The Nano Membrane Toilet (Cranfield University, UK) - new phase of funding until Jan. 2016

Posted by AParker - 08 Feb 2013 12:52

Our team at Cranfield University has been challenged to "Reinvent the Toilet". We propose a solution that uses membranes and electro-spray technologies to treat human waste on-site without external energy or water. The university received $810,000 funding from the Bill & Melinda Gates Foundation in August 2012 to produce a prototype in the UK by the end of November 2013 (in the Reinvent the Toilet Challenge (RTTC) Round 2 grant scheme).

Grant period: August 2012 until November 2013 (will apply for Phase 2 funding). Now extended until March 2014.

Overall goal:

Overall we will create a full on-site toilet system that turns faeces and urine (as a mixed stream) into pathogen-free water and sludge that cna be safely removed and converted to energy.

Short description:

Solids separation (faeces) is principally accomplished through sedimentation. Loosely bound water (mostly from urine) is separated using low glass transition temperature hollow-fibre membranes. The unique nanostructured membrane wall facilitates water transport in the vapour state rather than as a liquid state which yields high rejection of pathogens and some odorous volatile compounds. A novel nano-coated bead enables water vapour recovery through encouraging the formation of water droplets at the nanobead surface. Once the droplets form a critical size, the water drains into a collection vessel for reuse at the household level in washing or irrigation applications.

Following release of unbound water, the residual solids (around 20-25% solids) are transported by mechanical screw which drops them into into a coating chamber lined with a replaceable bag. Once inside the coating chamber, the solid matrix is periodically coated with a biodegradable nano-polymer. The nanopolymer coating serves to block odour and acts as a barrier to pathogen transport. The toilet will be powered using a modular hand crank or bicycle power generator supplied for household use that can also power other low voltage items (e.g. mobile phones).

The replaceable bag comprising the coated solids is periodically collected for transport to a locally sited small scale gasifier sized to accommodate around 40 toilets. Both toilet maintenance and solids collection will be undertaken with a trained operative responsible for the franchised area.

Research components and activities (all carried out at lab-scale in Cranfield):

- Testing of membrane pervaporation for separation of pure water from faeces and urine

- Testing of zeolite nanobeads to condense water and adsorb ammonia

- Development of electrohydrodynamic spray atomisation technology to eliminate odour

- Design of human powered electricity generator

- Overall toilet design, focussing on usability and desirability to get ready for demonstration and field-testing in UK (technology readiness level, TRL 6)

- Selection of technology for getting energy from sludge.

So far, we have presented the concept the Faecal Sludge Management Conference in November 2012:

www.susana.org/images/documents/07-cap-d...ld-university-uk.pdf

Video of my presentation at this conference:

Website:

The project has a website including a blog to which regular progress updates are posted:

www.nanomembranetoilet.org

Lead organisation: Cranfield University in Cranfield, UK

Project leader: Alison Parker

We welcome any comments and feedback.

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Re: The Nano Membrane Toilet

Posted by RowanBarber - 10 Feb 2013 14:09

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AParker wrote:

Our team at Cranfield University has been challenged to "Reinvent the Toilet". We propose a solution that uses membranes and electro-spray technologies to treat human waste on-site without external energy or water. The university received $810,000 funding from the Bill & Melinda Gates Foundation in August 2012 to produce a prototype in the UK by the end of November 2013.

I would love to be able to "field test" the proposed solution. I am interested in seeing these types of technologies out of the laboratories and into lavatories.

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Re: The Nano Membrane Toilet

Posted by Massimo - 11 Feb 2013 11:14

Good day,

I find your proposal quite interesting, but have a problem with some of the aspects (personal view / opinion).

Firstly, you are expecting the user to provide the required power by having to use the hand powered generator. If the user does not do so, what then?

Secondly, and more importantly, you are proposing to encapsulate the briquettes sludge with a product that would contain plastic. This means that if introduced into the ground as a fertilizer, you would be introducing plastic into the ground, which will never break down, or, if used as a fuel, would be exposing the users to potentially dangerous gasses / fumes.

We have been processing human waste for some time, successfully, and know that to briquette sludge at 25% is not so easy.

Finally, most of the rural toilet users don't have ready access to toilet paper, and you will also find that many use the toilet as a garbage pit! So, a large amount of detritus will make up the bulk of the waste that needs to be processes. How do you envisage tackling that problem.

Looking forward to your responses to the above.

Massimo

www.parsep.co.za

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Re: The Nano Membrane Toilet

Posted by AParker - 11 Feb 2013 12:50

Rowan - thanks for getting in touch. We're not planning on field testing until at least 2014 so I'll

remember your offer then!

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Re: The Nano Membrane Toilet

Posted by AParker - 11 Feb 2013 13:07

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Massimo - many thanks for your valuable feedback.

Massimo wrote:

Firstly, you are expecting the user to provide the required power by having to use the hand powered generator. If the user does not do so, what then?

We are planning to add some mechanism by which the toilet cannot be used if the battery is not charged. Obviously this needs to be accompanied by careful user education! If it transpires that the human powered generator is not going to be workable, we could use a solar panel (though these have their own accompanying challenges) or grid electricity (though this is outside the scope of the Reinvent the Toilet challenge). We also have an idea that the generator could also be used to charge mobile phoens, which adds extra utility to the toilet and potentially a source of income to the owners.

Massimo wrote:

you are proposing to encapsulate the briquettes sludge with a product that would contain plastic. This means that if introduced into the ground as a fertilizer, you would be introducing plastic into the ground, which will never break down, or, if used as a fuel, would be exposing the users to potentially dangerous gasses / fumes.

The plastic we are planning to use (polycaprolactone) is biodegradable so should not cause a problem for fertiliser and will be safe to burn.

Massimo wrote:

We have been processing human waste for some time, successfully, and know that to briquette sludge at 25% is not so easy.

I would be interested to learn about your experiences with 25% solids sludge. Are they documented anywhere? If necessary we may be able to extract more water so have a higher solids' concentration sludge.

Massimo wrote:

Finally, most of the rural toilet users don't have ready access to toilet paper, and you will also find that many use the toilet as a garbage pit! So, a large amount of detritus will make up the bulk of the waste that needs to be processes. How do you envisage tackling that problem.

At this stage we are not planning to deal with the type of detritus! But it is certainly not impossible and we may be able to deal with it in the future. Having said that, I think again user education is absolutely vital, accompanied in this case by a well managed solid waste programme!

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Re: The Nano Membrane Toilet

Posted by dorothee.spuhler - 11 Feb 2013 17:17

Dear Alison

Thank you for sharing your experiences on this ambitious invention!

I can understand that one might get critical as it sounds all quite complicated and high-tech! You may have already some ideas about futures maintenance requirements...

Besides using the hand crack - what other daily maintenance is required?

What are the expected overall costs for maintenance – does the usage costs remain under 0.05$/person/day as allowed by the Bill & Melinda Gates Foundation?)

What are the costs for the replacement of the membrane every 6 month and is this a membrane that would be easily available at large scale?

What other spare parts one may need and what about their availability and the skills needed for their installation?

With other words, where do you see the biggest niche or application area for the Nano Membrane Toilet?

And what planned (?) or potential collaboration with providers (i.e. spare parts / services) would be required to bring the Nano Membrane Toilet once out of the scale and up to scale?

Cheers, Dorothee

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Re: The Nano Membrane Toilet

Posted by AParker - 11 Feb 2013 17:37

Dear Dorothee,

Yes, I do feel a bit under the spot light. It would be good to hear from the other RTT grantees But it is good to have our ideas challenged!

I think that the hand crank will be the only daily maintenance requirement but we will see how the final design works out! The briquettes will need to be removed regularly as well, depending on the size of the collection hopper.

The membrane and beads do not need to be replaced - actually they are just regenerated at a central processing plant. We envision they will be replaced by a trained technician every six months. The polymer is a consumable but we are not sure of the cost yet as it depends on volumes used. The TRL 6 testing will reveal any other parts that are likely to fail and need replacing.

The toilet is designed for dense urban areas where pit latrines are not realisitic. I know B&MGF are already thinking quite hard about how to bring the Reinvented Toilets to scale and what local partners will be needed.

I hope this answers your questions!

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Re: The Nano Membrane Toilet

Posted by Massimo - 12 Feb 2013 06:50

Hi, Thank you for your response to my comments. One last item which I forgot to raise was the issue about pathogens, and the other nasty things. Your write up states that some of these would be killed off

in the proposed process. I think this is probably the most serious part of human waste management and handling / disposal. Tests conducted by a university here in South Africa found that 15 years after human waste has been buried, the pathogens still thrived in the soil adjoining the buried waste! You should give this a bit more though with regards treatment for pasteurization.

Keep us in the loop. Thank you

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Re: The Nano Membrane Toilet

Posted by emmanuel - 12 Feb 2013 10:30

Hello,

This process looks very interesting. Can it work with urine only ?

I ask that because if we do not mix urine and feces, it is quite easy to dry feces but urine is still a problem.

Do you do some test ?

Thank you and congratulation for this idea

Emmanuel

Ecodomeo

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Re: The Nano Membrane Toilet

Posted by AParker - 12 Feb 2013 13:53

Massimo wrote:

Your write up states that some of these would be killed off in the proposed process. I think this is probably the most serious part of human waste management and handling / disposal. Tests conducted by a university here in South Africa found that 15 years after human waste has been buried, the pathogens still thrived in the soil adjoining the buried waste! You should give this a bit more though with regards treatment for pasteurization.

Thanks for hihglighting this. I would also be interested to see your results showing that pathogens are not killed even after 15 years! (As well as your experience with 25% sludge, above.)

We are not intending to pasteurize the sludge. This would be quite energy intensive! Rather the coating of the sludge briquettes will contain the pathogens so they are safe to handle.

B&MGF are supporting a disinfection working group made up of RTT grantees so it would be interesting to hear from members of that group.

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Re: The Nano Membrane Toilet

Posted by AParker - 12 Feb 2013 14:00

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emmanuel wrote:

Hello,

This process looks very interesting. Can it work with urine only ?

I ask that because if we do not mix urine and feces, it is quite easy to dry feces but urine is still a problem.

Do you do some test ?

Emmanuel - we have decided to design for a mixed stream of urine and faeces and avoid urine separation and its associated problems. If the toilet was used simply for urine the membrane could still work and extract pure water but the resultant "sludge" would not really be sludge, just very concentrated urine. So you'd need to develop a different way of dealing with this, I don't think the coating mechanism could work.

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Re: The Nano Membrane Toilet

Posted by emmanuel - 12 Feb 2013 14:20

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Thank you for your answer.

It is interesting to notice that you can concentrate urine with your membrane.

I work myself to develop a urine separation toilet without problem. I know that urine treatment (reuse or other) is the problem now in my case.

I keep that in mind when I try to star new research on urine treatment.

Thank you

Emmanuel

Ecodomeo

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