www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(12): 5928-5933

www.thepharmajournal.com
Received: 01-10-2022
Accepted: 08-11-2022

Paramveer Singh
Department of Aquaculture, College of Fisheries Science, CCS Haryana Agricultural University, Hisar, Haryana, India

Rachna Gulati
Department of Aquaculture, College of Fisheries Science, CCS Haryana Agricultural University, Hisar, Haryana, India

Gajender Singh
Department of Fisheries Resource Management, College of Fisheries Science, CCS Haryana Agricultural University, Hisar, Haryana, India

Ashutosh Luwanshi
Department of Aquaculture, College of Fisheries Science, CCS Haryana Agricultural University, Hisar, Haryana, India

Reecha Sharma
Department of Zoology and Aquaculture, CCS Haryana Agricultural University, Hisar, Haryana, India

Rahul Kumar
Department of Zoology and Aquaculture, CCS Haryana Agricultural University, Hisar, Haryana, India

Corresponding Author:
Paramveer Singh
Department of Aquaculture, College of Fisheries Science, CCS Haryana Agricultural University, Hisar, Haryana, India

Working and construction status of Recirculatory aquaculture (RAS) Farms in Haryana

Paramveer Singh, Rachna Gulati, Gajender Singh, Ashutosh Luwanshi, Reecha Sharma and Rahul Kumar

Abstract
In super intensive fish farming practices, elimination of waste is a major concern leading to water contamination. Micro screens of drum filter are the key component of Recirculatory Aquaculture Systems (RAS). Treatment efficiency of micro screen under RAS also varies according to its rotator drum filter size, flow rate and mesh screen size. The aim of the present study is to represent on farm RAS survey of Haryana region regarding the use of its key components for culture purpose. Because, still there is lack of pragmatic data regarding RAS components efficiency on the basis of its size and flow rate. The result of the study concluded that in Haryana state of India mostly fish farmers prefer to install 50 micron mesh screen rotator drum filter as a primary component with flow rate of 38000 – 40000 litre water per hours as compared to 40 and 30 micron filter which has more efficiency to filter the water. Besides this, our 90 days survey across 12 districts fish farmer's samples size represents that only 11% farmers are utilizing 40 micron mesh screen drum filter, 5% utilizing 80 micron drum filter and 68% utilizing 50 micron drum filter in their RAS as primary filtration component. Moreover, as far material is concerned then 11% farmers uses Nylon mesh screen, 74% stainless steel micro screen and rest 16% fish farmers did not use drum filter in their backyard RAS. Much variation in this component has directly influenced the water quality management and fish economics. Smaller micron size drum filter has higher efficiency to filter the small size total suspended solids or particles from water which leads to the production of obnoxious gases like ammonia and nitrite. Around 58% of RAS farmers opted for tarpaulin, tin and iron as their tank construction material. Additionally, 42% farmers preferred the use of branded material for their RAS components. Stainless steel, aluminum, bricks and cement are the crucial ingredients used in composition of different RAS filtration components by 60% farmers. For the construction of RAS sheds, 73% farmers used Bricks, Cement, iron and tin shed.

Keywords: ammonia, drum filter, efficiency and total suspended solids

Introduction
Recirculation aquaculture systems (RAS) is mainly composed from various filtration key components. This eliminates the distinct kind of contamination on its each step. Recirculation aquaculture systems (RAS) are receptive to contamination due to its unique feature of taking higher stocking density in a confined water area as compare to others systems. Accumulation of waste matter includes faecal material, fish feed waste in the fish production system water and maintenance of optimum physico-chemical properties of this effluent water is obligatory for the success of fish farming. Rotator drum filter is the primary key component of RAS system. From where it prevents the entry of higher size total suspended particles to the next component with the help of a micro screen. On the other side, rotating drum filters micro screens are an alternative to sand filtration unit in RAS especially when excessive waste material is a matter of concern (Ali, 2013) [1]. Drum filter screens size measured in microns (10-200 micron). Drum filter process of filtration is very simple, efficient and reliable due its overall design with a rotating micro screen. Excess amount of total suspended solids (TSS) in aquaculture systems have lethal impacts on water quality, fish growth and survival respectively. Besides this, drum filter operation is like that to remove the excess size of TSS from water with the help of different types of screen. Besides this, adverse impact of total suspended particles on fish production in RAS systems were also observed in various researches by different investigators (Sandu *et al*., 2008; Couturier *et al*., 2009; d'Orbcastel *et al*., 2009) [16, 4, 6]. Whereas, various factors are considered as a significant part of investigation to judge the efficiency of rotary drum filter hydraulic design like: maximum flow rate, allowable head losses, porosity of the medium, and effective submerged surface area of drum filter screen, drum speed of rotation and characteristics of the feed size. (Rushton *et al*., 2000) [15].

Overall filtration process depends on various factors in rotating drum filter like: its micro screen size and flow rate. On the other side, drum filters are designed with its few moving parts to ensure the good water quality with long life and low maintenance costs (Ali, 2013) [1]. Moreover, filtration of the influent water in drum filter is accomplished by radial passage of the waste via a micro screen on the curved part of drum (Cripps and Bergheim, 2000) [5]. In whole aquaculture industry RAS is considered as a key culture system that will help the aquaculture sector to meet the future demand of aquatic species over the upcoming years (Ebeling and Timmons, 2012) [9]. Typically the selection of a rotary drum filter depends upon various factors like: the sized of drum filter screen with its flow capacity, effectiveness rotation speed of the screen to remove particulate matter from water and its capital cost (Dolan *et al*., 2011) [8]. There is very limited study available on working and construction status of Recirculatory Aquaculture (RAS) Farms in Haryana. Therefore, in our surveillance, we tried to investigate the involvement of various material of RAS filtration components and construction items preferred by RAS farmer of Haryana.

Material and Methods

This farm-to-farm based survey aim to analyse the efficiency of drum filter with different screen size on distinct districts of Haryana RAS farms. Randomly 19 RAS farmers were selected for this surveillance program from total 12 districts of Haryana state. A questionnaire was prepared to get the interview based appropriate information from different RAS farmers on their key locations regarding systems specifications and problems. Data recorded in this research are categorized into two types: quantitative and qualitative.

Results and Discussion

Respondent gender and age profile

Farming in the fishing industry is a high energy demanding job, so the farmers must be physically fit in order to succeed. The surveillance program among 19 RAS farms across 12 districts of Haryana showed prominent involvement of male respondents (89%) as compared to female respondents (11%) (Fig 1). Moreover, fisheries activity is significantly influenced by the age of the respondents ranging from 28 years to 67 years as represented in the study. Accordingly, respondents with age of 32 (21%) has led the most emphasis in RAS farming. The farmers in this category tends to have required knowledge and experience to intensify their fish culture. An equivalent participation was showed by respondent of age 36 and 34 (16%); 45 and 65-67 (11%); 28 and 30 (10%). (Fig 2). However, the minimum activeness (5%) was observed among the respondent of age 35.

Mutia *et al*. (2020) [12] also interviewed a random group of 407 respondents from eight municipalities residing in lake Taal, Philippines and observed a higher percentage of male respondents (54%) compared to female respondents (46%). Age distribution of fish farmers in Amethi district of Uttar Pradesh was studied by Sharma *et al*., 2018 [16] whose results was corroborated by the present findings. They reported a prominent fisheries activity in the age group of 15-30 years. A similar findings were demonstrated by Rivera (1989) [14] while analysing the socio-cultural aspects of the fish industry around laguna de Bay and reported that mostly fishermen tend to be younger with a mean age of 35 years as compared to other farmers.

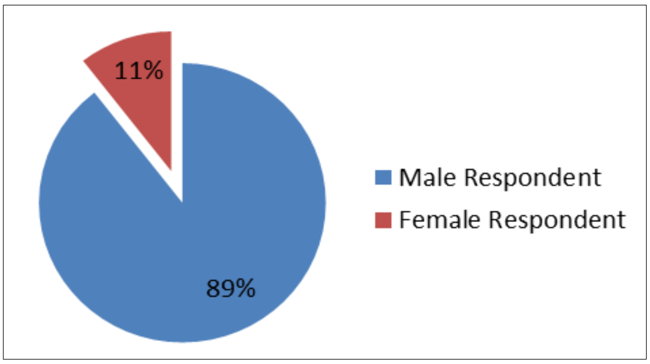

Fig 1: Gender Profile of the respondents

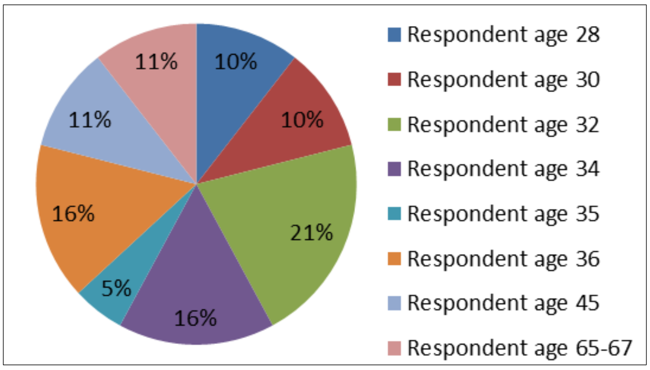

Fig 2: Age Profile of the respondents.

Types of RAS and Material used for Drum filter screen

In the 90 days survey, the data collected from 19 RAS farms reported that 84.21% farmers in Haryana region prefers to construct advance RAS systems for intensive fish farming practices as compared to backyard/integrated RAS systems (15.79%) (Fig 3). However, Department of Fisheries, Government of India encouraged small scale fish farmers and entrepreneurs to facilitate fish production in urban and periurban areas where land and water are scarce to promote Backyard Recirculation Aquaculture System because of its low production cost.

Additionally, it is imperative to note that most fish farmers favors to install drum filter made up of Stainless steel (SS) on their farms as a primary filtration component due to its high corrosion resistance and better filtration effect. Besides this, 15.79% of fish farmer in Haryana region cultivates fish without using drum filter. Stainless Steel has been used as the material of drum filter screen in 73.68% of advance RAS units which is significantly higher than the nylon made drum filter screen (10.52%.) (Fig 4). Ridha and Cruz (2001) [13] preferred to use polypropylene plastic or polyethylene blocks as the material of filter. The study conducted by Beg *et al.* (2019) concluded that the filter material made up of nylon led to the maximum removal of TAN (0.24 g N-TAN removed /m^2/ day).

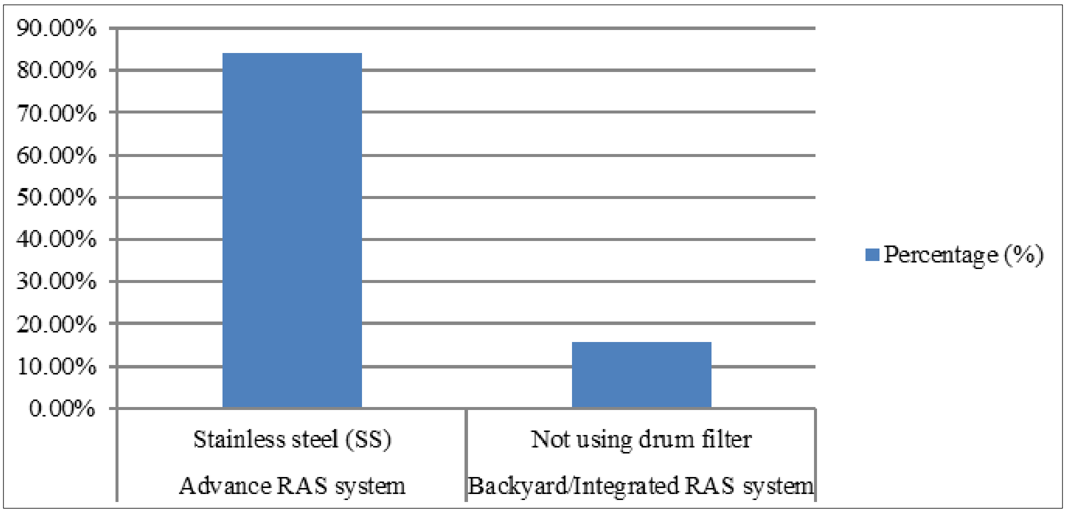

Fig 3: Different type of RAS and drum filter material used

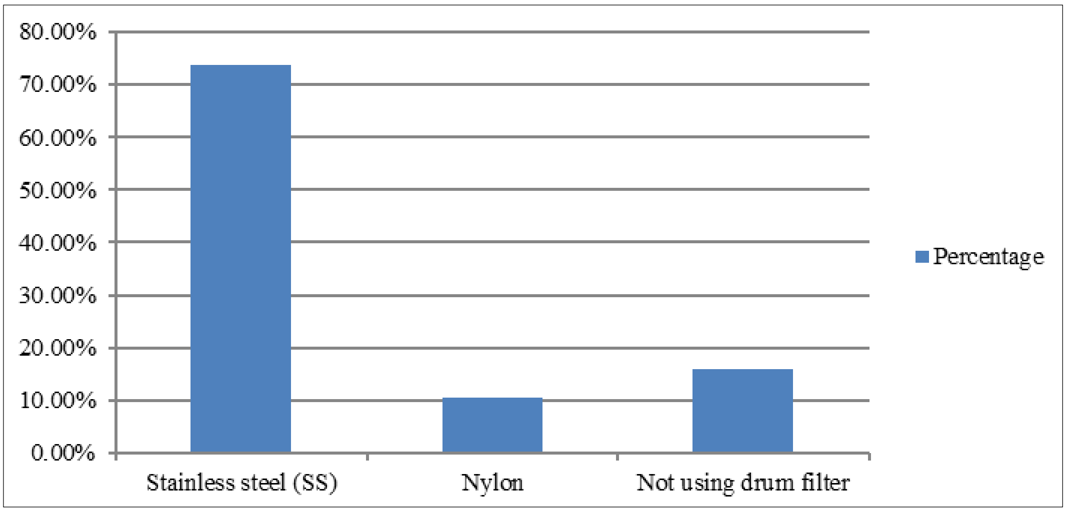

Fig 4: Material used for drum filter screen

Utility of drum filter in RAS farms

Recirculation of water within the tanks increase the concentration of residual feed, excrement and other physical matters which eventually affects the fish culture by damaging their gills and diminishing the water quality of the system. So, the removal of TSS in RAS has become a key aspect and can be proposed by using an effective filtration system. Comparative observation during the study has led to the result that around 13 RAS farms sites comprising 73.68% farmers in Haryana uses 50 micron drum filter screen with filter flow rate of 38000-40000 liter/hour capacity despite being less effective in comparison to 80 and 40 micron drum filter screen. Apparently, 15.79% RAS farmers in Haryana utilizes drum filter of 80 micron with 60000 litre/hour flow rate which is comparatively higher than 10.52% of RAS farmers functioning with 40 micron drum filter screen (Table 1). Moreover, a total of 3 RAS farm sites does not uses any type of drum filter. As observed during the RAS farms interrogation, when the mesh size of the drum filter screen reduced from 80 to 40 micron, the filter flow rate of the drum filter also decreased significantly. A similar observation was depicted by Su *et al*. (2008) [19] when the mesh number increased from 150 to 200, the removal rate also enhanced rapidly. Ali (2013) also shared the similar findings as presented in the study. The results of their study depicted that the water flow rate increased from 25 to 200 m^3/ h when the surface area of drum filter increased from 1.58 to 27.87 m^2. In contrast, the results concluded by Dolan *et al*. 2011 [8] to test the optimal method for micro-screen drum filter selection revealed that decrease in the mesh size from 60 micron to 40 micron yielded an increased efficiency of 24.22% whereas a more significant downward shift from 30 to 10 micron yielded 4.07% efficiency only. Cripps and Bergheim (2000) [5] also reported the similar results and stated the most common mesh pore sizes in drum filter screen is around 60-200 micron. He (2014) reported that increasing the mesh size from 260 to 420, the efficiency of the filtration also increased which correlate with the present results. Davidson *et al*. (2013) [7] also shared the similar results where drum filter with 60 µm significantly removed the majority of TSS, TP and TN. An average flow rate (15000, 7000-9000 and 1500-2000 litre/hour) of various RAS system was also observed by Anil *et al*. (2019) [2].

Data recorded from 19 RAS farms revealed that 7 RAS farms sites with 43.75% of RAS farmers opt to use the drum filter 24 hours followed by 18.75% farmer for 14 and 12 hours, 12.50% farmers for 18 hours and 6.25% farmers for 16 hours (Table 2). Undoubted water plays an important role in determining the growth and good quality of fishes. Therefore, the physcio-chemical parameters observed during the survey of different RAS farms were recorded and depicted that maximum RAS farmers (57.89%) of Haryana faces fluctuation in water quality parameters like: ammonia and nitrite (Table 3). Three RAS farm sites with 15.79% farmers indicated variation in the pH of the water in addition to ammonia and nitrite variation. However, 26.31% RAS farms of Haryana hasn't faced any kind of water quality fluctuations throughout production cycle indicating a better quality of water, hence a better yield of the culture. The fluctuation observed in the present findings was supported by the study of Ali, (2013). The result of the study showed ammonia and nitrite concentration ranging from 0.0093 to 0.018 mg/l and 0.05 to 0.62 mg/l respectively, whereas the pH remained between the ranges of 6.7 to 7.7. The changes in the ammonia and nitrite concentration corresponds with the results obtained by Soto-Zarazúa *et al.* (2010) [18]. The study observed total ammonia and nitrite concentration within the range of 1.67 to 3.67 mg/l and 0.01 to 0.21 mg/l respectively.

Table 1: Screen size and flow rate of drum filter at 19 RAS farms

No. of RAS Farm sites	Drum filter screen Size (micron)	Drum filter flow rate (litre/hr)	Percentage (%)	Rank
13	50	38000-40000	73.68	1
2	40	30000	10.52	3
1	80	60000	15.79	2
3	Not using	Not using	Not using	Not using
Total RAS sites 19			100%	

Table 2: Running time of Drum filter/ day at 16 RAS farm site using drum filter

No. of RAS Farm sites (16)	Running time of Drum filter/ day	Percentage	Rank
7	24	43.75%	1
2	18	12.50%	3
1	16	6.25%	4
3	14	18.75%	2
3	12	18.75%	2
Total RAS sites 16		100%	

Table 3: Fluctuation in water quality of RAS farms

No. of RAS Farm sites	Fluctuation in water quality	Percentage	Rank
11	Yes, Ammonia and nitrite	57.89%	1
5	No problem	26.31%	2
3	Yes Ammonia, pH and nitrite	15.79%	3
Total RAS sites 19		100%	

Brand value of RAS Components and tank construction production

The quality of the material used in the different components of RAS significantly affects the culture and economics of the fish farmers. As shown in Fig 5, majority of the farmers (42.11%) adopted branded material for their fish farms as predicted in the present study. About 31.58% of farmers goes for locally available components which may be available to them at a cheap price. However, a combination of both branded and local components were used by 5 farms comprising 26.31% of the total RAS farmers for their respective RAS components. Soto-Zarazúa *et al.* (2010) [18] succeeded to build an effective Recirculation system using low cost locally available materials and the results of the culture showed a considerable performance.

In case of RAS production tanks, 57.89% of RAS farmers (11 RAS farms) incorporated tarpaulin, tin and iron as their tank construction material. Least proposed material was FRP and blend of stainless steel and tarpaulin tanks installed at 2 farms sites each with 5.26% of RAS farmers. A total of four RAS farms picked bricks and cement tank (21.06%) followed by polyproplene tanks chosen by two farm sites (10.53%) (Fig 6). Helfrich and Libey (1991) [10] recommended the use of material like plastic, concrete, metal, wood, iron, glass, rubber, plastic sheets or any other material that functions to hold water efficiently and are non-toxic to fishes for the construction of tanks. of Anil *et al.* (2019) [2] also used 30000 to 2000 litre FRP tanks to design a low cost indigenous recirculating aquaculture systems (RAS) for brood stock maturation of marine fishes.

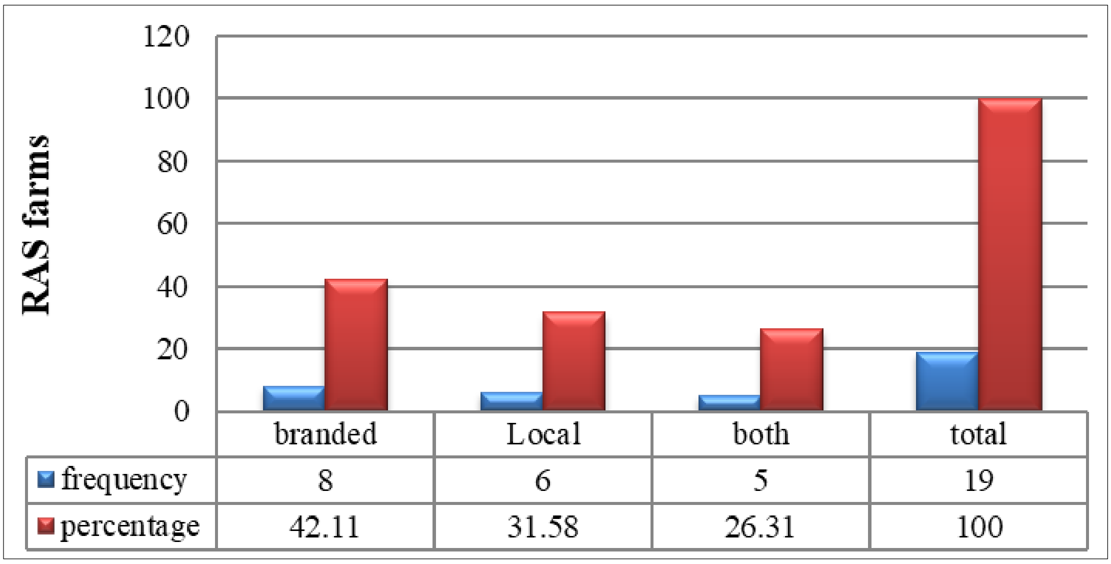

Fig 5 Material used brand value of RAS components

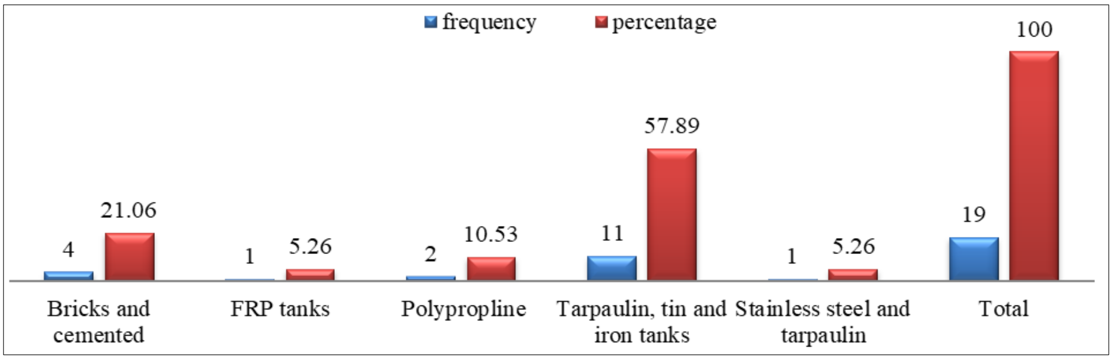

Fig 6: Material used for production tank construction

Material used for RAS filtration components and shed construction

Focusing on the material used in filtration components of RAS, the surveillance depicted that 10 of the RAS farms goes partial with the use of Stainless steel, aluminium, bricks and cement as their major filtration components followed by the utilization of only bricks and cement by four RAS farms (Table 4). In addition, only two RAS farms uses tarpaulin instead of aluminium when compared with the other farm. However, the remaining 3 farms uses the mixture of various components used by other farms. Interestingly, Stainless steel as a main component was used in maximum number of farms. Moreover, bricks, cement, iron and tin shed was used in constructing RAS sheds by majority of RAS farmers (73.68%) which was followed by iron, tin and steel (10.53%) and equally shared (5.26%) between iron, steel, aluminium and net; plastic shed; Iron and tin (Table 5). Anonymous (2017) [3] from Department of Animal Husbandry, dairying and Fisheries, Government of India also mentioned the use of bricks, cement, sand, stainless steel etc. in the construction of various components of RAS units. Usage of Cement concrete, stones, iron frames was recommended for the construction of RAS sheds. Additionally, material involved in the RAS filtration mentioned was cement, coarse sand, graded stone, brick with common burnt clay, cement plasters.

Table 4: Material used for different RAS filtration components at 19 RAS farms

Material used for different RAS filtration components	Frequency	Percentage	Rank
Stainless steel, tarpaulin, cement and bricks	2	10	3
Stainless steel	1	5	4
Stainless steel, aluminum and fiber	1	5	4
Bricks and cemented	4	15	2
Stainless steel, cemented, iron and bricks	1	5	4
Stainless steel, aluminum, bricks and cement	10	60	1
Total	19	100	

Table 5: Material used for RAS shed construction at 19 RAS farms

Material used for RAS shed construction	Frequency	Percentage	Rank
Bricks, Cement, iron and tin shed	14	73.68	1
Iron, tin and steel	2	10.53	2
Iron, steel, aluminium and net	1	5.26	3
Plastic shed covered	1	5.26	3
Iron and tin	1	5.26	3
Total	19	100	

Conclusion

It is crystal clear that, maximum number of fish farmers in Haryana state prefer to Install drum filter with 50 micron which has direct impact on the rate of filtration because 30-40 micron drum filter screens has more capability to filter the lower size total suspended particles (TSS) that leads into the contamination of RAS systems. This leads into the fluctuations of water quality parameters. On the other side, near about 50% RAS farms in Haryana region has a 12-16 hours running time of their drum filters throughout the whole day as compare to others. This is also a critical factor for filtration process. Because, maximum farmers are utilizing drum filters with flow rate of 38000-40000/hr and this rate of filtration is not sufficient to provide them at least 2 cycles of filtration in a day. Even they are not circulating a one complete cycle in whole day with this running time period.

Acknowledgement

The authors would like to express their appreciation to Department of Aquaculture, College of Fisheries Science, CCS Haryana Agricultural University, Hisar, Haryana providing me all the required help and materials during my research work.

References

1. Ali SA. Design and evaluate a drum screen filter driven by undershot waterwheel for aquaculture recirculating systems. Aquacultural Engineering. 2013;54(1):38-44.
2. Anil MK, Gomathi P, Ambarish GP, Surya S, Raju B, Udayakumar A. Design of low-cost indigenous recirculating aquaculture systems (RAS) for broodstock maturation of marine fishes. Marine Fisheries Information Service; Technical and Extension Series.

2019;240(1):23-24.
3. Anonymous. Recirculatory Aquculture System (RAS) (Pangasius Fish Production) Department of Animal Husbandry, dairying and Fisheries, Ministry of Agriculture and Farmers Welfare, Government of India. 2017. p. 1-4.
4. Couturier M, Trofimencoff T, Buil JU, Conroy J. Solids removal at a recirculating salmon-smolt farm. Aquacultural Engineering. 2009;41(3):71–77.
5. Cripps SJ, Bergheim A. Solids management and removal for intensive landbased aquaculture production systems. Aquacultural Engineering. 2000;22(1-2):33–56.
6. d'Orbcastel, RE, Blancheton JP, Belaud A. Water quality and rainbow trout performance in a Danish Model Farm recirculating system: comparison with a flow through system. Aquacultural Engineering. 2009;40(2):135–143.
7. Davidson J, Good C, Barrows FT, Welsh C, Kenney PB, Summerfelt ST. Comparing the effects of feeding a grain- or fish meal-based diet on water quality, waste production, and rainbow trout *Oncorhynchus mykiss*, performance within low exchange water recirculatory aquaculture systems. Aquaculture Engineering. 2013;52(1):45-57
8. Dolan E, Oliver RE, Murphy N, O'Hehir M. A Test Method for Optimal Micro-screen Drum Filter Selection. Department of Applied Technology, Dublin Institute of Technology (DIT), Bolton Street, Dublin 1, Ireland. 2011. p. 1-11.
9. Ebeling JM, Timmons MB. Recirculating aquaculture systems. In: Tidwell JH edn Aquaculture production systems. Wiley, Oxford. 2012, 1-421.
10. Helfrich LA, Libey GS. Fish farming in recirculating aquaculture systems (RAS). Virginia Cooperative Extension. 1991, 1-19.
11. He CL. Research on Recirculating Aquacukture Bio-Oxidation System Construction and Effect. M.S. thesis, Dalin Ocean University, Dalian, Liao Ning Province, China.
12. Mutia MTM, Magistrado ML, Fermaran MJL, Muyot, MC. Gender Participation in the Fisheries Sector of Lake Taal, Philippines. The Philippine Journal of Fisheries. 2020;27(2):157-182.
13. Ridha MT, Cruz EM. Effect of biofilter media on water quality and biological performance of the Nile tilapia *Oreochromis niloticus* L. reared in a simple recirculating system. Aquacultural Engineering. 2001;24(2):157–166.
14. Rivera FT. Socio-cultural aspects of the fish industry around Laguna de Bay (Philippines). PCARRD Book Series. 1989;46(1).
15. Rushton A, Ward AS, Holdich RD. Solid–Liquid Filtration and Separation Technology, edn 2, Federal Republic of Germany, 2000, 1-249.
16. Sandu S, Brazil B, Hallerman E. Efficacy of a pilot-scale wastewater treatment plant upon a commercial aquaculture effluent. I. Solids and carbonaceous compounds. Aquacultural Engineering. 2008;39(2):78–90.
17. Sharma S, Kumar R, Kumar M, Gupta S, Maurya PK, Singh P. A study on socio-economic status of fishermen of Amethi district, Uttar Prades, India. International Journal of Fisheries and Aquatic Studies. 2018;6(4):49-54.
18. Soto-Zarazúa MG, Herrera-Ruiz G, Rico-García E, Toledano-Ayala M, Peniche-Vera R, Ocampo-Velázquez R, Guevara-González RG. Development of efficient recirculation system for Tilapia (*Oreochromis niloticus*) culture using low cost materials. African Journal of Biotechnology. 2010;9(32):5203-5211.
19. Su M, Liu H, song HQ, Hu BC. Study on the TSS removal efficiency and energy consumption of micro-screen drum filter. Fishery Modernization. 2008;35(1):9-12.