[Stoves] Reviewing A.D. Karve's methane digestion device

Peter Singfield snkm at btl.net
Sun Oct 17 14:18:44 EDT 2004

- Previous message: [Stoves] Dissemination - What's the Score?
- Next message: [Stoves] Re: [Gasification] Reviewing A.D. Karve's methane digestion device
- **Messages sorted by:** [date] [thread] [subject] [author]

(Flipping this to Gas list as well -- being as this is about gas
making)

Posting this with all respect to A. D. Karve -- who in my opinion is
the
brightest beacon of pratical solutions on this mail list for all we
here
living in 3rd world.

Now -- this posting should get a few gears engaged!

Quoting A.D. Karve:

"The gas produced by this
system has thus almost the same calorific value as LPG. It burns
without
smoke or soot, producing an almost invisible bluish flame similar to
that of LPG."

As by now a few stover list members might be scratching their
collective
minds -- along these lines:

Gee -- gas production for cook stoves is a fine methology to avoid
death
due to smoke inhalation. Instead of harvesting/finding biomass for

fuel --
than intensive fuel conditioning -- designing tricky stoves that need constant attention to burn smoke free -- still requiring chimney and vents
-- just grow some sugar cane!

so -- for now -- "Focussing" on cane juice as portable fuel for A.D.s digester.

OK -- how do really poor people make cane juice??

Traditionally -- here in Central America:

Hand extraction of cane juice involves boring two holes in a tree -- the
upper one has a moveable stick inserted -- the lower a fatter -- jammed in
hard -- not moveable -- the "anvil" inserted.

A stalk of cane is placed between these two -- the top stick being raised
-- then pressed down -- squeezing out juice -- this is repeated down the
length of cane. The juices collected below.

If we can get A. D. to enter into discussion -- some questions need be asked.

1: Will fresh cane juice be a good "food" for your digester?

re:

Because the
material to be fed into the biogas plant consists mainly of starch and sugary material like sugarcane juice or fruit pulp,

2: How much cane juice would be required per day to supply for normal cooking needs?

(I self answer that based on information A.D has sent -- below)

3: Is it possible that the residual stalk -- which when extracted in

this
inefficient manner - -and still contains much sugar juice -- can also be
added to digester?? (Could digestion of begasse further enhance gas product
out?)

Re:

"Our studies also indicated that
the gas yield could be increased by using combinations of feedstock
materials. We are now looking at additives such as micronutrients,
nitrogen, phosphorous compounds etc."

Bagasse is very mineral rich.

4: The residue after digestion -- you note is a valid fertilizer agent --
is it a possible animal feed as well??

Re:

"The effluent slurry generated daily by the plant
is just a couple of litres. It can be used as manure for plants growing
around the house."

5: Source for bacteria required??

Self answer from notes below:

We do not use any special bacteria. To begin with we mix
about 10 kg cattle dung and water and pour the slurry into the
fermenter.

and:

However, to make the system more readily acceptable to the
users, we shall have to produce the culture ourselves and give it to the
users along with the biogas plant.

6: Is this device difficult to build??

Self answer:

A schoolgirl submitted a working model of it in a statewide science project competition and won the first prize in the state.

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Ok -- found this to self-answer #2:

"1kg of sugar or starch yields about 400 litres of methane, within a period of 6 to 8 hours. This quantity is enough for cooking one meal for 5 to 6 persons."

So that would mean around 12 kilograms of cane using the crude extraction methology above -- quite labor instensive -- but then -- a small hand operated rool type crusher could be used by numerous families to save much labor.

You can see example of such at:

http://www.rajeximp.com/products/sc.html

I have acquired and operated model "A" -- powered by a two HP electric engine -- for well over on year now. When in use we process 1400 kilo of cane stalk per day -- 3 workers.

This at better efficiency of juice extraction than the above -- but keeping a safety in guestimation factor there -- say the same --

1400/12 -- sufficient per day to supply fuel for 117 meals to be cooked.

At village level this would mean each household would collect by container the required amount of cane juice -- daily -- for their needs in their own individual digesters.

So yes -- "portable-fuel"

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To bring others on this list up to speed:

Posted to this list originally:

Date: Wed, 25 Jun 2003 09:48:03 +0530
Reply-To: "A.D. Karve" <adkarve at PN2.VSNL.NET.IN>

Extracted of importance:

I have developed a highly compact biogas plant, having a volume of just
400 litres. It operates on waste starch (spoilt grain, nonedible seed of
various species, oilcake of non-edible oilseeds, rhizomes of banana, canna,
nutgrass, arums, flour swept from the floor of a flour mill etc.) and
produces about 800 litres of gas from just 1 kg starch. It produces daily
just 5 litres of effluent, which can just be thrown at the base of any tree,
or applied to the vegetable bed in the backyard. The retention time of dung
in the dung-based biogas fermenter is 6 weeks, while that of starch is only
6 hours, which is why the volume of the fermenter could be reduced. The
biogas produced from starch has about 60% methane by weight, while that
produced from cattle dung has only 25% methane by weight. As a result, even
the 800 litres produced by my biogas plant is enough for cooking the meal of
a family.
We are trying to commercialise this new biogas fermenter. It costs only
US$30 as against US$250 for the conventional biogas fermenter.

Yours A.D.Karve

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Date: Fri, 27 Jun 2003 05:50:59 +0530
Reply-To: "A.D. Karve" <adkarve at PN2.VSNL.NET.IN>

"Extracted":

As far as the biogas fermenter is concerned, it is a small version of the
standard moving dome biogas plant, a very simple contraption
consisting of two drums, telescoping into one another. the outer drum is
open at the top and the inner one is open at its bottom. The outer drum is
filled with the material to be fermented and the inner drum is lowered into
it. A tap at the top of the inner drum is kept open while lowering the drum
into the outer one, and when it has been completely inserted into the outer
drum, the tap is closed. The gas accumulates in the inner drum which gets
lifted up due to increased buoyancy. (If a girl falls accidentally into
water, she should not remove her dress because the air caught in the dress
acts like a buoy :-))The inner drum is provided with a tap at the top,
through which the biogas can be led to the burner. Both the drums have a
capacity of approximately 200 litres.
A.D.Karve

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Date: Mon, 5 Jan 2004 05:58:20 +0530
Reply-To: "A.D. Karve" <adkarve at PN2.VSNL.NET.IN>

Several members asked me to provide more details about the compact biogas plant being developed by us. I give below the latest status of this technology.

The biogas plant consists of two cylindrical vessels telescoping into one another. The larger vessel, called the fermenter, has a total internal volume of about 500 lit. A drum having diameter of 85 cm and height of 85 cm would have the desired volume. The smaller vessel, which telescopes into the larger one, serves as the gas-holder. The diameter of the gas holder is about 2 cm smaller than that of the fermenter. The fermenter vessel is provided with appropriate inlet and outlet pipes for introducing the feedstock into it and for removal of spent slurry from it. The gas holder is provided with a gas tap, through which the gas is led to the burner. This system uses starchy or sugary material as feedstock. 1kg of sugar or starch yields about 400 litres of methane, within a period of 6 to 8 hours. This quantity is enough for cooking one meal for 5 to 6 persons. The biogas produced by this system contains theoretically about equal volumes of carbondioxide and methane, but in reality, it turned out to have less than 5% carbondioxide. This phenomenon is explained by the fact that carbon dioxide dissolves in the water in the fermenter vessel and diffuses out of it through the 1 cm gap between the fermenter and the gas holder. The gas produced by this system has thus almost the same calorific value as LPG. It burns without smoke or soot, producing an almost invisible bluish flame similar to that of LPG.

Several prototypes, in operation for more than a year, have been successfully tested using various feedstocks. The potential candidate feedstocks, namely rain damaged or insect damaged grain, flour spilled on the floor of a flour mill, oilcake from non-edible oilseeds, seed of various tree species, non-edible rhizomes (banana, arums, dioscoreas), leftover food, spoiled and misshapen fruits, non-edible and wild fruits, spoilt fruit juice, etc. are readily available in rural areas. This system is much easier to operate than the dung based biogas plant, because of the relatively small quantities of feedstock and effluent slurry to be handled. The effluent slurry generated daily by the plant is just a couple of litres. It can be used as manure for plants growing

around the house. The 500 litre biogas plant, mass produced from moulded
plastic drums, would cost about Rs. 3,500 (US$ 78). The smallest
cattle-dung based domestic biogas plant costs about Rs. 12,000 (US $267).
It requires daily 40kg dung, and owing to the retention period of almost
40 days, such plants have a minimum capacity of 2000 litres. They
generate daily 80 to 100 litres of effluent slurry. Daily handling of
such large quantities of feedstock and effluent is considered to be
arduous and bothersome by users.
Preliminary studies indicated that the amount of biogas produced and the
retention period varied from feedstock to feedstock and from season to
season. Also, when the feedstock was changed from one form to another,
the system took a few days to stabilise. Our studies also indicated that
the gas yield could be increased by using combinations of feedstock
materials. We are now looking at additives such as micronutrients,
nitrogen, phosphorous compounds etc., which might bacterial action and
yield more gas at a faster rate. Since the users would depend mainly
upon locally available feedstock, field trials are essential to
determine the retention periods and gas yield for different raw
materials.
Many people in India, who read my article in a local neuspaper, copied
our design and have started to use this biogas plant in their
households. A schoolgirl submitted a working model of it in a statewide
science project competition and won the first prize in the state. A
company supplying science equipment to educational institute wants to
manufacture models (50 litre capacity) for supply to schools and colleges.
We have supplied 200 litre models to 10 voluntary agencies in different
regions for demonstrating this technology to villagers in their
respective areas. This model is meant for areas where the main diet is
rice. This model yields enough gas to operate a pressure cooker to cook
rice, beans, vegetables or meat for a family of five. In areas, where
the main diet of the people consists of unleavened flat bread, somewhat
like the tortilla, each piece of bread is made individually, and

therefore the stove has to be in operation for a longer time. In such cases, we recommend the five hundred litre model.

A.D.Karve

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Date: Tue, 6 Jan 2004 08:06:52 +0530
Reply-To: "A.D. Karve" <adkarve at PN2.VSNL.NET.IN>
Sender: The Stoves Discussion List <STOVES at LISTSERV.REPP.ORG>

Dear Mr. Henson,
The fermenter vessel contains almost 200 litres of liquid. When you
pour a few litres of feedstock slurry into the biogas plant, a corresponding quantity comes out of the outlet pipe. Because the material to be fed into the biogas plant consists mainly of starch and sugary material like sugarcane juice or fruit pulp, the slurry consists
almost exclusively of water with a little suspended matter in it. In the
case of cattle dung or municipal soild waste, the slurry is thicker, because the feedstock material contains a lot of cellulose and lignin,
which are not as easily digestible as starch or sugar. Because the effluent also consists of bacteria, and because the quantum of the effluent is very small (just a few litres), we mix the starch powder or
fruit pulp into the effluent slurry and recycle it. We are currently advocating that the feedstock be fed into the biogas plant once in the morning and once again in the evening. Because the reaction time is short, one can theoretically have a continuous drip feed, but the relatively high viscosity of the feedstock may cause mechanical problems
like clogging of the dripper. It may also be theoretically possible to
produce alcohol and methane simultaneously, but we haven't looked for alcohol. The system however runs on vinegar, which is the oxidised product of alcohol. The system is sensitive to temperature. Here in Pune
it is not as cold as in the US, but at present the night temperatures touch 10 degrees C. This lowering of the night temperature has reduced

the gas outflow considerably. However, it would not be difficult to
cover the drums with an insulating material and conserve the heat
produced by the bacterial process. I t would however add to the cost
of
the system. We do not use any special bacteria. To begin with we mix
about 10 kg cattle dung and water and pour the slurry into the
fermenter. However, to make the system more readily acceptable to the
users, we shall have to produce the culture ourselves and give it to
the
users along with the biogas plant. Dung is a dirty and smelly
material.
In the initial phase, we add daily just 200 grams of flour. When gas
starts emanating, we test it for its combustibility. We get
combustible
gas in 7 to 15 days.After the methane production has started, we
increase the daily dose of 1 kg starch at each feeding. The inlet and
outlet pipes have a diameter of about 5 cm.
A.D.Karve

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Date: Thu, 5 Aug 2004 19:38:38 +0530
Reply-To: adkarve <adkarve at PN2.VSNL.NET.IN>

Dear Mr. Manar,
please tell me what is meant by AD, VS and TS.

I wish to correct the figures of oilcake used and biogas generated. It
takes daily about 30 kg oilcake to produce 15 cubic meters of gas.But
this
gas consists of almost pure methane. It is not a case of co-
generation, but
direct fermentation. Cattle dung was used only initially as a source
of
bacteria, but for more than a month, they are using only oilcake.

Let me also correct a fallacy that is current among scientists and
laymen

alike. The fact, that methanogenic bacteria are found in the excreta of
animals, led people to think that dung was their food. It is not. One
should take the advice of Mark Twain, namely not to allow school to
interfer with one's education, seriously. These bacteria live in our
intestines and eat whatever we eat. They are swept out of the intestine
along with undigested food and therefore they are found in the faeces.
Because dung is not the food of these bacteria, they have to take the help
of several other species of faecal bacteria, which break down the dung into
sugars and organic acids, before the methanogenic bacteria can convert
them into methane. As a result, the quantity of methane produced from dung
(and distillery effluent, paper factory waste, municipal solid waste etc.)
is very low in proportion to the feedstock used, and secondly, it also
takes a lot of time.
Mr. Malar wanted to know the production potential of oilcake to methane. It
is stated in the standard textbooks on biogas technology, that 1 kg of
starch or sugar produces about 800 litres of biogas, out of which about 400
litres are methane. In our biogas plants, the reaction time of the
starch-to-methane process is 8 hours. Theoretically, the product should
also contain equal volume of carbon dioxide, but in the system that we are
using, the carbon dioxide dissolves in the water in the fermenter and
diffuses out of the fermenter through the gap between the fermenter vessel
and the moving dome. After seeing the nalysis of our biogas, somebody
suggested that we could use our gas for a driving a car. We do not have the
compressor to put the gas into a cylinder, but we operated a petrol driven
portable electricity generator for about two hours, using just the biogas
produced from oilcake.
Yours
Dr.A.D.Karve, President,

Appropriate Rural Technology Institute,
Pune, India.

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rom: Carefreeland at aol.com
Date: Sat, 14 Aug 2004 03:46:00 EDT
Subject: Re: [STOVES] Does the methane flame travel back?
To: adkarve at PN2.VSNL.NET.IN, stoves at listserv.repp.org

"extracted"

Methane may also
explode, as in the cylinder of an internal combustion engine, if it
is mixed
with the appropriate quantity of oxygen. But under the anaerobic
conditions
under which methane is produced and stored, it would not explode or
burn as
long as it is inside the gas holder or inside the fermenter.
You also asked me if agricultural crop residues could be used for
producing
methane instead of making charcoal. Unfortunately, the anaerobic
bacteria
cannot digest lignin. Woody and lignified crop residues like cotton
stalks,
sugarcane leaves or wheat straw have to be first decomposed by aerobic
organisms. The digested mass is then fed into a biogas digester. This
is
called two stage fermentation. It is used for agricultural residues
and also
for municipal solid waste, but not in a domestic methane fermenter,
because
the added cost of the extra fermenter and the extra space required by
the
system.

The residual slurry of a biogas fermenter is a good organic source of
plant
nutrients, because the process of methane formation removes CO2 and
CH4 from
the biomass. Because of the selectinve removal of these elements

form the
biomass, the other constituents such a N,P,K,Ca, Fe, etc. get concentrated
in residual slurry.

Now -- for those on the Gas list that have made it down this far -- what do
you believe is the practical economic viability of converting abandoned
sugar factory plants into centralized gas production facilities for further
distribution??

Peter Singfield -- in Belize

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