Performance of a modified vehicle drive system in generating hydropower

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Abstract

Micro hydropower generated electricity can function as an effective tool for rural development. One of the barriers to smooth implementation of community/village micro hydropower schemes in the country is lack of appropriate hydraulic turbines, thus making the site specific costs of micro hydropower rather high, hence not easily affordable by the rural communities. The purpose of the study was to investigate the use of a vehicle live axlepropeller shaft system to replace conventional turbines for micro hydropower generation. There are axle-propeller shafts of many vehicles that have fallen into disuse and are commonly found in many motor vehicle scrap yards. New ones are also entering the Kenyan market with the small vehicles (saloon cars; station wagons; panel Vans, Pick-ups, lorries/trucks, buses/coaches and minibuses/matatus) comprising the biggest percentage, for example in the year 2008, out of 121,831 newly registered vehicles 65,556 (53.8%) belongs to this category.

The study was carried out mainly to investigate and establish the performance of the live rear vehicle axle-propeller shaft as a micro hydropower electricity generation system with the objective of lowering the unit cost of hydropower generation in small water streams. This was done by modifying a vehicle axle propeller shaft system by fixing designed buckets on the wheel rim to take the role of a turbine runner and replacing the propeller shaft right from the rear universal joint with a solid bright steel shaft where mechanical power is generated and tapped. A wheel rim/turbine casing with a nozzle for creating a water jet was fabricated and together with a mounting frame for the axle formed a complete Vehicle Propeller-Axle as a Turbine (PAA T). A jet of water from the nozzle strikes the buckets and the kinetic energy is converted into rotating shaft power by the wheel rim and the rear axle. The power is transmitted through the differential box with an accompanying speed increase to the rear universal joint where a shaft is fixed for eventual mechanical power take off. The power can be used to drive mechanical equipments or an alternator to generate electricity.

The performance of the propeller-Axle as a turbine was tested at a community hydropower site in Kirinyaga, constructed for this purpose. The tests were conducted to determine the power output and efficiency under a constant head and different discharges. The final result of the study was a low cost vehicle axle-propeller shaft system operating as a turbine cost of USD 274.4), generating 1.18 kW of shaft power at an optimum flow rate ofO.0238 m /s at a gross head of 21.874 m and at an optimum loaded runner speed of 500 rpm. The specific

speed of the modified vehicle system as a hydraulic turbine was 12. The energy cost from a hydropower scheme using a vehicle axle-propeller shaft as a turbine is 10 times cheaper than that of a similar scheme using a diesel generator as its source of power.

These research findings are an important contribution to providing a solution to increasing use of micro hydropower for rural electrification by making the technology available and affordable to individual and communities in the rural areas. Vehicle drive systems are available as dumped materials in most metal scrap yards and car garages scattered across the country and they are an environmental hazard as there are no vehicle parts re-cycling facilities in the country.