

2005 Escape Hybrid Special Features

Ford Escape Hybrid Technology

At the heart of the 2005 Ford Escape Hybrid is its advanced hybrid powertrain, an integrated system that uses a half-dozen key components to deliver seamless, efficient power.

Ford expects more than 100 patents to be issued on the Escape Hybrid.

"Ford's history of leadership in the electric vehicles market aided the development of the Escape Hybrid, and the technologies we're putting on the road this year are necessary steps toward the development of fuel-cell vehicles," said Phil Martens, group vice president, Product Creation.

The Hybrid Principle

"Hybrids are all about increasing average thermal efficiency," said Tom Watson, powertrain supervisor, referring to the amount of energy the vehicle can extract from its gasoline fuel. The 2005 Escape Hybrid's increased efficiency comes from:

- A "Right-sized" four-cylinder engine with electric drive boost. The four-cylinder gasoline engine easily meets the cruising needs of the vehicle with reduced fuel consumption. When needed, the electric drive system teams with the gasoline engine for the performance feel of a larger V-6.
- An electronically controlled continuously variable transmission (eCVT). A planetary gear set connects the drive wheels to the gasoline engine and electric traction motor, so that the vehicle can move on any combination of electric and gasoline power, depending on what is most efficient at that instant.
- Engine stop-start. When it isn't needed to supply power, such as when coasting or while stopped in traffic, the gasoline engine automatically shuts off instead of idling inefficiently. When circumstances warrant, a powerful starter motor can restart the engine within 400 milliseconds for seamless performance.
- Regenerative braking. In traditional vehicles, the energy used to decelerate the car is lost as heat when the driver applies the brakes. Hybrids, on the other hand, can recover a substantial portion of what would otherwise be "lost energy" and store it in the battery for later use.
- Electric drive. The Escape Hybrid can be driven up to 25 mph using the electric motor alone, thus using no gasoline and causing no emissions.
- Electric-assist power steering. The electric assist system enables power-assisted steering when the gasoline engine is shut off. While driving at low speeds or coasting, it offers improved fuel economy, even when the engine is running, because it consumes less power than belt-driven power steering.

Full Hybrid

The Escape Hybrid is a "full" hybrid, meaning it has a high-voltage storage battery and the capability of driving on electric power alone. Full-hybrids can achieve 50 percent or more improvement in fuel economy during stop-and-go driving where the electric motor is most efficient. Mild hybrids, in contrast, are distinguished by relatively small battery capacity and lack an electric-only drive mode, limiting their fuel-saving potential. Mild hybrids are unable to achieve as much improvement in fuel economy as full hybrids.

When the driver calls for maximum acceleration, the gasoline engine and electric motor work in parallel, providing launch performance feel similar to that of a powerful V-6 engine. In less demanding situations, the Escape Hybrid can run on its electric motor alone, its gasoline engine alone or the most efficient combination of the two.

Atkinson-Cycle Engine Operates Efficiently

Escape Hybrid's four-cylinder gasoline engine is an Atkinson-cycle variant of the conventional Escape's Duratec 23 2.3-liter engine. The Atkinson cycle is similar to the familiar four-stroke cycle - intake, compression, power, exhaust - except the intake valve closes well after the piston begins moving upward to compress the air-fuel mixture. There are two key benefits of the Atkinson cycle. First, it reduces the "pumping losses" associated with all gasoline engines. Additionally, because a fraction of the air-fuel mixture is released from the cylinder back into the induction system without being burned, the effective displacement of the engine is reduced. The power stroke, or the distance that burning fuel pushes on the piston, is longer than the effective intake stroke. This helps extract more energy from each drop of fuel.

Viewed by itself, the Atkinson cycle engine in the Escape Hybrid is about 4 percent more efficient than the nearly identical conventional 2.3-liter engine in the base Escape model. Why then is the Atkinson cycle not more widely used in conventional vehicles? Its main disadvantage is reduced torque, particularly at low engine speeds. The Escape Hybrid supplements the gasoline engine with an electric traction motor to provide low speed torque and a satisfying launch feel.

High-Power Traction Motor Does Double Duty

In addition to its gasoline engine, the Escape Hybrid has a 70-kilowatt (the equivalent of 94 horsepower) permanent-magnet traction motor. This motor can propel the vehicle alone or team with the gasoline engine for a boost of power similar to - a V-6 engine.

The electric drive system is most efficient at low speeds and at low loads - exactly the conditions where the gasoline engine is least efficient.

Electronically-Controlled Continuously Variable Transmission

In place of a conventional transmission is an electronically controlled planetary gear set that includes the traction motor and power-management electronics in one compact assembly.

The planetary gear set can vary the distribution of power among the gasoline engine, electric motor and the vehicle's wheels. Because of this capability, the vehicle can run on the gasoline engine, the electric drive system or both - depending on the driving situation.

In addition, the planetary gear set acts as an electronically controlled continuously variable transmission (eCVT), meaning the gasoline engine can always run at its most efficient or powerful engine speed for a given vehicle speed. This eCVT contributes to efficiency and performance, as well as to refinement, because there are no defined shifting "steps" during acceleration.

Engine Stop-Start Saves Gasoline

Significant fuel savings can be realized by switching off the gasoline engine when it isn't needed. The traction motor provides a smooth method of stopping the engine when appropriate, making this process almost invisible to the driver.

But a traditional reduction starter motor - a relatively lightweight device that cranks the engine at only a few hundred revolutions per minute - isn't up to the task of restarting it instantaneously. Instead, the Escape Hybrid uses a much more powerful starter motor to restart the engine when needed, such as during strong acceleration from a stop. It can do so in less than 400 milliseconds and without the increased engine emissions associated with typical starts.

In the U.S. Environmental Protection Agency's city driving cycle, the Escape Hybrid makes extensive use of engine stop-start and electric-only operation. During that kind of stop-start driving, the gasoline engine is off as much as 40 percent of the time.

Regenerative Braking Recaptures Energy To recover the energy that a traditional vehicle loses as heat through its brakes, the Escape Hybrid uses an advanced "by-wire" electro-hydraulic braking

system. With this system, the pressure on the brake pedal acts as an input to a computerized brake controller that modulates the electric drive system and the traditional disc brakes.

When the driver lifts off the accelerator pedal, the electric drive motor operates as a generator, slowing the vehicle slightly. As the driver presses the brake pedal, this "motor-generator" slows the vehicle to match the driver's demand. During this regenerative braking phase, the motor transforms the vehicle's momentum into electric energy and charges the hybrid storage battery with electricity that can be used later.

If the motor is providing its maximum braking force, but the driver calls for more deceleration, the brake controller applies friction braking force with the traditional disc brakes as needed. The electro-hydraulic system has antilock brake functionality as standard equipment.

Much of the braking in everyday driving can be done by the electric drive system alone, extending the service life of the traditional brakes.

Hybrid Storage Battery Offers 330 Volts

A 330-volt nickel-metal-hydride battery pack located beneath the rear load floor stores energy recovered during braking and powers the electric drive system. The Escape Hybrid, like a conventional vehicle, still has a 12-volt battery under the hood to power the vehicle's lights and electrical accessories.

The hybrid storage battery consists of 250 D-sized cells in a sealed enclosure. Nickel-metal-hydride batteries have been used with excellent success in notebook computers and cell phones for years.

Hybrid-specific components, including the battery pack, are covered by a warranty of at least eight years or 100,000 miles. The entire vehicle comes with a bumper-to-bumper warranty for three years or 36,000 miles and complimentary roadside assistance.

Thermal management for optimal performance

"Batteries are like people," Watson said. "They don't like to work when they're cold, and they get stressed when they're hot." To keep the battery pack at its optimum temperature, it has a thermal management system to deal with temperatures from minus 40 degrees Centigrade (-40 Fahrenheit) to 50 degrees Centigrade (122 Fahrenheit). An electric heater and forced-air cooling system help keep the battery comfortable.

While it's never necessary - or even possible -to plug the Escape Hybrid into a charger, in the unlikely event that insufficient energy is available to start the gasoline engine, jumpstarts are possible. Sophisticated electronics within the Powertrain Control Module manage energy flow.

Electric Power Makes Steering Easier

Because the Escape Hybrid's gasoline engine automatically stops to save fuel when possible, an electric power-assisted steering system replaces the traditional belt-driven hydraulic system.

An electronic control module detects the driver's input torque at the steering wheel, instantaneously computes the proper amount of assist and commands a brushless electric motor to help control the steering mechanism.

The electric power-assisted steering brings several other benefits, including quieter operation. Because there is no power steering fluid, the chance of leaks is eliminated, as is fluid circulating noise. The amount of steering assist also is fully independent of engine and vehicle speed, allowing engineers to give the Escape Hybrid a very easy steering effort at parking-lot speeds, while retaining Escape's hallmark steering feel while driving.