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Progress in Science and Technology Research Symposium

Letter of Acceptance

Padang, Indonesia, 25 Nov 2019

Dear authors: Nuzul hidayat, M. Yasep Setiawan, Ahmad Arif, Wanda Afnison

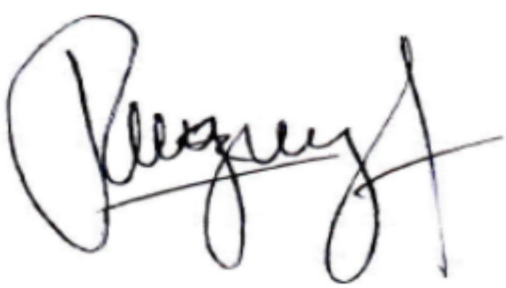
We are pleased to inform you that your abstract **GS.AB-10** entitled:

"Comparison of Effectiveness in Straight-Fin Radiator Types with variations in Time and cooling air velocity"

has been **Accepted** at PSTRS conference to be held on 04 November 2019 in Padang, Indonesia.

Please submit your full paper and make the payment for registration fee before the deadline. For more information please visit our website.

Best Regards,



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[GS.AB-10]

STUDY OF EXPERIMENTAL CAPABILITY OF HEAT RELEASE ON HEAT EXCHANGER FOR STRAIGHT FIN RADIATOR FIN TYPE FLAT TUBE WITH COOLING LIQUID VARIATIONS

Nuzul hidayat, M. Yasep Setiawan, Ahmad Arif, Wanda Afnison

UNIVERSITAS NEGERI PADANG

Abstract

The development of radiators at this time is very rapid both in construction, material maker and dimensions that tend to be more efficient and effective in heat release. In the automotive world, developing technology about coolant that has a high ability to release heat and is able to survive in high temperatures. Current cooling liquid is also developed by having advantages compared to ordinary water which is actually equipped with anti-freeze so that the liquid does not freeze during winter, also equipped with anti-rust content so that the radiator has a longer service life. Efforts to clearly determine the radiator's ability so that this can help in choosing the right type of coolant in a car so that the engine does not overheat or the engine keeps its working temperature. The method used in this study is to use an experimental method. Tests are carried out on a straight

Keyword : EFFECTIVENESS, COOLING FLUID, RADIATOR

Topic : Chemical physics and physical chemistry

PAPER • OPEN ACCESS

Comparison of Effectiveness in Straight-Fin Radiator Types with variations in Time and cooling air velocity

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Journal of Physics: Conference Series **1594** (2020) 012032 doi:10.1088/1742-6596/1594/1/012032

Comparison of Effectiveness in Straight-Fin Radiator Types with variations in Time and cooling air velocity

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Abstract. The heat is the result of combustion that occurs in the combustion chamber with very high temperatures above 800 ^{0}C. If this temperature is left, it will cause the engine to overheat so that it can cause damage to engine components. Current cooling liquid is also developed with advantages compared to normal water which is actually equipped with anti-freeze so that the liquid does not freeze during winter, it is also equipped with anti-rust content so that the radiator has a longer service life. This research was conducted experimentally on a 5K series Toyota Kijang car engine. The effectiveness of the radiator is known by measuring the temperature of the coolant entering the radiator, the temperature of the liquid coming out of the radiator, then measuring the temperature of the coolant inlet air, measuring the temperature of the coolant air after passing through the radiator. The results obtained that the Prestone brand coolant at 60 seconds with a cooling air velocity of 2.4 m / s is better in reducing the heat generated by this machine is proven by the effectiveness value of 0.494.

1. Introduction

The cooling system is one of the most important components in an engine that serves to keep the circumstance of the engine to stay at a working temperature of 80^{0}C. To keep these stipulations requires most advantageous work from the cooling system. One vital thing of the cooling system is the radiator. Radiator is a device that features as a heat exchanger. This warmth is obtained from the combustion of an engine that is transferred via the cooling fluid to the radiator. Then the heat in the radiator is transferred to the surroundings via the radiator fins.

The improvement of radiators at this time is very rapid both in construction, cloth maker and dimensions that tend to be greater environment friendly and high-quality in heat release. On the other hand the automotive world is additionally developing science about cooling liquid which is right in warmth dissipation and is able to survive at excessive temperatures. Current cooling liquid is additionally developed by way of having benefits compared to regular water which is in reality geared up with anti-freeze so that the liquid does no longer freeze at some stage in winter, also geared up with anti-rust content so that the radiator has a longer provider life.

Currently, for cooling fluid in radiators, many are sold in the market with a number of types and a variety of compositions, including Preston, Master Premixed Green, Coolant Mega cool Radiators and others. Ordinary people do not get suggestions on the use of coolant which is suitable for their vehicles. It is vital to recognize that humans can purchase coolants according to the persona of the automobile.

In expanding the adequacy of radiators a part of work was done. [1] Conducted inquire about on shifting the sort of radiator and motor speed and gave the same treatment to the test examples. The comes about appeared that of all varieties of the cooling speed of the radiator sort that has great warm scattering capacity is the level tube sort with an viable esteem of 0.593 with a variety of stream speed

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of 3.52 m / s and 120 s. It can be concluded from the inquire about that level tube sort radiators have way better warm dissemination than circular barrel tube sorts. At that point inquire about on radiator testing was carried out on Toyota Kijang 5k radiator blades with a straight tube sort level blade show by changing the point of assault of the tube on the radiator. With this investigate, the finest warm scattering prepare is at the radiator position with a tube point of 5^0 compared to the standard position [2].

This investigate on the utilize of coolant was conducted [3] employing a Mitsubishi Colt L300 Pick-up in 2003. The coolant tests utilized were water, Mitsubishi Long Life Coolant, TOP1 Super Coolant, and Prestone. The viability test is carried out at a steady turn of 1500 rpm and inside 5 minutes, 10 minutes and 15 minutes. The comes about appeared that the use of coolant which features a higher bubbling point than the bubbling point of water includes a critical impact on the viability of the diesel motor radiator. The adequacy esteem of the radiator on the utilize of Mitsubishi LLC 0, 1943 or higher 0, 0094 (5, 08%). The adequacy esteem of the radiator on the utilize of TOP1 SC 0, 1965 or higher 0, 0116 (6, 27%). Whereas the viability of the radiator on the utilize of Prestone 0, 2001 or higher 0, 0152 (8, 22%) compared with the viability of the radiator on the utilize of water as a coolant

Inquire about conducted [4] approximately varieties in coolant on a gasoline-powered cruiser. Based on perceptions, information investigation and talk, it is known that 100% of RC Control coolant liquids gotten the adequacy esteem of 0.512 on a standard fan. Whereas the twofold fan has a viability esteem of 0.539, the adequacy esteem is expanded by 2%. So it can be concluded that the more prominent the fan utilized, the more compelling the esteem rises. Typically due to the collision of increasingly angina so that warm assimilation within the radiator gets to be speedier. Though on liquid varieties, on a twofold fan with 100% RC Mega cools liquid is gotten 0.477. Within the 50% RC Control coolant + 50% RC Mega cools liquid gotten by 0.502, the viability esteem increased by 5.2%. Whereas within the 100% liquid RC Power coolant has a viability esteem of 0.539, the viability esteem expanded by 7.3%. At that point it can be concluded that the fluid with 100% RC Control coolant is the leading liquid esteem of its adequacy since the liquid 100% RC Control coolant includes a bubbling point higher than other liquid varieties since it contains ethylene glycol [5].

From a few of the over considers it can be concluded that the radiator capacities as a warm exchanger that will influence motor execution. So distant, much inquire about has centred on altering the separate of the radiator position, warm dissemination discuss speed, radiator water volume, coolant temperature and flow rate as well as changes within the geometry of the radiator blades and the shape of the tube where the cooling water is cooled. Subsequently, analysts attempted to conduct inquire about by changing comparing the straight tube radiator straight-fin radiator coolant in order to induce the most excellent radiator viability against the brand of coolant.

2. Literature Study

Heat exchange is the vitality move within the frame of warm since of the temperature angle. Normally the heat exchange happens within the course of a moo temperature and in case the more noteworthy the temperature slope, the more noteworthy the warm exchanged. Warm exchange takes place in a few ways. Conduction warm exchange is the method of warm exchange in which warm streams from tall temperature districts to moo temperature districts in a medium (strong, fluid or gas) or between distinctive mediums which are specifically in contact so that vitality and energy trade happens. The warm exchange rate that happens in conduction warm exchange is relative to the typical temperature slope concurring to the taking after condition. The basic equation of conduction is

$$\boldsymbol{q = -kA\frac{\partial T}{\partial x}} \quad (1)$$

Where

q = heat transfer rate (kj/s or watt)

k = material heat conductivity (W/mK)

A = area of heat transfer (m^2)

∂T= Temperature difference (K)

∂x= Distance difference (m)

DT/dx = temperature gradient in the direction of heat transfer

The positive constant "k" is called the conductivity or thermal neglect of the object, while the minus sign is inserted to meet the second law of thermodynamics, namely that heat flows to a place that is lower on the temperature scale [6].

Convection heat transfer is heat transfer because of the movement / flow / mixing from the hot part to the cold part. Examples are heat loss from car radiators, cooling of a cup of coffee etc. According to the way of moving the flow, convection heat transfer is classified into two, namely free convection and forced convection. When fluid movements are caused by differences in density due to temperature differences, the heat transfer is called free / natural convection. If the fluid movement is caused by the force of force / excitation from the outside, for example with a pump or fan that moves the fluid so that the fluid flows over the surface, then the heat transfer is called forced convection.

The heat transfer rate at a certain temperature difference can be calculated by the equation

$$\boldsymbol{q = -hA(T_w - T_\infty)} \quad \text{.......(2)}$$

where

q = Heat transfer rate (kj/s or W)
h = Convection heat transfer coefficient (W / m^2 K)
A = Area of heat transfer surface area (m^2)
T_w = Wall temperature (k)
T_∞ = ambient temperature (K)

The minus sign (-) is used to fulfill the thermodynamic II law, while the heat transferred always has a positive sign (+). Equation (2.2) defines heat resistance to convection. The coefficient of moving surface heat h, is not a substance, but it states the magnitude of the rate of heat transfer in the area close to that surface.

Force convection is the heat transfer where the flow originates from outside, such as from a blower or faucet and pump. Forced convection in a pipe is the condition of convection displacement for internal flow or what is called internal flow. The flow that occurs in the pipe is a fluid that is limited by a surface. So that the boundary layer cannot develop freely as it does in the external flow. As an illustration is the phenomenon of heat transfer flow in a pipe which is stated as:

$$q = \dot{m} c_p \Delta T_b$$

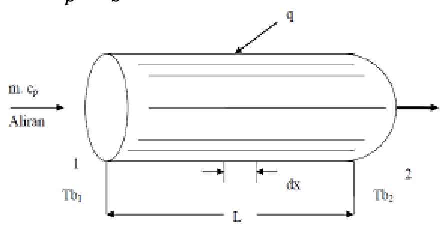


Figure 1. Forcible convection heat transfer

Radiation heat transfer is the process by which heat flows from a high-temperature object to a low-temperature object if the objects are separated in space, even if there is vacuum between the objects. Radiation energy is released by objects due to temperature, which is transferred through the intermediate space, in the form of electromagnetic waves when the radiation energy overrides a material, then some of the radiation is reflected, some is absorbed and some is continued. To determine the amount of energy is

$$\boldsymbol{q" = \varepsilon\sigma T_s^4)} \quad \text{.......(3)}$$

Where

$\boldsymbol{q}$" = heat transfer rate (W)
$\boldsymbol{\sigma}$ = Boltzmann constant (5,669.10-8 W/m2.K4)
$\boldsymbol{\varepsilon}$ = emissivity (0 < $\boldsymbol{\varepsilon}$ < 1)
$\boldsymbol{T_s}$ = absolute temperature of an object (^{0}C)

Heat Exchanger

A heat exchanger is a device used to move heat between two or more fluids which has a temperature difference that is a high temperature fluid to a low temperature fluid. Heat transfer is either directly or indirectly. In most second systems this fluid does not experience direct contact. Direct contact of the heat exchanger occurs as an example of heat gas fluidized in cold liquid to increase the temperature of the liquid or cool the gas.

The heat exchanger used in vehicles can be found on radiators whose function is basically as a heat exchanger. Radiator is a heat exchanger that is used to move heat energy from one medium to another which aims to cool or heat. Radiators that we know are generally used in motorized vehicles (two wheels or four wheels), but not infrequently the radiators are also used on engines that require extra cooling. As in the production machine or other machine that works in heavy or long working conditions. In a vehicle, either a motorbike or a car radiator is generally located in front of and located near the engine or at a certain position that is favorable for the cooling system. This is so that the engine gets maximum cooling as needed by the engine. Radiator consists of the upper water tank, lower tank and radiator core in the middle. Radiator heat transfer

The function of the radiator is to release heat, so in the manufacture of radiators that have a high thermal conductivity, which is capable of delivering good heat such as copper and brass. The heat discharged by coolant can be calculated using the equation

$$\boldsymbol{q = \dot{m} c_p \Delta T} \quad (4)$$

$$\boldsymbol{q = \dot{m} c_p T_2 - T_1} \quad (5)$$

Where

q = heat transfer rate (kJ/det atau W)
m = mass coolant flow rate (kg/s)
c_p = incoming heat capacity (J/kgK)
T_1 = temperature in (K)
T_2 = Temperature out (K)

From this equation, we can analyze heat transfer in a radiator as follows [5]: Amount of heat released by water

$$q_a = \dot{m}_a c_p T_{a1} - T_{a2} \quad (6)$$

Where

q_a = the rate of heat transfer released by water (kJ/det atau W)
m_a = mass rate of flowing water (kg/s)
c_p = incoming heat capacity (J/kgK)
T_{a1} = Inlet water temperature (K)
T_{a2} = outlet water temperature (K)

Whereas to calculate the flowing water mass can use the equation

$$\dot{m}_a = \rho_a V_a A \quad (7)$$

Where

ρ_a = density of water (kg/m^3)
V_a = speed of incoming water (m/s)
A = cross section area of the inlet (m^2)

Amount of heat by cooling air

$$q_u = \dot{m}_u c_p T_{u2} - T_{u1} \quad (8)$$

Where

q_u = The heat transfer rate received by aircooler (Watt)
$\dot{m}_u$ = mass flow rate of air flowing (kg/s)

c_p = incoming heat capacityk (J/kgK)
T_{u1} = temperature of the air out (K)
T_{u2} = temperature of the air out (K)
Whereas to calculate the air mass that flows can use the equation is

$$\dot{m}_u = \rho_u V_u A \quad (9)$$

Where
ρ_u = air density (kg/m^3)
V_u = incoming air speed (m/s)
A = cross section of air inlet
Effectiveness (heat transfer ability)

The effectiveness of a heat exchanger is defined as the ratio between the actual heat transfer rate and the maximum possible heat transfer rate. Where the equation can be shown as follows [6]:

$$\varepsilon = \frac{q}{q_{max}} \quad (10)$$

Where
$\boldsymbol{q}$ = Real heat transfer (W)
$\boldsymbol{q_{max}}$= maximum heat transfer which is allow (W)

For actual heat transfer, it can be calculated from the energy released by the hot fluid or energy received by the cold fluid for the opposite heat flow exchanger.

$$q = \dot{m}_h c_h (T_{h,in} - T_{h,out}) = \dot{m}_c c_c (T_{c,out} - T_{c,in}) \quad (11)$$

Where
$\boldsymbol{\dot{m}_h}$ = hot fluid flow rate (kg/s)
$\boldsymbol{\dot{m}_c}$ = cold fluid flow rate (kg/s)
$\boldsymbol{c_h}$ = heat fluid heat capacity (Kj/kg K)
$\boldsymbol{c_c}$ = cold fluid heat capacity (Kj/kg K)
$\boldsymbol{T_{h,in}}$ = Temperature of entering hot fluid (K)
$\boldsymbol{T_{h,out}}$ = Temperature out of hot fluid (K)
$\boldsymbol{T_{c,in}}$ = Temperature out of hot fluid (K)
$\boldsymbol{T_{c,out}}$ = Cold fluid exit temperature (K)

The heat capacity of each fluid can be searched through equations:

$$C = \dot{m} \ c_p \quad (12)$$

Where
$\dot{m}$ = fluid flow rate (kg/s)
c_p = specific fluid heat (Kj/kg K)

To determine the maximum heat transfer for the heat exchanger it must be understood that the maximum value will be obtained if one of the fluids changes in temperature by the maximum temperature difference found in the heat exchanger, namely the difference in temperature of the hot fluid and cold fluid. The fluid that may experience this maximum temperature difference is the minimum cold fluid flow rate, the energy balance requirement that the energy received by one fluid must equal the energy released by the other fluid. If the fluid that experiences a higher fluid flow rate value is made, then the temperature difference is greater than the maximum, and this is not possible. So the maximum possible heat transfer is stated as follows.

$$q_{max} = \dot{m} c_{min} (T_{h,in} - T_{c,in}) \quad (13)$$

Where,
c_{min} is the smallest heat capacity between cold fluid and hot fluid. If $c_h = c_{min}$ the effectiveness value can be searched with the following equation:

$$\varepsilon = \frac{\dot{m}_h c_h (T_{h,in} - T_{h,out})}{\dot{m} c_{min} (T_{h,in} - T_{c,in})} \quad (14)$$

$$\varepsilon = \frac{(T_{h,in} - T_{h,out})}{(T_{h,in} - T_{c,in})} \quad (15)$$

Whereas for $\boldsymbol{c_c = c_{min}}$, the effectiveness value can be found with the following equation

$$\boldsymbol{\varepsilon = \frac{\dot{m}_c c_c (T_{c,out} - T_{c,in})}{\dot{m} c_{min} (T_{h,in} - T_{c,in})}} \quad (16)$$

$$\varepsilon = \frac{(T_{c,out} - T_{c,in})}{(T_{h,in} - T_{c,in})} \quad (17)$$

3. Research Methods

This research was conducted using experimental methods. Tests carried out on the engine stand of a Kijang super 5K series engine car with a straight tube type radiator flat fin type. To obtain the effectiveness of the radiator whose engine rotation speed (low, middle and high) and also with time variations, then analyzed using the effectiveness equation (ε) on the heat exchanger by measuring the temperature of the cooling water and cooling air. The process of installing the radiator and the whole series of tests was carried out at the Motor Fuel Laboratory and vehicle testing of the Department of Automotive Engineering, Faculty of Engineering, and State University of Padang

Test equipment that will be used in this study include the following:

Straight fin radiator, with specifications:

Engine : Toyota Kijang 5K
Fin model : straight fin
Tube Model : flat tube
Coolant type : water coolant
Flow type : down flow

Image of flat tube type radiator straight fin scheme on top view

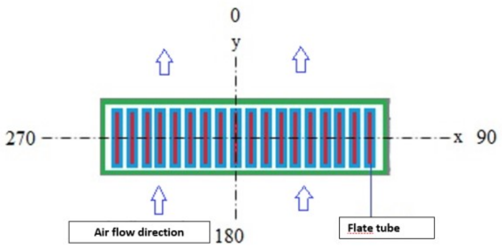


Figure 2. Straight fin radiator type flat tube on top view

As for the research apparatus experiment scheme can be seen as shown below

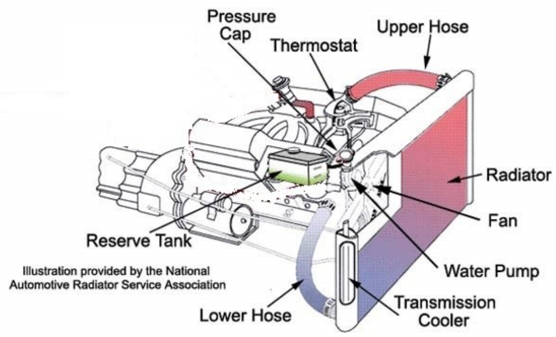


Figure 3. Scheme of experimental research apparatus [7]

4. Results

After conducting research experimentally the following assessment results are obtained. Tests carried out on the radiator obtained data from measurements of the temperature of water entering the radiator, the temperature of the water exiting the radiator and the temperature of the intake air cooler and the temperature of the outlet of the cooling air.

Measurement results on the Prestone brand coolant in the variation of cooling air velocity are shown in table 1.

Table 1. Low speed effectiveness values with time variations

Velocity (m/s)	Rpm of engine	Times (s)	T Air In (^{0}C)	T Air Out(^{0}C)	T Coolant In(^{0}C)	T Coolant Out(^{0}C)	Effectiveness
2.04	1000	60	31.80	48.00	64.60	55.20	0.494
		120	31.80	48.20	65.10	55.60	0.492
		180	31.80	48.40	65.80	56.10	0.488
		240	31.80	48.50	66.10	56.20	0.487
		300	31.80	48.90	67.20	56.20	0.483
		360	31.80	48.70	67.40	56.30	0.475

In table 1 above it can be seen that the best effectiveness value is 2.4 m / s cooling air flow velocity at 60 seconds with an effectiveness value of 0.494. This condition is the optimum condition of the effectiveness of the radiator in reducing the cooling temperature of the cooling liquid. The longer the operating time of the engine so that the cooling time will also be longer the radiator cooling ability decreases. This is evidenced by the effectiveness value on the radiator getting smaller at a maximum time of 360 seconds with a cooling air speed of 2.4 m / s the effectiveness value of 0.475.

Table 2. Value of the effectiveness of medium speed with time variation.

Velocity (m/s)	Rpm of engine	Times (s)	T Air In (^{0}C)	T Air Out(^{0}C)	T Coolant In(^{0}C)	T Coolant Out(^{0}C)	Effectiveness
4.54	2000	60	31.80	48.40	71.80	51.50	0.415
		120	31.80	48.50	72.80	58.40	0.407
		180	31.80	48.50	73.70	59.00	0.399
		240	31.80	48.60	74.50	59.30	0.393
		300	31.80	48.40	74.70	59.60	0.387
		360	31.80	48.00	74.80	59.80	0.377

In table 2 can be seen the ability of the radiator to reduce the best temperature is on the duration of 60 seconds with a speed of 4.54 m / s with an effectiveness value of 0.415. Along with the duration of the operation of the engine, the effectiveness of the radiator decreases even though the cooling time is prolonged as evidenced by the cooling speed of 4.54 m / s at a cooling duration of 360 seconds.

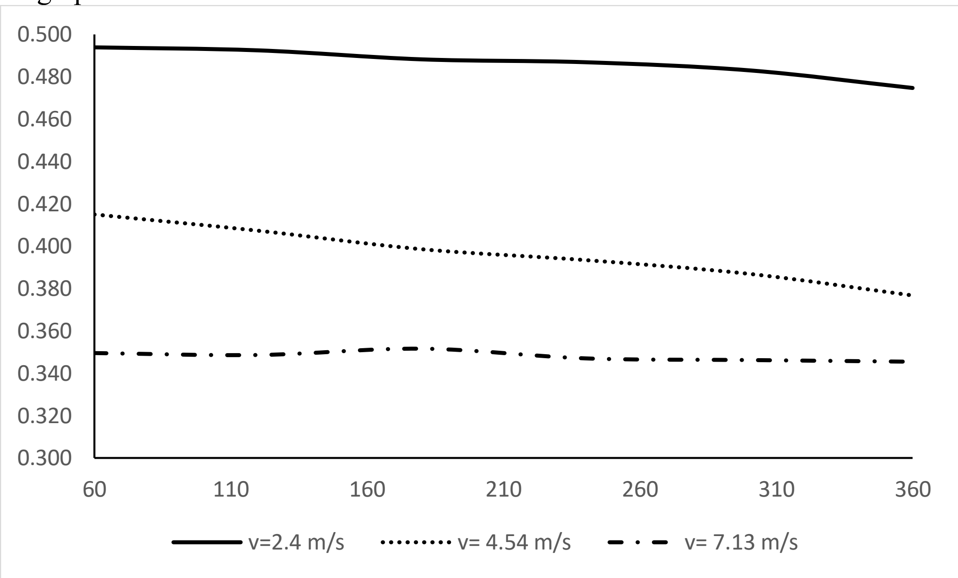
Table 3. High speed effectiveness values with time variations

Velocity (m/s)	Rpm of engine	Times (s)	T Air In (^{0}C)	T Air Out(^{0}C)	T Coolant In(^{0}C)	T Coolant Out(^{0}C)	Effectiveness
7.13	3000	60	31.80	46.90	75.00	60.00	0.350
		120	31.80	47.00	75.40	60.20	0.349
		180	31.80	47.20	75.60	60.60	0.352
		240	31.80	47.00	75.60	60.80	0.347
		300	31.80	47.00	75.70	60.90	0.346

	360	31.80	47.00	75.80	61.00	0.345

In table 3 we can see that the effectiveness value on the radiator is in the position of the cooling air velocity with a duration of 60 seconds with an effectiveness value of 0.350. The tendency for effectiveness of the radiator decreases with increasing duration of cooling because it is influenced by the longer operation of the engine.

For more clearly we can see a comparison of all variations on the effectiveness of the radiator on graph 1.



Graph 1. Comparison of the effectiveness of the radiator with variations in time and speed of the cooling air

In Graph 1 above, it can be seen that overall effectiveness tends to decrease with increasing cooling time and increasing cooling air speed, this is due to the fact that this test uses an engine stand, resulting in poor air circulation around the engine. To increase the speed of cooling air it must increase engine speed, with increasing engine speed, the heat production generated by the engine also increases as a result the effectiveness of the radiator also decreases. The best effectiveness is in the cooling air speed of 2.4 m / s and a cooling time of 60 seconds with an effectiveness value of 0.494. if we look at the cooling air velocity 7.13 m / s, it can be seen that the trend of the effectiveness of the radiator is constant and does not experience significant changes because the high enough air velocity is able to help the radiator release heat properly.

5. Conclusion

From the above research it can be concluded that with increasing duration of operation of the engine can reduce the effectiveness of the radiator. Increase the speed of cooling air then the effectiveness of the radiator has a stable and constant tendency.

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Day 2, 08 November 2019

Venue: Room 1 - Room 4 are located in The Auditorium of Faculty of Economy UNP (Round Table)

Time	Activities	
PARALLEL 1 07.30 – 08.30	Room 1 PSTRS	Heri Prabowo, Fadhilah *Reduction of Heavy Metal Levels (Fe, Mn) in Mining Acid Water Using Constructed Wetland System in Coal Open Mine of PT Ba South Sumatera*
		Heri Prabowo, Yunasril *Analysis of Technical Aspects and Sustainable Environmental Mine Closure Plan PT. Bukit Asam Ombilin Sawahlunto West Sumatera Province*
		Jana Hafiza, S.T., M.T., Fachrul Rozi Ramadhan, S.T.,M.T., Dr. Fadhilah, S.Pd., M.Si., Admizal Nazki, S.T.,M.Si. *Identification of Potential Non-Gold Precious Metal Minerals in the Abai Area Based on Geochemical Approaches Based on X-Ray Fluorecences Analysis*
	Room 2 PSTRS	Irma Husnaini, Hastuti, Dwiprima Elvanny Myori, Asnil, Krismadinata *Design of PI, PID and Fuzzy Logic Controller for DC Shunt Motor*
		Khairi Budayawan; Vera Irma Delianti *The Design of Microstrip Antennas as The Sensor Using Three-Layered Substrate*
		Department Of Chemistry, FMIPA, Universitas Negeri Padang *The Characterization Of West Sumatera Iron Sand As A Raw Material To Synthesize Magnetic Nanoparticles*
	Room 3 PSTRS	Rahadian Zainul, Sri Wahyu Wardani, Arizka Tamarani, Devi Purnamasari *Design and Engineering of Tandem Hydrogen Generator-Photoreactor Systems For New Energy Investigation*
		Muhammat Rasid Ridho, Muhammad Taufik Syastra *Development Internet Of Things For Smart Factory In PT Wik East Batam*
		Sukardi, Reska Mayefis, Usmeldi *Development of Android Based Mobile Learning Media on Computer Assembly at Vocational High School*
	Room 4 PSTRS	Ahmad Arif, Rifdarmon, Milana, Martias, Nuzul Hidayat *Effects of Fuel Types on Performance in Gasoline Engine with Electronic Fuel Injection System*
		Erita Astrid, Ali Basrah Pulungan, Doni Tri Putra Yanto, Citra Dewi *Modified Particle Swarm Optimization (MPSO) to Solve Economic Load Dispatch with Multiple Fuel Sources*
		Irma Yulia Basri, Maswandi, Dedy Irfan, Dony Novaliendry *Lubrication of The Motorcycle Chain Automatically*
PARALLEL 2 08.30-09.30	Room 1 PSTRS	Riko Maiyudi, Yoszi Mingsi Anaperta, Fachrul Rozi Ramadhan, Tri Gamela Saldy *Methods of Enhancing Understanding of Natural Disaster Mitigation for high school students in the city of Solok*
		Edidas, Ilmiyati Rahmy Jasril, Ika Parma Dewi. *Peningkatan Keterampilan Mikroprosesor dan Mikrokontroler bagi*

		Guru-guru SMKN 2 Solok dan SMKN 2 GunungTalang
		Dedi Setiawan, Hendra Dani Saputra, Muslim, M. Nasir *Skill Training of Self-Based Motorcycle Workshop Business Building for Vocational School Students*
	Room 2 PSTRS	Yaumal Arbi, Ahmad Fauzi Pohan, Ari Syaiful Rahman, Muvi Yandra, Gilang Ababil *Acuifer Analysis with Seismic Methods in Parambahan Region*
		Rifky Pratama Putra, Harizona Aulia Rahman, M. Ilham Rasyidi, Rizaldi *Preliminary Geological Study and Mapping of Batu Kapal Cave in Solok Selatan, West Sumatera*
		Hendry Frananda, Fitri Mudia Sari *Mapping the Marine Tourist Zone of Pasumpahan Island*
	Room 3 PSTRS	Heru Pramudia, S.St.Par, M.Sc *A Specific LPG Gas Oven for Lemang Ketan Bamboo*
		Juli Sardi, Hamdani *Active Database Management System on Posyandu (Integrated Service Post) for Children Growth Monitoring*
		Devia Kartika, Agung Praman Putra , Mutiana Pratiwi, Rima Liana Gema, Silky Safira *Expert System of Analysis in Diagnosis for Gynecology*
	Room 4 PSTRS	Heri Prabowo, Harizona Aulia, Riko Maiyudi *Management Carbonate Industry In Mining Limestone Area Bukit Tui Padang Panjang City West Sumatera*
		Rahadian Zainul, Sri Wahyu Wardani, Arizka Tamarani, Devi Purnamasari *Design and Engineering of Tandem Hydrogen Generator-Photoreactor Systems For Newest Energy Investigation*
		Rina Hidayati Pratiwi *Anatomy and Secretory Cell Structure in Tropical Medicinal Plants*
09.30-09.45	Coffee Break	
PARALLEL 3 09.45-10.45	Room 1 PSTRS	Hasanuddin, Hendri Nurdin, Waskito, Delima Yanti Sari *Characteristic of Areca Fiber Briquettes as Alternative Energy*
		Aslimeri *Pembangkit Listrik Tenaga Surya*
		Heri Prabowo, ST.,MT , DR. Fadhilah, M.Si, Trigamela Saldy, ST.,M.T *The Feasibility Test of the Physical and Chemical Properties of Muaro Bingguang Pasaman Barat Iron Sand for Portland Cement*
		Nuzul Hidayat, M. Yasep Setiawan, Ahmad Arif, Wanda Afnison *Study of Experimental Capability of Heat Release on Heat Exchanger for Straight Fin Radiator Fin Type Flat Tube with Cooling Liquid Variations*
	Room 2 PSTRS	Resti Fevria, Indra Hartanto *Isolation of Lactic Acid Bacteria (Lactobacillus Sp) from Sauerkraut with Addition of Sugar*
		Rina Hidayati Pratiwi *Diversity and Biopotential of Neesia altissima in Indonesia*
		Hendri Nurdin, Waskito, Hasanuddin *Particle Board Made from Areca Fiber With Tapioca Adhesive*
	Room 3 PSTRS	Indra Hartanto, Resti Fevria *Training Making Milk Ginger for Singgalang Community Singgalang District Tanah Data*
		Tuti Lestari, Skunda Diliarosta, Firda Az Zahra *Need analysis for Biodiversity Teaching Material Development Based on Local Wisdom*

		Ta'ali And Fivia Eliza *Scada Based AC Motor Systems and Control Monitoring*
	Room 4 PSTRS	Refdinal, Junil Adri, Budi Syahri *Mesin Penyiang Gulma Sistem Roda Cakar*
		Junil Adri, Bulkia Rahim, Refdinal Dan Nelvi Erizon *Efektivitas Penggunaan Mesin Perontok Padi Sistem Lorong Hembus*
		Wanda Afnison, Hasan Maksum, Nuzul Hidayat *The Effect of Vibration Energy Harvester Mechanism Toward the Shock Absorber Efficiency*
		Muldi Yuhendri, Risfendra, Mukhlidi Muskhir, Hambali *Development of Automatic Solar Egg Incubator to Increase the Productivity of Super Native Chicken Breeds*