DUTY CYCLE MODEL OF AN INTERNAL COMBUSTION ENGINE AS PART OF A HYBRID POWER PLANT OF ENGINEERING AND CONSTRUCTION EQUIPMENT

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Today, the task of reducing fuel consumption by power plants of transport units, engineering and construction equipment is relevant. One of the ways to solve this problem is the introduction of hybrid power plants. Traditionally, a hybrid power plant combines an internal combustion engine (ICE), an electric motor, a generator and an electric energy storage. The maximum power of the power plant is provided by the joint operation of the ICE and the electric motor powered by a battery. During periods when high power is not required from the power plant, the ICE charges the battery using a generator. Thus, the load on the ICE can be significantly aligned in time and brought closer to the zone where the lowest specific fuel consumption is achieved.

Most engineering and construction equipment objects are characterized by frequent changes in the load on the power plant within the working cycle and a large number of such working cycles. At the same time there is no need for long-term operation from the battery, and therefore, a battery of relatively small capacity can be used. Chemical batteries are rather poorly suited for operation in such conditions: high charge/discharge current (relative to the battery capacity), a large number of charge/discharge cycles will result in low efficiency and battery life.

Flywheel-based energy storage devices are much more suitable for operation in such conditions. Structurally, they are an electric motor/generator and a flywheel located on the same shaft. The flywheel design is optimized to ensure maximum moment of inertia with minimum mass and fulfillment of strength conditions. The most optimized designs use magnetic bearings and vacuum chambers to reduce friction losses and aerodynamic drag, respectively.

Such a unit is essentially an electric power accumulator with a virtually unlimited number of charge/discharge cycles. The energy density of such accumulator is in the range of 0,36…0,5 MJ/kg (for comparison 0,59…1,06 MJ/kg for lithium-ion battery). The advantages of this method of energy storage also include the ability to operate in a wide temperature range, simple design, high efficiency, environmental friendliness, long service life and a very long lifespan. The disadvantages of energy storage using a flywheel include a relatively high rate of energy dissipation over time (not suitable for long-term energy storage), high mass and gyroscopic moment of the flywheel. It is important to note that these disadvantages will practically not lead to deterioration in the characteristics of engineering and construction equipment.

References:

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