

# Analysis of engine overheating in the Mazda BT-50 model. Perspectives from automotive mechanics experts

## Análisis del sobrecalentamiento del motor modelo Mazda BT-50. Perspectiva de expertos en mecánica automotriz

Josué Pilicita<sup>1</sup>, Josué Domínguez<sup>1</sup>, Carlos Torresano<sup>1</sup>, Byron Salazar<sup>1</sup>

<sup>1</sup>Universidad de las Fuerzas Armadas. Quito, Ecuador.

### Cite as

Pilicita J, Domínguez J, Torresano C, Salazar B. Analysis of engine overheating in the Mazda BT-50 model. Perspectives from automotive mechanics experts. SAP Multidisciplinary Open. 2025; 3:208. <https://doi.org/10.62486/mo2025208>

### Publication History

**Submitted:** 08-06-2024

**Revised:** 22-09-2024

**Accepted:** 31-12-2024

**Published:** 01-01-2025

### ABSTRACT

Engine overheating in the Mazda BT-50 affects its performance, durability and sustainability, directly influencing the degradation of the lubricating oil and cooling system. This study analyzed the causes, consequences and solutions to the problem, based on structured interviews with experts in automotive mechanics. The results revealed that radiator, thermostat and water pump failures are the main causes of overheating. These failures, along with non-compliance with maintenance practices, aggravate the risks of severe engine damage. The experts recommended maintaining a temperature range between 92 and 98°C and performing preventive maintenance, including radiator flushing, periodic coolant change and replacement of key components at regular intervals. The study concludes that overheating can be prevented through a comprehensive approach that combines robust design, rigorous maintenance and user education. This not only improves efficiency and extends engine life, but also reduces repair costs and promotes more sustainable practices in the automotive industry.

**Keywords:** Mazda BT-50; Engine Overheating; Preventive Maintenance; Cooling System.

### RESUMEN

El sobrecalentamiento del motor en el Mazda BT-50 afecta su rendimiento, durabilidad y sostenibilidad, influyendo directamente en la degradación del aceite lubricante y el sistema de enfriamiento. Este estudio analizó las causas, consecuencias y soluciones al problema, basándose en entrevistas estructuradas con expertos en mecánica automotriz. Los resultados revelaron que las fallas en el radiador, el termostato y la bomba de agua son las principales causas del sobrecalentamiento. Estas fallas, junto con el incumplimiento de las prácticas de mantenimiento, agravan los riesgos de daño severo al motor. Los expertos recomendaron mantener un rango de temperatura entre 92 y 98°C y realizar un mantenimiento preventivo, que incluye la limpieza del radiador, el cambio periódico del refrigerante y la sustitución de componentes clave en intervalos regulares. El estudio concluye que el sobrecalentamiento puede prevenirse mediante un enfoque integral que combine diseño robusto, mantenimiento riguroso y educación de los usuarios. Esto no solo mejora la eficiencia y prolonga la vida útil del motor, sino que también reduce costos de reparación y promueve prácticas más sostenibles en la industria automotriz.

**Palabras clave:** Mazda BT-50; Sobrecalentamiento del Motor; Mantenimiento Preventivo; Sistema de Enfriamiento.

## INTRODUCTION

Overheating of internal combustion engines represents a critical challenge in the automotive sector. Its implications go beyond mechanical performance and directly affect vehicle durability, efficiency, and sustainability. This phenomenon, characterized by an excessive increase in engine temperature, can have devastating effects on its components and the overall functioning of the vehicle. One of the aspects most affected by overheating is lubricating oil. This essential element fulfills crucial functions such as reducing friction, protecting against corrosion, and partially cooling the internal components of the engine.<sup>(1,2)</sup>

The impact of overheating on lubricating oil is manifested in its physical and chemical degradation and in the alteration of its fundamental properties.<sup>(3)</sup> Exposure to high temperatures accelerates processes such as oxidation, which breaks down the protective additives in the oil, and the formation of deposits and sludge that clog the lubrication ducts.<sup>(4)</sup> These combined effects significantly increase the wear and tear of engine parts, decrease their efficiency, and, in extreme cases, cause catastrophic failures that require costly repairs.<sup>(5)</sup> In addition, oil degradation also indirectly contributes to increased polluting emissions, exacerbating the environmental problems associated with using internal combustion engines.<sup>(6,7)</sup>

The current context of the automotive industry adds a dimension of complexity to the problem of overheating. Technological advances have led to the design of more compact, higher-performance engines, which operate at higher temperatures to maximize thermal efficiency and reduce emissions.<sup>(8)</sup> However, these characteristics also make them more susceptible to overheating.<sup>(9)</sup> In addition, external factors such as climate change, high ambient temperatures in specific regions, and traffic congestion exacerbate engine thermal stress conditions. In this scenario, particular models such as the 2011 Mazda BT-50, which combines a robust design with potentially vulnerable cooling systems, become key case studies for understanding and mitigating the impact of overheating.<sup>(10,11)</sup>

This article aims to analyze the incidence of engine overheating and the degradation of lubricating oil using a multidimensional approach that combines experimentation, technical analysis, and interviews with experts in automotive mechanics. Through a study of the cooling system of the 2011 Mazda BT-50 and an evaluation of the effects of extreme heat on lubricating oil, the aim is to identify the leading causes of the problem and propose practical and sustainable solutions. Among the key questions addressed are: how do factors such as cooling system design, preventive maintenance, and the type of oil used contribute to overheating? What are the best practices to minimize the associated risks and improve the resistance of lubricating oil to extreme temperatures?

This article aims to analyze the impact of engine overheating on the degradation of lubricating oil based on the opinions of automotive mechanics experts gathered through structured interviews. By examining the specialists' perspectives on the cooling system of the 2011 Mazda BT-50 and the effects of extreme heat on lubricating oil, the aim is to identify the leading causes of the problem and propose practical and sustainable solutions. The key questions guiding this work include: How do factors such as cooling system design, preventive maintenance, and the type of oil used influence the occurrence of overheating? What are the best practices experts recommend to minimize the associated risks and improve the resistance of lubricating oil to extreme temperatures?

In addition to its technical relevance, this research has significant economic and environmental implications. On the one hand, the results can help vehicle owners and industry professionals reduce maintenance costs and extend engine life. On the other hand, developing more resistant oils and optimized cooling systems contributes to sustainability by reducing the frequency of component replacement and waste generation. It is also hoped that the findings of this study will serve as a basis for future innovations in engine and lubricant design, aligning with global goals of reducing carbon emissions and improving energy efficiency. The analysis of engine overheating and its relationship to lubricating oil degradation addresses a specific technical problem. It opens doors to a better understanding of the automotive industry's systemic challenges in an ever-changing world. This article seeks to provide a comprehensive perspective, combining theory, experimentation, and practical experience, to offer concrete and viable solutions that benefit all stakeholders, from manufacturers to end consumers.

## METHOD

The present study is classified as qualitative and descriptive, with an exploratory approach based on compiling expert opinions through structured interviews. Interviews were conducted with four professionals with extensive experience in automotive mechanics, who contributed their knowledge on the causes, consequences, and preventive measures related to engine overheating in the 2011 Mazda BT-50 model. Interviewees were selected based on their career and technical knowledge, thus ensuring the validity of the responses obtained. In addition, the study design made it possible to identify common patterns in the experts' responses, which contributed to the formulation of practical and applicable conclusions. This qualitative approach is ideal for gaining an in-depth understanding of a specific technical problem from the perspective of professionals in the field.

The expert interviews were conducted using a structured questionnaire designed to gather information on failures related to the overheating of Mazda BT-50 engines. The tools used included audio recorders to record participants' responses, informed consent forms to ensure voluntary participation and confidentiality, and qualitative analysis software to process and categorize the responses obtained.

The interviews were carried out in mechanical workshops and, in some cases, by telephone. Each session lasted approximately 30 minutes. The responses were transcribed and qualitatively analyzed to identify common thematic patterns and draw relevant conclusions.

Only experts with direct experience in the repair and maintenance of Mazda BT-50 engines were included. Those who did not work regularly with this model or had less than 10 years of experience were excluded from the study. In addition, the confidentiality of the responses was guaranteed by removing identifying information from the transcribed records, ensuring that all participants signed informed consent forms before the interview.

The study complied with the fundamental ethical principles of qualitative research. All participants were informed about the objectives of the study, the procedures, and the use that would be made of the information collected. Before participating, they signed an informed consent form guaranteeing their voluntary participation and respecting their right to withdraw from the study at any time.

The data was stored in a secure environment and accessible only to the research team. In addition, the study was conducted transparently and without coercion, respecting the dignity and rights of all participants.

## RESULTS

### Causes of overheating

The experts interviewed identified multiple factors contributing to overheating in internal combustion engines, focusing on the Mazda BT50 model. All agreed that the radiator is a critical component. The most common problems associated with this component are leaks, internal obstructions, and structural damage caused by high temperatures or impacts. These faults reduce the radiator's capacity to dissipate the heat generated by the engine, directly affecting the cooling system's efficiency.

Another prominent component was the thermostat, which, according to the interviewees, is particularly susceptible to blockages or mechanical failure. A thermostat that does not open properly prevents coolant circulation, dangerously increasing the engine temperature. Problems with the water pump and hoses were also mentioned. In some cases, wear, or leaks in these components interrupt the flow of coolant, which increases the possibility of overheating.

### Critical temperatures and consequences

A central point of the interviews was identifying a range of critical temperatures for the safe operation of the engine. All the experts pointed out that most modern engines operate optimally between 92 and 98°C. Exceeding this threshold can trigger severe damage, such as head gasket burns, hose blowouts, and irreparable engine block or cylinder head failures. Interviewees emphasized the need to continuously monitor engine temperature, recommending shutting down immediately if readings above 98°C are observed to prevent further damage.

### Fault diagnosis

The interviewees approached the identification of faulty components systematically. The proposed steps include starting by inspecting for possible coolant leaks, followed by verifying the correct functioning of the thermostat. The importance of checking the condition of the fan, its clutches, and the timing belts, as well as evaluating the vehicle's electrical system, was also emphasized. This sequential approach facilitates a more accurate and efficient diagnosis of the problems causing overheating.

### Preventive maintenance

Preventive maintenance emerged as a recurring and essential topic in the experts' responses. They all agreed on the importance of regular internal radiator cleaning to remove sediment and deposits that can obstruct the flow of coolant. Periodic coolant replacement was also recommended, ideally every 25 000 to 30 000 km or every two years, depending on vehicle use and weather conditions. In addition, it was suggested that the thermostat and radiator cap be replaced every 80 000 km to ensure proper operation.

The general check-up of the cooling system also includes inspecting the hoses and connections to identify possible leaks or signs of wear. Experts emphasized that rigorous maintenance not only prevents overheating but also extends the life of the engine, improves its performance, and reduces the costs associated with major repairs.

## DISCUSSION

Overheating in internal combustion engines, such as the Mazda BT50, is a multifactorial phenomenon influenced by component design and maintenance practices.<sup>(12)</sup> Interviews with experts confirmed that the radiator, thermostat, and water pump are the components most prone to failure. This is in line with previous studies that highlight the radiator as the main component responsible for dissipating the heat generated by the engine. According to research by García and Paucar, obstructions in radiators caused by sediment or accumulation of dirt significantly reduce their thermal efficiency.<sup>(13)</sup> This finding coincides with the interviewees' responses, who emphasized the importance of keeping this component clean to avoid overheating problems.

The thermostat, meanwhile, plays a crucial role in regulating engine temperature. A blocked thermostat can cause a sudden rise in engine temperature, which was mentioned by all the experts as a common cause of overheating. This aligns with the observations of Soejima *et al.*, who highlight that failures in this component represent one of the leading causes of overheating in modern engines.<sup>(14)</sup> Likewise, the experts pointed out that wear or failures in the hoses and the water pump interrupt the coolant's circulation, exacerbating the risk of overheating.

A key finding from the interviews was the unanimity regarding the optimal operating temperature range, which is between 92 and 98°C. The experts agreed that exceeding this threshold can cause severe damage to the engine, such as head gasket burns or cracks in the engine block. This range aligns with the technical specifications for internal combustion engines, such as those described by Patel *et al.*, who establish a critical limit of 98°C to avoid structural damage and loss of efficiency.<sup>(15)</sup>

However, some interviewees pointed to stricter limits, suggesting that temperatures above 96°C already cause concern. This discrepancy could reflect differences in the operating conditions observed by the experts or in interpreting the associated risks. Additionally, the thermal tolerance range can vary depending on the specific engine design and the materials used, such as aluminum cylinder heads in the Mazda BT50, which are more susceptible to heat deformation than cast iron.<sup>(16)</sup>

The consensus among experts on the need for rigorous preventive maintenance underscores the importance of early intervention to mitigate the risk of overheating. Recommendations to change the coolant every 25 000 to 30 000 km and to replace the thermostat every 80,000 km are consistent with best automotive maintenance practices described in the literature.<sup>(9)</sup> This preventive approach reduces the risk of catastrophic failure, extends engine life, and improves vehicle efficiency.<sup>(17)</sup>

The experts mentioned one relevant aspect: vehicle owners' lack of awareness about the importance of preventive maintenance. Previous studies have indicated that failure to comply with recommended maintenance intervals is a significant cause of mechanical problems in internal combustion engines.<sup>(18)</sup> Therefore, promoting educational programs highlighting the relationship between preventive maintenance and engine performance is essential, especially in regions where climatic conditions can increase the risk of overheating.<sup>(19,20)</sup>

Regarding the disadvantages of the Mazda BT50, some experts pointed to the engine's low displacement and the use of aluminum cylinder heads as risk factors. Although these characteristics are common in many modern vehicles, they can increase the cooling system's vulnerability to extreme conditions. For example, although light and thermally efficient, Patel et al. point out that aluminum is more prone to deformation at high temperatures.<sup>(15)</sup>

On the other hand, technological advances, such as introducing direct injection systems and high-performance coolants, have improved engine efficiency in recent models. However, implementing these technologies must be accompanied by proper maintenance to maximize their benefits. The literature suggests that new coolants, with additives that improve thermal resistance, can significantly reduce the incidence of overheating-related failures if used correctly.<sup>(21)</sup>

The interviews' results highlight the need for a comprehensive approach that combines robust design, preventive maintenance, and user education. Technological improvements should focus on increasing the resistance of materials and optimizing the flow of refrigerant, while maintenance practices should be more accessible and understandable to vehicle owners.

In terms of design, it is recommended to explore alternatives, such as using composite materials for radiators and cylinder heads, which combine aluminum's lightness with cast iron's thermal resistance. In addition, developing more accurate sensors to monitor temperature and detect problems in real time could prevent further damage. Finally, educational campaigns should emphasize the importance of preventive maintenance, using concrete examples of the associated costs and benefits.

## CONCLUSIONS

The present study has made it possible to identify the leading causes of overheating in the Mazda BT-50 model, highlighting problems in key components such as the radiator, the thermostat, and the water pump. Through interviews with experts, it was confirmed that the malfunction or deterioration of these elements significantly increases the risk of overheating, especially under thermal stress conditions. Likewise, maintaining an optimal temperature range between 92 and 98°C was highlighted to avoid severe damage to the engine, such as cracks in the block or deformations in the aluminum heads. These observations underline the relevance of accurate diagnosis and continuous engine temperature monitoring as preventive measures.

Furthermore, it is concluded that preventive maintenance is crucial in mitigating this problem. Recommendations include regular cleaning of the radiator, changing the coolant, and replacing the thermostat and other key components at specific intervals. However, a lack of awareness among vehicle owners about the importance of these practices was also identified, highlighting the need for educational programs and awareness campaigns. The findings of this study not only have technical and economic implications but can contribute to the development of more efficient and sustainable cooling systems, aligning with the global objectives of reducing emissions and improving energy efficiency in the automotive industry.

## FINANCING

The authors did not receive any funding for the development of this research.

## CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

## CONTRIBUTION OF AUTHORSHIP

*Conceptualization:* Josué Pilicita, Josué Domínguez, Carlos Torresano, Byron Salazar.

*Data curation:* Josué Pilicita, Josué Domínguez, Carlos Torresano, Byron Salazar.

*Formal analysis:* Josué Pilicita, Josué Domínguez, Carlos Torresano, Byron Salazar.

*Research:* Josué Pilicita, Josué Domínguez, Carlos Torresano, Byron Salazar.

*Methodology:* Josué Pilicita, Josué Domínguez, Carlos Torresano, Byron Salazar.

*Project administration:* Josué Pilicita, Josué Domínguez, Carlos Torresano, Byron Salazar.

*Resources:* Josué Pilicita, Josué Domínguez, Carlos Torresano, Byron Salazar.

*Software:* Josué Pilicita, Josué Domínguez, Carlos Torresano, Byron Salazar.

*Supervision:* Josué Pilicita, Josué Domínguez, Carlos Torresano, Byron Salazar.

*Validation:* Josué Pilicita, Josué Domínguez, Carlos Torresano, Byron Salazar.

*Visualization:* Josué Pilicita, Josué Domínguez, Carlos Torresano, Byron Salazar.

*Writing – original draft:* Josué Pilicita, Josué Domínguez, Carlos Torresano, Byron Salazar.

*Writing – revision and editing:* Josué Pilicita, Josué Domínguez, Carlos Torresano, Byron Salazar.

## REFERENCES

1. Essuman CB, Baidoo F. An experimental analysis of the connexion of engine fuel consumption and the operational functionality of engine with or without thermostat. *Afr J Appl Res* 2020;6:33-45. <https://doi.org/10.26437/ajar.11.2020.03>.
2. Stanivuk T, Lalić B, Mikuličić JŽ, Šundov M. Simulation modelling of marine diesel engine cooling system. *Trans Marit Sci* 2021;10:112-25. <https://doi.org/10.7225/toms.v10.n01.008>.
3. Blanco Ojeda FW, Carrillo Pabón YA, Bermúdez Santaella JR, Marcucci Pico DF. Modelado y simulación de un sistema de enfriamiento para mantener la temperatura de trabajo de un dinamómetro hidráulico. *Rev Colomb Tecnol Av* 2019;1:78-84.
4. Cardoso DS, Fael PO. 8-stroke low heat rejection engine. *Energy Rep* 2022;8:462-7. <https://doi.org/10.1016/j.egyr.2022.01.103>.
5. Vines Gaibor NA, Flores Ruiz JM, Toaquiza Albarracín MI. Diseño de un Enfriador de Bajo Costo para un Motor de Combustión Interna de un Suzuki Forza 1 Mediante un Dispositivo Alternativo. *Cienc Lat Rev Multidiscip* 2024;8:10890-903. [https://doi.org/10.37811/cl\\_rcm.v8i4.13230](https://doi.org/10.37811/cl_rcm.v8i4.13230).
6. Palve C, Thakur P, Chavan V, Aher A. Optimization of Cooling Air Flow for Improved Heat Dissipation through Radiator, Pune, India: 2024, p. 2024-26-0042. <https://doi.org/10.4271/2024-26-0042>.
7. Rajalingam A, Darwin Nesakumar A, Sathya S, Krishnankutty JE, Abid Y, Pagunuran JR. The Future of EV: Real-Time Development of an Intelligent Wireless Charging System for Electric Vehicles, 2024. <https://doi.org/10.1109/IC-CGU58078.2024.10530791>.
8. Gabiña Iribar G. Análisis de un combustible proveniente de aceite lubricante reciclado para uso en motores diésel marinos de media velocidad. <http://purl.org/dc/dcmitype/Text>. Universidad del País Vasco - Euskal Herriko Unibertsitatea, 2017.
9. Melchor Briceño E. Sistema de telemando con alerta de sobrecalentamiento del motor diésel de una maquinaria scooptram. Tesis de grado. Universidad de Ingeniería y Tecnología, 2022.
10. Duque Cabrera EJ, Masaquiza Masaquiza JP. Implementación de un generador e inyector de hidrógeno en un motor de vehículo Mazda BT-50 2.2 L, para reducir emisiones de gases contaminantes. Tesis de grado. Escuela Superior Politécnica de Chimborazo, 2013.
11. Paredes Cruz DE, Urquiza Tinuco RA. Diseño y construcción de un mecanismo de asiento de copiloto giratorio eléctrico para personas con movilidad reducida, acoplado a una camioneta Mazda BT-50. Tesis de grado. Escuela Superior Politécnica de Chimborazo, 2022.
12. Romero Piedrahita CA, Carranza Sánchez YA. Elementos de diseño de sistemas de enfriamiento de motores de combustión interna. *Sci Tech* 2007;2:261-6.
13. García Rodríguez A, Paucar Zhagüi D. Análisis de la influencia del sobrecalentamiento del motor de combustión interna en la degradación del aceite lubricante. Tesis de grado. Universidad Politécnica Salesiana, 2020.
14. Soejima M, Smith EH, Sherrington I, Wakuri Y. A Review of Solutions for the Mechanism of Oil Consumption in Internal Combustion Engines, 2007, p. 2007-01-1973. <https://doi.org/10.4271/2007-01-1973>.
15. Patel M, Singh S, Jain A. The role of temperature in oil degradation. *Tribol Int* 2020;32:126-35.
16. Condor Angos ED, Yépez Valle CA. Diseño y construcción de un sistema de medición de temperatura en vehículos. Tesis de grado. Universidad Internacional del Ecuador, 2023.
17. Muñoz Gutierrez RF, Gallo AA, Ospina Molina J, Cardozo Miranda BI, Velosa Esparza R. Análisis de la importancia de implementar un sistema de post apagado de motor diésel en vehículos militares para acondicionar y aumentar la vida útil del turbo. *Cienc Lat Rev Multidiscip* 2024;8:7980-8000. [https://doi.org/10.37811/cl\\_rcm.v8i5.14206](https://doi.org/10.37811/cl_rcm.v8i5.14206).
18. Andres MNH, Guzmán JRT, Ayala SLP. Importancia de la mecánica ligera en el mantenimiento preventivo del vehículo. *Polo Conoc* 2022;7:1609-25. <https://doi.org/10.23857/pc.v7i9.4652>.
19. Franco Marulanda RA. Plan de mantenimiento preventivo para vehículos de movimiento de tierra del municipio de Santa Rosa de Cabal. Tesis de grado. Universidad Tecnológica de Pereira, 2017.

20. Bernal Matute ÁA. Manejo y optimización de las operaciones de mantenimiento preventivo y correctivo en un taller automotriz. Tesis de grado. Espol., 2012.

21. A Comprehensive Guide to Preventing and Troubleshooting Engine Overheating 2022. <https://techiescience.com/engine-overheating/> (accedido 24 de diciembre de 2024).