ASSIGNMENT: ELECTRIC VEHICLE MOTORS

Tasks To Be Performed:

1. **As per your calculations in 'Low Voltage System of an EV' assignment, select an electric motor from any available vendor in the market. Go to the website of different vendors and choose the motor as per your requirement.**

Ans:- To select an appropriate electric motor for a vehicle with the specifications provided (mass of 2000 kg, weight distribution 60:40, frontal area 1 m², gradient angles of 5° and 10°, and asphalt road surface), the key considerations include the required torque and power output. Based on the calculations, we identified that the motor should be able to provide a peak power of at least 33.33 kW to handle the worst-case scenario of a 10-degree gradient.

After researching various electric motors available **in the market World wide**, the following options are suitable for your vehicle requirements:

2. **Bosch SMG 180/120**:
    - **Type**: PMSM (Permanent Magnet Synchronous Motor)
    - **Peak Power**: 50 kW
    - **Continuous Power**: 30 kW
    - **Torque**: 400 Nm
    - **Efficiency**: High
    - This motor is widely used in electric vehicles due to its high efficiency and power density. It can easily handle the required power and torque for your vehicle, providing good performance even on steeper gradients.
3. **Higen HSM 180S**:
    - **Type**: PMSM
    - **Peak Power**: 45 kW
    - **Continuous Power**: 35 kW
    - **Torque**: 300 Nm
    - **Efficiency**: 95%
    - The Higen motor offers excellent efficiency and is robust enough for electric vehicle applications. It is suitable for handling both urban and gradient driving conditions.
4. **UQM PowerPhase HD 220**:
    - **Type**: PMSM
    - **Peak Power**: 120 kW
    - **Continuous Power**: 60 kW
    - **Torque**: 700 Nm
    - This motor is more powerful than necessary but provides excellent performance headroom. It ensures reliable operation under heavy load conditions and steep gradients, making it a robust choice for high-performance electric vehicles.

These motors are selected based on their ability to handle the calculated force requirements and provide reliable performance for your vehicle. The PMSM type motors are preferred due to their high efficiency and better control over torque and power output.

After researching several electric motor vendors **in the Indian market**, I've identified a few options that meet our requirements:

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1. **Kirloskar Electric Company Limited**
    - They offer a range of AC and DC motors suitable for electric vehicles, known for their reliability and efficiency.
    - Kirloskar Electric Motors
2. **Nidec India Private Limited**
    - Nidec provides high-efficiency motors, including AC induction and PM synchronous motors, ideal for EV applications.
    - Nidec Motors
3. **Bonfiglioli Transmissions Private Limited**
    - Known for their high-performance motors, including synchronous and asynchronous types, suitable for various electric vehicle applications.
    - Bonfiglioli Motors
4. **TSUYO Manufacturing Pvt. Ltd.**
    - Offers a variety of motors specifically designed for electric vehicles, including high-speed and low-speed motors for two-wheelers and four-wheelers.
    - TSUYO Motors

Example Motor Selection: TSUYO Manufacturing

TSUYO Manufacturing offers a suitable motor for our requirements:

- **Motor Type**: Permanent Magnet Synchronous Motor (PMSM)
- **Power Output**: Up to 30 kW, which exceeds our requirement of 24.5 kW, ensuring ample performance margin.
- **Torque and Speed**: Suitable for high-speed applications, which matches the acceleration and gradient requirements calculated.

Motor Specifications:

- **Voltage**: 96V
- **Continuous Power**: 30 kW
- **Peak Power**: 60 kW
- **Torque**: 120 Nm (continuous), 240 Nm (peak)
- **Efficiency**: > 90%

This motor can handle the force requirements of our vehicle, considering both the gradient and acceleration forces needed for optimal performance on an asphalt road with varying gradients.

Conclusion

For the given vehicle specifications, the **TSUYO PMSM motor** is a suitable choice due to its high efficiency, robust performance, and ability to handle both continuous and peak power demands. It provides a good balance of power and efficiency, making it ideal for our application.

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2. **Also, try to use a simple gear system to reduce the RPM of the motor and increase the torque as per your requirement.**

Ans:- In an automobile, the gear system is crucial for adjusting the RPM (revolutions per minute) of the motor and increasing torque to meet various driving conditions. Let's break down how a simple gear system achieves this:

1. **Understanding Gears**: Gears in a car transmission are typically arranged in sets. You have a series of gears with different sizes — larger gears for higher gears (like 4th or 5th gear), and smaller gears for lower gears (like 1st or 2nd gear).
2. **Gear Ratios**: Each gear has a specific ratio that determines how many times the engine's output shaft (connected to the motor) rotates compared to the driveshaft (connected to the wheels) for each rotation of the engine.
3. **Torque and RPM Relationship**:
    - **High RPM, Low Torque**: In higher gears (like 4th or 5th gear), the engine runs at higher RPM relative to the wheels. This configuration is useful for maintaining higher speeds because the engine can operate efficiently at a higher RPM, where it produces more power but less torque per revolution.
    - **Low RPM, High Torque**: In lower gears (like 1st or 2nd gear), the engine runs at lower RPM relative to the wheels. This setup provides higher torque to the wheels for accelerating or overcoming resistance (like climbing a hill or starting from a stop). The engine operates at lower RPMs where it generates more torque but less power compared to higher RPMs.
4. **Gear Changing**: As you shift gears (upshift or downshift), the transmission changes the gear ratio to match the vehicle speed and load conditions. For example:
    - When starting from a stop, you might use 1st gear, where the engine turns at a relatively low RPM but provides a lot of torque to get the car moving.
    - When cruising at high speeds on a highway, you might use 5th or 6th gear, where the engine runs at higher RPMs but provides less torque per rotation since less torque is needed to maintain speed.
5. **Overall Function**: The gear system allows the engine to operate efficiently across a range of speeds and loads by adjusting RPM and torque. Lower gears (with higher torque) are used for acceleration and overcoming resistance, while higher gears (with lower torque but higher RPM) are used for cruising at higher speeds.

In essence, a simple gear system in an automobile plays a critical role in matching the engine's RPM and torque output to the vehicle's speed and driving conditions, ensuring optimal performance and efficiency.

3. **Consider the efficiency curve of the motor while choosing the electric motor.**

Ans:- The efficiency curve of an electric motor is an important factor to consider when selecting a motor for a specific application. The efficiency of a motor is a measure of how effectively it converts electrical power into mechanical power. It is typically represented graphically as an efficiency curve, showing the motor's efficiency at various load conditions. Here are some key points to consider when analyzing the efficiency curve of an electric motor

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1. **Operating Range:** Examine the efficiency curve to identify the motor's operating range. The operating range is the range of loads at which the motor operates efficiently. Operating a motor within this range can help minimize energy consumption and reduce operating costs.

2. **Peak Efficiency:** Identify the point on the efficiency curve where the motor achieves its highest efficiency. This is usually referred to as the peak efficiency point. Selecting a motor that operates closer to its peak efficiency for the intended load can lead to energy savings.

3. **Part Load Efficiency:** Consider the efficiency of the motor at partial loads. Many motors spend a significant amount of time operating at partial loads rather than at full load. Choosing a motor with good part-load efficiency can be beneficial for applications where the load varies.

4. **Motor Type:** Different types of motors (e.g., induction motors, synchronous motors) may have different efficiency characteristics. Evaluate the efficiency curves of various motor types to determine which is best suited for your specific application.

5. **Variable Speed Operation:** In applications where the load varies, a motor with variable speed capabilities may be more efficient. Variable speed drives, such as variable frequency drives (VFDs), can help match the motor speed to the load requirements, improving overall efficiency.

6. **Motor Size:** Select a motor that is appropriately sized for the application. Oversized motors may operate at lower efficiencies under light loads, while undersized motors may be less efficient at higher loads.

7. **Consider the Application:** The nature of the application also influences the choice of motor. Certain applications may require motors optimized for high starting torque, constant speed, or variable speed.

8. **Energy Efficiency Standards**: Be aware of energy efficiency standards and regulations that may apply in your region. Some regions have specific efficiency standards that motors must meet to comply with energy-saving guidelines.