Gasifier Fed on the Wooden Residues of Harvesting the Pignolia Nuts the Fruit of Domestic Pine

1. Aim of the Project

This project consisted of two downdraft gasifier units, one for power generation and the other for heat generation. Both units are installed at the premises of SICALP, Campiglia Marittima (Livorno) Italy. The project co-ordinator, GENERALFRUT srl, is a SME company harvesting and processing 2,000 to 3,000 ton/y pine-cones which result to an annual disposal problem of about 300 tons/y of broken shells.

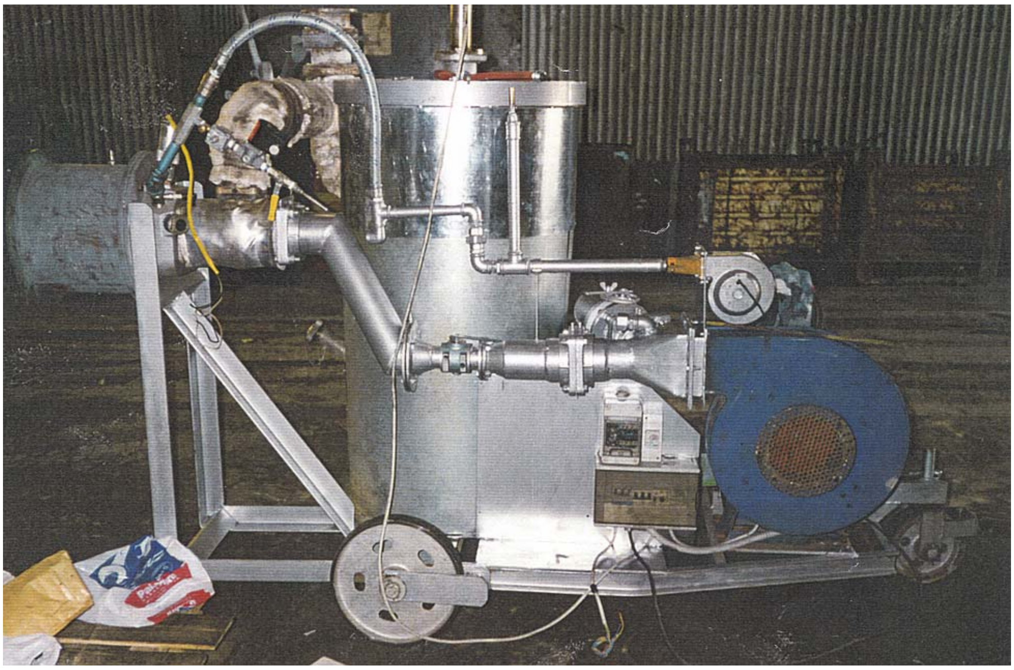

Photo 1: Picture of one of the downdraft gasifiers

2. Introduction

This amount of residue is sufficient to satisfy all the thermal energy requirements of the plant (such as dryers, and building heating) when gasified at the rate of 1ton/day. In addition, stumps an scales, the residue from the processing of the cones, can also be used in order to meet the feedstock requirements for the two gasifier units. The processing of the pine-cones consists of threshing (separation of the nuts from the cone), crushing of the nut, separation of the kernels and subsequently sorting, washing, drying and packaging of the pignolia nuts.

The heat requirements of the plant for drying purposes were estimated equal to 80 kWth. This corresponds to a gasifier capacity of 35-40 kg/h of biomass with a calorific value of 13.4 MJ/kg_(and a moisture content of 15%). The power requirements of the plant are 20 kWel. This can be generated by a gasifier of the same capacity as for the heat demand coupled to an electric generator.

3. Technical Description

Construction and operation of a gasifier which, fed with 70 kg/h of a wooden fuel, gives a gas flow equivalent to a thermal power of 836 GJ/h. Two different prototypes have been planned and achieved: 1), a "thermal" unit, feeding a dual-fuel (methane-wood gas) burner; 2) and an “electricity generation" unit, where the produced gas (cooled, washed and filtered) is fed to a four-stroke engine powering an electric generator (up to an electric power of 35 kW).

Thermal application

The gasifier, coupled with its burner, is mounted on an easy- towing three-wheels carriage as shown in Photo 1. The body of the gasifier is a cylindrical steel vessel made with 10 mm thick steel sheet. The inner walls of the vessel are lined by a 80 mm thick refractory layer. Also the lid (welded) is protected by a refractory lining. Outside, a light thermal protection is obtained by means of a layer of ceramic fibres, covered by a zinc-plated sheet. The inner diameter of the gasification chamber is about 60 cm. On the lid, a touch-down probe is mounted, which controls the embers level in the chamber.

The granulated feedstock is stored in a hopper and is supplied to the gasifier by means of a screw feeder. To start up the gasifier a small quantity of fuel is manually placed on the fuel bed through a side inspection door and lit by means of a butane gas torch introduced through a side manifold. Once a first core of flaming charcoal is obtained, the feeder and the air blower are switched on. Within two hours steady state conditions are attained and the feeder maintains, automatically, a constant level of the charcoal in the gasification chamber. The gasifier reaches its highest capacity when fed with an inlet air flow-rate of 100 Nm^3/h, producing 160 Nm^3/h of gas with a gas heating value about 5 GJ/Nm^3 (1,200 KCal/Nm^3). The design of the nozzle of the burner eliminates elutriation of fine glowing charcoal from the gasifier. Once in a steady state, the gasifier can be stopped at any moment, simply by turning "off" the main switch.

Power application

The gas generation section is identical as for the thermal unit. The hot gas leaving the gasification chamber comes through a cyclone, entering the bottom of a spray washing scrubber where a circulating pump feeds a spray nozzle placed on the top. This scrubber carries out a first cooling and washing of the fuel gas from which the largest fraction of the combustion water and of the condensable tar is removed. The tar condenses on the specially designed finned tubes cooling radiator, and withdrawn (see photo 2). The gas pressure is then raised by a blower which blows the gas through a washing vessel, followed by a filter box.

The filtered gas is fed to a four-stroke engine powering an electric generator. In the demonstration stand, the whole gas generating and cleaning unit is mounted on a heavy wheeled carriage. Constant monitoring is necessary during the start up phase, when the gas is vented in the air only partially purified.

4. Performance of the thermal and power units

The thermal unit was installed in December 1994 and, since January 1995, is operational for demonstration phase of the project. Up to April 1st, 1996, it has been used for 22 runs each of them about a week (3-5 days) long. The unit is easy to be moved and to be towed. The maximum capacity (200.000 kCal/h) is reached when the gasifier is fed with 100 Nm^3/h of air. The fuel consumption is then about 70 Kg/h resulting in gas production of 160 Nm3/h.

The electricity generation unit was installed only in February 1996. Up to April 1st, 1996, the unit had been operated for three runs of about 12 hours each. The most serious problem in the operation of this unit arose from the fact that the static pressure available downstream the gasifier appeared to be too low to overcome the resistances existing through the scrubbing, cooling and filtering apparatus. Of course the gas pressure can be increased by means of the blower feeding with air the gasifier, but in this case the fuel gas leaks into the fuel hopper creating explosion, environmental and health hazards.

Photo 2: The finned tube heat exchanger

The negative performance of the electricity generating unit is due to the fact that a continuous monitoring is necessary during the start up phase, when the gas is vented in the air being partially purified. Furthermore, because of the scrubber and the other fuel gas purification equipment, the unit is cumbersome and heavy to transport.

5. Economic Performance

The total cost of the project is 624 M Lit, more than the double of the initial estimated cost. The payback time of the project is:

For the thermal application:
- versus methane replacement 1.9 years
- versus fuel oil replacement 0.7 years

For the electricity generation application:
- versus network: 68.0 years
- versus Diesel fuelled generators: 0.8 years

For this gasification technology no commercialisation activities have been undertaken up to now. However, an analysis of the market resulted in specific market segments in which this technology could become competitive:

- Potential uses for thermal application: pine nuts drying; greenhouse winter heating; mobile dryers for freshly harvested maize.
- For electricity generation applications a specific opportunity could be in isolated farms far from network.

Especially for the heat applications the heating of greenhouses in winter seems to be an attractive opportunity since the technology was successfully demonstrated and no operation problems due to the condensation of tar is expected.

6. Project Identifiers

Project:	**BM/007/92 IT/BE**
Owner:	**GENERALFRUT sprl**, Viale dei Pini 210 Migliarino Pisano (Pisa), Italy Tel + Fax: +39-50-803200
Contractors:	**GENERALFRUT, SICALP, Centre de Recherches Agronomiques**
Technology:	**GENERALFRUT, SICALP, University of Louvain-la- Neuve**
Total Cost:	**191,485 ECU**
EC Support:	**75,552 ECU**