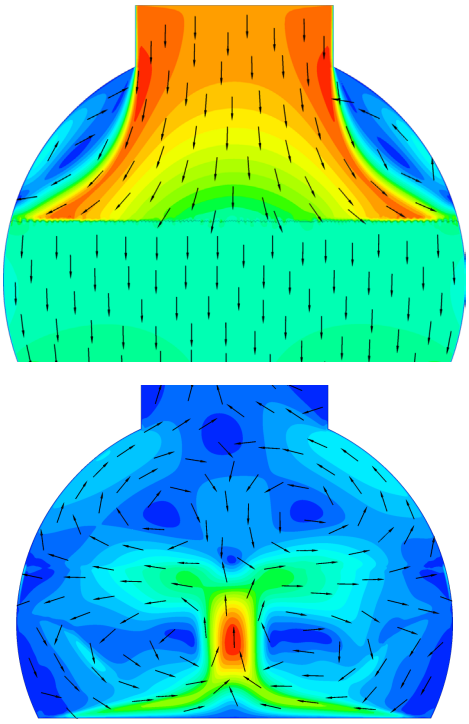
Horizontal Cylindrical Rapid Gravity Filter Study

BHR Group
EXPERTS IN FLUID ENGINEERING

Computational Fluid Dynamics (CFD)

AQUARDIA PROCESS SOLUTIONS



Aquardia HDPE rectangular vessel

The Rapid Gravity Filter (RGF) is a water treatment method favoured by major water utilities due to its excellent performance coupled with relatively low operating and maintenance costs.

RGFs use graded sand and other granular media to remove particles and impurities that are often trapped in a floc through the use of flocculation chemicals. The unfiltered water flows through the filter medium under gravity and the floc material is trapped in the sand matrix.

Aquardia has designed a horizontal cylindrical RGF and commissioned BHR to undertake CFD studies to confirm that the product would perform to the design criteria once in operation.

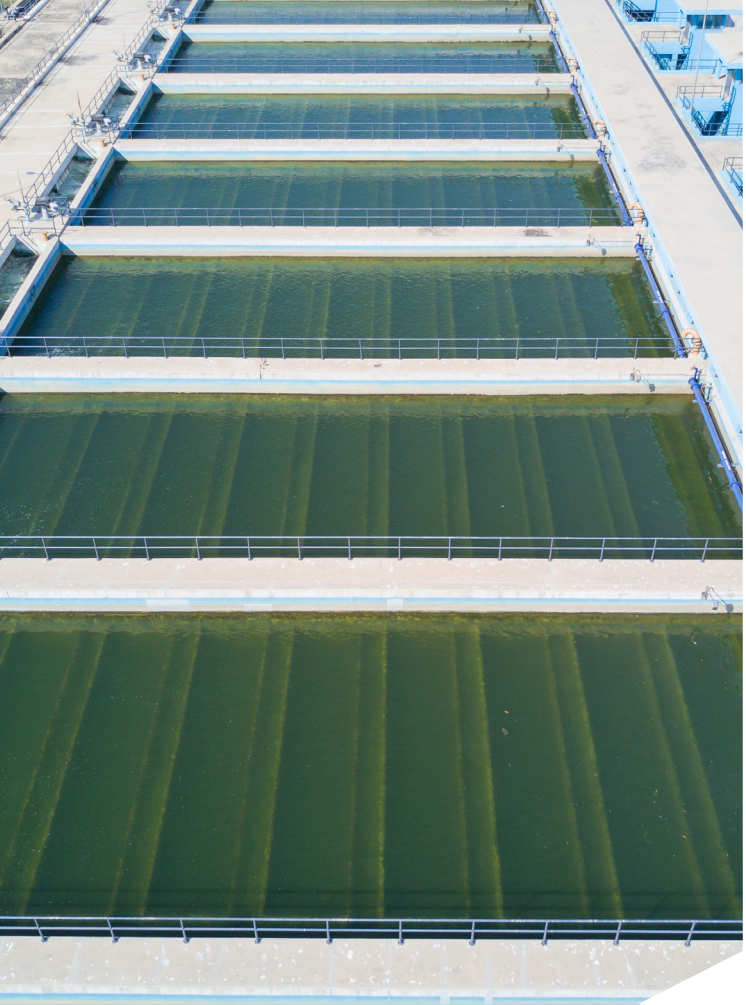
Coagulation, flocculation and sedimentation processes are typical treatment stages that precede filtration. Disinfection, typically using chlorine or ozone, is commonly used after filtration.

RGFs must be cleaned frequently. If the solids load onto the filter is high then cleaning may be required several times a day. An initial air scour phase is followed by a backwash phase where the direction of flow is reversed and clean water pumped up through the filter to flush trapped particles out of the filter.

"With backwashing, there is a balance to be met between effective fluidisation of the bed, channelling and media loss. The new Aquardia RGF was designed with this in mind. BHR carried out CFD modelling of our design and confirmed it met our performance expectations, giving us the technical data required to move to the production phase."

Simon Wild
DIRECTOR, AQUARDIA

Channelling refers to the tendency for backwash water to flow through the bed centreline towards the top. Sufficient headloss must be designed into the backwash water distribution system to ensure that the backwash water is distributed evenly across the whole of the filter. The upwash velocity must be sufficient to fluidise the media bed sufficiently to remove trapped particles but not risk media loss through excessive bed expansion.



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The objective of this study was to assess the flow through the RGF during the filtration phase and the backflush operation under the minimum and maximum values of the influent velocities in the operational range.

Filtration phase:

To investigate the ''radial or lateral'' flow uniformity when the water enters the vessel in the freeboard region before meeting the bed to ensure there is no preferential flow through the vessel centreline. The client is satisfied with the axial flow uniformity in the RGF.

Backwash phase:

Ascertain if the backflush would cause significant media loss as the media bed rises along the pipe sidewalls and investigate the effectiveness of the backflush for floc detachment and removal from the RGF.

"It's been great working closely with the BHR team to model RGF operation and provide clear answers to ensure the success of this radical design. BHR took a collaborative approach, working hard to meet our agreed deadlines. I'm very happy with the report which will help inform our work moving forward"

Simon Wild
DIRECTOR, AQUARDIA

Findings

During the filtration phase the media bed acts as a fixed bed with a high resistance to the flow of water. The flow through the media bed is almost uniform in the downward direction with very little lateral component. The whole bed is utilised in the filtering operation and there is no sign of channelling of the flow of water along the centreline of the bed.

During the backwash phase the media bed fluidises and expands until the fluid-particle interaction forces and net weight of the bed balances out. The CFD studies determined the optimum water velocity that would not result in media loss whilst still being able to remove the required range of floc particles. Based on the CFD results the water backwash velocity could be increased resulting in the removal of a wider range of floc particles whilst ensuring the retention and efficacy of the media bed.

BHR's CFD studies provided the client with confirmation that the RGF design would perform as expected in practice and showed the potential for enhanced performance during the backflush operation.

FILTRATION PHASE

During the filtration phase the whole bed is utilised in the filtering operation with no sign of channelling and the flow across the media bed exhibited minimal lateral component.

BACKFLUSH OPERATION

The CFD studies determined the optimum backwash water velocity to balance floc removal with media loss. Importantly, the CFD results suggested that backwash velocity could eventually be increased, resulting in the removal of a wider range of floc particles, without loss of filter media.

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