GTZ / EnDev

Final Mission Report
09.03.2010 – 14.03.2010
(Kigali [Rwanda] / Nairobi [Kenya])
25.04.2010 – 30.04.2010 (Kigali)
Low Cost Polyethylene Tube Digester in Rwanda

Marc Lüer
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Germany

Content

Report of preparation from 09.03.2010 - 14.03.2010 (Kigali [Rwanda] / Nairobi [Kenya]) for a pilot phase of Low Cost Polyethylene Tube Digester in Rwanda

1. Introduction and motivation for the pilot phase

In the context of the “Energising Development” program (EnDev) of the German – Dutch energy partnership, the GTZ supports the national domestic biogas program of Rwanda (NDBP). Actually the NDBP disseminates the popular “Fixed Dome” digesters. Because strongly increased material overheads, the investment costs in Rwanda had mounted for this technology to almost 1,000. - €.
A more economic alternative could be the “Low Cost Polyethylene Tube Digester”.
This technology was implemented successfully with the EnDev project in Bolivia. In the case of the Low-Cost Polyethylene Tube Digester model which is applied in Bolivia (Peru, Ecuador, Colombia, Centro America and Mexico), the tubular polyethylene film (two coats of 300 microns) is bended at each end around a 6 inch PVC drainpipe and is wound with rubber strap of recycled tire-tubes. With this system a hermetic isolated tank is obtained (Figure 1). One of the 6" PVC drainpipes serves as inlet and the other one as the outlet of the slurry. In the tube digester finally, a hydraulic level is set up by itself, so that as much quantity of added prime matter (the mix of dung and water) as quantity of fertilizer leave by the outlet.
At the moment Low-Cost Polyethylene Tube Digesters in Bolivia have costs between 93, - € and 148, - €. To operate a digester, the producer has to charge it day to day with 20 kg of cow dung (or other animal dung), mixed with 60 liters of water. Once the digester starts its operation (between 30 to 60 days), it produces around 4 - 5 hours of biogas daily, for cooking or other applications like use of gas lamps. Furthermore the digester provides daily 80 liters of ecologic fertilizer, which helps to increase the production of agriculture. The digester system has a pressure between 15 cm - 20 cm of water column.
The construction and installation of a polyethylene tube digester, need just one morning, assumed that the trench is excavated, ready and the materials are available. The biogas supply line up to the kitchen needs some hours more, according to the challenge and distance of each case.

In Rwanda doesn´t persist sufficient experience of the “tube digester – system” however. In the context of a pilot phase of the “Low Cost Polyethylene Tube Digesters”, it should be earned experience in the application of this system and discovered, if the tube digester really could be an additional alternative for Rwanda.
Because the personnel of the NDBP actually are busy with the implementing of the “Fixed Dome” systems, the pilot phase should be supervised in cooperation with a university of Rwanda. The tube digester systems should be installed in representative households.

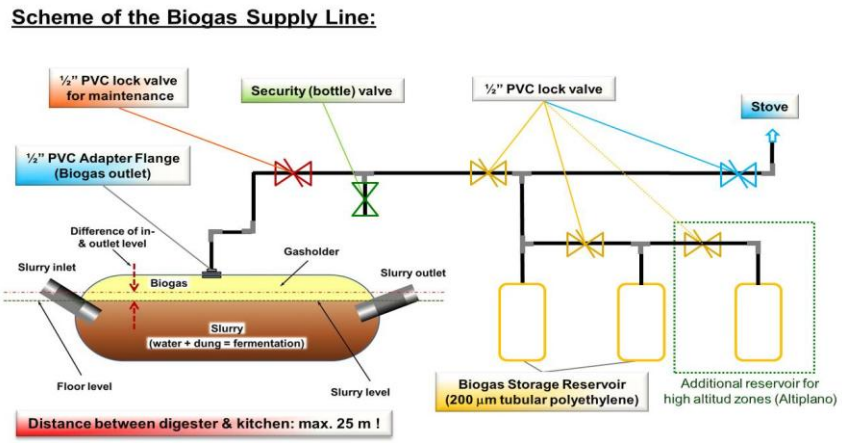

Figure 1: Scheme of the complete tube digester system

2. Visits of potential technician schools, which could supervise the pilot phase.

Two technician schools were visited, to see how cooperation could work. The idea of the pilot project and the technology of the PE-TD (Polyethylene Tube Digester) were presented.

The first one is the “Tumba College of Technology” TCT and was visited the 09.03.2010. The result of the meeting is that TCT will search for three pilot households were the PE-TE could be installed.

The second is the ”Institut Superieur d'Agriculture et d'Elevage“ ISAE, which was visited the 10.03.2010. The result of the meeting is that the PE-TE could be installed on the two farms of ISEA. In one farm they would use the biogas to heat water for the cleaning of the udders before milk the cradle.

After the revision of the two potential partners, the ISAE is chosen like the best institution to test the polyethylene tube digester in Rwanda. Additionally the possibility is obtained, to install on each farm other types of household digester to be able to compare directly the different technologies.
The TCT doesn’t have shown the expected interest. Additionally TCT does not have the favorable conditions like ISAE.

3. Field visit Kenya

There are recent experiences in Kenya where it is claimed that about 300 tube digester units have been installed through some organisations. From the 12. – 13.03.2010 the company Pioneer Technologies (Nairobi/Kenya) was visited to see what kind of PE-TD they are offering. And what kind of experience they have made.
The main business of Pioneer Technologies is the production of PE- films with 20 persons working in the fabric. The department for the tube digester consist of 10 members in total, with an installation team of 6 technicians.

Pioneer Technologies has installed about 200 tube digester system in the last 5 years. As per own indications, 85 % are still working. With the earned experience, they have modified the PE-TD from a two PE-layer system (inner and outer layer of PE) to a PE/PVC system (inner layer PE / outer layer PVC). Pioneer Technologies has modified they digester system, because they have had problems with burst digesters. The new outer layer or the carrier is manufactured from PVC material which is UVR treated of 800 microns. The carrier is further strengthened by synthetic mesh to withstand stress or high pressure.
The inner layer is fabricated with a 250 micron PE. In comparison with the Bolivian system, the Pioneer system doesn´t works with an over pressure security valve, which explains the problems with burst PE/PE digesters in the past.
The Pioneer systems work with a mix ratio of 1/1 by a retention time of 70 days. The life time is given with about 15 years.

Figure 2: Pioneer system - PE/PVC layer

Pioneer Technologies offers two system sizes:

Standard size

Lay flat measurements:	1,4 m x 10 m
Volume (Pioneer indications):	3 m³
Weight:	24 kg

Volume calculation

D:	*0,89 m*
L/D ratio:	*11,22 (should be between 5 – 10)*
Total volume:	*6,24 m³*
Liquid volume:	*4,67 m³*
Gasholder volume:	*1,56 m³*

Cost of finished digester: 24.200,00 KES
180.862,32 RWF
232,8 €

Large size

Lay flat measurements:	2,6 m x 10 m
Volume (Pioneer indications):	6 m³
Weight:	45 kg

Volume calculation

D:	*1,66 m*
L/D ratio:	*6,04 (should be between 5 – 10)*
Total volume:	*21,52 m³*
Liquid volume:	*16,14 m³*
Gasholder volume:	*5,38 m³*

Cost of finished digester: 33.800,00 KES
252.616,80 RWF
325,16 €

The costs are without customs dues and transportation from Nairobi to Kenya.

During the visit of Pioneer Technologies a field visited nearby Nairobi was realized. Two systems were seen. The first system was working and full of biogas. The second was flat but returning, because a few days before the lock valve was broken and had to be replaced.

Figure 3: Tight and flat Pioneer digester nearby Nairobi

The Pioneer systems don´t have biogas storage reservoirs like the Bolivian system. The Pioneer system used weights like old car tires (Figure 3). This doesn´t seem very user-friendly. Pioneer Technologies is thinking about the implementation of the Bolivian biogas reservoirs.

Some experiences which were reported are the following. Sometimes the tube digesters were damaged by sabotage like a cut from a machete. Or people had given up feeding the system. Pioneer has noted that it is very important to start with the user training from the first visit. They give the users a follow up of one year like after sells service and realize 2 – 3 visits what at last gives a good result of working digesters. The visited farmers were content with their tube digester and with the service of Pioneer Technologies.

It seems that one of the key factors of a sustainable tube digester system is the training of the users. Another key is the adequate protection of the biogas systems to achieve a satisfactory life time.

One point it is to mention, that the farmers are not using fresh dung. They put the fresh dung into chambers or barrels and let the dung some days there. This is to regard as critical, because the production of methane begins yet in the chambers and the gas flows unhampered in the atmosphere. The first seen system was indicated from the farmer with a life time of more than 6 years. Pioneer Technology has indicated, that they have around 5 years field experience (first with the PE/PE layers). So it is not sure how many years the digester is working, or if Pioneer has changed the old with the new system, how is it they case in the second visited digester.

Pioneer Technologies produced their own PE, so that they can offer to produce PE in different sizes with a thickness of 250 microns. This is an interesting alternative for the Bolivian system, which could be installed in Rwanda.

The costs for the different sizes without transport are the following:

PE 250 microns

Lay flat width:	1,5 m
Cost for serial meter:	200,7 KES
	1.499,4 RWF
	1,93 €

Lay flat width:	1,75 m
Cost for serial meter:	233,75 KES
	1.748,0 RWF
	2,25 €

Resume: After some years of experience in the field, Pioneer Technologies has developed a system which promises a good quality. This system is prefabricated in comparison with the Bolivian system.

4. Visit of the ministry of energy - Kenya

During the stay in Nairobi, the ministry of energy was visited. The reunion with Mr. Paul N. Mbuthi a renewable energy officer, was an idea and organized by the GTZ office in Nairobi. The idea was to find out which experience were made in Kenya with the tube digester system. Mr. Mbuthi couldn´t report any experience but was very interested in a presentation of the tube digester system, which was realized during the meeting. The result of the presentation was, that Mr. Mbuthi wanted to verify, if the tube digester system could be an alternative for Kenya, supported by the ministry of energy.

5. Implementation of the Pioneer Tube Digester System

To earn experience with tube digester system in Rwanda, it is decided to install 2 large Pioneer digesters.
The planned places where the tube digester should be installed are Rubinizi (nearby the capital Kigali) and Busogo (nearby the frontiers of Uganda and the Democratic Republic of Congo) (Figure 4).

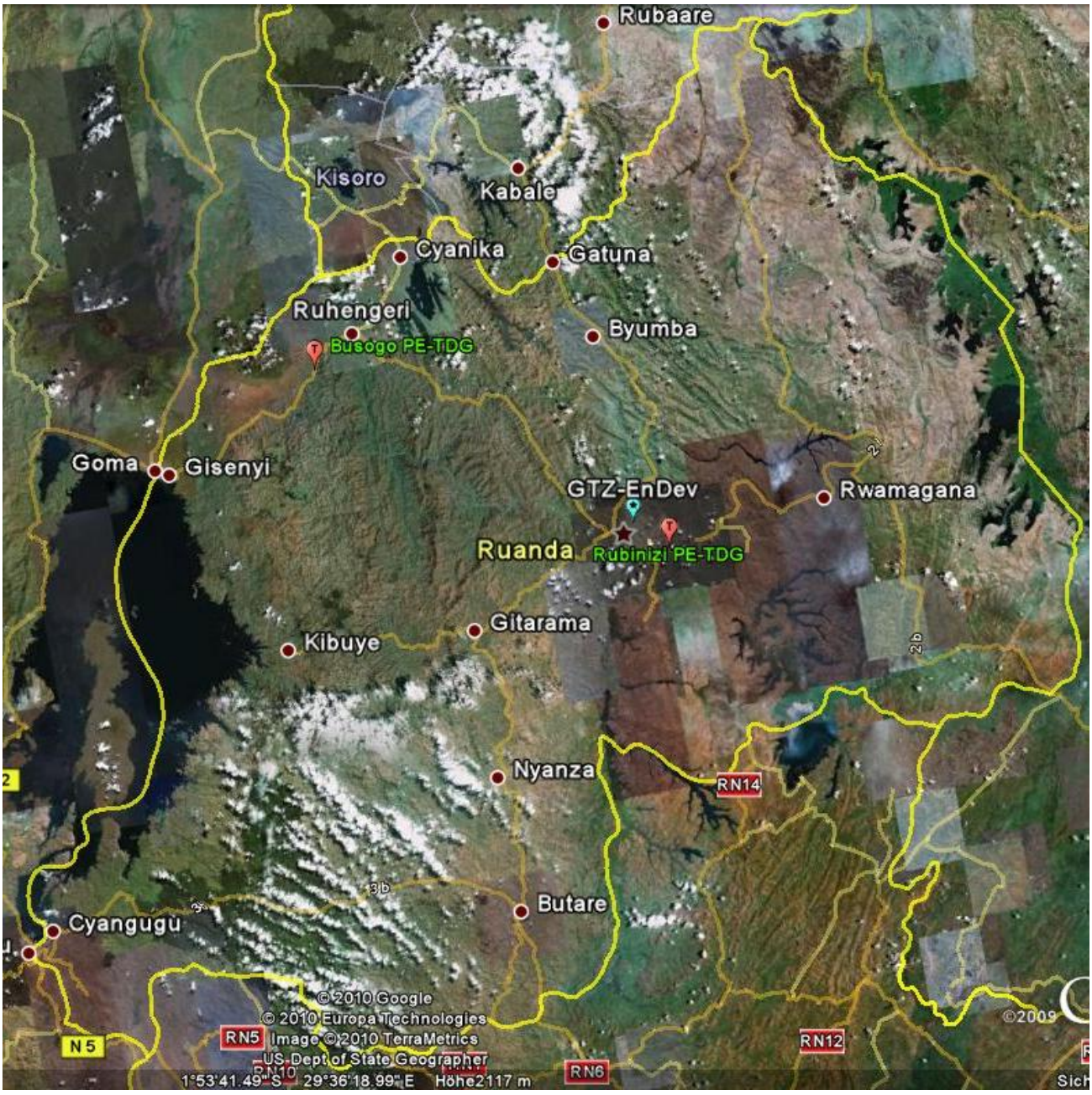

Figure 4: Satellite map of Rwanda

During the mission in Rwanda (25/04/10 – 30/04/10), unfortunately it was not possible to install the two digesters, because the customs had confiscated unexpected the delivered digesters from Pioneers. This had caused official measures to get out the materials. These measures on the other hand had caused a delay, which had overtopped the planned time frame of the mission.
To not lose the available mission time, together with a technician from Pioneers and technicians of the MINIFRA, the installation places were defined and the limits for the digester trenches were marked. Additionally the materials for the reservoir suspension construction were bought and the construction for Rubinizi itself was installed.

5.1. Biogas storage reservoir

Pioneer was engaged to produce additionally biogas storage reservoirs. To have a more insensitive reservoir, an additional PVC layer was provided.

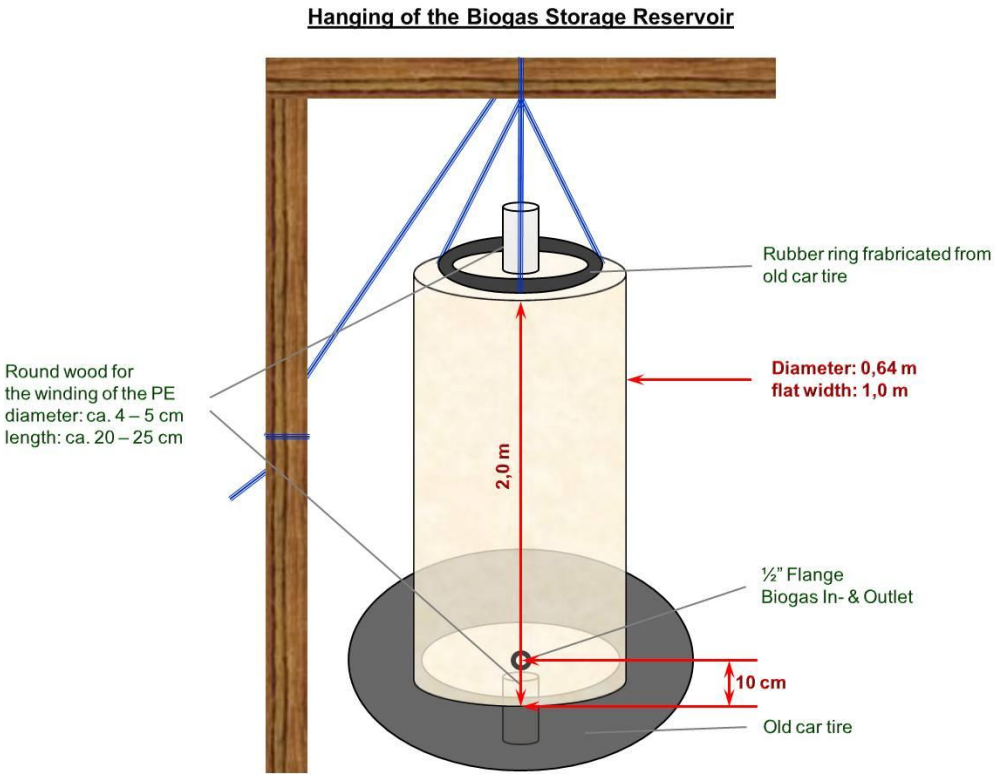

Figure 5: Biogas storage reservoir with suspension

The length of the biogas supply line must not have more than 25 m. The difference between version A and version B consists in the number of the biogas storage reservoirs. This means that version A has 2 reservoirs and version B has 3 reservoirs. The place requirement for the reservoirs is around 1,2 m² (0,8 m x 1,5 m) or rather 1,76 m² (0,8 m x 2,2 m) with a height of around 2,2 m.

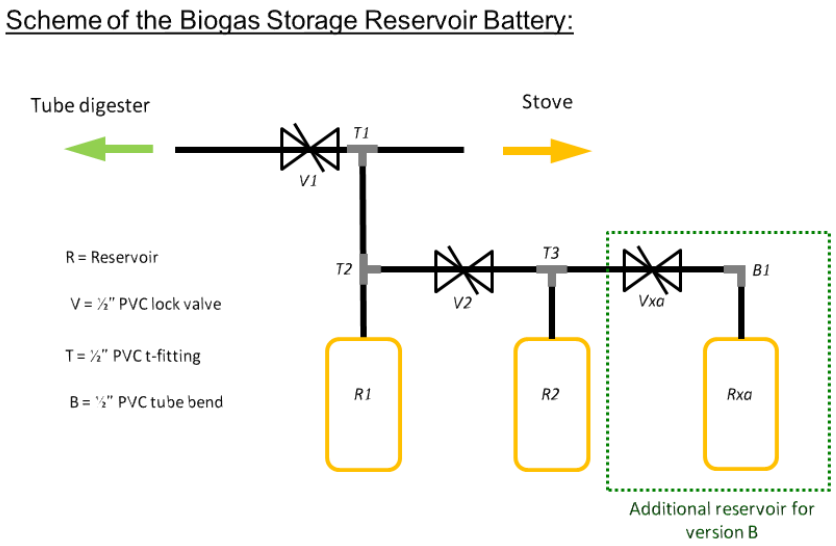

Figure 6: Scheme of the Biogas Storage Reservoirs

5.2. Rubinizi

One tube digester will be installed in Rubinizi, nearby the capital Kigali. The digester stands close beside the cow stable, which will simplify the charging of the digester with the cow dung. The altitude of this location is 1.350 m above sea level. (Position: 1°59'24,4'' S ; 30°08'11,1'' E)

Figure 7: ISAE Rubinizi – placement of the tube digester

In Rubinizi the trench was prepared and the reservoir construction was installed. The following pictures give a view on the work which was realized in Rubinizi.

Figure 8: View from the digester location to the cow stable

Figure 9: Marking of the trench limits

Figure 10: Digging of the trench

Figure 11: Digging of the trench

Figure 12: Sawing of the wood for the reservoir suspension construction

Figure 13: Installation of the reservoir construction

Figure 14: Installation of the reservoir construction

Figure 15: Marking of the protection zone

To protect the tube digester against animals, a protection zone was marked and closed with a wire fence. Additionally a protection roof should be installed, to increase the lifetime of the digester.

The technician Mr. John Njenga from Pioneers is introduced in the construction of the biogas storage reservoirs and its suspension construction. This allows to realize the second construction in Busogo.

5.3. Busogo

The second tube digester will be installed in Busogo, nearby the frontiers of Uganda and the Democratic Republic of Congo. The digester stands close nearby the college staff kitchen, but with a distance of around 150 m to the cow stables. The altitude of this location is 2.180 m above sea level. (Position: 1°33'16,5'' S ; 29°33'05,9'' E)

Figure 16: Satelite picture of the region of Busogo

In Busogo a meeting with the Rector of ISAE Dr. Charles Karemangingo was realized, which is supporting the installation of the digesters. During the mission time, the limits of the tube digester were defined and marked.

Figure 17: Staff kitchen of Busogo

Figure 18: Marked trench limits – Busogo

A team of ISAE have to dig the marked trench before Mr. John Njenga from Pioneers will come to install the tube digester. Additional a location where the reservoir suspension construction should be, is to define.

6. Final Recommendations

It is important to attend ISAE during the pilot phase. ISAE has demonstrated interest but is not the owner of the project. This means that ISAE need pushes of motivation and a clear idea of the potencial for its students.

With an unsufficient company, the project could run into the risk to fail. During the preparations an inadequately assistance from the ISAE technicians was shown.

For a correct feeding of the digester and an adquate maintance, a strong assistance from ISAE is absolute necessary.

It is to define the responsibility of ISAE and MINIFRA-NDBP.

The digesters should be protected with a wire fence and a roof, the same is valid for the reservoir batteries.

A regularly state report of the digesters is recommended, also a feeding report with date, time and substrate quantity.