Popular science summary of the PhD thesis

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Title of the PhD thesis	Beyond water quality: Micro particles in Recirculation Aquaculture Systems
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Build-up of micro particles in of recirculating aquaculture systems (RAS) has been known for a long time. With the fast expansion of RAS in recent years, with lower water usages and longer retention times, larger focus has been put on understanding the impacts of micro particles on fish and systems alike. Micro particles small size has made them challenging to remove and their high surface area to volume ratio has been shown to be partly responsible for bacterial activity with systems. However, gaps of knowledge on the origins of micro particles and their implications remain. Likewise, technologies that can help reduce micro particles in RAS are still lacking.

The results obtained during the PhD showed that micro particle levels in commercial facilities vary wildly even within the same commercial facility operated at similar conditions, suggesting that individual systems specificity plays a large role in micro particle build up. Strong correlations were found between micro particle surface area and bacterial activity, suggesting that bacteria activity in low intensity RAS is partly controlled by micro particles, supporting previous research. Trials conducted during the thesis also showed that micro particle abundance can change rapidly, even under typical storage conditions and in as little as 3 hours.

In high intensity RAS, living microorganisms were shown to compose a large proportion of micro particles. This in turn has opened new avenues for controlling micro particles in RAS. Both ultra violet radiation (UV) and ozone were tested as ways to control micro particles in RAS with good results obtained by both technologies (over 50% reduction in numbers of micro particles and bacterial activity).

However, while both treatments showed a strong potential for controlling micro particles they did not address the underlying cause of build-up of micro particles: the presence of organic matter.
In order to address this, both micro filtration and freshwater foam fractionation were tested as methods to control micro particle development in RAS. Micro filtration was shown to reduce micro particle numbers by 50% and micro particle volume by 83%, while reducing bacterial activity by 54%. Freshwater foam fractionation reduced micro particle numbers by 58% and volume by 62%, while reducing bacterial activity by over 54%. While both methods shown great promise, the ease of use of foam fractionation makes it very relevant for systems where micro particle control is needed. The combination of methods mentioned above (micro filtration in combination with UV, and foam fractionation together with ozone) produced very large reductions in micro particles, with approximately 90% reduction of micro particle numbers and bacterial activity, as well as large reductions in organic matter.

No negative effects on fish performance were observed in any of the trials carried out throughout the thesis.

In conclusion, this thesis shows that it is possible control the level of micro particles in RAS by different methods and that this leads to significant improvements in different physicochemical water quality parameters. Furthermore, and as observed in other recent studies, the thesis indicate that rainbow trout is highly tolerant to high levels of micro particles.

The thesis also shows that micro particles in RAS are intrinsically connected to bacteria. In low intensity RAS, surface area provided by micro particles seems to partly control the amount of bacterial activity in the system, while in higher intensity systems most micro particle dynamics seems to be the result of changes in bacterial populations. The main driver behind the large fluctuations in micro particles seems to be organic matter build-up.

The results of this thesis suggest that micro particles are not a cause of a problem directly but rather a symptom of an underlying issue: organic matter build-up.