DEVELOPMENT OF ELECTRO-HYDRAULIC EXCAVATOR USED IN
HEAVY DUTY APPLICATIONS: A NOVEL VIEW

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Abstract: The increasing trend in the employment of electro-hydraulic systems has become prominent due to their advantages in bettering efficiency. The hybrid system as in whole fuses the electric and hydraulic technology into a compact unit, have been accommodated to an extensive variety of force, speed and torque prerequisites. Hence, these hybrid systems are being exploited in heavy duty applications as they can easily cope up with the environmental problems. This paper examines the difference between hybrid powered automobile vehicle and hybrid powered heavy duty application machinery such as excavator. Normally energy storage source supervises the energy consumption in case of hybrid machines. There is substantial loss of energy as the machine starts and stops frequently which makes the way for the concept of energy regeneration. Hence the design, development and the research guided on the energy regeneration of the excavator and its wide applications are also portrayed.

Keywords: electro-hydraulic systems, hybrid power, excavator

I. INTRODUCTION:

The manner in which natural resources are being depleted, a day will come in future when we will have acute shortage of natural resources. Widespread research and brainstorming is being done to explicate nature friendly heavy duty machines such as electro-hydraulic excavator which can bestow importantly to improve fuel economy globally. The problem associated with previous older models lies in low fuel efficiency and bad exhaust. Hence the need of the hour is hybrid technology which can be effective in solving the energy problem. Moreover heavy duty vehicles should be evolved which will have fewer bearings on the environment. The need to improve fuel economy, reduction in emissions and reliability has made hybrid vehicle as the ultimate savior in this present world. So, due to these above mentioned features, hybrid vehicles are postulated. Hong Yao, Qingfeng Wang [1] (shown in fig.1) focused on the development rules of 20 ton hybrid excavator which included parameter design rules of key components and hierarchical structure of control strategy of hybrid power system. Through experiment, it was demonstrated that the developed hybrid power system can significantly ameliorate the fuel economy of the hybrid excavator.

The maximum torque of the swing motor can be estimated by equation (1) as:

\[ T_{s \max} = \frac{p \cdot g \cdot l}{2f} \]  

Therefore the capacity of capacitor has to satisfy equation (2).

\[ C = \frac{2E_{c \max}}{v_{2}^{2} - v_{1}^{2}} \]

Tianliang Lin, Qingfeng Wang et al [2] (shown in fig.2) examined the development of hybrid powered construction machinery. They broke down the deviation between the hybrid powered automobile vehicle and the hybrid power construction machinery.

Sun Hui, Yang Lifu, Jing Junqing [3] (shown in fig.3) exhibited a hydraulic/electric synergy system (HESS) for heavy hybrid vehicles to subdue the existing drawbacks of single energy storage source. The experiments and simulations manifested that the projected synergy system can provide good fuel economy and overall system efficiency.
Maximum working pressure of accumulator cannot exceed the allowed maximum pressure of accumulator which is expressed as:

\[ P_{\text{max}} < P_{\text{acc,max}} \quad (3) \]

Junli Yang, David J. Edwards, Peter E.D. Love [4] (shown in fig.4) portrayed a computational intelligent fuzzy model with the ability to portend excavator cycle time. The tests on the descended model keyed out that its accuracy was satisfactory but the accuracy could be amended using large samples and a more comprehensive and exhaustive range of variables to predict machine cycle time.

Yoshiyuki et al. [5] concentrated on a series type hybrid system to meliorate fuel economy, exhaust emissions and noise. Pump/motor systems were used to independently trigger off the boom, arm and bucket and to revitalize their moving energy during retardation. The test results depicted that the system can abridge fuel consumption by 35% equated to the conventional system. Zhang et al [6] showcased a simulation study concerning hybrid construction machinery. They compared different hybrid systems (series, parallel and series-parallel systems) and other potential energy saving methods based on a 20-ton excavator. Results designated the best energy saving possibilities on a system that combines the hybrid system, motor regeneration system and separate driving system. Dongyun Wang, Xiao Lin, Yu Zhang [7] (shown in fig.5) purposed a parallel hybrid hydraulic excavator for the intention of better energy distribution. A mathematical model of parallel hybrid hydraulic excavator is laid out in detailed way. The results signaled that hybrids with the suggested strategy can better fuel economy for the excavator.

Wonhee Kim, Daeehee Won, Donghoon Shin, Chung Choo Chung [8] (shown in fig.6) demonstrated an output feedback nonlinear control for position dogging of electro-hydraulic systems (EHSs). The constancy of the closed-loop is learned using singular perturbation theorem. The execution of proposed method is formalised through simulations and experiments.

The loading force can be defined as:

\[ F_l = A_p (P_A - P_B) \quad (5) \]

Where \( P_A \) and \( P_B \) are pressures in N/ m\(^2\) and \( A_p \) is the pressure area of piston in m\(^2\). Sung-Uk Lee, Pyung Hun Chang [10] (shown in fig.7) devised a time-delay control and switching action (TDCSA) using an integral sliding surface in a 21-ton robotic excavator. Experiments depicted that the advised controller displays good operation.

Takao et al. [11, 12] evolved a simulation model of a hybrid excavator for the idea of the fuel consumption in the practical operations of a hydraulic excavator. The whole hybrid excavator comprises of a series of hybrid power system, a boom driven by a closed system comprising an electric motor and a hydraulic pump-motor, and the other actuators systems impelled by electric motors and pumps. It is evidenced that the energy saving effect of the proposed hybrid excavator can be over 40%.

REFERENCES:


