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Research paper

Structural And Thermal Characteristics of Aluminum Grades 6063 and 7075 with Application of Nano Coatings

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Abstract

To fabricate any product, material selection is one of the major constraints for many engineers even on today. An intensive research is being done by scientists and engineers over the properties and characteristics of the materials. Due to the technology advancement, applications of various new products are entering into market with different materials. From the past few decades composites and alloy materials are playing a vital role because of their unique nature. In the present work heat exchangers are taken into application. In nuclear and power plants heat exchangers plays a crucial role in cooling the reactors. When these are made to cool with water by sending through metal pipes over a period of time, metal pipes get easily corroded because of water and thermal conductivity of the metal. When base metals are coated with Nano-particles there is a drastic change in their behavior. In this paper Aluminum grade 6063 and grade 7075 are considered and coated with Al2O3-NaOH Nano fluids. Their thermal and structural characteristics are identified before and after Nano coating.

Keywords: *Heat exchangers, Reactors, Nano-particle, Aluminum andThermal Conductivity.*

1. Introduction

The device used for efficient way of heat transfer is Heat exchangers. These are used in various industrial applications for both cooling and heating. It is also used to convert the waste energy into useful thermal energy. There are several factors which are to be considered for selecting an appropriate heat exchangers and one of the constraints is selection of material. In early day's carbon steel, stainless steel, copper, bronze, brass, titanium and various alloys are used in making of heat exchangers but due to less accuracy of these materials composite alloys came into picture. Alloys are majorly used because of their distinctive nature and these are classified into different grades. Each grade has unique properties. As technology in getting developed day by day there is lot of research advances in the material sciences. Nano technology is one of the newborn and modern technologies in the sciences. When the metals are either coated with the Nanoparticles or doped with the nano particles, the behavior of the materials are getting changed tremendously. In the present work Aluminum grade 6 and 7 are considered coated with nano particles and work was carried out.

2. Literature Review

Arul.Prakash et al explain about Aluminum oxide (al2o3) Nano particles which have been prepared by using micro emulsion methods will definitely have great and wide usage in cosmetic. Pharmaceutical areas and other industries applications. Exposure of these NANO particles to human can be ris6to health and accurately assessing toxicity is of utmost importance important and may attach to cell membrane to disturb its permeability and respiration. Future studies must concentrate on this toxicity of Nano particles mechanism.

Krishna murtiMuralidharah et al explain Another synthesis route has been used for related for the creation of Aluminum Nano particles (Al-NPs) were acquired by reducing aluminum acetylacetonte [AL (acacia) 3] to lithium aluminum hydride (liALH4) in mestitylene at 165 degrees centigrade. The characterization by powder x ray diffraction pattern of NANO particles and AL-MAS-NMR where un ambiguous. When decomposed with acacia ligand, carbonaceous residue was formed which acts as stabilizing agent.

M.Farahmandjou et al explain Aluminum oxide Nano particles were prepared successfully by aluminum nitrate and glycine Hexagonal structure of Alfa al203that was shown by XRD spectrum annealed at 1000 degrees centigrade and form SEM & TEM images .It is clear the al2o3 decreases with raising temperature and size decreases to 10 nm respectively the brand gap energy shown by uv-spectrum of 2.65 ev increases with raising temperature because of decreasing the size.

M. Farahmandjou et al explain Novel Alfa al2o3 Nano particles ceramic prepared using sol gel method by ethanol solution of aluminum-nitrate at 1000 degrees. The rombhohydral structure of Alfa al2o3 annealed and shown by XRD spectrum firm SEM and TEM image .It is clear that the particles with diameter about 28mm respectively in prepared al2o3 EDS shown plenty of o2 and al.

Rodica ROGOJAN et al explain Alumina is a bio material which is highly in medical application. It is a biodegradable a material which is also used in implants sol gel method is a process which formed from metallic oxides or organic metallic pressure phase transformation the sol gel methods of Alfa alumina is done by x-

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ray diffraction thermo gravity (DTA TG) transmission electron microscopy (TEM) scamming micro electroscope after application of sol gel method after heat treatment for 2 hours at 1000 degrees alumina powder is obtained which is at Nano scale. When compared at alumina powder in larger sizes Nano scale powders have very good properties. Which can be used in medical applications.

Majidfarahmandjou et al explain By using Aluminum nitrate and Aluminum isopropoxide as precursor new nonporous alumina ceramic were synthesized in presence of z-ethyleneglycole surfactant hexagonal structure of Alfa al2o3 annealed at 100 degrees was shown by XRD spectrum AL-o stretching made of al2o3 was shown by FTIR measurement and bend gap of 2.61 ev was indicated by uv-v absorption for the samples.

Qiang Fu et al explain By using Aluminum we can form a complex compound (alc36h2o). They form smooth and crack free alumina films. The complex forms as chelating ring structure which makes the solution stable and thereby using the sintering process it prevents from forming of cracks.

Kamal kayed,EsaafAlsoki et al explain Aluminum samples are there by prepared by compressing the metal and there by applying the annealing where heating is also done using co2 laser where compared to both co2 laser and oven there was high structural change during the application of co2 laser as compared to the oven it also proved high hardness and also very less structural defects.

S.O Adeosun et al explain Some of Aluminum 6063 sample was rolled and other are forged at 32 degrees the rolled samples have improved strength as they were cooled in water after the polling process the strength of the rolled sample (127)Mpa and also the received up to 27%.

P. S. Pao, et al explain The alloys of 7000 series Aluminum are tested in terms of corrosion pits and fatigue cracks due to the presence of the corrosion pit the fatigue crack initiation is thereby reduced to the maximum extent and there by 50%of the threshold of alloy is decreased if the pits were not present the fatigue cracks were formed through large inclusions.

G.Britto Joseph et al explain The mechanical properties of the 6063 Aluminum alloy are increased by the addition of Aluminum al2o3 on the surface of the AA 6063aluminium alloy by the friction processing technique (ESP) after the dispersion the results shows that there was 1.7 times higher strength .Where compared to the metal that was unpressured combination al203 over the AA 6063 can be applied in aerospace application.

G.AL-Marahleh et al explain The mechanical properties of the homogenized billets are compared with and without aging to form an perfect homogeneous structure thermo mechanical treatment such as hot extension is better .If AA 6063 is to be homogenized temperature of 520 degrees should not be exceeded withhold 2h during the process.

Grazynamrowka-nowotniket al explain The heat treatment of both the AA6005 and 6082 alloys were done are increased efficiency is increased.

Daniel Damin et al explain Alumina can be used as waste water treatment and thereby as biomaterial using hydrothermal treatment synthesis of Nano particles with smaller than 10nm is performed from 510 to 530 degrees aging was done at room temperature the aging of 120h was obtained by metallographic ad transmission electron microscopy (TEM) after the Brinell`s Sharpness Strength AA6082 is sensitive when it is cooled in water when compared to homogenization the Rm is higher after the forging process when compared to cast state heat treatment of 6065 has no difference.

NituBhatnagar et al explain Have more demand to minimize cost or maintenance of metallic structures while the performance for protective coating. That can long & well to corrosive conditions in marine environment CNF`s are great interest to due mechanical & electron`s properties. The result of angle value which high with the Al2O3 Nano coating on steel surface.

3. Experimental Investigation

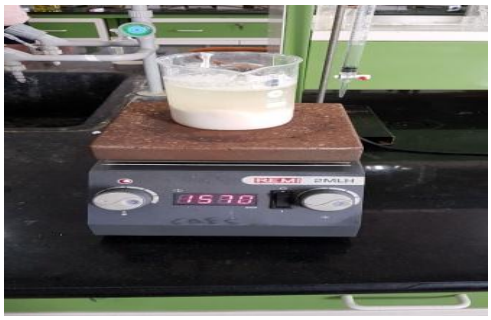


Figure (a): Magnetic stirrer.



Figure (b):Thermometer



Figure (c): aluminum bar

Magnetic stirrer and sonication techniques are used to make Al_2O_3 nano particles amalgamate with NaOH solution (dispersion medium) and it is mixed with a ratio of 0.1 gm/cc. Initially magnetic stirrer is used to stir the solution and then sonication method is carried out for two hours. After the completion of sonication, job is made to dip in the solution with regular intervals for uniform nano coating. Coated aluminum grades(6 & 7) are placed on the wooden stand which is in a glass beaker (whose dimensions are 45x20 cm). Digital thermocouple probes are fixed to the work piece at various locations for measuring the temperature at regular intervals of time. Hot water is made to flow on the work piece until the object reaches the constant temperature. It is repeated with different water temperatures (35^0c, 450c, 550c& 65^0c) and the temperature distribution was identified. Initially experimentation is carried out without nano coating and then with nano coating. Finally the hardness of the material (after and before nano coating) is calculated with the help of Brinell`s hardness testing machine.

4. Results:

4.1 Hardness testing

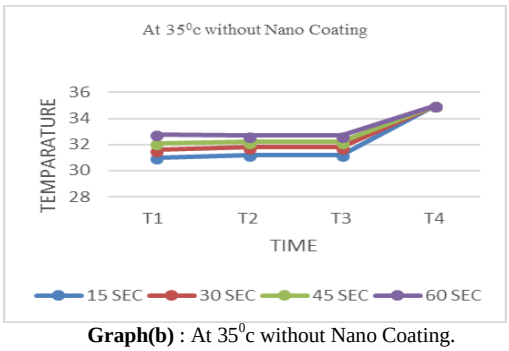
Following are the hardness values obtained from the brinell`s test.

Table (a): Brinell`s hardness test

	BHN Without	BHN With
Al (6063)	88.91	113.66
Al (7075)	104.40	136.12

4.2 Aluminium Grade 6063.

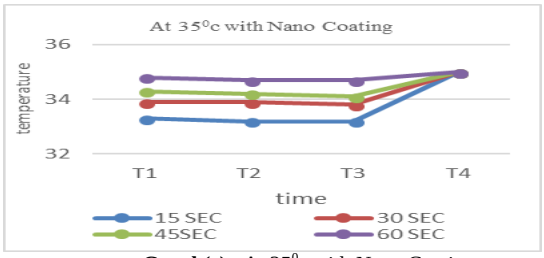
Following graphs are the temperature distribution of aluminum 6063 work piece (with and without Nano coating).To measure the temperature on the surface, at different locations digital thermo-couple thermometer is used. This digital thermometer have 4 probe holes in the top, this holes correspond to T1, T2, T3 & T4 temperature. T4 probe is placed in the water and remaining 3 probes (T1, T2 & T3) are fixed to the surfaces.



Graph(b) : At 35^{0}c without Nano Coating.

Table(b) : At 35^{0}c without Nano Coating.

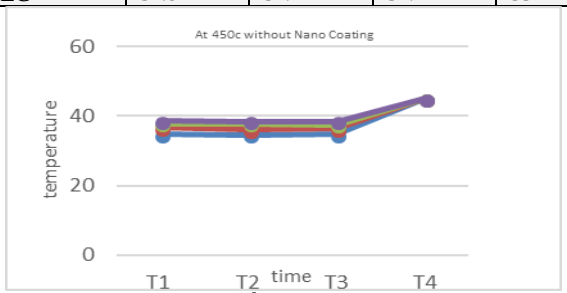
		35 °		
	T1	**T2**	**T3**	**T4**
15 SEC	31	31.2	31.2	35
30 SEC	31.6	31.8	31.8	35
45 SEC	32.1	32.2	32.2	35
60 SEC	32.8	32.7	32.7	35



Graph(c) : At 35^{0}c with Nano Coating.

Table(c) : At 35^{0}c with Nano Coating.

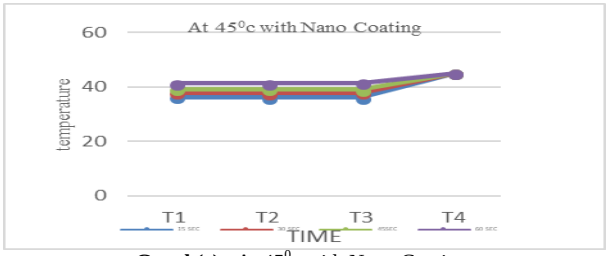
		35°		
	T1	**T2**	**T3**	**T4**
15 SEC	33.3	33.2	33.2	35
30 SEC	33.9	33.9	33.8	35
45SEC	34.3	34.2	34.1	35
60 SEC	34.8	34.7	34.7	35



Graph(d): At 45^{0}c without Nano Coating

Table (d): At 45^{0}c without Nano Coating.

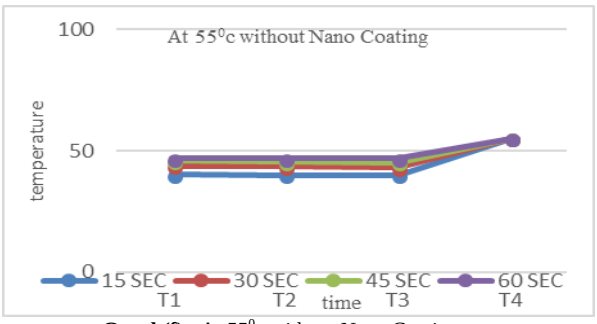
		45 °		
	T1	**T2**	**T3**	**T4**
15 SEC	34.8	34.5	34.7	45
30 SEC	36.6	36	36.4	45
45 SEC	37.7	37.7	37.5	45
60 SEC	38.6	38.4	38.4	45



Graph(e) : At 45^{0}c with Nano Coating.

Table (e): At 45^{0}c with Nano Coating.

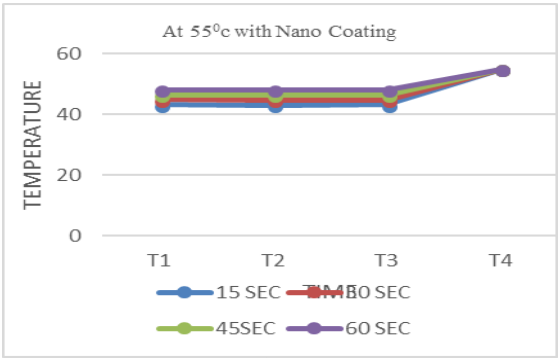
		45°		
	T1	**T2**	**T3**	**T4**
15 SEC	36.2	36.1	36.1	45
30 SEC	37.9	37.8	37.9	45
45SEC	39.2	39.2	39.1	45
60 SEC	41.3	41.3	41.4	45



Graph(f) : At 55^{0}c without Nano Coating.

Table (f): At 55^{0}c without Nano Coating.

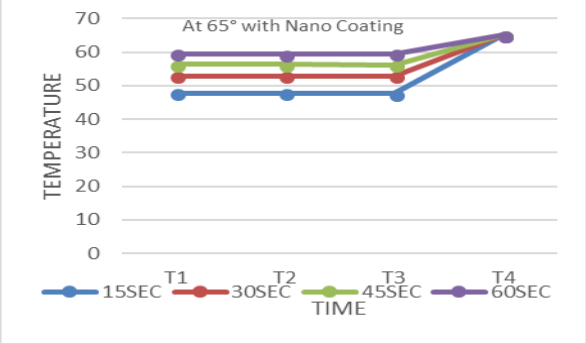
		55°		
	T1	**T2**	**T3**	**T4**
15 SEC	40.2	39.9	39.9	55
30 SEC	43.8	43.4	43.1	55
45 SEC	45.8	45.3	45.1	55
60 SEC	38.5	38.4	38.1	55



Graph(g) : At 55^{0}c with Nano Coating

Table(g) : At 55^{0}c with Nano Coating

		55°		
	T1	**T2**	**T3**	**T4**
15 SEC	43.3	43.1	43.2	55
30 SEC	44.9	44.8	44.8	55
45SEC	46.5	46.4	46.5	55
60 SEC	48.2	48.1	48.1	55



Graph(h) : At 65^{0}c without Nano Coating.

Table(h) : At 65^{0}c without Nano Coating.

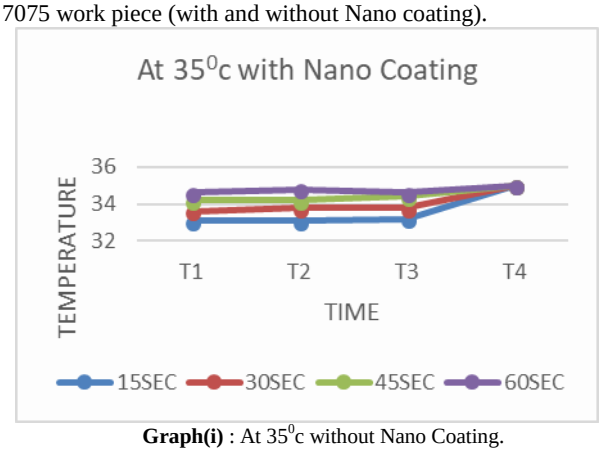
	T1	T2	T3	T4
15 SEC	45.8	45.8	45.7	65
30 SEC	50.2	50.1	50.1	65
45 SEC	54.3	54.2	54.3	65
60 SEC	57.2	57.3	57.2	65

Figure(b to h) : Temperature distribution for 6063 grade.

From the graphs it was observed there is a rise in temperature from 1 c° to 3 c° after application of Nano coating.

4.2 **Aluminium grade 7075.**

Following graphs are the temperature distribution of aluminium 7075 work piece (with and without Nano coating).

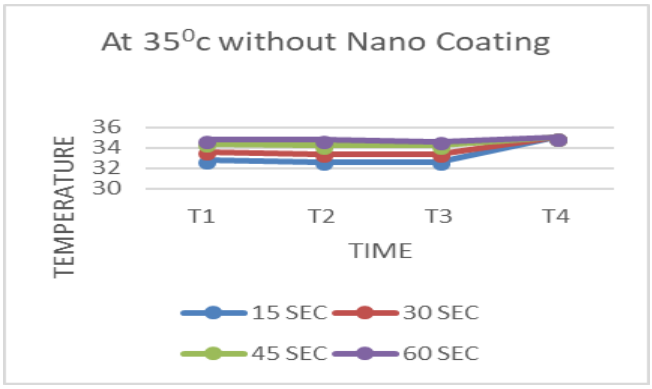


Graph(i) : At 35^{0}c without Nano Coating.

Table(i) : At 35^{0}c without Nano Coating.

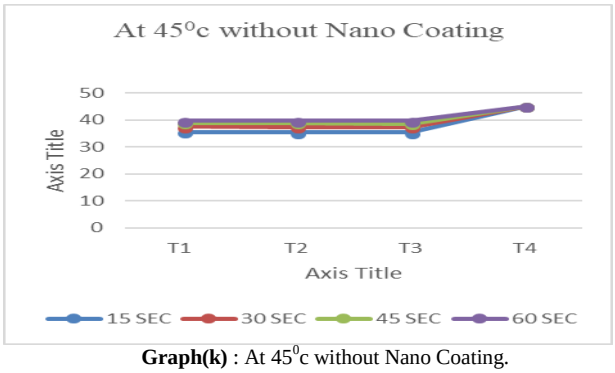
		35^0		
	T1	**T2**	**T3**	**T4**
15 SEC	32.8	32.6	32.6	35
30 SEC	33.6	33.4	33.4	35
45 SEC	34.4	34.2	34.2	35
60 SEC	34.8	34.8	34.6	35

Graph (j): At 35^{0}c with Nano Coating.



Table(j) : At 35^{0}c witht Nano Coating.

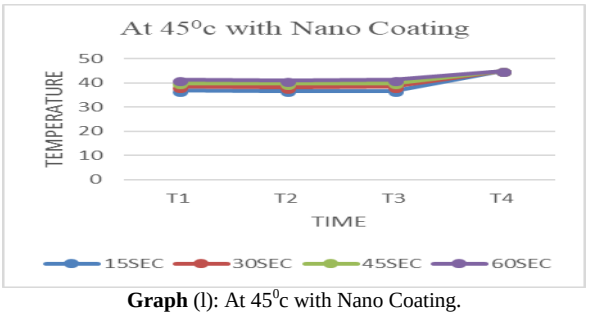
		35^0		
	T1	**T2**	**T3**	**T4**
15SEC	33.1	33.1	33.2	35
30SEC	33.6	33.8	33.8	35
45SEC	34.2	34.2	34.4	35
60SEC	34.6	34.8	34.6	35



Graph(k) : At 45^{0}c without Nano Coating.

Table(k) : At 45^{0}c without Nano Coating.

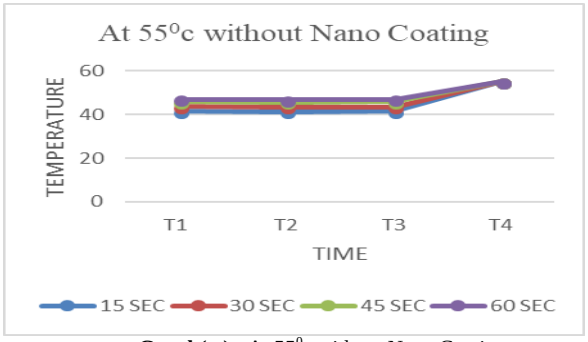
		45^0		
	T1	**T2**	**T3**	**T4**
15 SEC	35.5	35.4	35.3	45
30 SEC	37.5	37.3	37.4	45
45 SEC	38.9	38.8	38.6	45
60 SEC	39.7	39.7	39.6	45



Graph (l): At 45^{0}c with Nano Coating.

Table(l) : At 45^{0}c with Nano Coating.

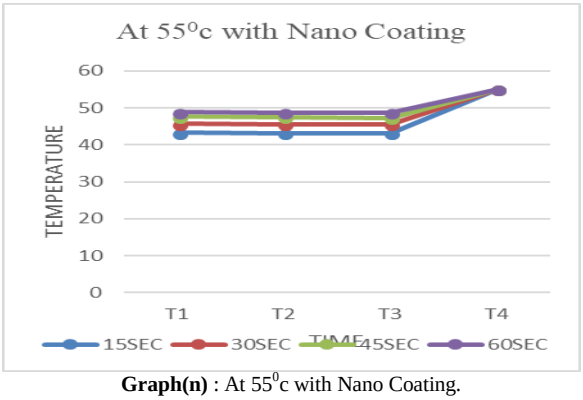
		45^0		
	T1	**T2**	**T3**	**T4**
15SEC	36.9	36.7	36.7	45
30SEC	38.5	38.1	38.5	45
45SEC	39.9	39.8	39.9	45
60SEC	41.3	41	41.3	45



Graph(m) : At 55^{0}c without Nano Coating.

Table(m) : At 55^{0}c without Nano Coating.

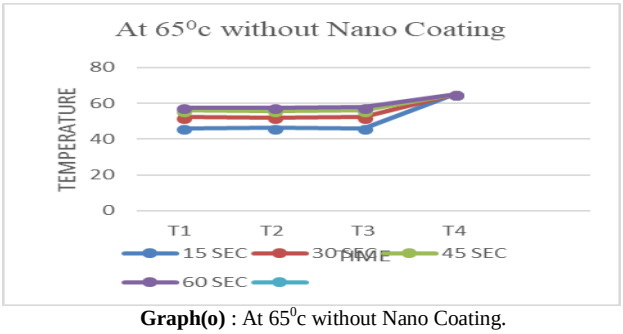
		55^0		
	T1	**T2**	**T3**	**T4**
15 SEC	41.5	41.4	41.5	55
30 SEC	43.7	43.4	43.5	55
45 SEC	45.9	45.7	45.8	55
60 SEC	46.9	46.8	46.9	55



Graph(n) : At 55^{0}c with Nano Coating.

Table(n) : At 55^{0}c with Nano Coating.

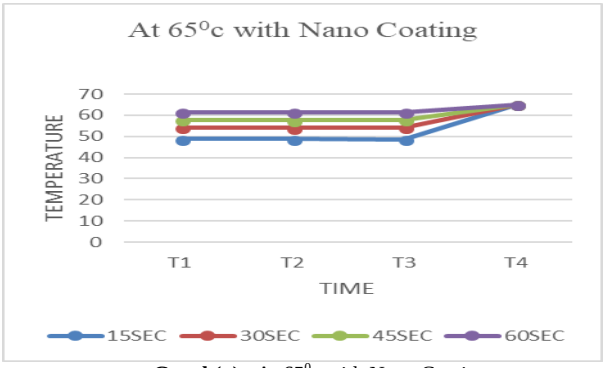
		55^0		
	T1	**T2**	**T3**	**T4**
15 SEC	43.3	43.2	43.2	55
30 SEC	45.7	45.6	45.6	55
45 SE C	47.6	47.5	47.3	55
60 SEC	48.9	48.7	48.7	55



Graph(o) : At 65^{0}c without Nano Coating.

Table(o) : At 65^{0}c without Nano Coating.

		65		
	T1	**T2**	**T3**	**T4**
15 SEC	46.1	46.2	46.1	65
30 SEC	52.4	52.1	52.3	65
45 SEC	55.9	55.8	55.9	65
60 SEC	57.7	57.7	57.9	65



Graph(p) : At 65^{0}c with Nano Coating.

Table(p) : At 65^{0}c with Nano Coating.

		65		
	T1	**T2**	**T3**	**T4**
15SEC	48.7	48.7	48.5	65
30SEC	54.3	54.1	54.2	65
45SEC	57.9	57.7	57.8	65
60SEC	61.5	61.4	61.4	65

Figure(I to p) :Temperature distribution for 7075 grade

From the graphs it was observed there is a rise in temperature from 1 c° to 4 c° after application of Nano coating.

5. Conclusion

From the results, hardness of the material is increased by 20% and interestingly it was observed that after application of Nano-coating there is an increase in temperature from 1^0 to 3^{0}c and 1^0 to 4^{0}c for grades 6063 and 7075. Which mean Al-NaOH nano coated metal will be heated more when compared to without nano coating hence these heat-exchangers can be used for heating purpose rather than for cooling.

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