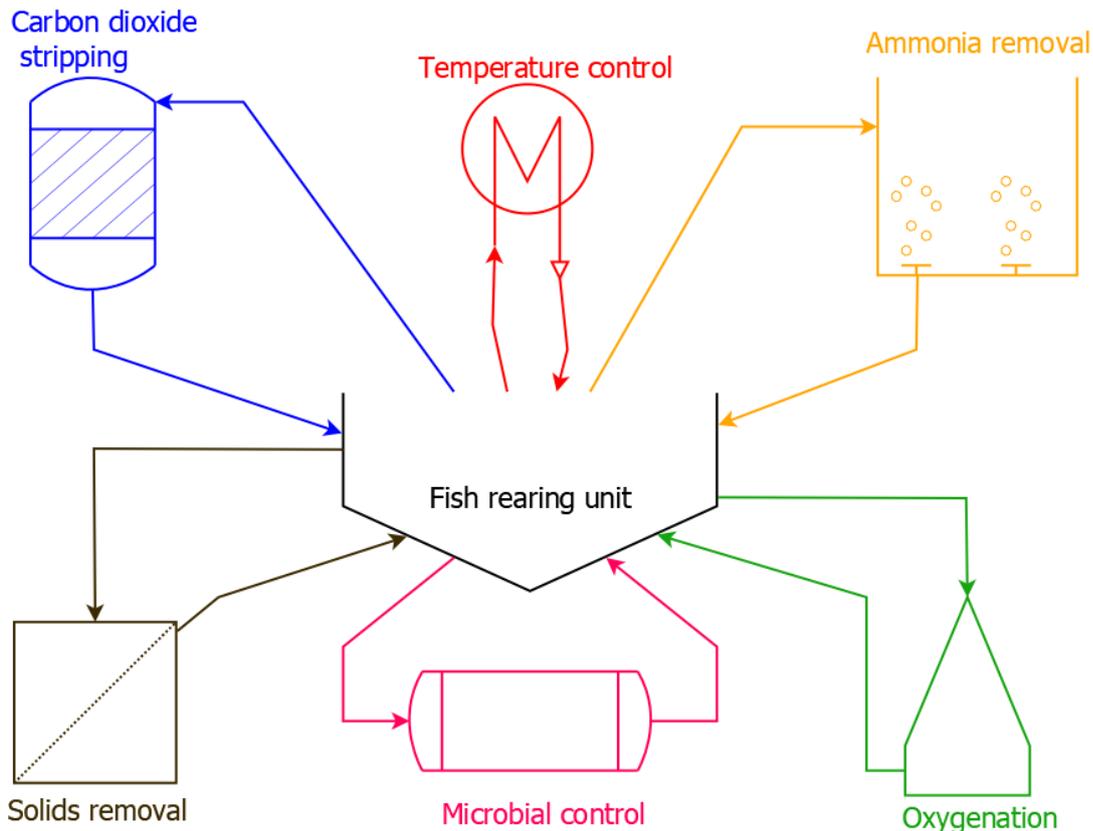


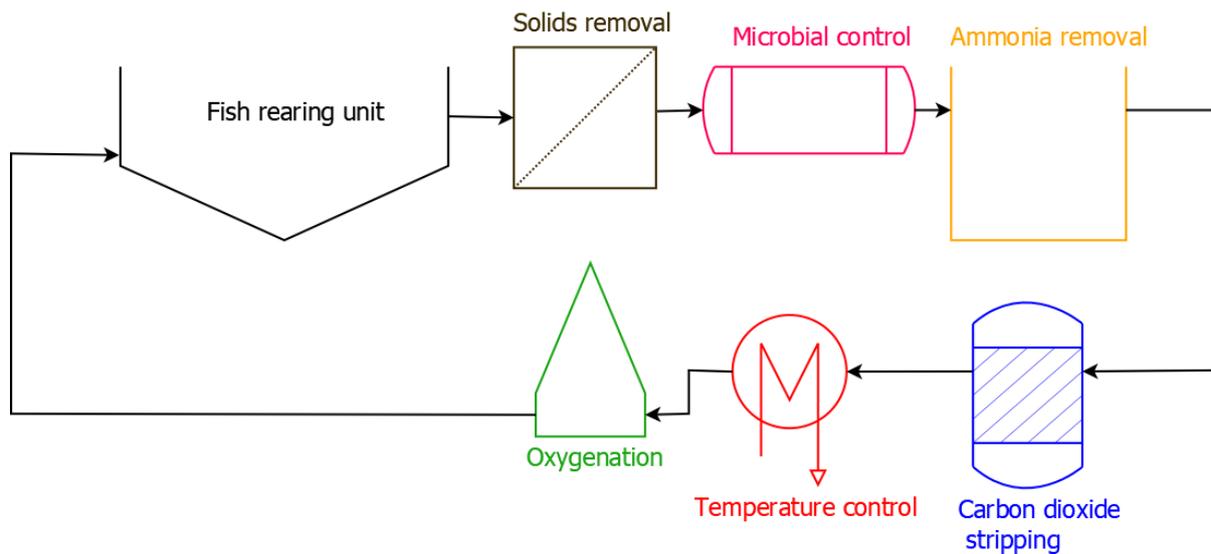
## Introduction to recirculating aquaculture systems (RAS)

Recirculating aquaculture systems (RAS) are fish farming systems which utilize a series of water depuration devices to control water quality and allow for the fish rearing water to be continuously reused. A RAS, in principle, should be able to rapidly depurate metabolic waste (faeces, ammonia, carbon dioxide) whilst supplying the fish with oxygen. In addition, a RAS should provide the fish with appropriate conditions for exercise, low territorial behaviour and freedom of disease.



In practice these water depuration processes follow a certain sequence to prevent them from working against each other. For example:

- Biofilters for ammonia need clean water, free from organic solids. Therefore, it is sensible to place solids removal devices before the biofilters.
- Biofilters produce carbon dioxide, therefore, it makes sense to place carbon dioxide stripping after these
- Carbon dioxide strippers will bring the water in balance with atmospheric gases. Therefore, adding pure oxygen before a stripper will vent the precious gas from the water to the atmosphere.
- Changing the temperature of the water will change the amount of gases that can be dissolved in it. Therefore, it is only useful to add oxygenation devices after thermal treatment



The mode of water flow between filtration steps may be by gravity or using pumps. Generally, gravity flows are used for gentle transport of the faeces to solids removal, whilst pumped flows can be used to create pressure to transfer gases or to elevate the water so it can flow by gravity to the next filtration step. The following table shows common filtration devices and their typical mode of operation

Process	Device	Gravity flow /pumped flow
Solids removal	Microscreens (drum and disc filters)	Gravity flow
	Depth filters (bead and sand filters)	pumped flow
	Protein skimmers	pumped flow
Biofiltration	Fluidised sand biofilters	pumped flow
	Moving bed bioreactors	Gravity flow
	Fixed bed bioreactors	Gravity flow
	Trickling biofilters	Gravity flow
Microbial control	Ozone contacting	Pumped flow or gravity flow
	UV lamps	Pumped flow or gravity flow
Carbon dioxide stripping	Packed column aerators	Gravity flow
	Trickling towers	Gravity flow
	Oxygenation	Oxygen cones
Oxygenation	Low head oxygenators	Gravity flow
	U-tubes	Pumped flow
	Diffused aeration	Gravity flow
	Temperature control	Boilers, heat pumps, chillers