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Modification of a two-wheel tractor as a versatile power machine for post disaster recovery programs

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Abstract

In the present study two-wheel tractor is modified to use it as a versatile power machine for the post disaster recovery programs with its special features including simplicity, affordability, multiple means of power take off for electricity generation, water pumping, land preparation and ability to drive or pull a considerable load over any ground conditions.

Modification process included incorporation of an alternator with a power transmission system while improving the performance of the tractor. Three-phase alternator was selected with a capacity of 7.5 kW and rated line voltage, phase voltage and frequency are 400 V, 230 V and 50 Hz respectively. Performance testing was carried out using a variable load system with 200 W intervals. Frequency was maintained at 50 Hz by operating the tractor at constant engine speed. Phase current, voltage and fuel consumption over the different load conditions were tested. Further the increment of the drawbar pull after modification of the tractor was also tested.

Results revealed that 7.5 kW alternator can be coupled to a two-wheel tractor (GN 12) with a power rage of 9.12 kW while keeping the stability under normal running condition. The efficiency of the established power transmission system was 77.06 % at the maximum stable power output of the alternator. Maximum fuel consumption at the maximum stable power output was 1.97 L/h. Further this modification increased the drawbar pull by 11.98 %, could be useful in terms of transportation over the different ground conditions during the post disaster situations.

Therefore modified tractor can be used as a self-driven, mobile and versatile power machine for the post disaster recovery and reconstruction process in the developing countries.

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1. Introduction

Natural disasters inflict serious impacts on increasing technological, economic, social and environmental concerns [1]. In the aftermath of a disaster, utility services may be damaged or destroyed leaving people without power and water supply, sanitary facilities, communication services etc [2]. Therefore, mitigation measures would be necessary in order to rebuild the sustainability of the community [3].

In post disaster recovery programs, infrastructure reconstruction involves the immediate and temporary restoration of infrastructure and long term reconstruction. Duration for the recovery period depends on the number of factors such as the nature of the disaster and the development stage of the country. As the ability of the developing countries to face the impacts of the disaster is comparatively low, the period taken for the complete recovery and reconstruction is also longer [4].

Power supply is crucial to normalize the human habitats and almost all of the supporting efforts during the periods of post disaster recovery and reconstruction processes. Lack of power affects directly and indirectly to the critical infrastructural facilities in the affected regions such as water supply, sanitation and sewage plants, telecommunication networks, transportation systems, hospitals and emergency service facilities. Therefore re-establishment of power supply is highly important for disaster recovery efforts within a limited timeframe [5]. As a temporary restoration requirement, alternative means of power solutions are essential to provide the basic needs of displaced population, especially for the rescue camps in the remote areas with limited access and no proper infrastructure facilities.

Although a numbers of conventional solutions for power supply are available in different scales for immediate and temporary restoration, several practical difficulties are associated such as; 1) unavailability of the large scale generators in the region; 2) difficulties in transportation to the nucleared target areas through damaged road systems; 3) reluctance of the suppliers to provide their service under uncertain and vigilant situation after a disaster; 4) difficulty in fulfilling the requirement of complicated power transmission systems for large scale generators with different recovery and reconstruction processes; 5) problems associated with small scale portable generators and backup systems such as fires and fuel explosions due to improper handling and theft due to their portable nature; 6) inability of using solar systems during rainy periods ; and 7) the high cost of the most of conventional generators, which are not suitable for rough handling and operations under hazardous environmental conditions [6].

Considering the practical difficulties stated above, there is a current and urgent requirement for a medium scale, low cost, robust, and mobile source for power supply, which can be transported to the areas affected by the disaster through damages and uncleared road systems. The major aim of such system would be satisfying the basic power necessities of several families or a small group of people for small-scale post disaster recovery and reconstruction programs.

Two-wheel tractors are widely utilized in worldwide agricultural farms and industrial operations. It is a simple machine that the maintenance and repairing can usually be done by the operator himself on the spot [7]. Furthermore, it has special features such as versatility and multiple means of power take off for electricity generation, water pumping, land preparation, and transportation [8, 9, 10]. Its versatility through damaged areas, and the ability of pulling a considerable load to the target area as an off road vehicle are of equally advantageous.

Considering the features of the two-wheel tractor, it seems a versatile machine that can reach the affected areas and accomplish a variety of tasks, including power generation and reduce the drudgery. Still, the present features of the two-wheel tractor are not sufficient enough to provide the proper power supply to an area during a period of disaster recovery. Therefore, the main objective of this study was to modify two-wheel tractor as a versatile agricultural machine for power generation to accomplish a variety of tasks in a post disaster recovery and reconstructing process in remote areas of developing countries.

The specific objectives of this study were to; 1) assess the means of modifying a two wheel tractor as a versatile machine for power supply by incorporating an alternator and suitable power transmission systems for efficient power conversation without causing interruption to the normal operation of the tractor, and 2) test the performance of the modified tractor in terms of power output and drawbar pull.