HYBRIDS

http://projektstepahead.sk/

STEP AHEAD: The support of Professional development of VET teachers and trainers in following of New trends in Automotive Industry

2015-1-SK01-KA202-008909-P1

Tento projekt je spolufinancovaný Európskou úniou v rámci programu ERASMUS+.

HYBRIDS

EVOCATION

The aim of the activity: Continuing of the previous lesson, motivation of students for the topic of the Integrated Motor Assist (IMA) hybrid vehicles.

STEP 1.

Description of activity: Linkage to the homework from the previous lesson: "Imagine, that you are a head technician in a workshop. Explain to your new co-worker the basic differences between classic and hybrid vehicle, describe the plusses and minuses of both and their impact on the environment."

Teacher summarizes the outcomes – asking one students to write the notes down on a blackboard/flipchart in the two – column structure: plusses – minuses.

Instructions: On the previous lesson you worked on a homework describing the plusses and minuses of the classic and hybrid vehicles. Please mention the basic differences between both types. We will note them on a blackboard.

STEP 2.

Description of activity: Teacher hands out the students the papers with the mixture of words related to classic or hybrid vehicle. The task for the students is to match the right words to classic or hybrid type.

Instructions: Now we already know the differences between both types of vehicles. Does any of you know in detail what are the IMA operating modes? On the handed out papers you´ll find the mixture of words. Your task is to match them with the classic or hybrid type of vehicle. Divide the words into two groups.

STEP 3.

Description of activity: Evaluation of the previous task of words matching. Working in pairs, without the feedback of a teacher.

Instructions: Please compare your words matching results with your neighbour. Discuss it.

Tools for the activity: Homework results, blackboard/flip, Annex 1 for each student – mixed words

Estimated time: 10 minutes (steps 2,3 might be skipped in a case there is not enough time for the next activities)

Notes: Task for the teacher in ANNEX 1 - please mix the words before handing them out to the students.

APPRECIATION

The aim of the activity: Deepening and consolidation of the knowledge of the IMA operating modes.

STEP 1.

Description of activity: Working with 3 different texts in 3 different groups. Each group receives one text. Understanding the text, explanation of the meaning of the text and basic terminology to other students. / Teaching the others.

Texts:

A) 3 types of hybrid vehicles overview,

B) IMA, power split, power splitter,

C) IMA operating modes

Instructions: Split in 3 groups. Each group receives a text. Your task in the group is to study the basic terminology and present it/explain to the other groups. Group A) works with the text about the 3 types of hybrid vehicles overview B) IMA, power split, power splitter, C) IMA operating modes. If there is anything in the text that you don´t understand, please note it down on a paper.

STEP 2.

Description of activity: Presentation of the group work results. Noting the unclear issues/terminology on a blackboard. If anything unclear, there can be a short discussion about it, and students can be challenged to find additional information on the internet – as a homework.

Instructions: When you finished your work in the groups, please explain what you learnt and teach your fellow students about it. If there is anything unclear, we´ll explain it on a next lesson.

STEP 3.

Description of activity: Practicing of knowledge gained in the previous steps (A) B) C) group work) through online exercises – work with interactive learning screens.

Instructions: Please work with the learning screens on http://projektstepahead.sk/.

Tools for the activity: Texts A), B), C) (Annex 2), flip papers & markers for the work in the 3 groups, computers with the internet access and logins into the portal

Estimated time: 20 + 10 minutes

Notes: If there won´t be enough time, Step 3 – work with the portal can be assigned as homework.

REFLECTION

The aim of the activity: Summary of gained knowledge, practical application.

STEP 1.

Description of activity: Summary and practical application of the gained knowledge.

Instructions: Imagine you are a head technician in a workshop. Your task is to explain to your fellows the basic principle of operating process of the hybrid vehicle. Draw the basic structure of the 3 types of the hybrid. If you need to, you can use the picture in the text A). Describe the 5 IMA operating modes. Mark them on the adequate part of the picture 14 of the text C).

STEP 2.

Description of activity: Summary of the knowledge, practical application. Working in pairs/roleplays.

Instructions: Work in pairs. One of you is a hybrid vehicles expert, the other is a family friend who wants to buy a new hybrid car. Based on the knowledge gained on the lesson, please discuss which type of the hybrid would suit your friend the most, describing the differences and mentioning the aspects to consider before making the decision.

Tools for the activity: Paper/notebook, pencils for drawing, Annex 2 A), B) C) texts

Estimated time: 10 minutes

ANNEX 1

Classic or Hybrid vehicle? Or both?

RESERVOIR

DIFFERENTIAL

FUEL

TIMING MECHANISM

CLUTCH

ELECTRIC MOTOR

ENGINE

GEARBOX

CONTROLLER

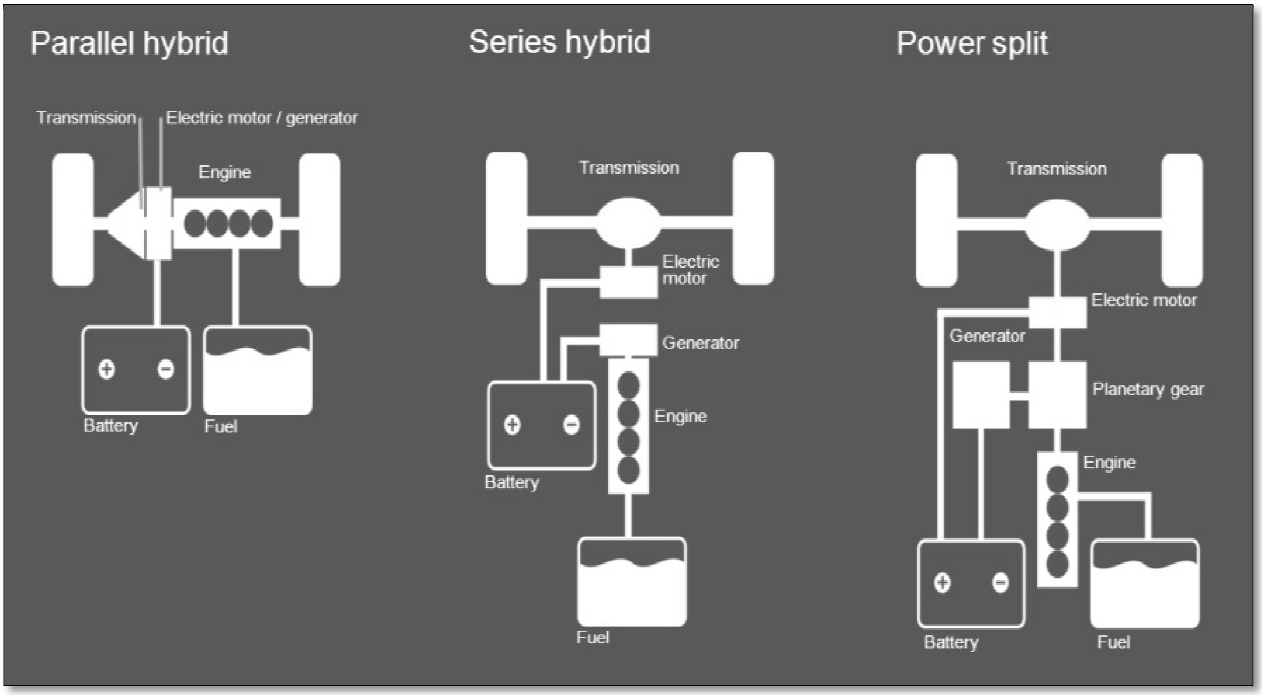
BATTERY

GENERATOR

ANNEX 2

A) Overview

A hybrid power system for an automobile can have a series, parallel or power split configuration. With a series system, an engine drives a generator, which in turn powers a motor. The motor propels the vehicle. With a parallel system, the engine and motor can both be used to propel the vehicle. Most hybrids in current use employ a parallel system known as Integrated Motor Assist (IMA). The power split has additional advantages but is also more complex.



Three types of hybrid vehicles

B) Integrated Motor Assist (IMA)

The IMA method is a technologically advanced parallel hybrid power system. By employing techniques such as brake-energy regeneration to maximize the efficiency with which energy is used, it combines low-pollution, low-cost operation with high levels of safety and running performance. The main components of the system are:

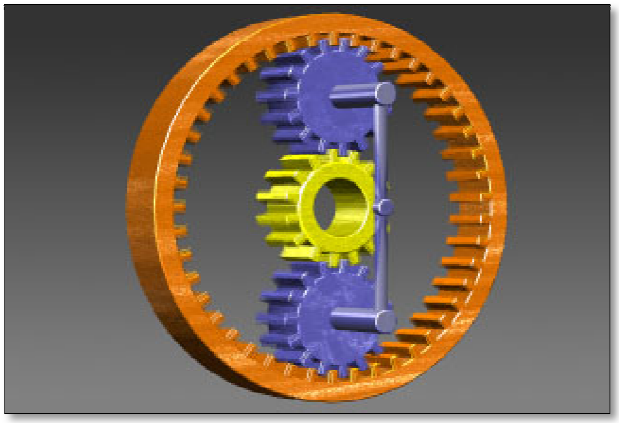
- IMI motor
- Battery module
- Power drive unit (PDU)
- Motor control module (MCM)
- DC-DC converter

Power split

The Toyota Prius, for example, uses a splitting device that effectively allows a combination of series and parallel systems. The three main operating conditions are:

- The high voltage battery provides power to motor 2 to drive the wheels.

- When the wheels are driven by the engine via the power splitting device, generator 1 is also driven via the planetary gears to supply electricity to motor 2 to drive the wheels.
- When the vehicle is decelerating, kinetic energy from the wheels is recovered, converted into electrical energy and used to recharge the battery by means of motor/generator 2.



Power splitter

This device is an epicyclic gearbox that transmits mechanical power between the Engine-Motor-Generator system.

Figure 1 / The splitter is an epicyclic gearbox

C) Operating modes

There are five main IMA operating modes:

- Start-up
- Acceleration
- Cruising
- Deceleration
- Idling

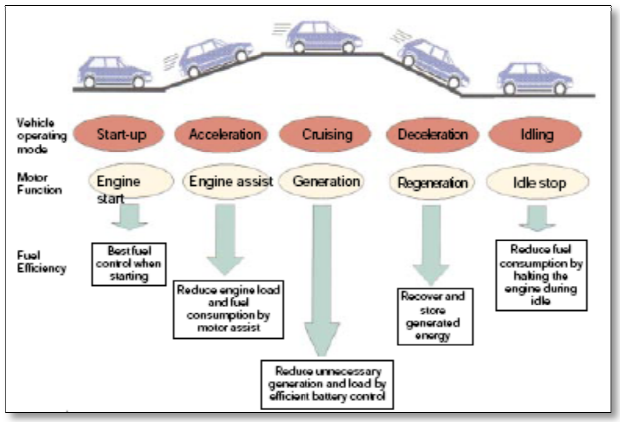
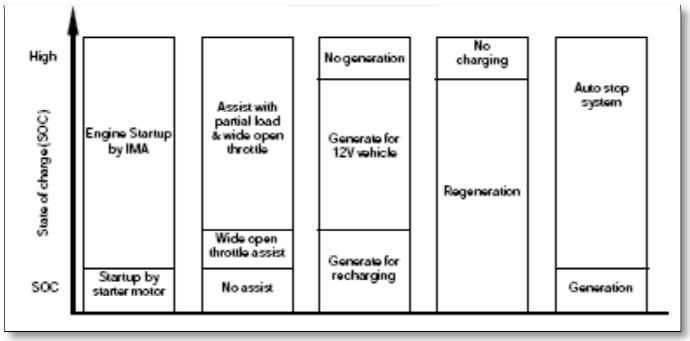


Figure 2 / Operating conditions



The diagram shown here as figure 2 and the chart shown as figure 3, gives an overview of each mode. The following screens explain each mode in more detail.

Figure 3 / IMA operating details

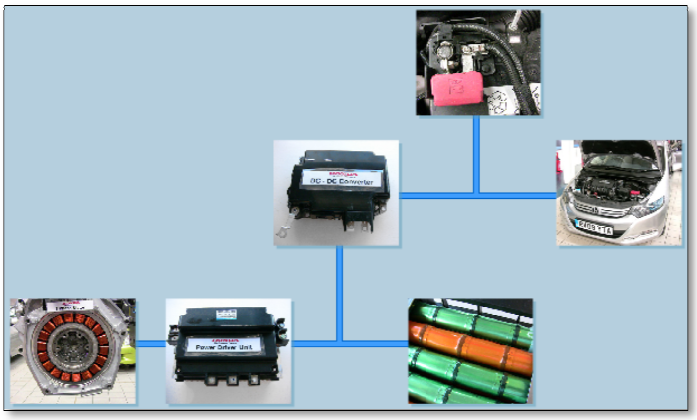


Figure 4 / Add arrows to show direction of current flow

Engine start-up

Under normal conditions, the IMA Motor will immediately start the engine at a speed of 1000 rev/min. When the state of charge (SOC) of the high voltage battery module is too low, when the temperature is too low, or if there is a failure of the IMA system, the engine will be cranked by the normal 12V starter motor.

Acceleration

During acceleration, current from the battery module is converted to AC by the power drive unit (PDU) and supplied to the IMA motor, which functions as a motor. The IMA motor output is used to supplement the engine output so that power available for acceleration is maximized. Current from the battery module is also converted to 12V DC for supply to the vehicle electrical system. This reduces the load that would have been caused by a normal alternator and so improves acceleration.

When the remaining battery module state of charge is too low, but not at the minimum level, assist will only be available during wide open throttle (WOT) acceleration. When the remaining state of charge is reduced to the minimum level, no assist will be provided. The IMA system will generate energy only to supply the vehicles 12V system.

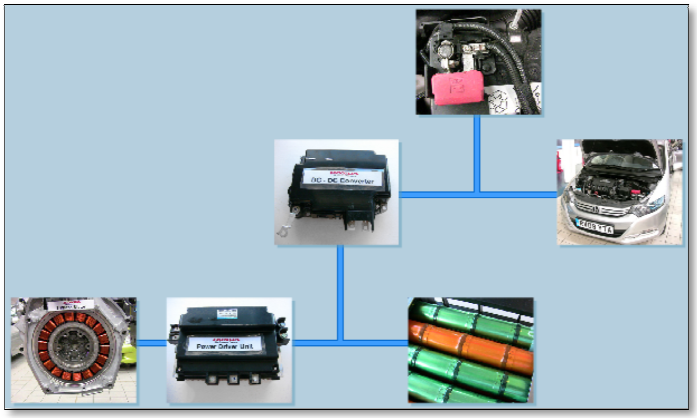


Figure 5 / Add arrows to show direction of current flow

Cruising

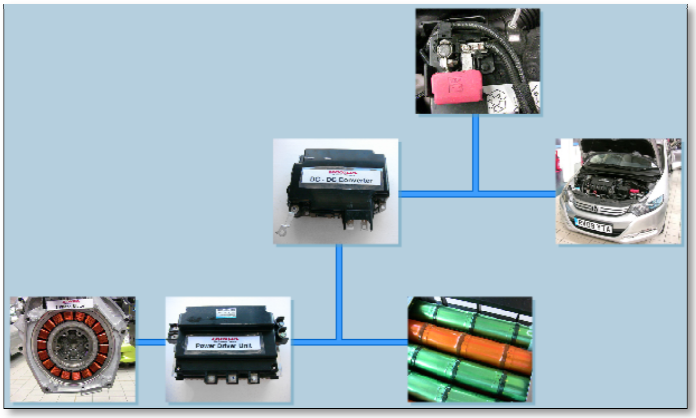


Figure 6 / Add arrows to show direction of current flow

When the vehicle is cruising and the battery module requires charging, the engine drives the IMA Motor, which now acts as a generator. The resulting output current is used to charge the battery module and is converted to 12V DC to supply the vehicle electrical system. When the vehicle is cruising and the high-voltage battery is sufficiently charged, the engine drives the IMA motor. The generated current is converted to 12V DC and only used to supply the vehicle electrical system.

Deceleration

During deceleration (during fuel cut), the IMA motor is driven by the wheels such that regeneration takes place. The generated AC is converted by the power drive unit (PDU) into DC and used to charge the battery module. The DC output of the PDU is also applied to the DC-DC converter which reduces the voltage to 12V, which is supplied to the vehicle electrical system. It is further used to charge the 12V battery as necessary.

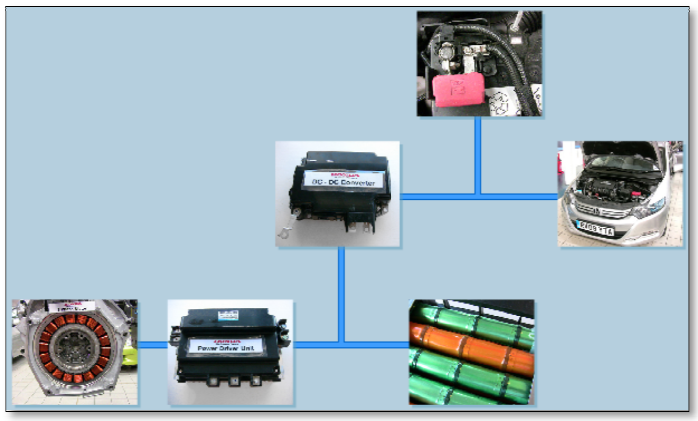


Figure 7 / Add arrows to show direction of current flow

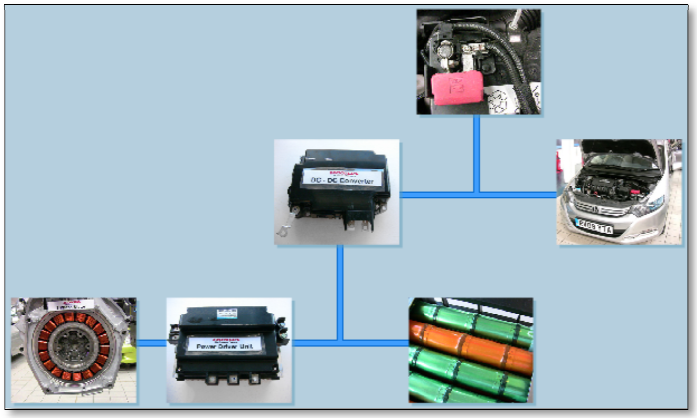


Figure 8 / Add arrows to show direction of current flow

During braking (brake switch on), a higher amount of regeneration will be allowed. This will increase the deceleration force so the driver will automatically adjust the force on the brake pedal. In this mode, more charge is sent to the battery module. If the ABS system is controlling the locking of the wheels, an 'ABS-busy' signal is sent to the motor control module. This will immediately stop generation to prevent interference with the ABS system. When the high voltage battery is fully charged, there will only be generation for the vehicle's 12V system.

Idling

During idling, the flow of energy is similar to that for cruising. If the state of charge of the battery module is very low, the motor control module (MCM) will signal the engine control module (ECM) to raise the idle speed to approximately 1100 rev/min.

Summary

The IMA technique used by most hybrid cars can be thought of as a kinetic energy recovery system (KERS). This is because instead of wasting heat energy from the brakes as the vehicle is slowed down, some is converted to electrical energy and stored in the battery as chemical energy. This is then used to drive the wheels so saving chemical energy from the fuel!

Source: ©IMI eLearning

NOTES