Toyota Prius Brake Failure Complaints

Team 3

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Background

The Toyota Prius is a hybrid-electric vehicle that revolutionized specifically the hybrid automotive industry with its innovative design and technology. The Prius was first introduced in 1997 in Japan, and then introduced worldwide in 2000. Throughout the next two decades, the Prius became the most prominent hybrid car in the market. It also represented 61% of the 10 million hybrids sold worldwide by Toyota since 1997.

The Prius contains a hybrid drivetrain, combined with an internal combustion engine and an electric motor. This drivetrain allowed the Prius to switch seamlessly between the engine and the motor, which optimized fuel efficiency and reduced emissions. It was designed with a brake system accumulator to develop pressure for the brake system. As shown in figure 1, When the system is switched on, the master cylinder isolation valves are closed, the stroke sensor solenoid valve is opened and the rear brake linear valves V8 and V10 are closed. Since a hybrid's engine only runs sometimes and is at rest most of the time, there must be a system in place to develop brake pressure while the engine is not running. The

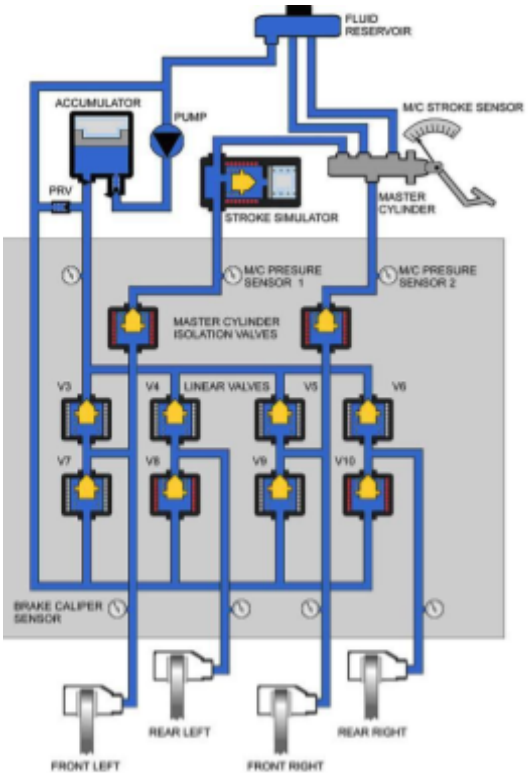

Figure 1. The diagram shows how the Prius' braking system worked

brake accumulator was used for this, as it had a pump and an accumulation chamber, as well as other electronic subsystems. The pump itself develops pressure that is stored in the accumulator and is used when the brakes are pressed. The Prius' brake system combines traditional friction braking with regenerative braking. There is an electric motor that functions as a generator, which converts the kinetic energy of the car's motion into electrical energy that is then recharged or stored in the battery for later use. Not only does the new braking system enhance the vehicle's energy efficiency, but it also extends the life of the brake pads.

However, despite its innovative design and technology, the Prius has experienced issues with its brake system. Users have reported that the brakes would not engage when the pedal was pressed. Ultimately, this issue led to a series of recalls and has been the subject of numerous studies to determine the cause of the failure and develop solutions. This report will explore deeper into these studies and focus on the solutions implemented by Toyota engineers to address the brake failure issue in the Toyota Prius.

General Description of Failure

The failure of the Toyota Prius' brake was first noticed in 2010 when Prius users reported the brakes would not engage in braking when the pedal is pressed. This is the third time Toyota had to recall this issue after concerns about Prius' manufacturing defect in its steering intermediate extension shaft. Furthermore, there were more complaints about the Prius having defects in its electric water pump that is used to circulate coolants through the components of the car. There were about 100 complaints and 4 accidents relating to the brake issue. The issue of brakes in Prius caused there to be 437,000 recalls globally. Toyota announced that users should check if the recall affects users' hybrid vehicles. They state that there's a possibility of the

development of a fatigue crack on an internal component because of vibration with vehicles that have brake pressure accumulators. David Champion, senior director of automotive testing for "customer reports" discusses why this is. He states that any pulsing movement coming from bumps, potholes, or perhaps a railway crossing, causing vibration, may stop the breaks all of a sudden. Toyota will eventually take responsibility and admit to the design of the anti-locking brake system(ABS).

Studies carried out to determine the causes of failure

Several studies were conducted to determine the root cause of the brake failure in the Toyota Prius. Specifically, one study was carried out to highlight the pre-symptoms of a failing brake accumulator, which was a critical component of the hybrid drivetrain, as it allowed brake pressure to develop while the engine was not running. Users of the Prius reported that the system pump of their 2008 Prius was running every 30 to 45 seconds to keep the accumulator pressurized, which was a significant change from its usual infrequent operation. This frequent operation of the pump could have been an indication of a leak or malfunction in the accumulator, which was causing the pressure to drop rapidly. This symptom was later confirmed by a dealer to be the beginning stages of actuator failure. Soon

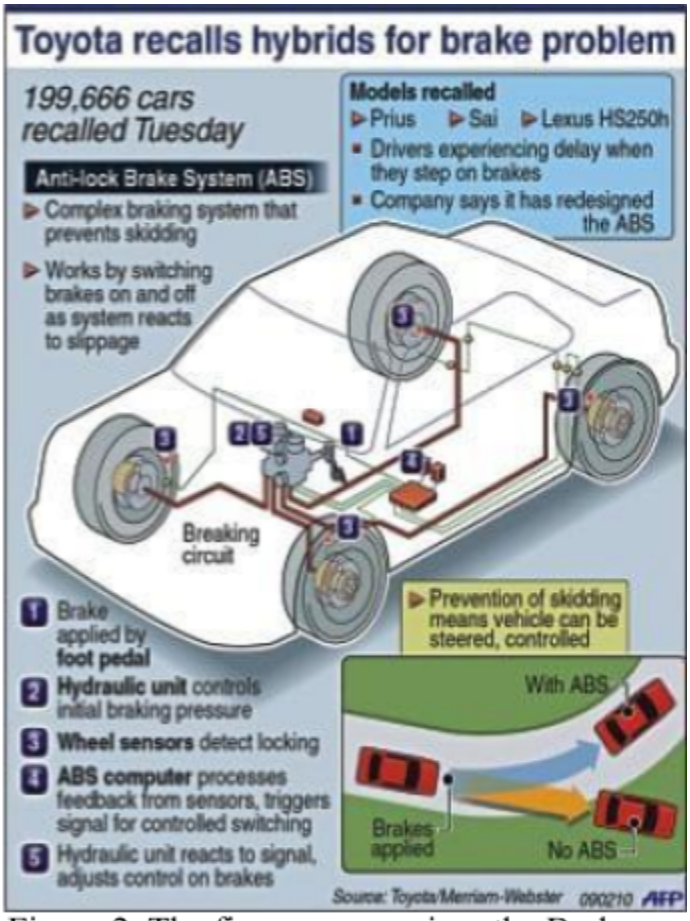

Figure 2. The figure summarizes the Brake failure recall.

after, the vehicles began getting three warning lights, ABS, a Brake System, and a VSC light, as well as the code C1256, which indicates a low-pressure accumulator. Figure 1 shows the order of events that led to the brake failure. The figure also shows how the Prius would use ABS in a driving scenario. This code meant that the brake booster was not working properly, leading to a big decrease in braking performance and often complete braking failure. Since the accumulator needed to run more frequently to maintain pressure, there was much more stress on the pump, leading to premature wear and potential failure.

Another study carried out by Prius users reported total brake failure in their newer 2023 Prius Hybrid. The vehicle threw five codes related to various malfunctions in the brake system, intelligent clearance sonar, electric control system, and smart stop. This study suggests that the brake failure could have been linked to a malfunction in the brake module.

Along with these studies, a lawsuit also shed light on the brake defect issue across several Toyota hybrid models. This lawsuit specified that hundreds of crashes had been reported as a result of the dangerous brake defect. At first, Toyota refused to fix the faulty brake system until after the vehicle experienced brake failure. In this lawsuit, the problem found for the brake system was the brake booster pump assembly, which didn't effectively ensure the brakes would work properly when the pedal was pushed. In the 2013 recall, Toyota reported that the plunger design in the brake system would crack while driving over a rough surface, resulting in gas leaking into the brake fluid. This caused a reduction in pressure and stopping distance when the brakes were applied in the vehicle.

Solutions

In response to the brake failure issues found in the Toyota Prius 2010 models, Toyota implemented a series of measures to rectify the root causes of these failures and ensure they do not recur. Upon identifying the issues, a global recall was promptly issued, affecting approximately 437,000 vehicles. Owners were urged to visit dealerships for the necessary repairs or replacements.

The primary concern was a software glitch in the antilock brake system or ABS, which delayed the transition between regenerative and traditional hydraulic braking. This was resolved through a software update that also addressed the noises that occurred upon releasing the brake pedal. (T-SB-0363-10) Additionally, the brake booster pump assembly, particularly the accumulator and the plunger, were identified as problematic. (MC-10149975-9999)

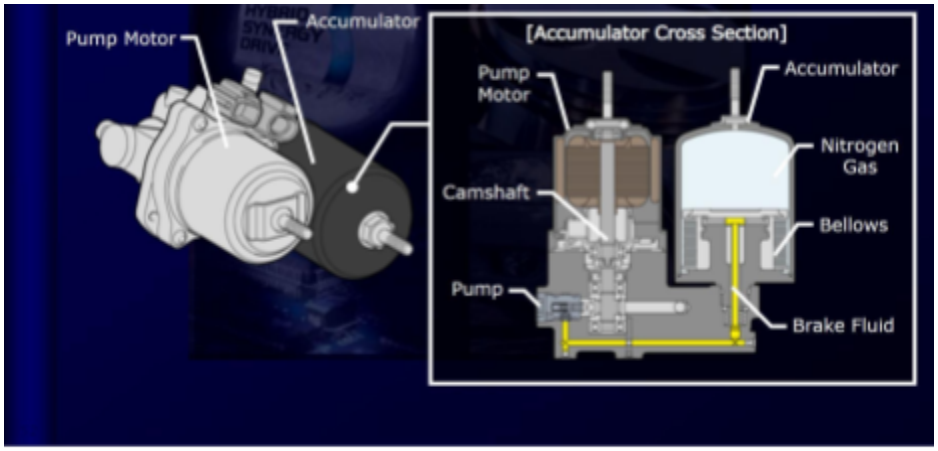

Figure 3. The figure shows the brake booster pump assembly.

Both components were replaced with enhanced versions. As shown in figure 2, the brake booster pump assembly was switched with a new system that stores hydraulic pressure more effectively. The plunger also underwent a redesign to prevent cracking and gas leakage into the brake fluid, thereby improving the overall safety of the brake system.

Moreover, Toyota has introduced advanced monitoring and reporting systems. These systems are designed to detect early indications of a brake system malfunction or any other issue,

facilitating prompt inspections and repairs. With these measures in place, Toyota is well-equipped to avert potential issues and ensure the continued safety of its vehicles.

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