Journal of Engineering and Social Sciences (JESS)

RESEARCH ON THE CORROSIVITY LEVEL OF FLUIDS IN MOBILE COOLING SYSTEMS BASED ON TEMPERATURE

Abdul Malik Perwira Negara, Bambang Triono, Fadllah Farah Diba

University of Sunan Giri Surabaya

ABSTRACT

The water-cooling system plays a crucial role in preventing engine components from experiencing overheating. Minor disturbances in the cooling system can lead to overheating due to the accumulation of deposits in the fluid-passing components. Considering the above issues, corrosion is a factor that influences the performance of the cooling system. The aim of this research is to determine the corrosion level of fluid variations within the cooling system based on temperature factors. The selection of fluid variables was conducted through personal surveys in the environment of SMK – SMA Plus Darma Siswa Sidoarjo. This research method employs an experimental approach. For the boiling point test, fluid variations will be heated until boiling at the highest temperature, meeting the engine's operating temperature standard. For corrosion resistance testing, fluid variations will be immersed with a nail and soaked for 6 hours at the engine's operating temperature and 24 hours at normal closed temperature. Data collection is carried out qualitatively by observing color changes in the nail and fluid, and quantitatively using the method of measuring the difference in nail mass before and after testing. The test results are divided into four criteria: ranking of colors during operating temperature, ranking of colors during normal closed temperature, ranking of corrosion during operating temperature, and ranking of corrosion during normal closed temperature. From these four criteria, it is concluded that the final ranking from best to worst is coolant fluid, mineral fluid, PDAM fluid, AC fluid, and ACCU fluid.

Keywords: Corrosion, Fluids, Temperature

Introduction

At present, human daily life is closely tied to transportation, especially two or four-wheeled motor vehicles. The use of four-wheeled motor vehicles always involves the use of fuel, and the combustion process is always accompanied by the release of heat (Manik et al., 2018). The combustion of fuel in the cylinder that generates power produces heat due to the components rubbing and working against each other, which if left uncontrolled can lead to excessive heat (overheating effect). As known, the radiator water is used to cool the engine to maintain the motor at an optimal temperature and prevent corrosion. If this condition does not receive proper cooling, the combustion temperature will affect the overall engine performance (Yono, 2020).

The engine temperature must be stabilized with a cooling system assisted by coolant fluid flowing through the radiator so that the engine's temperature can be maintained (Saifudin et al., 2020). The coolant fluid in the radiator plays a crucial role in transferring engine heat to the environment, allowing the engine to operate at an optimal temperature, which contributes to fuel savings. The radiator functions to contain and cool the heated coolant fluid (Simamora et al., 2015). The cooling system acts as a heat absorber generated by the engine from the combustion process in the cylinder, and allowing this heat to accumulate can lead to overheating (Atmadja, 2010).

Many people still use alternatives instead of radiator coolant. For example, distilled water from the AC, PDAM water, battery water, and mineral water. They consider radiator coolant the same as the types of water mentioned above and believe it is better than radiator coolant. Research on fluid variations has been conducted, including by Samik et al. (2017) with the title "The Effect of Coolant Variation on the Effectiveness of Radiators in Diesel Engines." Based on the existing background, it is considered necessary to determine the boiling point of distilled water from the AC, PDAM water, battery water, mineral water, radiator coolant, as well as to determine the corrosion resistance of distilled water from the AC, PDAM water, battery water, mineral water, radiator coolant.

Research Methods

The type of research used is experimental research, aimed at determining the comparison of boiling points and corrosion resistance in the use of radiator water variations. The research object is a nail with a length of 87.86 millimeters and a nail rod diameter of 3.80 millimeters, representing the metals present in the water-cooling system. This experimental research will be conducted on February 21, 2022, at the Pharmacy Laboratory of SMK

Darma Siswa Sidoarjo and the Biology Laboratory of Adi Buana University Surabaya.

Research methods are fundamentally scientific ways to obtain data for specific purposes and objectives. Based on this, there are four keywords that need to be considered: scientific methods, data, goals, and purposes. Research design is a plan that guides researchers in the process of collecting, analyzing, and interpreting observations. It is a logical proof model that allows researchers to make inferences about causal relationships between variables in a study.

The research method used is experimental research with boiling point testing, where fluid variations will be heated until boiling at the highest temperature, reaching the standard operating temperature of the engine. For corrosion resistance testing, fluid variations will be immersed in a nail and soaked for 6 hours at the engine's operating temperature and 24 hours at normal closed temperature. Data collection is done qualitatively by observing color changes in the nail and fluid, and quantitatively using the method of measuring the mass difference of the nail before and after testing. The test results are divided into four criteria: ranking of colors during operating temperature, ranking of colors during normal closed temperature, ranking of corrosion during operating temperature, and ranking of corrosion during normal closed temperature.

An instrument is a tool selected and used by researchers in their data collection activities to make the process systematic and easier. Equipment used in this research includes:

Equipment used in this research includes:

a. Analog Thermometer.
b. Single-burner Stove.
c. Pot.
d. Digital Temperature Thermos.
e. Graduated Glass.
f. Used Bottles.
g. Analytical Scale.
h. Sandpaper P500 CC-CW.
i. Vernier Caliper.

Materials used in this research include:

a. Nails.

b. Radiator Coolant.
c. Club Brand Mineral Water.
d. AC Condensation Water.
e. Battery Water (refill).
f. PDAM Water.

The research variables serve as objects or attributes that exhibit variations between one object and another. Research variables represent qualities that researchers study and draw conclusions from in a research process. In this research, three types of variables are used:

a. Independent Variable: The independent variable used is the result of the comparison of boiling points and corrosion for each material.
b. Dependent Variable: The dependent variable used is the types of water used for the water-cooling system, specifically in the radiator.
c. Control Variable: The control variable used is in the boiling point test, where each fluid will be heated with a volume of 500 milliliters until boiling, and for the corrosion test, each fluid will be immersed with a nail for 6 hours under engine operating temperature conditions and 24 hours under normal closed temperature conditions.

In this study, the researcher employs data analysis techniques using both qualitative and quantitative methods. The statistical analyses involved are boiling point testing and corrosion testing. The following are the details of the tests to be conducted:

a. Qualitative Data Analysis: Qualitative data in this research is obtained through the observation of color changes in the nail before and after testing, as well as the color of the fluid before and after testing. The observed results will be ranked from best to worst.
b. Quantitative Data Analysis: Quantitative data in this research is obtained by calculating the mass difference of the nail before and after testing. The calculated results will be ranked from best to worst.

Results and Discussion

In this study, to conduct a thorough analysis, the need for data/information, theories, and tools is crucial. Data collection methods for qualitative research involve observation and experimentation, which are evident in the study's objects and results. The data analysis to be performed includes weighing the mass of the nails that have been immersed in water samples under working temperature and normal temperature conditions. The weight differences before and after immersion will be calculated to determine the corrosion extent on the nails (Gapsari, 2017). In addition to weighing, the analysis also involves visual observation of the condition of the water fluid and nails, which will then be ranked using a weighting method. The different colors produced by the corrosion process on the immersed nails will be observed. Below is the ranking table for fluid colors from the cleanest to the dirtiest:

Table 1. Ranking of Fluid Colors After Testing at Operating Temperature

Ranking of Fluid Colors at Operating Temperature (25%)	Rangking	Value
Coolant Water	1	0,25
Mineral Water	2	0,5
PDAM Water	3	0,75
ACCU Water	4	1
AC Water	5	1,25

Table 2. Ranking of Fluid Colors After Testing at Closed Normal Temperature

Ranking of Fluid Colors at Closed Normal Temperature (10%)	Rangking	Value
Coolant Water	1	0,1
Mineral Water	2	0,2
PDAM Water	3	0,3
ACCU Water	4	0,4
AC Water	5	0,5

Meanwhile, for the nails, the color differences resulting from the corrosion process are observed. Here is the ranking table for the condition of the nails from best to worst:

Table 3. Ranking of Nail Conditions After Testing at Operating Temperature

Corrosion Ranking at Operating Temperature Conditions (50%)	Rangking	Value
Coolant Water	1	0,5
Mineral Water	2	1
AC Water	3	1,5
PDAM Water	4	2
ACCU Water	5	2,5

Table 4. Ranking of Nail Conditions After Testing
at Closed Normal Temperature

Corrosion Ranking at Closed Normal Temperature Conditions (15%)	Rangking	Value
Coolant Water	1	0,15
AC Water	2	0,30
PDAM Water	3	0,45
Mineral Water	4	0,60
ACCU Water	5	0,75

The results for each value are obtained from the multiplication of the ranking and the percentage weight of each criterion. The smaller the value, the higher the ranking position. The data obtained is divided into two types: the difference in nail mass after sanding with the nail mass after operating temperature testing and the difference in nail mass after sanding with the nail mass after closed normal temperature testing. Here is the table of the difference:

Table 5. Corrosion During Operating Temperature Testing

Corrosion During Operating Temperature Testing	
Nail	Corrosion
Coolant	0,0004 g
Mineral	0,0015 g
AC	0,0019 g
PDAM	0,0041 g
ACCU	0,0272 g

Table 6. Corrosion During Testing at Closed Normal Temperature

Corrosion During Operating Temperature Testing	
Nail	Corrosion
Coolant	0,0002 g
AC	0,0008 g
PDAM	0,0037 g
Mineral	0,0121 g
ACCU	0,0202 g

Quantitative data in this study is based on the results of weighing the mass of the nails after sanding, after operating temperature testing, and after closed normal temperature testing. Here is the table:

Table 7. Nail Mass Weighing Results

No	Test Samples	Coolant Water	ACCU Water	Mineral Water	AC Water	PDAM Water
1	Nail before sanding	8,4794 g				
2	Nail after sanding	8,0883 g	7,9599 g	7,9660 g	7,7426 g	7,9446 g
3	Nail after operating temperature testing	8,0887 g	7,9871 g	7,9810 g	7,7505 g	7,9487 g
4	Nail after closed normal temperature testing	8,0885 g	7,9669 g	7,9689 g	7,7497 g	7,9450 g

Based on the data description and data analysis explained above, each testing result has different ranking orders. The obtained data is divided into four criteria:

1. Ranking of fluid colors in operating temperature conditions.
2. Ranking of fluid colors in closed normal temperature conditions.
3. Ranking of corrosion in operating temperature conditions.
4. Ranking of corrosion in closed normal temperature conditions.

Therefore, the researcher uses a weighting method by combining the four criteria mentioned above, which will eventually become a single final ranking ordered from best to worst. The allocation of weights for the final ranking is as follows: corrosion ranking at operating temperature is given a weight of fifty percent, fluid color ranking at operating temperature is twenty-five percent, corrosion ranking at closed normal temperature is fifteen percent, and fluid color ranking at closed normal temperature is ten percent. The reason for assigning a significant weight to normal temperature is that mass weighing tests can provide more specific and accurate results regarding the corrosion process, and also because at normal temperatures, the corrosion rate may be slower compared to high temperatures (Priyotomo, 2015). Here is the table of rankings based on the sum of values obtained from the total sum of values of the four criteria:

Table 8. Table of Ranking Results from the Sum of Values

Ranking of the Sum of Values		
Fluida	Ranking	Value

Coolant	1	1
Mineral	2	2,3
PDAM	3	3,5
AC	4	3,55
ACCU	5	4,65

Here is the final ranking table of the five fluids sorted based on the values above:

Table 9. Final Ranking

Fluida	Ranking
Coolant	1
Mineral	2
PDAM	3
AC	4
ACCU	5

The data above indicates that the coolant fluid occupies the first position because it is a special liquid containing propylene glycol, which can minimize corrosion and increase the boiling point. Other fluids besides coolant are not suitable for the cooling system. Similar to boiling water for cooking, when the engine is hot, the water fluid in the radiator evaporates, forming deposits that can eventually clog the channels. In ACCU fluid, its appearance is cloudy, but when observed on the condition of the nail, corrosion is not very visible. This is because corrosion that is not visually apparent may still result in a significant decrease in mass weighing. Therefore, it cannot be concluded that corrosion is only assessed visually. The type of corrosion consistent with the characteristics described in the theoretical basis and visible on the nail is uniform corrosion. The reason the researcher used nails as a substitute for metals in the cooling system is that nails are materials that are easily corroded in a short period.

Conclusion

The final results show that Coolant fluid is at the top ranking because radiator fluid has a higher boiling point and also prevents corrosion. For other fluids, it is not recommended as a substitute for coolant. In emergency conditions, one can consider using alternative fluids based on the final ranking of this study, but continuous use of these alternative fluids is not recommended.

References

Atmadja, S. T. (2010). Pengendalian Korosi Pada Sistem Pendingin Menggunakan Penambahan Zat Inhibitor. ROTASI, 12(2), 7-13.

Gapsari, F. (2017). Pengantar Laju Korosi. UB Media: Universitas Brawijaya Malang.

Manik, T. U., T. B. Sitorus., & R. Irfandi. (2018). Analisa dan Uji Eksperimental Performansi Alat Penukar Kalor Kompak Jenis Radiator Kendaraan Berkapasitas Mesin 1300 CC. Jurnal Sistem Teknik Industri, 20(2), 1-8.

Priyotomo, D. (2015). Buku Praktis Korosi dan Logam untuk Mahasiswa. Nulisbuku. com: Gadang Priyotomo.

Saifudin, S., S. Munahar., & D. A. Khusaeni. (2016). Perilaku Inhibitor Korosi Pada Radiator. FLYWHEEL: Jurnal Teknik Mesin Untirta, 2(1), 1-6.

Samik, S., P. Setiarso., & I. G. M. Sanjaya. (2017). Pemanfaatan Air Buangan AC (Air Conditioner) Sebagai Pengganti Akuades. Indonesian Chemistry and Application Journal, 1(1), 29-36.

Simamora, D. F., F. P. Sappu., & T. V. Ulaan. (2015). Analisis Efektivitas Radiator Pada Mesin Toyota Kijang Tipe 5 K. Jurnal Poros Teknik Mesin UNSRAT, 4(2), 138-147.

Yono, B. (2020). Pengaruh Penggunaan Air Sumur, Air Coolant, Air Tetes Ac Terhadap Suhu Mesin Pada Mobil Toyota Kijang Grand Extra 1994. Jurnal Teknovasi: Jurnal Teknik dan Inovasi Mesin Otomotif, Komputer, Industri dan Elektronika, 7(2), 86-91.