Instructions for building UASBs?

Posted by canaday - 05 Jan 2013 12:17

Hi everyone,

I have been reading about UASBs (Upflow Anaerobic Sludge Blankets), but have not found a detailed manual of how to design and build one.

Is there such a manual available on the internet?

I am especially interested in placing UASBs upstream of Vegetated Sand Filters, as a means of getting as much of the suspended solids out as possible and converting these solids into useable biogas. I am thinking about domestic wastewater and slaughterhouse wastewater. Even without the artificial wetland, a stand-alone UASB would be much, much better than the existing straight pipes to the rivers.

UASBs seem especially applicable here in the Amazon, where the soils are mostly all clay, so a 5-meter-deep reactor could be readily dug down into the ground and then the walls could get reinforced with ferrocement, bricks, concrete blocks, or something. This would also apply in much of the Andes, where there is a thick layer of compressed volcanic ash that also allows for deep digging. By being below ground, this should allow them to be gravity-fed.

All suggestions would be welcome.

Best wishes,

Chris Canaday

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Re: Instructions for building UASBs? Making liner from PET bottles?

Posted by JKMakowka - 23 Jan 2013 20:19

Ahh, ok I misunderstood your idea, cement filled bottle columns might be strong enough. Horizontal connection would be probably the main design dificulty however.

Concerning the insitu fired clay... there isn't much and I just recently came across this idea. This document explains the process on page 31pp:

www.friendsofkitui.com/images/PDFs/TR28-...nwater%20STORAGE.pdf

However only for small (1.5m3) water tanks. Especially deeper holes would probably have to be artificially ventilated to have sufficient oxigen for the fire.

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Re: Instructions for building UASBs? Making liner from PET bottles?
Posted by sjoerdnienhuys - 27 Jan 2013 10:47

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I would think that making shingles from PET bottles is a lot of work and if they are on the inside, they need to be fixed (held) in place in a very durable manner. It would be faster to line the inside of the reactor with butyl foil, ofcourse far more expensive, but smooth and very durable.

You can use the PET bottles as cavity wall, either having masonry on both sides or cast them centrally inside a concrete wall. This will reduce the amount of concrete and increases the wall stiffness. In addition it will improve the thermal insulation of the wall, making the reactor work at higher temperatures, which may be a benefit in colder climate zones/periods. For reinforcing the interior or exterior sides, glassfibre webbing (e.g. Vitrulan) would not be affected by the acids, but they have to be covered with cement mortar. When you build the installation it has to last 30 years, so economising on the building materials by using untested solutions is seldom a good idea. That is why I like to hear of any dyrale results with PET lining.

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Re: Instructions for building UASBs?
Posted by MRonteltap - 28 Jan 2013 11:22

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Dear Chris and other authors:

You will likely not hear anything about building a reactor with PET bottles...., but we do have a course in anaerobic wastewater treatment coming up early March, with design and calculation of UASBs as an important aspect. It is a one week course, also the starting week of the 3 week module on Resource Oriented Wastewater Treatment and Sanitation. Teachers are prof. Jules van Lier, one of the successors (and former students) of Prof. Gatze Lettinga, and Prof. Carlos Chernicharo, who has a sea of expertise on UASBs in Brasil.

For this year the scholarship application is closed but for next year you can apply now.

Registration for this year is still open!

More information can be found on www.unesco-ihe.org/Education/Non-degree-...tment-and-Sanitation

and in the attached brochure. Oh for some reason the PDF does not attach.. I can send it via email upon request.

Please do not consider this hidden commercial; if it's interesting for you then it is; if not then not.

Best regards,

Mariska.

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Re: Instructions for building UASBs?

Posted by AquaVerde - 09 Feb 2013 16:51

Dear Chris Canaday,

How fare are you with your possible UASBs?

Would be nice to here more from you on your subject in question mark.

Regards,

Detlef SCHWAGER

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Re: Instructions for building UASBs?

Posted by AquaVerde - 04 Oct 2013 21:16

Chris,

at ocw.tudelft.nl/courses/watermanagement/w...on-uasb-design-base/

you can find many good cc (open source)lecturing's via video and ppt about UASB's and AD-technology in general by Prof. Jules van Lier...

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Re: Instructions for building UASBs?
Posted by canaday - 06 Oct 2013 05:21

Dear Detlef,

Thank you very much for this great link (with other chapters that also look very interesting). If online books become available, with more details on building UASBs, this would also be very appreciated.

I still have yet to build my first UASB, but I think I am starting to digest the idea.

Best wishes,

Chris Canaday

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Re: Instructions for building UASBs?
Posted by AquaVerde - 06 Oct 2013 10:54

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just a suggestion:

get on possible cc (open source) online books & handy manuals in direct contact to Prof. Jules van Lier, NL at TU Delft, I guess he will be very helpful to you on less sophisticated and more robust designs for smaller decentralized applications, like he explained in Columbia and Basil. On latest high tech UASB developments I guess not.

This e-mail address is being protected from spambots. You need JavaScript enabled to view it

additional see online page 427 of Chapter 16 of his book about his view on ABRs (...a series of serially operated UASB units.) In my opinion ABR's are only a purposely simplified version of UASB design. The potential of this purposely staged design is not used up to now and not further developed. **I am**

wondering why
, as the mentioned problem of flushing out of granular (sludge) is not really a big problem, if geometric design is based on a low up stream velocity (e.g. 0,1 - 0,6 m/h) and so on. Even the SRT's in each camber can be nicely controlled by separated sludge outlets for each camber.

Maybe I am missing out some more important technical issues, as I am probably like you, just learning by doing...

Under our cold climate it will be already a big financial success, if not only during summer time, even during winter large amount of sludge been reduced (theoretical up to 90% via AD!) by a purposely simplified AD-System, even if only small amounts of bio-gas volumes been generated and used. This "sludgy" approach would be mainly for large centralized wwtp's from economical and environmental advantages. So I am not only targeting decentralized systems with purposely simplified UASB. E.g. see UK/US-ABR ATKINS study.

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Re: Instructions for building UASBs?
Posted by F H Mughal - 17 Oct 2013 19:04

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While there are few plus points of UASB, like: production of low sludge, higher degree of waste stabilization, no oxygen requirements, production of methane gas and, low nutrient requirements (USABs are particularly effective in tropical locations where temperatures are warmer and relatively stable), the process has some de-merits to its credit.

A major risk with a UASB is the possibility of washout of the biomass if the HRT (hydraulic retention time) is too low. To maintain the population of useful microorganisms and anaerobes a larger reactor volume or HRT may be required which can lead to higher capital costs.

The UASB has a long start up time. Recovery from stressed conditions can also take many days, making control of the reactor important. Control of factors that will affect operation include temperature, pH and influx of any toxic substances in the feed stream. Toxics in raw wastewaters are common in Pakistan.

Operation of the UASB requires trained and experienced operators. USAB has been used, typically, for industrial wastewater treatment and seen as less effective on dilute municipal feeds but more recent design improvements have seen the use of UASB in municipal sewage treatment in countries such as Brazil.

Anaerobic systems for waste treatment have been used since late 19th century, but their use has been limited due to restricted treatment efficiencies. A closer look at the theoretical considerations (see below) will further reflect on their restrictions. Relative to anaerobic systems, aerobic systems, such as activated sludge process, trickling filters, oxidation ponds and aerated lagoons, are more common.

Back in 1968, P L McCarty and Young did a lot of work on anaerobic digestion. USABs were developed by Lettinga and his co-workers in Holland in the early 1970's.

Theoretical Considerations

Anaerobic digestion is a three-stage process. In the first stage, the complex insoluble organics are hydrolyzed to simple soluble organics by the extra cellular enzymes. During this stage, the cellulose and starch are hydrolyzed to simple sugars, while proteins bifurcate into amino acids. In the second stage, called the acid phase, the acid formers (various species of Pseudomonos, Alcaligens, Flavobacterium, Escherichia and Aerobacter) convert simple organics to organic fatty acids (acetic acid). This results in higher acid concentration and low pH. In the third stage, called methane phase, methane formers utilize the organic acids and metabolized them to methane and carbon dioxide. Amino acids give rise to ammonia, which in turn, neutralize the remaining acids.

Methane formers (species of Methanobacterium, Methanococcus and Methanosarcina) are highly frail in nature. They are strict anaerobes, grow over a wide range of temperature, difficult to cultivate and, they remain inalienable. They are highly sensitive to low pH conditions.

These concomitant reactions in actual digestion occur simultaneously. Flawless performance of the digester will take place only when there is a balanced bacterial population of acid formers and methane formers, or, in other words, the volatile acids production equals volatile acids breakdown. If the volatile acids formation is greater than its breakdown (which usually is the case, in actual digesters), the pH lowers, inhibition or wash-out of methane formers occurs and, the process fails, biologically.

F H Mughal

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Re: Instructions for building UASBs?

Posted by AquaVerde - 18 Oct 2013 08:20

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Dear Mughal,

A major risk with a UASB is the possibility of washout of the biomass if the HRT is too low.

I guess you have a typing error and probably "if is too high" in mind?

All the Theoretical Considerations are known. Do you have **practical** considerations on the the UASB and ABR subject?

All the best

Detlef

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Re: Instructions for building UASBs?

Posted by F H Mughal - 20 Oct 2013 05:56

Dear Detlef,

At lower hydraulic retention times (time for the contents to remain in the reactor), there is significant possibilities of washout of the biomass. That means, it would be difficult to maintain desired number of bacterial population in the system. To maintain adequate population on anaerobes, higher HRTs are required, or, larger reactor volumes.

What I have stated before the theoretical considerations, are the practical condiderations.

F H Mughal

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Re: Instructions for building UASBs?

Posted by AquaVerde - 20 Oct 2013 07:47

Dear Mughal,

Thanks for your clarification. It is my , English is not my first language, so I got mixed up.

In plain English, in my practical consideration just for planing of simple **COD**-ABRs avoiding washouts of biomass, I use a **low**

up-flow velocity [Vup] at peaks not more them 0,6 m/h (better less) and a
long
HRT not less them 2 better 3 days. For
Biogas
-ABRs it needs more know-how and empiric science...

May you come in with your experiences on that topic?

In general, the necessary reactor volume for anaerobic wwtp technologies you can not avoid, it only seams large, but is still smaller in comparison to aerobic wwtp technologies for reactor and sludge treatment plus its high energy demands. Special in warm areas the anaerobic wwtp technologies have many advantages.

All is based on empiric science by others.

All the best

Detlef

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Re: Instructions for building UASBs?
Posted by christoph - 20 Oct 2013 12:40

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Dear Mughal,

do you do research on UASB?

I would like to know a bit more about how you calculate the retention time.

(correction after an observation from Mughal)

On what time do you calculate the HRT?

a) Volume reactor (m^3) / Wastewater flow (m^3/h) = HRT (h)

or

b) "Sludge reaction volume" (m^3) / Wastewater flow (m^3/h) = Reaction HRT (h)

or

c) "effective sludge reaction volume"* (m^3)/ Wastewater flow (m^3/h) = effective reaction HRT (h)

*(which would be just considering the volume until reaching the decantation area)

In my view b or c are the more correct numbers when talking about HRT for UASB.

In separate there should be an analysis of the decantation time which is in my opinion the responsible factor for losing sludge, not the overall HRT.

What do you think?

Yours

Christoph

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