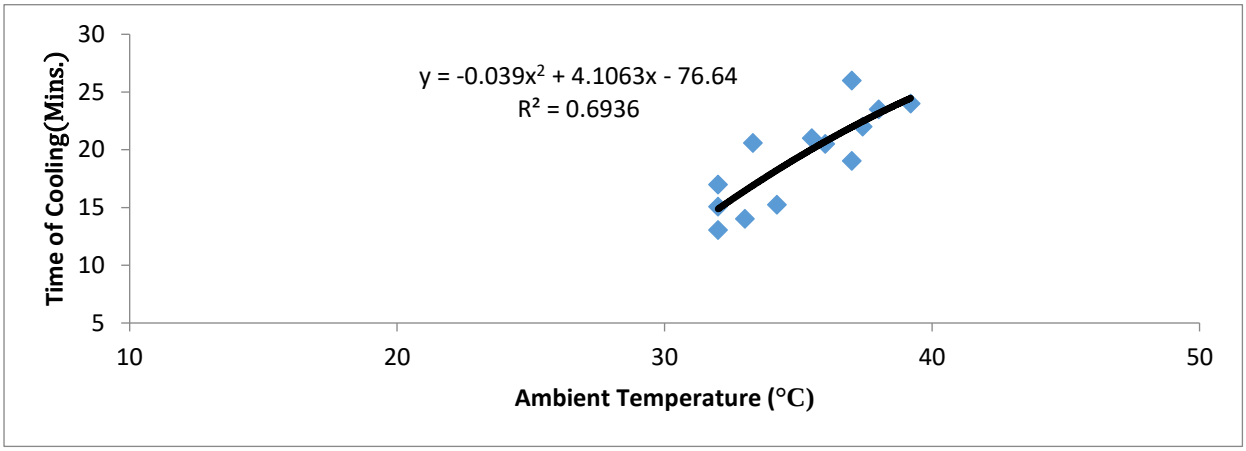

Figure 4**.** Influence of Ambient Temperature on the Time of Cooling during Afternoon Period:12pm – 2pm

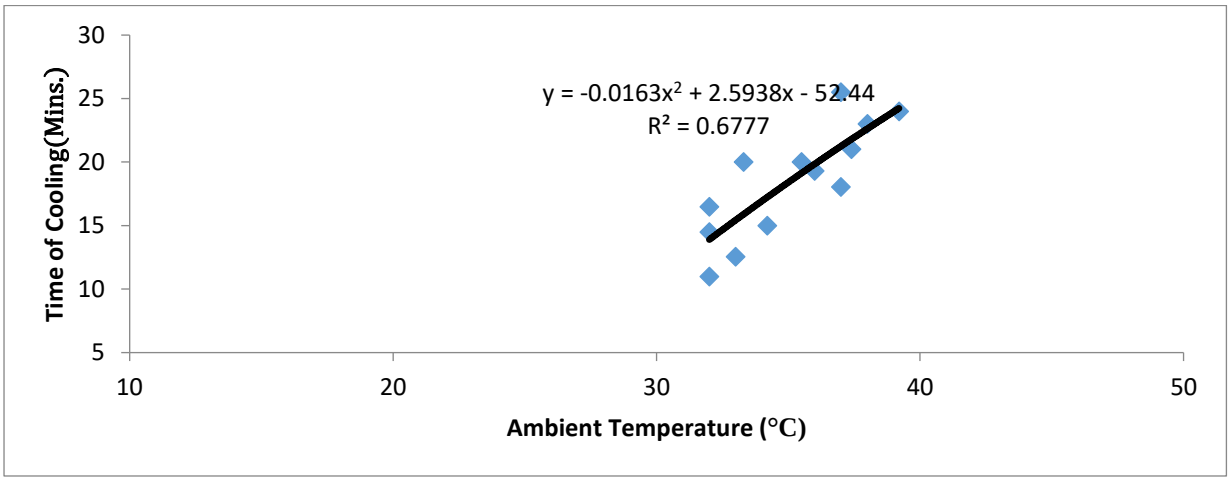

Figure 5**.** Influence of Ambient Temperature on the Time of Cooling during Afternoon Period: 4pm – 6pm

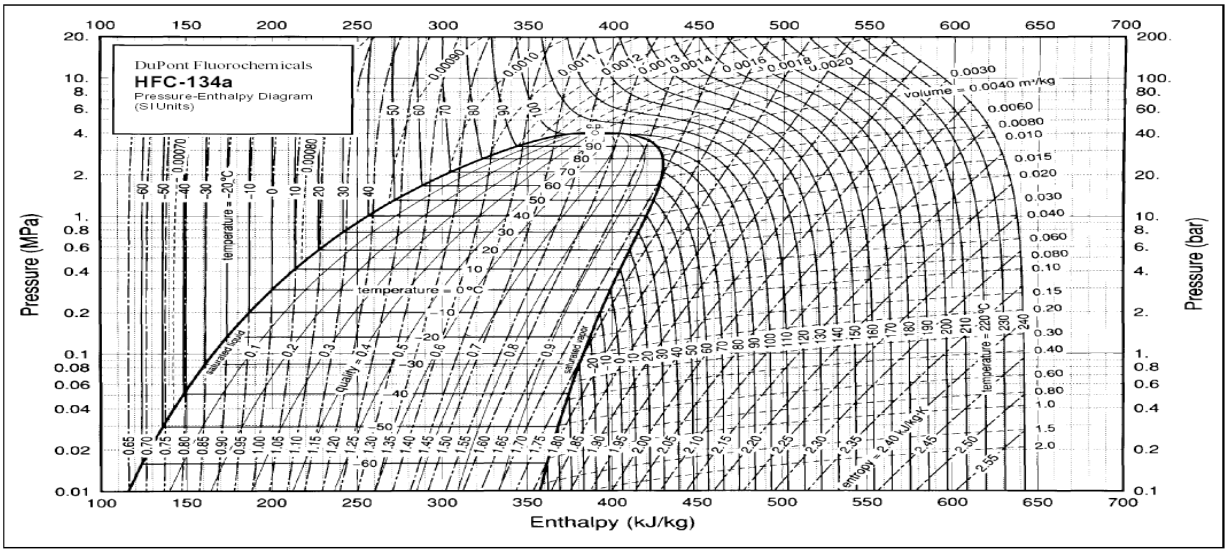

Figure 6. Psychometric Chart [7][8][16][18][19]

3.2 **Discussion**

The graphs (Figures 2 – 6) show that as the ambient temperature increases from 32^{o}C to 38^{o}C the following changes in the cooling temperature, time of cooling during morning period, time of cooling during the afternoon period and the time of cooling during evening period occurred: 18^{0}C to 25^{0}C, 12mins to 24mins, 14.5min to 24mins and 13mins to 22.5mins respectively. All the graphs depict increasing trends for the different parameters as the ambient temperature increases. The least coefficient of determination R^2 for the graphs, obtained from the Excel Software Program, is 0.677 (that is, for the time of cooling during evening period). According to statistical data by [20], R^2 requisite for a 95% assurance level is 0.500. Since this is less than 0.677, there is 95% assurance that all the graphs can be used in the obtainment of the different parametric values which they stand for coupled with the cognition of ambient temperature.

Furthermore, using the figure 6 and taking into cognizance the temperatures of the air conditioner at 16^{0}C and 25^{0}C respectively, the enthalpies: h_1= 415KJ/Kg, h_2=435KJ/Kg, h_3 = h_4= 230KJ/Kg can be computed utilizing Equations: 1 and 2, and the COP= 9.25 and Q_{41} =185KJ/Kg [16][17].

4.0 Conclusion

This paper look at the influence of ambient temperature on the performance of a 1.5HP Air – Conditioner that is connected to office of size 6830mmx248mmm . The results show that as the ambient temperature increases to ambient temperature of 38^{o}C, the cooling temperature increases to 25^{0}C while the time of cooling during morning, afternoon and evening periods increases by 24mins, 24mins and, 22.5mins respectively signaling that at high ambient temperature it requires more time thereby dissipating much energy which in turn will bring about the wear and tear of the air - conditioner. It was also found that the coefficient of performance was 9.25 and the refrigerating effect was 185KJ/Kg. It is recommended that keeping the air – conditioner at a cooling temperature of 22^{0}C is advisable during usage.

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