European Association for the Development of Renewable Energies, Environment and Power Quality (EA4EPQ)

International Conference on Renewable Energies and Power Quality (ICREPQ'10)
Granada (Spain), 23th to 25th March, 2010

A biomass powered Ringbom-Stirling engine for developing countries: a low-budget solution for distributed electricity generation.

S. Parmigiani[1], D. Zani[1], C. Invernizzi[1], A. Mazzù[1], V. Villa[1] and A. Lezzi[1]

[1] Department of Mechanical & Industrial Engineering
Università degli Studi di Brescia
Via Branze 38, 25123 Brescia (Italy)
Phone number:+39-030-3715567, e-mail: simone.parmigiani@ing.unibs.it

Extended Abstract.

In many isolated settings electricity is not available or is supplied by fossil fuels, while biomass is used for cooking purposes, not exploiting all of its potential. We are building a prototype of a biomass powered $1kW_{el}$ Ringbom-Stirling engine that doesn't require high technology, but nevertheless brings relevant innovations. It is meant to be used in developing countries and to be producible in loco, with the locally available technology and materials; this is one of the main bonds for this project.

This solution aims to generate electricity using a single source in alternative to the simultaneous use of coal, gasoline and wood. The first two energy sources may not be available with continuity, while the last one is often obtained through deforestation, which is not sustainable. On the other hand it is almost always possible to find some residual biomass from local production. Agricultural residues are often burned just for disposal, while their energetic exploitation can relieve the local ecosystem from a great part of it's deployment. The social relevance of our project is strictly related to a context where biomasses residues are perceived as a better alternative. The use of this machine and it's local production will be contextualized in an African mission where CeTAmb (Brescia's University Research center for appropriate technologies for environmental management in Developing Countries) has an energetic-awareness program already running.

The system we are building is composed of a gasifier which supplies the syngas that is then burned to heat the Ringbom-Stirling engine, which produces electricity, while the remaining heat is available for other purposes like cooking.

As fuel source for the engine we have chosen a down-draft gasifier, which is build up from very simple materials. This kind of gasifier can be fed continuously from above, unscrewing the cap, while the ashes can be removed from the lower part. This gasification process has many advantages, like the possibility to use one single machine with distinct settings for many different agricultural residues, some of which can not be burnt directly like rice husks.

We discuss the general scheme of this solution with particular regard for some new applications that greatly simplify the operation of traditional Stirling engines, such as metal bellows, used instead of the typical cylinder-piston arrangement, to totally eliminate the need of sealing between moving parts.

This kind of moving bellows appear to have never been used for this type of applications. The shape of the bellows is a central issue that has to be investigated. The number of bends and their area, especially in relation to welding issues, are crucial for good performance and reliability. The engineering problem that has to be solved is quite complex, there are metallurgical concerns, structural and technical ones. The solution of this experimental investigation is the main challenge of this project.

Key words

Biomass gasification, Ringbom-Stirling engine, metal bellows.