Teacher Support

1. Automotive Chassis Design

The chassis design consists of installing all of the components necessary for the effective operation of the powertrain. Very compact fuel cells may appear some day and they may be fitted in the same place as the combustion engine. For SUV chassis it is already possible to locate the fuel cell in the large engine compartment, it is less the case for sedan cars. Depending on vehicle type and size, many different chassis designs are possible.

That means that manufacturers will answer the question by distributing the components on the available chassis area, taking into account the energy and fluid circuits. Figure 1 shows what has to be taken into consideration:

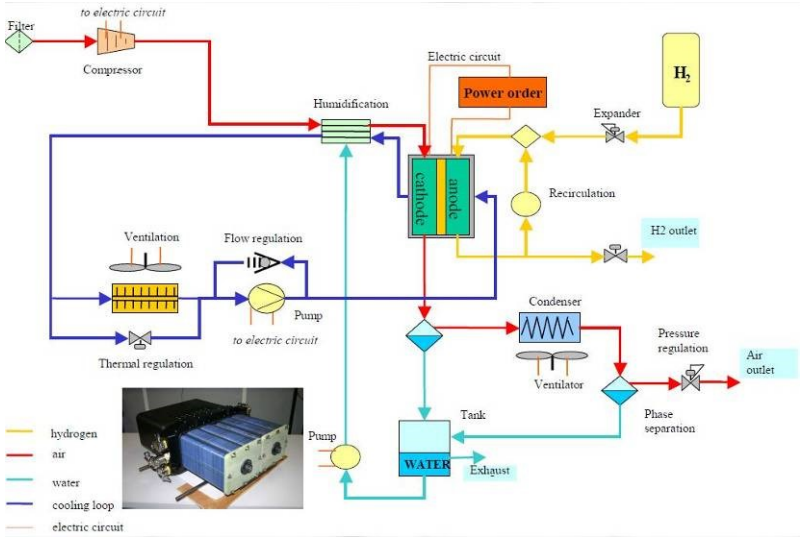

Figure 1: Fluid circuit in a FC vehicle

- A compressed air circuit ideally located in the front of the vehicle.
- A hydrogen circuit arriving from the tanks via the safety accessories and the pressure control. This circuit supplies the low-voltage cell.
- A hydrogen purge circuit exiting the cell and allowing it to be decontaminated in the event of reduced performance.
- A recycled water circuit arriving from the cell exhaust and supplying a humidifier placed on the air intake circuit.

- A release circuit for water produced by the cell.
- A cell cooling circuit, connected to an exchanger for heating the passenger compartment.

The first vehicle prototypes were standard ones with a traditional fuel cell being placed under the hood instead of the combustion engine. Honda was then the first manufacturer to offer a vehicle model marketed with the name Clarity FCX. The chassis of the first models is shown in Figure 2. The architecture was subsequently used on a widespread basis.

Figure 2 Design of a fuel cell chassis (source Honda).

The hydrogen gas tanks are located at the rear of the vehicle, where the high-voltage battery is also found. The fuel cell and its management electronics are in a central position. At the front of the vehicle are the radiators, the air supply scoop, the inverter, the electric motor and transmission to the wheels. Other architectures are possible when considering large tanks needed to be placed longitudinally on the chassis or considering SUV vehicles with more volume under the hood. By observing the market, we can establish a description of FC chassis available and split them into three categories.

<u>Possibility 1 (SEDAN)</u>
Back of the vehicle: high-pressure tanks, high-voltage battery
Middle: Fuel cell
In front: Inverter, motor, air scoops, radiators

<u>Possibility 2 (SUV)</u>
Back of the vehicle: high-pressure tanks
Middle: High voltage battery
In front: Fuel cell, inverter, motor, air scoops, radiators

Possibility 3 (large cars)
Back of the vehicle: High voltage battery, inverter, motor
Middle: high-pressure tanks, cryo-compressed tank system
In front: Fuel cell, air scoops, radiators

Figures 3, 4 and 5 show examples of a car chassis adapted to a fuel cell powertrain. All of the available space is used: under the hood in front, under the floor and under the rear trunk of the vehicle. The architectures are similar in the case of the three manufacturers. These figures are followed by a video of the powertrain batch production process for the Toyota Mirai and its assembly on the vehicle chassis.

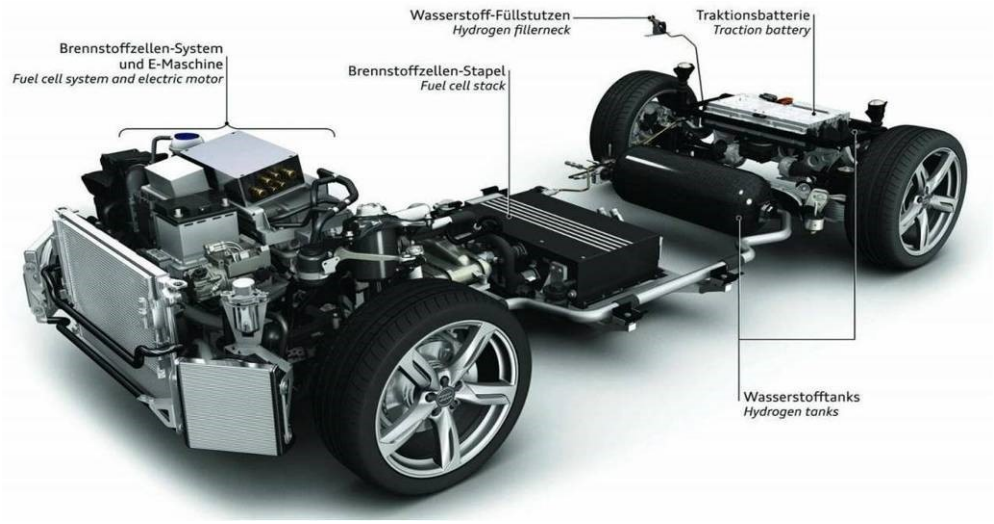

Figure 3 Example of a fuel cell powertrain (source Audi via EDUCAM)

Figure 4 Example of a fuel cell powertrain (source Mercedes via EDUCAM)

Figure 5 Example of a fuel cell powertrain (Source Toyota)

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Video 1 Construction of the Toyota Mirai powertrain

Source: https://www.youtube.com/watch?v=bge5K4lt-ow

2. List of components of the powertrain

These components are visible and printable in the joined PowerPoint; you will find hereafter the list of the most important ones.

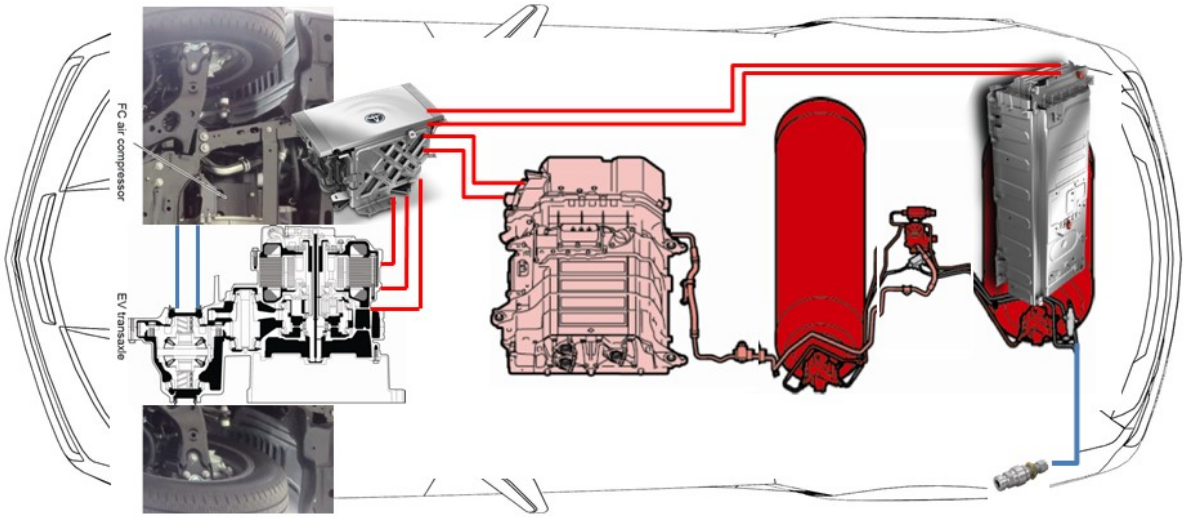
1. Chassis frame
2. Filling plug
3. Tank(s)
4. Pressure regulator
5. Fuel cell and auxiliaries (sub-exercise)
    a. Radiator
    b. Hydrogen pump & inverter
    c. Air Filter
    d. Air compressor & intercooler
    e. Humidifier
    f. Exhaust
6. High Voltage Battery
7. Traction Inverter
8. Electric motor
9. Transmission & wheels

Problem asked to the students: Locate correctly the components on the chassis and visualize connections between them thanks to wires and pipes represented by lines on the blackboard.

Solution: You will find a representation and short description of the components in the joined PowerPoint. Print it and use it as a support for the exercise. The students must draw a schematic chassis frame on the blackboard and locate correctly the components. They must finally associate their functions by drawing lines with a whiteboard marker or a chalk, the lines representing interactions between components.

3. Solutions

See the joined power point for explanations



Solution 1, components & links in a FCV powertrain

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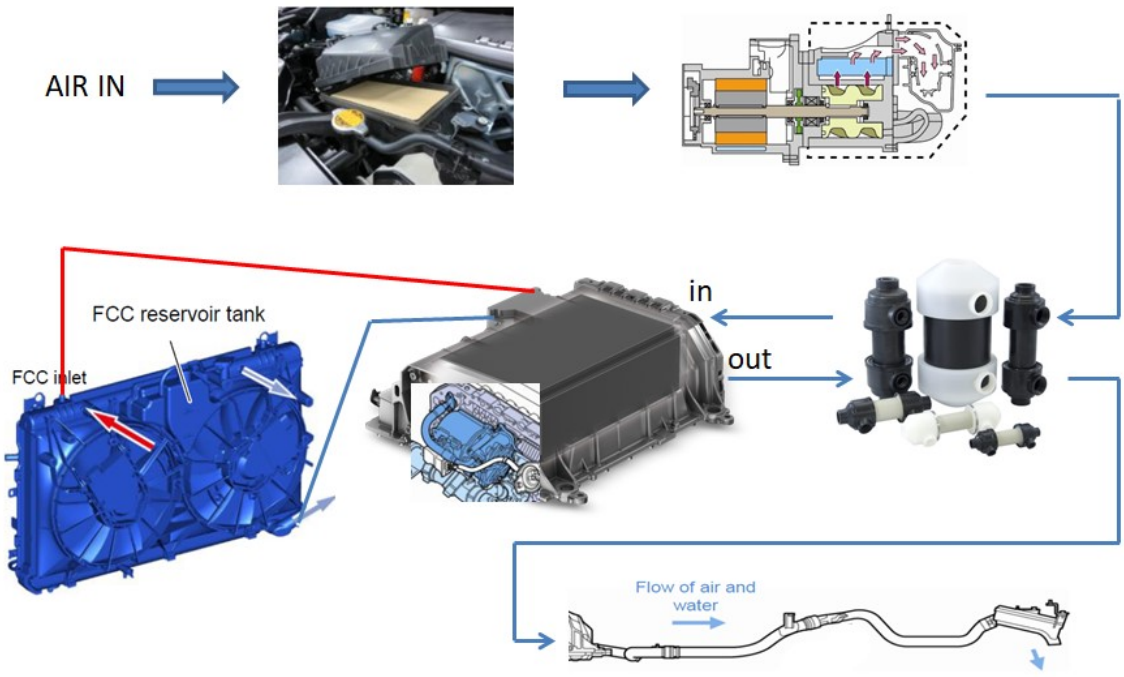

Solution 2, major auxiliaries associated to the fuel cell