Advanced Aquaculture Technology
Professor Gourav Dhar Bhowmick
Department of Agricultural and Food Engineering
Indian Institute of Technology, Kharagpur
Module 02: Technology of Closed Aquaculture
Lecture 08
Re-Circulatory System

Hello everyone, welcome to the lecture 3 of module 2 of advanced aquaculture technology course, I am professor Gourav Dhar Bhowmick from agriculture and food engineering department, IIT Kharagpur.

(Refer Slide Time: 0:35)

So, these are the concepts that will be covered in this particular lecture material. The introduction to the recirculating aquaculture system, the components associated with it. The

fish cultures, what are the fish that we normally culture in RAS technology, and merits and demerits of RAS technology in general.

(Refer Slide Time: 0:52)

As, we already have the some basic idea about what is recirculating aquaculture systems, as we have already discussed in earlier lectures in brief. So, it's actually a recirculating aquaculture system it is a land based closed system used for culturing the aquatic organisms, it involves the rearing of fishes in indoor, or outdoor tanks within a controlled environment. It involves the recycling and reuse of the waste culture water after mechanical, biological filtration, or the both and the removal of the suspended solids, definitely by means of mechanical filtration process.

It normally uses a very minimal amount of land and water because, it reuse the water which is circulating over the in its units. It involves the addition of new water only to make up for the evaporation loss, splash out, and that uses to remove the waste materials. So, now it is even the evaporation loss has been also somehow bypass, because the whatever the control environment that the system has been designed nowadays by in different countries, the evaporation loss is also been minimized by capturing that evaporated water, evaporator moisture in the air circulation units, and they actually condense it back and they will put the that water is actually given back to the systems.

So that is how the technology advancement is been taking place in aquaculture sectors and that is how evaporation loss, like the water which is due to the evaporation loss is also being somehow, it is been make up by the system itself. It in general, recirculatory aquaculture system, it reduces the environmental impact and improve the food security.

(Refer Slide Time: 02:35)

So, how it improves food security? Because, it provides us the additional amount of because we normally do the intensive aquaculture system in RAS technology, utilizing this RAS units. So, and also the environmental point of view also less water uses, and also the whatever treated, whatever the effluent, whatever the pollutant that is being generated from the culture of the aquatic species, that is being taken care of by the treatment unit itself. So, we are not throwing that water out of out in the surface water bodies which will create a nuisance in the system, and nuisance in their biological ecosystem and all. So, we try to that is why RAS technology has been preferred all over the world.

The feed that is used it is a high protein feed with all essential minerals, and vitamins we try to produce and we try to introduce it to the to our recirculatory aquaculture systems for maximum output. The species that is being cultured in RAS systems it is mainly the Baramundi, Bhetki, Cobia, Silver, or Indian Pompano, Tilapia, Pearl Spot, Karimeen, Pangasius, Rainbow Trout etcetera, etcetera.

(Refer Slide Time: 03:42)

So, the components that involved with the RAS is mainly the tanks, like the grow out tanks, the settling tanks, the water storage tanks, and the overhead tanks. There are pumping units which are also the part of RAS unit which are actually in the pumping the water from the aquaculture wastewater that is coming out of the system to the different filtration units. Then the filtration unit comes, where the suspended solid filtration, suspended solids removal is happening in the mechanical filters, the glass wool on the muslin cloth filter, drum filter, biofilters, where normally the bioconversion of the pollutants to the favourable bioproducts will happen, it normally happens in the biofilters.

Then the UV unit to further get rid of all the unwanted microorganisms from the wastewater. Then the sludge and settable solid collectors are also there where the whatever the filtered, settled, filtered solids which are actually taken out from the system that collector of the there is a system there is a continuum way we want to collect those sludge and all. And this sludge is actually sometimes beneficial because it is very rich in nutrients. So, you can utilize it for different purposes like bio fertilizers and etcetera. After obviously, you can go for drying and etcetera, and after the drying is done, then it can be used for different other purposes as well as production of biogas and all, so, it is possible in certain cases.

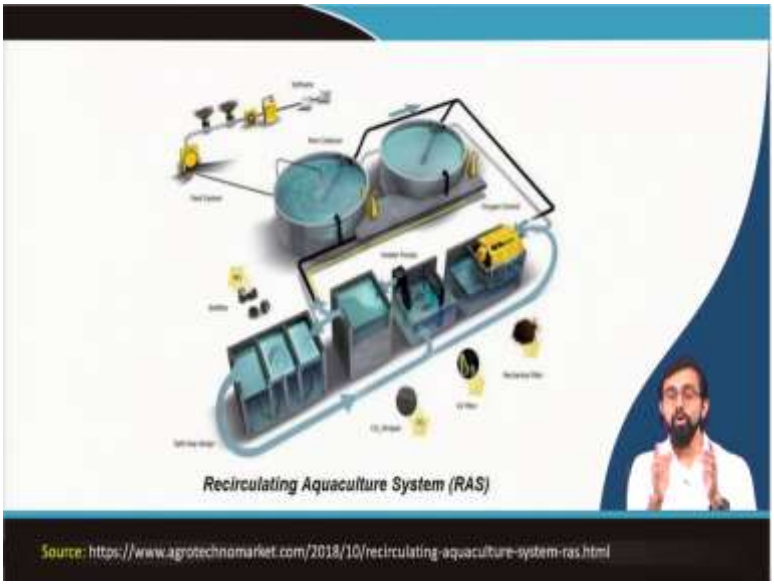
The aeration and the oxygenation in it, which is very like one of the major components, because you need to provide dissolved oxygen through aerator to your aquatic species all the time, because unless and until they are having ample amount of oxygen present in the system and, because we are doing intensive aquaculture, because we are not introducing any natural fertilization system or natural feed supply system in this particular case. So, what happened,

the whole aquatic species, all the farming in its day are entirely depending on the aeration and the food that we feed, that we are providing.

So, this aeration is very important, it has to be there and you have to be very cautious whenever you will be designing aerators units, aeration units, so, the number of aerators that is actually ample enough to make that DO level of the system around 4 to 6, try to do it. And if not, at least, try to make it 2 to 3 so that the oxygen availability for and it also depends upon the aquatic species that you are culturing. Sometimes Tilapia can sustain a very low dissolved oxygen level, this type of fishes, but there are certain amount of certain type of fishes which cannot sustain DO level less than 4.

So, in order to identify to go for the aerated unit design and all, you have to understand what are the aquatic species that will culturing in your system. Carbon dioxide removal system, degasser at the end which is very important the water supply system proper conduct lines and all. Water testing it is very important to get to know about the what are the parameters, the quality of the water after even being treatment, the treatment is being done. The inputs like seed, feed, additives, or the supplements are also involved with it.

(Refer Slide Time: 06:45)



So, this is a typical design of a recirculating aquaculture system as you can see, the from the pond, if you see from the pond the water is coming to the first mechanicals filter, in the mechanical filter all the suspended solids of the heavy materials are like actually, like taken out. And then, all like the particles which are having certain like specific gravity and also specific which are having higher in a particular size is being taking care of by the this particular unit. And then, it comes to the UV filter when it kind work on the amount of

microorganisms present on in the system, then it comes to the carbon dioxide strippers and also then to the biological units.

If this units this is not fixed, this actually varies, the place of this per individual unit varies with the type of design, or the type of target species, with the type of wastewater quality that you are expecting. So, this is not fixed. And in the biofilter we normally use it see, at the end where, is this there is split loop designed biofilter is provided, in this biofilter it can be moving bed biofilm reactor, it can be membrane bioreactor. So, there are different options.

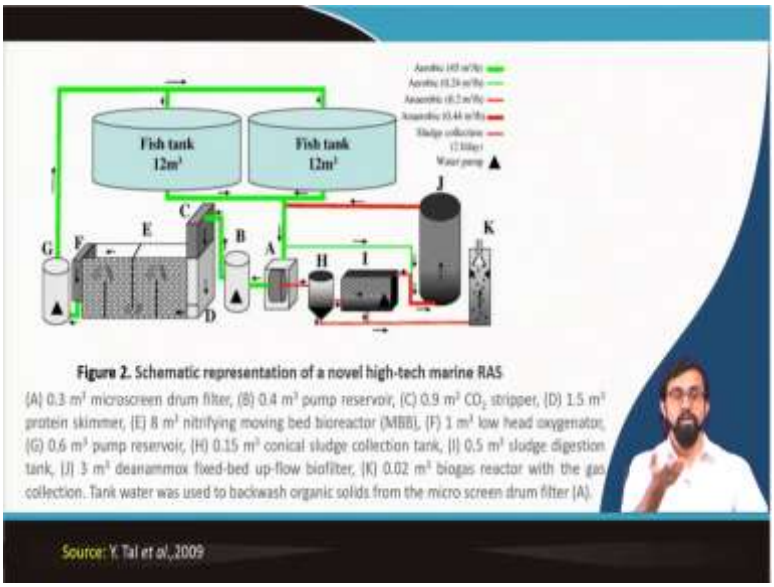
So, what is this moving bed biofilm reactor what is membrane bioreactor? Maybe you can discuss well I cannot discuss about all these things, all this wastewater treatment technology at this moment, maybe later on in the later lectures you will find it or else you can Google it like what is moving bed biofilm reactor, what is membrane bioreactor, how it works?

So, I am giving a very brief about it. So, normally we provide it with a different bio medias it is like a plastic normal coils we provide. In this plastic coil, it has a very high specific surface area. So, and also because of providing enough amount of aeration, and the amount of nutrient present in the wastewater what happened different kinds of nitrifying bacteria will grow on its surface, not only nitrifying, different other types of bacterias will also grow in the surface of this biofilters bio medias. So, in this bio medias, so this nitrifying these bacteria what they do they consume the nutrient present in the wastewater and they convert that chemical composition to the to their biomass.

Whatever there in the nutrients present into this wastewater they convert it to into their biomass, and that biomass is easily separable. So, by this way, we can get rid of the nutrient present in the wastewater, and wastewater can be purified by this way. So, then this wastewater is again taken back to the tank. So, this way the treatment of wastewater is happening, and after then the treated water is again circulated back to the tank. So that is why it is called recirculating aquaculture systems.

Now, this is I am discussing this system as it gross. So as a whole, there are individual units which are varied, like depending upon, it is all together different type of systems, depending upon the expectation of the customer, or expectation of the bio row, expectation of your designs firm and all.

(Refer Slide Time: 09:42)



You can see this is another typical example of high-tech marine recirculatory (())(9:53) aquaculture systems, where you can see the fish tank, both of the fish tanks having 2 cubic meters of volume. Where the water which is coming out of the fish tank is introduced to the unit A, and B if you can see the first the microscreen drum filter from there to the pump preserver, that arrow sign is showing it means the pump.

So, it is taking that water from after the screening is done in microscreen drum filter, that water is taken to the number C, which is a carbon dioxide stripper. After the carbon dioxide stripper, it is coming down to the protein skimmer, through protein skimmer it comes to the nitrifying moving bed biofilm bioreactor MBB, or MBBR sometimes it is called.

In MBBR you see this small black thing is what actually those are actually different bio media or which is involved, in this bio media there are a lot of different types of microorganisms there. So, these microorganisms what they do? They consume the ammonia, or consumed the pollutant and present in the wastewater and they convert it to the nitrate or nitrite and also even in certain places this somehow anaerobicity can be prepared, the anaerobic in that condition the denitrifying microorganisms can also start working on it and nitrate, nitrite can also be converted to the dinitrogen gas on N2 gas.

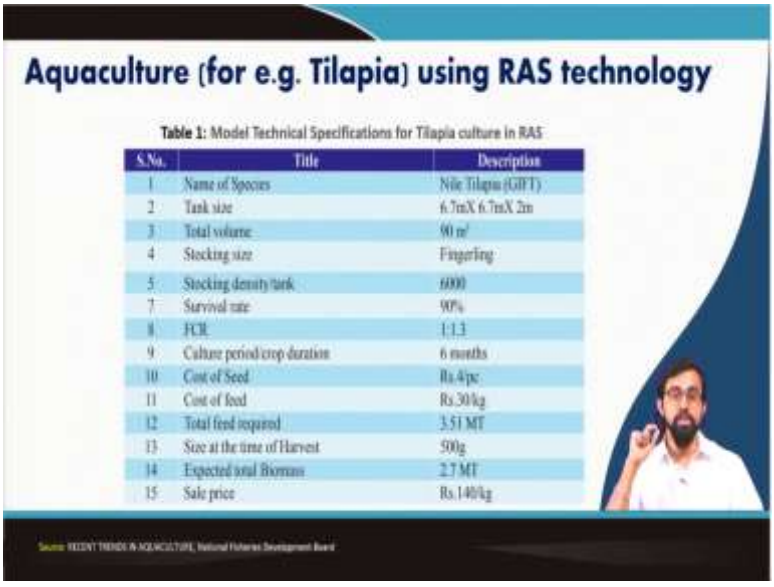
So, once it is possible, once it is converted to the nitrogen what happened all the ammonia is, all the nitrogen species is removed from the system, then it goes to the number F, which is like the oxygenator low head oxygenator or the like simply if I say it is a type of aerator. So, we are supplying the oxygen to your system and then it goes to the G which is another pump

reservoir. From there, the pump is actually taking the water to the taken back to the fish tank. So that is the clean water again. So, this way the water circulation is being taking place.

Other than that, if you go to the red line, if you consider into the red line where the mostly the anaerobic and like anoxic zone is prevailed here. So, what is happening all the sludge, all the micro skin filter sludge which is producing there that is come to the sludge collection tank, which is number H, from there it goes to the sludge dilution tank which is like A, and from I and from there it goes to the deanammox fixed-bed up-flow biofilter. So, that is also type of bioreactor where deanammox is like it is a type of microorganisms, which are present in the system, which actually utilize the water or the whatever the pollutant present in the incoming waste, and that they utilize in their converted to the further bio-products.

And this, from there it goes to this bio gas collecting unit. You see the number K, and from there it will see the again like the water which is like collecting which is purified in the number J or like fix bed after bioreactor, that is also called again coming back to the this initial microscreen drum filter and the by this way, the whole recycled aquaculture system is working. So, this is only a type of design that is available in literature if you go for Y. Tal et al., 2009. The reference is given at the end, they have nicely designed this system and it is already available, and these kind of design is already available.

(Refer Slide Time: 13:07)



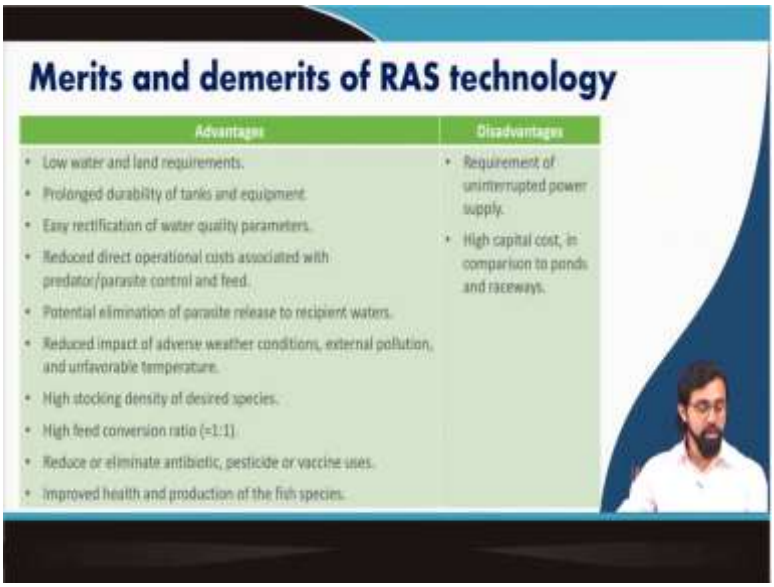
So, giving you another model technical specification for Tilapia culture in a recycled aquaculture systems. So, suppose we are targeting the Nile Tilapia, the tank size is say like 6.7 * 6.7* 2 like length, width and height, total volume of around 90 m^3 or stocking sizes fingerlings of 6000 per tank, survival rate is around 90 %, the food conversion ratio of 1:1.3,

and the culture period of around 6 - 7 months, cost of seed s.2 metric tonne and the size of the time of harvest will be size at the time of harvest will be around 500 gram at the end of 6 months. So, total expected bio mass will be 2.7 metric tons. So, we can see the difference there and also the sale price will be around 140 rupees per kg in general.

(Refer Slide Time: 14:03)

So, that is how we, this is just giving you some basic example of how we do the calculation. It is not fixed for any particular region and all, it can vary drastically place to place, and in different consideration and design values that we input. So, there are like capital cost which involved with designing of this RAS, there are like input costs, there are like recurring costs, there are non-recurring cost, and based on that we go for the deposition value calculation, and we do the total amount at the end how much is the cost for each unit, or of these RAS and all.

(Refer Slide Time: 14:41)



So, I will be discussing about more in details, about this cost analysis of aquaculture sector, aquaculture farm. How we do it? How we can do it more precisely so that we have in depth idea about the amount of benefit that we are getting out of the system? The demerits, and demerits of RAS technology, in general the advantages which involved with the RAS technology are it is low water and land requirement, prolong durability of the tanks and equipments, easy rectification of water quality parameters. Reduced direct operational cost associated with a predator, or parasite control on the feed. Because which is not possible in case of open channel, or in case of sorry open culture and all, it is not possible in this case of only in case of RAS we can control these things.

We can have a very high stocking density, and very high food to feed conversion ratio. You know what is feed conversion ratio? The amount of feed the aquatic species is taking and that how much is like convert how what is the portion of it as actually converted to its biomass. So, that is called the feed conversion ratio. So, that is also very much high in this particular case. It reduces the anti presents the requirement of antibiotic, pesticides, or the vaccine uses in the system. It improve the health and also the production of the fish species, or the any cultures aquatic species that is what that we are doing in recircular aquaculture system.

But, it comes with the some disadvantages the major disadvantages is because it is completely artificial, it is completely anthropogenic activity, complete human presence is required, or the complete automation is required, in that automation we have to make sure that it has uninterrupted power supply, if it does not have uninterrupted power supply what will happen? If for some time, if even for very few minutes, the aeration system starts not

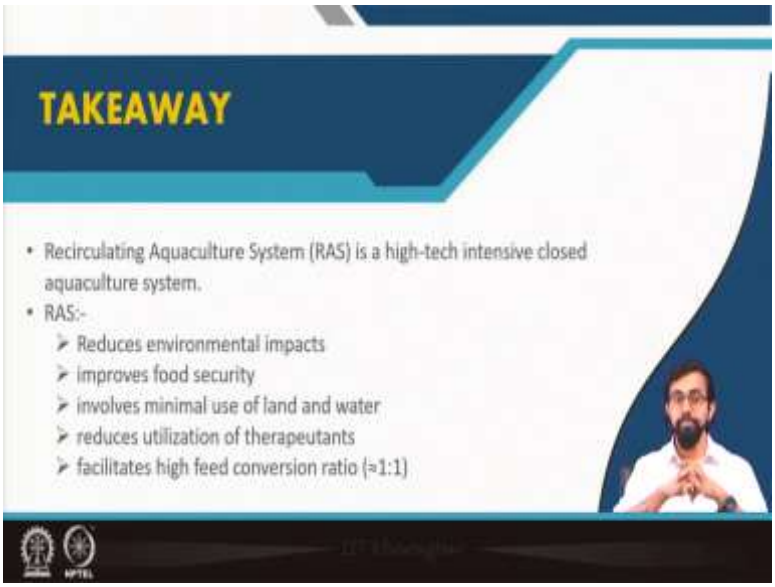
working, or say like feeder is not working for like 1 hour, like 2 hour 3 hour, say something like that.

So, depending upon the species and the maturation stage, it can cause drastic effect in your system, it can cause complete loss of your aquatic output from your farm. So, that is a very big of a disadvantage added to the RAS technology. And, also it involves a very high capital cost in the beginning, compared to the ponds, and raceways. But with time, definitely with the benefit that we will be getting from selling your product and all. So, the payback period is also less so, but it involves with the basic high capital costs, which actually problematic issues.

(Refer Slide Time: 17:22)

So, it reduces the overall environmental impacts, and improves the food security, as we have discussed and it reduces the utilization of the therapeutants, and facilitators, high food conversion ratio, and production rates, most of the fish species can be reared using the RAS technology.

(Refer Slide Time: 17:40)



So, what will be the takeaway message from this lecture? That the recirculating aquaculture system, it is a high-tech intensive closed aqua culture system, which are being practiced all over world nowadays in all the aquaculture farm, most of the aquaculture farm, like where we try to avoid any kind of environmental impact, where we try to improve the food security, where we try to involve the minimal use of land and water, and also we try to reduce the utilization of therapeutants, where we want to facilitates the more higher amount of fish conversion ratio. So, all these cases we introduce the recirculating aquaculture system. And, it will give us some economic benefits as well. So, that is all for.

(Refer Slide Time: 18:27)

These are the references that you can go ahead and you can search for more understanding about the system. And, that is it for this lecture. So, we will discuss about more in details in the coming lecture. Thank you so much.