AQUACULTURAL ENGINEERING SOCIETY

Newsletter, Dec 2020

Presidents Letter

Dear AES members,

The past year is slowly fading away, probably one of the strangest years I have memory of. It started smoothly at the AA2020 conference in beautiful Hawaii. We successfully organized a session oriented towards aquaponics systems and their engineering applications (you can find some of the presentations in the AES webpage). In the meanwhile, the COVID numbers were increasing signaling that something big was going to happen. In March, the lockdowns followed; experiments, meetings, lectures and conferences had to be postponed or adapted. The outcome was an extensive offer of webinars and conferences. We offered two interesting webinars; 'Water Biosecurity through Real Design: How to Ensure UV System Performance Delivery and Integration in Aquaculture Operations' presented by Aran Lavi (Atlantium Technologies) and 'A new approach in tropical recirculating aquaculture systems' presented by Farshad Shishehchia (Blue Aqua International group). We deeply thank the exponents and if you missed their presentations, you can find them in the AES webpage.

Circular economy, sustainability, insects based meal, life cycle analysis, energy efficiency, carbon footprint and residual resources are the recurring concepts I heard of within the different webinars, conferences and funding opportunities this year. Aquaculture and specially RAS will have the chance to prove why they are called the 'technology for the future' and a solution for the human existence. I foresee we will play a fundamental role in the big discussion on how to sustain this exponential human growth population and why aquaculture is more adequate than other food producing industries to solve this problem. Our field has the ability to transform wastes into constant and secure resources and slowly decouple human growth from resource pressure. With feed conversion of 1 to 1 achieving a high-nutritional product, minimal water usage and capacity for reduced nutrients discharge, together with the potential for use of wastes as resources for other processes such as energy production, fertilizers and feed to other trophic food levels, RAS show all the important features for achieving the circular economy concept within aquaculture. In order to have a good standing point we need to start talking the same language between us, the aquaculture sector. We have to agree what the units on which we measure and define processes are, simple things such as when a system is considered a RAS or how we express the performance of a treatment. We need to work on this and the AES will do its best to provide information and opportunities for discussion.

We are working for the coming year on organizing workshops to favour discussion between the stakeholders in the aquaculture sector. We will offer webinars on topics such as biofilter design, dimension and considerations, waste collection technologies from sea cages and hydrogen sulfide formation and prevention in marine RAS, among other interesting topics. We will work as hard as possible to improve our commitment to our members and be an authority and voice in aquaculture engineering. I am therefore happy to inform that John Colt will join the team as administrative assistant of AES.

I wish each of you a happy new year. Thank you for your support, and may this new year be a full of great accomplishments.

A big hug and I hope good water quality is always running in your life.

Best wishes, Carlos

Member Spotlight

Interview with Dr. Michael Timmons, a founder member of AES

AES: What are you working at the present?

Michael: I am actually working with my golf game. I am so passionate about aquaculture, so I have to force myself to do something else once in a while. Weather has been very beautiful up here, so I got up and played an hour of golf. However, even when playing golf, I end up thinking about aquaculture. The signature hole of the golf course is over a pond, where I put some koi from one of our experiments at Cornell, so I have been checking them when I go playing, and they are getting really big. But what I am really working at the present? I need hats, so I have multiple hats at the moment. Because I am a professor, since even before the current AES president was born, I am thinking on how we are going to feed all these people. So, it really comes down to aquacultural engineering. The thing I am actually working on is aquaponics. About 8 years ago, I was the RAS guy and the we had Dr. Albright, the hydroponics guy at Cornell. The only we could agree on was that RAS is complicated and hydroponics is complicated, so combining them would be really complicated. However, almost 15 years ago, the people in my short courses already asked about aquaponics, and I told them to go away. But this kept happening over and over again. Then, I heard some people, who I actually respected, like Dr. Jim Rakocy from University of the Virgin Islands, the father of aquaponics, speaking for the aquaponics. And next, I did a consortium project with RAS farm on aquaponics, and they started getting fabulous results on vegetables tasting better and having a better nutritional value, so I started to think that maybe there is something in this. However, we still needed some scientific evidence with replicated controlled setup. Cornell was not too encouraging, but we managed to set up controlled experiments to compare aquaponics and hydroponics, and with lettuce to start with. Much to our surprise, we could not reject the hypothesis on hydroponic lettuce growing as good as the aquaponics lettuce. So it was like: “wow!”. Then we did spinach, and the same: “wow!”. And strawberries: “wow!”. So combining complicated RAS and complicated hydroponics is actually so simple! And to improve RAS sustainability, we can actually design to match our plant system to absorb and settle all the nutrients from the fish. So pretty exciting!

AES: How do you perceive the evolution of RAS?

Michael: Well, I am also an example of evolution, since I am an agricultural engineer and before starting in RAS 25 years ago, I worked in poultry industry. I can say that actually saved my professional career. There, I saw a complete integration between growers growing the birds and commercial companies processing and marketing the birds, but also telling growers how to manage the farm and providing the system and expertise for the growers. I considered that as a very good idea, and that is what I have been trying to do ever since in RAS, and I think we are getting pretty close these days. Personally, I started a private farm in 1997 with 500t per year of tilapia, in cold climate with average temperature of 10°C and winter temperature going down to -20°C. Makes a lot of sense: let’s grow a tropical fish in the arctic climate.

Michael: But in RAS, since there is not so much water coming in, I can created any condition needed for the species I want to farm and even make some money. The only challenge is that the amount of water taken in needs to be treated to make it acceptable to the aquifer where it came from. The smaller the amount of water is, the easier it is to operate the farm. So. On this tilapia farm, I have learned a lot. And I can say that the number one rule for startup is: Do not run out of money. Going back a bit to president Carlos asking me what I am doing at the moment. I am actually becoming a professor emeritus at Cornell University on January 4th 2021 and I have a new 7 hectares farm. We are doing a tilapia genetic program, and demonstration of my latest and greatest technology, which will of course change the world. And we have a couple of greenhouses and aquaponics. I actually have a website, professort.fish, go there and see what my life is all about.

AES: What do you think aquaculture sector is missing nowadays?

Michael: Entrepreneurs, who are able to risk everything. All of you, take the risk! But, back when I started, the engineering approach was to put a RAS together and produce a high value species to create cash flow. But that is a totally wrong approach. So, you have to be able to produce the fish in the economically competitive basis, if you cannot do that, you won't be successful. We have actually invented a new pump, which patent is pending. Most pumps will give you approximately 400 L min^{-1} KW^{-1}, the pump we have tested gives 12 000 L min^{-1} KW^{-1}. Since the pumping costs have always been what kills us, plus expensive design, the pump is revolutionary, since now we can actually move water around almost for free.

AES: You have been a member for a long time in AES. Tell us a bit about that and what does AES mean to you?

Michael: Well, I was a founder member. In the beginning, we met in conferences and our sessions on RAS were always full. We realized we need a society to control and produce standards, and all the things Aquacultural engineering society now does for Aquacultural engineering community. So, we formed a society, and being proactive, got people to join. It has been a great society, and now with the new leaders, we will have a new invigoration, membership drive, and will be able to restore our services to the community. The need for our services is so large now, because of environmental constraints, where the only way to produce food in sustainable way is through aquaculture, aquaponics, and hydroponics. As a society, we need to gear up to provide service, the educational opportunities, and technology transfer, which is needed. We are in the special place in the society right now, because they really need us.

AES: A particular memory of AES you would like to share with us?

Michael: First memory is when I took 200 hundred copies of the first edition of the yellow book and people were lining up to get it. I have so many memories on getting to know members, on meetings, social interactions, and tradeshows. I think that occasionally I should have even learned something.

AES: So what is the role of AES in the industry and academia?

Michael: I think we have to be really proactive and aggressive to create the technology transfer and educational support for the new growers. There is plenty of knowledge we need to implement, so we should not re-invent the wheel, just transfer the information to the general public. We have to make sure that the technologies, techniques, and management methods are readily available for the consumers. And networking is also very important. As a final remark, I want to say this: I am an aquacultural engineer, I cannot wait to get up in the morning or do not like to go the bed in the evening, because there are so much things to do. Life is so exciting right now! And we are helping to make the world a better place.

Scientific Spotlight

Turn it upside down (or downside up) - floating faeces and its potential of rapid solid removal in RAS

Background

Since beginning of aquaculture, main solid removal mechanisms were primary based on sedimentation. But what will happen if we simply turn the table and try to remove solids close to the water surface before they settle down and/or begin to disintegrate. Such a new approach has been investigated at the Fisheries Research Station of Baden-Württemberg in Germany in recent years. The idea behind it was to create floating faeces by adding indigestible density-reducing material in the fish feed. Initially, the main challenge was the search for suitable additives. Among others, cork (*Quercus suber*) turned out to be the most efficient material to bring density values of faecal matter below the crucial 1 g cm^{-3}.

Floating faeces from rainbow trout transported by the surface flow to a surface skimmer.

However, before transferring the idea to a low water exchange RAS, previous extensive laboratory experiments and a commercial-scale trial in a semi-recirculating aquaculture system (RAS) were carried out in order to achieve sufficient density reduction resulting in the faecal pellet floating up.

The study in a fully closed RAS was carried out under the following conditions: A commercial trout diet producing feces in the upper recorded density range (1,034 ± 0,0042 g cm^{-3}) was used as a control. The addition of 2.5 % cork to the control diet resulted in stable and consistently floating faecal casts with a mean density of 0.993 ± 0.003 g cm^{-3}. In a duplicate 10 tank RAS, each stocked with 500 rainbow trout (*Oncorhynchus mykiss*), fish were fed over a period of 120 days. Stocking density increased from 10 kg m^{-3} at the beginning of the experiment to a final density of 75 kg m^{-3}. Mean final fish weight was 567 g and did not differ statistically between systems.

Solid waste from the control system was collected in a sump before being transported to a drum filter. The tanks of the system in which the experimental cork diet was fed were additionally equipped with simple stainless steel outlet pipes at the water surface, which transported the floating feces directly to the drum filter.

Intact rainbow trout faeces collected directly before entering the drum filter

More about floating faeces:

Schumann, M., Unger, J., and Brinker, A., 2017. Floating faeces: Effects on solid removal and particle size distribution in RAS. *Aquacultural Engineering*, 78, 75–84.

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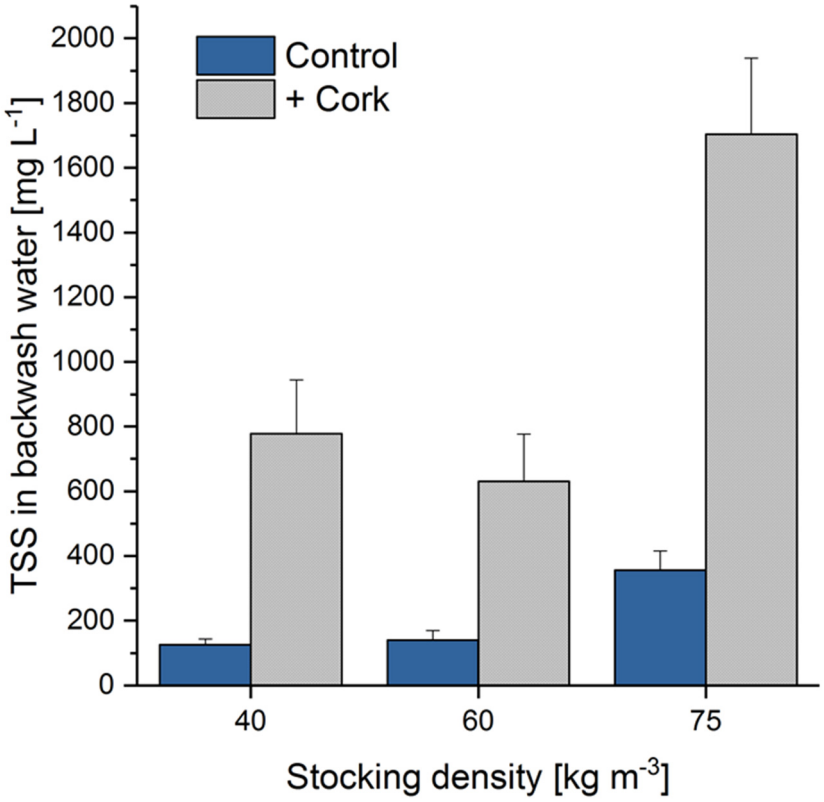
Results

Drum filter removal efficiency of cork-treated solid wastes was more than four times greater than that achieved in the control (about 90 % vs. 20 %). Over the entire period of the experiment, the TSS-concentration in the backwash water of the drum filter was significantly higher and thus a higher amount of suspended matter was continuously removed directly from the system. Total ammonia nitrogen (TAN) and nitrite nitrogen levels were comparable during the first weeks of the experiment. However, when the biofilters reached their capacity, TAN and nitrite removal was distinctly more efficient for the cork-treated system than the control. Physiological health assays indicated no pathologic tissue alterations associated with the experimental diet and growth, survival and feed conversion were unaffected.



Concentration of TSS in drum filter backwash water was distinctly higher during all phases of the experiment in the system where cork-enriched feed was applied.

Conclusion and outlook

A minimal feed-mediated density modification of fish faeces improves nearly all aspects of water quality investigated while at the same time resulting in significantly higher nutrient recovery and dry matter content of sludge.

This novel approach showed positive effects in different types of systems, but seem to be particularly suitable in RAS, where any amount of suspended matter remaining in the loop can lead to serious problems. The previous positive effects of floating faeces were all achieved in existing systems through relatively small structural changes. The efficiency of this new approach could be significantly increased by adapting new recirculating systems and removal devices design to remove solids dislocating in the surface water film.

Upcoming Events 2021

Latin American & Caribbean Aquaculture 2020

Guayaquil, Ecuador, March 22-25, 2021 – virtual conference and e-Market

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AQUACULTURE EUROPE 2020 Cork

Ireland April 12-15, 2021 – virtual conference and e-Market

WORLD AQUACULTURE 2020

Singapore June 14-18, 2021 New Dates

AQUACULTURE AMERICA 2021

San Antonio, Texas, USA August 11-14 2021 New dates

ASIAN PACIFIC AQUACULTURE 2021

Surabaya, Indonesia Sept 7-10

WAS North America & Aquaculture Canada 2021

St John's Newfoundland, Canada, Sept 26 – 29 New Dates

AQUACULTURE EUROPE 2021

Madeira, Portugal Oct 5-8

WORLD AQUACULTURE 2021

Merida, Mexico November 15-19

AQUACULTURE AFRICA 2021

Alexandria, Egypt December 11-14 new dates

Industrial Spotlight

Danish Salmon A/S and example of perseverance, commitment and success

Danish Salmon is one of the first Marine land based recirculating aquaculture systems constructed in Denmark and Europe, and is receiving much attention from the industry and researchers. The facility was constructed in 2012 with a planned annual production capacity of 2000 tons of salmon.. Reality showed that the achievable production is not much more than half of what was expected, leading to financial losses; €1.5 million in 2014 and €2.9 million in 2016. In 2018 Danish Salmon cracked the code and there was a clear shift on the economics as a response to an improvement on the technology and operations. This lead in 2020 to gain the interest of two Japanese giants (Nissui and Marubeni) investing in the company for targeting an increased production up to 2700 ton/year.

Danish Salmon is an example of perseverance, commitment, and success, being one of the first >1000 ton/year full cycle land based marine systems in full operation with a water recirculation degree of 99% (200L 400L make-up water/kg fish produced) and a feed conversion rate of 1.15. Additionally they are environmentally responsible by removing 60% of N and 65% of P and 50% of organic matter produced.

Production Manager of Danish Salmon, Arndt von Danwitz, is one of the key persons responsible for this shift on Danish Salmon's fate

AES: Arndt, what is your previous background and how has this experience been for you?

Arndt: I have studied agricultural science with focus on animal production. My Bachelor Thesis was a comparison of mechanical filters in RAS and my Master Thesis about fish meal substitution in fish nutrition. After my studies I worked for three years in a research institute with focus on fish nutrition and filtration systems in RAS. I think my education and previous work has given me the right set of tools to identify problems and develop the production, even though most of my studies had a focus on land animal production.

AES: What are the main challenges you had to overcome at Danish Salmon?

Arndt: We had to work on thousands of small and big challenges. We are still not done and will never be completely. In my opinion the biggest challenge throughout the first years has been the internal and end-of pipe wastewater treatment. Equally important has it been to establish a working feeding regime in RAS, installing redundancy for stability and improved fish logistics. Another challenge has been to build a good team with a mix of experiences fish farmers, technicians and young people all motivated to develop the farm and our business.

AES: Much has been said about the risks of H_2S in marine land based RAS. Have you got any challenges regarding this?

Arndt: We always had and will always have minor production of H_2S, btw not inly in the marine systems. It is a matter of understanding and working around the problem. All staff in the team need to be aware of the potential risks and be trained accordingly. I think it is important to spend time on explaining the risks and follow protocols strictly to avoid incidents. We have always worked with full strength salinity here but didn't lose fish due to H_2S.

AES: In your point of view, is RAS salmon culture sustainable?

Arndt: It certainly has points where it is sustainable e.g. recycling nutrients back into the food chain. On the other hand, we must work on our carbon footprint, but we are already working on the options as there is wind or other green energy available in Denmark.

AES: What is your opinion regarding salmon culture in sea cages?

Arndt: It is a vital part of seafood production and there have not been serious alternatives until recently. I expect that sea cages will still produce the majority of salmon during the next 10-15 years, but times change. Let me say it with another example: would you invest your money into a car factory producing only diesel engines when you can invest in electric vehicles instead?

AES: What would be your advice to other salmon fish farms being constructed around the world?

Arndt: Do not fool yourself and think you can produce healthy and fast-growing Atlantic Salmon at over 100 kg/m^3. Too many projects are based on what we call 'Excel-fish' and growth curves far from reality considering the intensity and stocking densities you need to run at to get an economical viable fish production in RAS.

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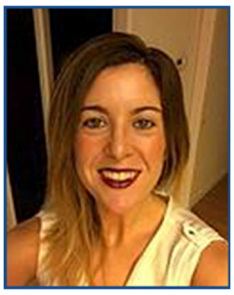

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