A TRACTOR INSTRUMENTATION AND DATA ACQUISITION SYSTEM FOR POWER AND ENERGY DEMAND MAPPING

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Introduction

Management decisions related to agricultural machinery affect plantation profit in many ways. To improve productivity, it is necessary to have detailed information on the energy input of the utilised machinery in the area of locality. Advancement of microcomputer and microprocessor technologies have proven to be the key factor in improving the overall productivity and performance of today's agricultural machinery. This particular study is undertaken to develop a complete instrumentation and acquisition system on board a tractor for the development of a database on power and energy demand for the agricultural field operations in Malaysia. The available agricultural machinery management database in the literatures cannot be adapted for local use because of different crop types, field practices and farming systems. The new developed database will be very much useful to our local managers, planners and designers in their management or designing decision process. Further, the developed data acquisition system will be useful to machinery manufacturers for field testing and evaluation of any new design implement that is to be introduced in the plantation.

Materials and Methods

The Massey Ferguson 3060 tractor used in this study has a maximum rated power of 64kW @ 2200 rpm. The tractor is equipped with a 4.07 litre, naturally aspirated, direct injection, 4 cylinder PERKINS engine and selectable 2 or 4 wheel drive options. The already built instrumentation on board the tractor is able to measure and display information on engine speed, PTO speed, forward speed, drive wheel slippage, acres worked, fuel consumption per hectare, acres per hour, cost factor, fuel consumed, fuel remaining, and distance travel. The data acquisition consisted of a locally designed and fabricated drawbar pull transducer to measure horizontal pull at tractor drawbar, wheel torque transducers to measure torque at tractor drive wheels, PTO shaft torque transducer. It measures the torque at tractor PTO output, and a 3 point auto hitch dynamometer and the horizontal and vertical forces on the tractor linkages. Static calibration test on all the special made transducer were conducted with both ascending and descending load applications to check on the measurement hysterisis. Consequently, field demonstration tests were conducted provided a quick check on the developed data acquisition system on board the tractor for actual field measurements.

Results and Discussion

The data acquisition system with the associated transducers had been successfully designed, fabricated and calibrated to complete the already available instrumentation system in the Massey Ferguson 3060 tractor. The design of the wheel torque transducer consisted of an extension shaft securely mounted between the rear wheel axle flange and tyre rim with a sensitivity of 0.101 μV/V/Nm. The design of the PTO torque transducer is based on the modification made on a standard commercial PTO tractor drive shaft with measurement range of 0 to 037 Nm at a sensitivity of 0.2852 μV/V/Nm. The design of the drawbar transducer was based on a thick proof ring element with a sensitivity of 13.68μV/V/kN. The design of the 3-point auto hitch dynamometer comprises of 3 extended octagonal transducer that are located between the frame and hook brackets. Each transducer is designed for a maximum horizontal and vertical forces of 25 and 12.5 kN, respectively. Static calibration tests on each designed and fabricated transducer showed excellent measurement linearity with correlation coefficient closed to 0.99. Field demonstration tests showed that the developed data acquisition system was able to function successfully without giving much problems. All measurements were able to measure and record by the respective transducers within the system under the harsh field environments. The stored data in the memory card of the system from the field demonstration tests was able to down load into the hard disk of the host computer in the laboratory. The complete system on board the Massey Ferguson 3060 tractor could successfully monitor and measure engine speed, PTO speed, forward speed, drive wheel slippage, acres worked, fuel consumption per hectare, acres per hour, cost factor, fuel consumed, fuel remaining, distance travel, horizontal pull at tractor drawbar, drive wheel torques, PTO torque, and both horizontal and vertical forces on the tractor linkages.

Conclusions

A tractor instrumentation and data acquisition system has been designed and developed to monitor and measure the power and energy demand of a tractor during field operations.

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