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ANTI-LOCK BRAKE SYSTEM (ABS): IMPLEMENTATION OF ANTILOCK BRAKE SYSTEM ALONG WITH ITS ADVANTAGES AND LIMITATIONS

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ANTI-LOCK BRAKE SYSTEM (ABS): IMPLEMENTATION OF ANTI-LOCK BRAKE SYSTEM ALONG WITH ITS ADVANTAGES AND LIMITATIONS.

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Abstract- This paper presents Anti-Lock Brake System. It is a system which is installed on vehicles to eliminate wheel lockup and prevent skidding. This helps drivers to maintain control during stops on low traction surfaces and in emergency stopping situations. In addition to the direct benefit of greater directional control, the improved vehicle control offered by ABS reduces the potential for trailer swing-out and jack-knifing of combination vehicles.

Moreover, this system has its own practical applications and limitations which are enlisted further

Keywords- Anti-lock Brake System (ABS), Hydraulic Control Unit (HCU), Electronic Brake Control Module (EBCM), Electronic Stability Control (ESC), Electronic Brake force Distribution (EBD), Electronic Control Unit (ECU).

INTRODUCTION:

ANTILOCK BRAKING SYSTEM, which is commonly known as ABS is used as an antiskid device in a vehicle. It is used to prevent skidding of wheels while braking when we want to stop the vehicle or suddenly reduce its speed at any time. It provides better stability and control over vehicle while braking at high speed. An antilock brake system provides a high level of safety to the driver by preventing the wheels from locking, which maintains directional stability. A professional driver may be capable of maintaining control during braking by pumping the brake pedal which allows a locked wheel to turn momentarily. Whereas a professional driver may be capable of modulating the brakes approximately once per second, ABS is capable of modulating the brake pressure at a given wheel up to fifteen times per second. An ABS system does something else that no driver can do, it controls each front brake separately and the rear brakes as a pair whenever one of the wheels starts to lock. ABS helps stop a car in the shortest possible distance without wheel lockup while maintaining directional control on most types of road surface or conditions. If a ABS system malfunctions, normal braking will not be affected. Anti-lock braking system is an automobile safety system that allows the wheels on a motor vehicle to maintain tractive contact with the road surface according to driver inputs while braking, preventing the wheels from locking up (ceasing rotation) and avoiding uncontrolled skidding. It is an automated system that uses the principles of threshold braking and cadence braking which were practised by skilful drivers with previous generation braking systems. It does this at a much faster rate and with better control than a driver could manage. ABS generally offers improved vehicle control and

decreases stopping distances on dry and slippery surfaces for many drivers; however, on loose surfaces

like gravel or snow-covered pavement, ABS can significantly increase braking distance, although still improving vehicle control.

Since initial widespread use in production cars, anti-lock braking systems have evolved considerably. Recent versions not only prevent wheel lock under braking, but also electronically control the front-to-rear brake bias. This function, depending on its specific capabilities and implementation, is known as electronic brakeforce distribution (EBD), traction control system, emergency brake assist, or electronic stability control (ESC).

ANTI-LOCK BRAKING SYSTEM (ABS):

Even when applying the full force of braking power, the vehicle remains under your complete control thanks to the Anti-lock Brake System. It uses precise regulation of the braking pressure on the individual wheels to ensure that the vehicle can always be steered easily. ABS prevents the wheels from locking, regardless of the road surface's friction coefficient and the applied brake pressure. Unexpected obstacles on the lane ahead, a pedestrian suddenly stepping on the road, an abrupt change in traffic or driving conditions: there are many moments when a driver reacts quickly with intense application of the brakes. At these moments, ABS assists the driver by preventing the wheels from completely locking and applying the optimum braking pressure to the individual wheels, thus ensuring the vehicle can still be steered and shortening braking distances on slippery surfaces. The driver may sense that ABS

is functioning by the slight pulsing movement of the brake pedal.

ABS regulates the force of brake pressure on each wheel to provide both maximum braking effectiveness while still allowing the wheel to continue rotating in a controlled way. If the system recognizes that a wheel is locked or almost locked, it momentarily reduces the brake force, letting the wheel rotate, regain traction and thus allowing the vehicle to be steered. ABS then reapplies the brake pressure. Thanks to modern electronics and intelligent control algorithms, ABS does this with such remarkable speed and smoothness that both braking and steering are simultaneously effective throughout the braking process - and the driver stays in control of the vehicle.

BRAKE TYPES:

Anti-lock braking systems use different schemes depending on the type of brakes in use. They can be differentiated by the number of channels: that is, how many valves that are individually controlled—and the number of speed sensors.

Four-channel, four-sensor ABS:

This is the best scheme. There is a speed sensor on all four wheels and a separate valve for all four wheels. With this setup, the controller monitors each wheel individually to make sure it is achieving maximum braking force.

Three-channel, four-sensor ABS:

There is a speed sensor on all four wheels and a separate valve for each of the front wheels, but only one valve for both of the rear wheels.

Three-channel, three-sensor ABS:

This scheme, commonly found on pickup trucks with four-wheel ABS, has a speed sensor and a valve for each of the front wheels, with one valve and one sensor for both rear wheels. The speed sensor for the rear wheels is located in the rear axle. This system provides individual control of the front wheels, so they can both achieve maximum braking force. The rear wheels, however, are monitored together; they both have to start to lock up before the ABS will activate on the rear. With this system, it is possible that one of the rear wheels will lock during a stop, reducing brake effectiveness. This system is easy to identify, as there are no individual speed sensors for the rear wheels.

One-channel, one-sensor ABS:

This system is commonly found on pickup trucks with rear-wheel ABS. It has one valve, which controls both rear wheels, and one speed sensor,

located in the rear axle. This system operates the same as the rear end of a three-channel system. The rear wheels are monitored together and they both have to start to lock up before the ABS kicks in. In this system it is also possible that one of the rear wheels will lock, reducing brake effectiveness. This system is also easy to identify, as there are no individual speed sensors for any of the wheels.

ABS COMPONENT DESCRIPTION:

Modern antilock braking systems all feature the following major components:

- Electronic Control Unit (ECU)
- Modulator Valves
- Wheel Speed Sensors (pickup and exciter)
- ABS Malfunction Indicator Lamps.

These components are described as follows:

A. Electronic Control Unit (ECU):

The ECU processes all ABS information and signal functions.

It receives and interprets voltage pulses generated by the sensor pickup as the exciter teeth pass by, and uses this information to determine:

- impending wheel lock-up and
- when/how to activate the ABS modulator valves.

The ECU connects to the following ABS components: wheelspeed sensors, ABS modulator valves, power source, ground, warning lamps, blink code switch. The ECU sends signals to the ABS malfunction indicator lamp or blink code lamp to communicate ABS faults. It also sends signals to the retarder control to disengage the retarder when the ABS is working. When the ABS stops modulating the brake pressure, the ECU permits retarder use once again.

B. Modulator Valves:

ABS modulator valves regulate the air pressure to the brakes during ABS action. When not receiving commands from the ECU, the modulator valve allows air to flow freely and has no effect on the brake pressure. The ECU commands the modulator valve to either:

- change the air pressure to the brake chamber, or
- hold the existing pressure.

However, it *cannot* automatically apply the brakes, or increase the brake application pressure above the level applied by the driver.

C. Wheel Speed Sensors:

The wheel speed sensor has two main components: the exciter and the pickup. Other components include associated wiring and mounting equipment.

Exciter—The exciter is a ring with notched teeth. The most commonly used exciter has 100 evenly spaced teeth, but the number of teeth can vary depending on the system design. The component is known by several names: sensor ring, toothwheel, tone ring, and exciter.

Pickup—The pickup is commonly called “the sensor.” It contains a wire coil/magnet assembly, which generates pulses of electricity as the teeth of the exciter pass in front of it. The ECU uses the pulses to determine wheel speeds and rates of acceleration/deceleration. The strength of these electrical pulses decreases rapidly with slight increases in the gap between the pickup and the exciter.

Wheel speed sensor location varies. It can be located anywhere on the axle to sense wheel speed. The sensor can be an assembly containing both the exciter and the pickup with a fixed gap. Or, the pickup and the exciter can be mounted separately on different parts of the axle assembly. The sensor pickup is a sealed unit and typically of elbow or straight design.

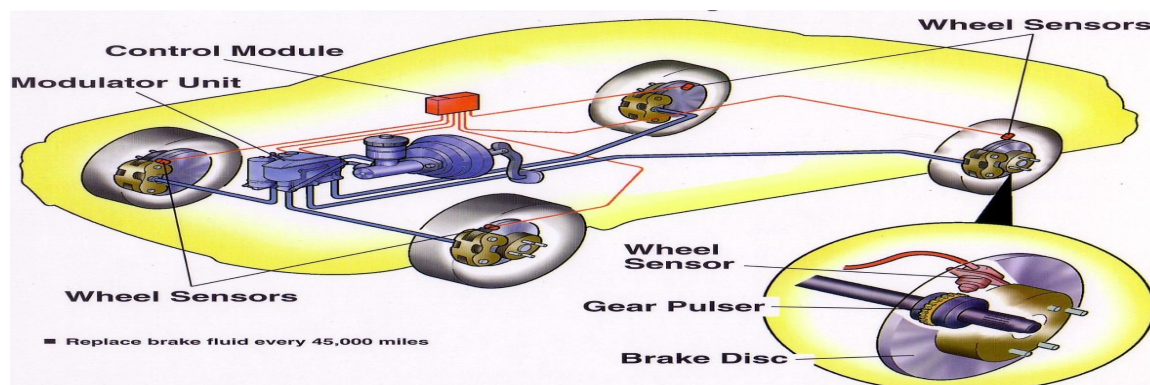
D. ABS Malfunction Indicator Lamps:

Vehicles required to have an ABS must have ABS malfunction indicator lamps. These lamps must be yellow and light up when the ABS has a “malfunction that affects the generation or transmission of response or control signals” in the ABS. ABS malfunction indicator lamps are *not required* to light up for every type of malfunction. However, they are required to light up for short periods of time for a bulb check whenever the ABS starts to receive electrical power. The warning lamps for trailers and dollies are not required to light up for a bulb check unless the vehicle is stopped. In-cab ABS indicator lamps are typically located on the instrument panel. The exact location and appearance vary by vehicle/component manufacturer.

OPERATION:

When the brakes are applied, fluid is forced from the brake master cylinder outlet ports to the HCU inlet ports. This pressure is transmitted through four normally open solenoid valves contained inside the HCU, then through the outlet ports of the HCU to each wheel. The primary (rear) circuit of the brake master cylinder feeds the front brakes. The secondary (front) circuit of the brake master cylinder feeds the rear brakes.

If the EBCM senses a wheel is about to lock, based on speed sensor data, it closes the normally open solenoid valve for that circuit. This prevents any more brake fluid from entering that circuit. The EBCM operates the anti-lock pressure valve to keep the wheels from locking up to do this the EBCM uses a three-step cycle: Pressure Decrease, Pressure Increase, Pressure Maintain.



The EBCM then looks at the speed sensor signal from the affected wheel again. If that wheel is still decelerating, it opens the solenoid valve for that circuit. Once the affected wheel comes back up to speed, the EBCM returns the solenoid valves to their normal condition allowing fluid flow to the affected

brake. Loss of hydraulic fluid in the brake master cylinder will disable the anti-lock system. The 4-wheel anti-lock brake system is self-monitoring. When the ignition switch is turned to the RUN position, the anti-lock brake control module will perform a preliminary self-check on the anti-lock electrical system indicated by a three second

illumination of the yellow ABS warning indicator. Each time the vehicle is driven, as soon as vehicle speed reaches approximately 20 km/h, the anti-lock brake control module turns on the pump motor for approximately one-half second. At this time, a mechanical noise may be heard.

This is a normal function of the self-check by the anti-lock brake control module. When the vehicle speed goes below 20 km/h, the ABS turns off.

ABS FEATURES AND BENEFITS:

Features and Benefits	
<i>Features</i>	<i>Benefits</i>
Control of steering, drive and trailer wheels	Increases steering ability and vehicle stability during braking Reduces possibility of jackknifing and trailer Swing Reduces tire flatspotting
Fail-safe electrical/electronic system	If the electrical/electronic system fails, the ABS is shut off, returning the vehicle to normal braking. On some systems, the ABS is only shut off at the affected wheels.
Traction control	An optional feature that controls excessive wheel spin during acceleration, reducing the possibility of power skids, spins or jackknifes.
Self-diagnosing system	Built-in system makes maintenance checks quick and easy.
Diagnostic tool compatibility	ABSs are compatible with industry standard hand-held and computer-based diagnostic tools. Blink codes and other diagnostic schemes can also be used for troubleshooting, if other tools are not available.
ABS Malfunction Indicator Lamp	Informs the driver or technician that an ABS fault has occurred. The warning lamp may also transmit blink code information. It does not signal all possible faults.

ADVANTAGES:

1. It helps in avoiding potential accidents.
2. Anti-lock Braking System provides greater vehicle stability and control during hard braking (lockup) to the driver.
3. Anti-lock Braking System helps in shortening the stopping distance.

LIMITATIONS:

1. Anti-lock Braking System does not increase or decrease ultimate stopping power.
2. Poor brake maintenance.
3. Loss of hydraulic fluid in brakes master cylinder will disable the anti-lock system.
4. It is high in cost.

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