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# Output

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## Introducing 'Next Generation' Feedwells

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### Introduction

Thickening of solids to separate and recover water has been a critical step in mineral processing plants since the late 19<sup>th</sup> century. Initially due to effective dewatering of the solids being required to recover the valuable minerals, but now in the 21<sup>st</sup> century recovery and re-use of the water is equally important. Development of flocculants in the early 1960's started a revolution in thickener design and operation eventually leading to the start of high rate thickening in the late 1960's. These thickeners are characterised by a feedwell with a bottom plate to deflect the flocculated feed horizontally into a preformed flocculated bed.

Modern high rate thickeners generally incorporate some form of internal dilution into the feedwell to dilute the feed and improve flocculation. Other than some minor design changes feedwells in high rate thickeners have changed little for nearly 40 years.

### The Feedwell's Job

A thickener feedwell has six basic functions to fulfil:

1. Dissipate the energy of the incoming feed
2. Introduce dilution water to achieve the optimal density in the feedwell for flocculation of the solids
3. Mix the flocculant into the incoming feed
4. Retain feed in the feedwell whilst dilution and flocculation occur
5. Distribute the flocculated material evenly over the thickener diameter
6. Deaeration of the incoming feed

Optimising these tasks in a single chamber is at times difficult. Energy dissipation creates high shear zones in the feedwell, which are not conducive to the formation of the desired large flocculated aggregates. However energy dissipation within the feedwell creates the energy required to provide sufficient mixing of the feed and dilution water streams and to prevent feed short-circuiting. Thus if the incoming feed is "baffled" too much the feed simply drops out of the feedwell without adequate dilution and subsequent flocculation.

Feed short-circuiting in thickener feedwells creates a number of serious operational problems including:

- Excessive use of flocculant that increases operating costs and can lead to “donuts” forming in the thickened bed
- Uneven distribution of feed into the thickener bed leading to possible torque and raking issues
- Poorly flocculated feed exiting the feedwell that forms a plume on the surface of the thickener and results in solids carry over into the clean water launder
- Decreased underflow density

All of the above performance criteria and problems are accentuated when feedwells get larger in diameter.

### The Aspect Ratio Issue

As thickeners get larger in diameter to accommodate ever-increasing throughputs their feedwells also increase in diameter, however feedwell depth does not increase in equal proportion. This has led to the use of high aspect ratio (diameter/depth) feedwells. In these feedwells, 8m diameters and above, the tasks assigned to the feedwell of energy dissipation, feed dilution, flocculant formation and even distribution of the flocculated material become very difficult indeed. High energy in the incoming feed is required to maintain adequate mixing of feed, dilution water and flocculant but lower shear zones are required for aggregate growth. Ideally a two zoned feedwell is required, the upper zone having multiple directional dilution flows which maintain sufficient energy for the feed and dilution water to mix whilst a lower bottom zone has low shear levels which allows aggregates to grow to the optimal size and be evenly dispersed into the thickener body. The transfer of material from one zone to the next must also be even throughout the feedwell to prevent short-circuiting.



A high Aspect Ratio Feedwell

### The Vane Feedwell

A feedwell with an inner floor of vanes separating it into two chambers is the answer. The upper chamber is mixed using tangential feed entry and directional feed dilution whilst the lower chamber is maintained as a low shear zone that allows aggregates to grow prior to being evenly distributed into the main thickener body.

Extensive development and modelling of this idea, and others, by Outotec has led to the design seen in figure 1. During the development phase Outotec, through their sponsorship of the AMIRA P266E "Improving Thickener Technology" project, engaged CSIRO's Computational Fluid Dynamic modellers to verify and improve on the Next Generation design.

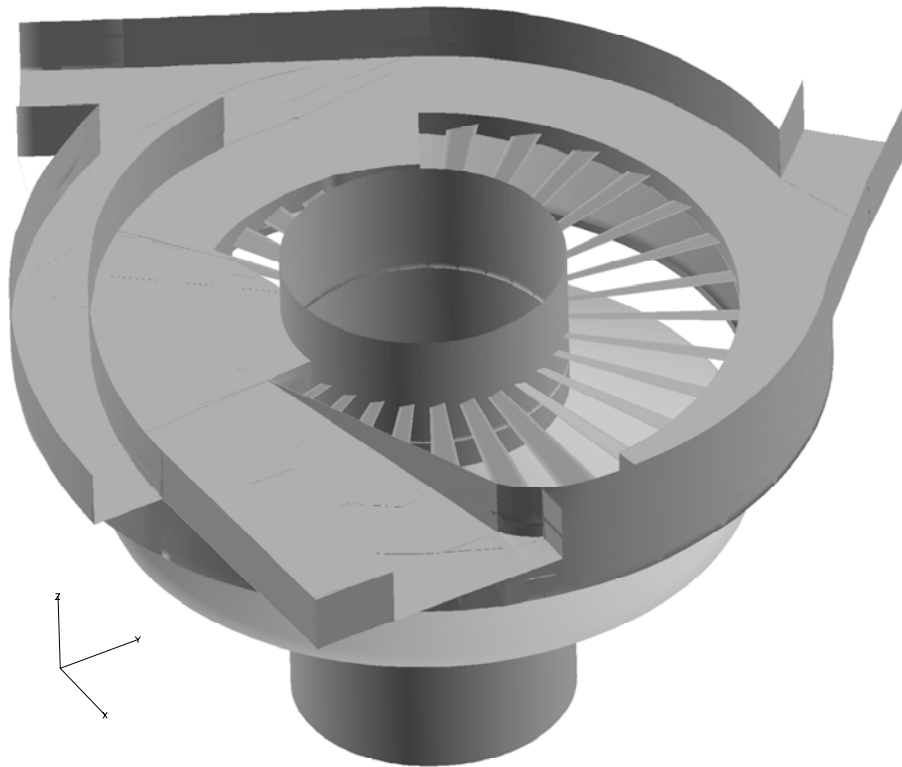


Figure 1: "Next Generation" feedwell design (subject to 4 separate international patents)

### The CSIRO observations from CFD modelling of the vane feedwell were:

"The final geometry gave good feedwell performance by all modelled criteria. Sufficient auto-dilution flow was provided for good flocculation, and the dilution water was well mixed with the feed solids. The solid residence time was maintained by retaining the solids in the feedwell and the final discharge symmetry was good, although not entirely uniform.

In terms of the momentum and energy dissipation, the feedwell appears to be excellent. Very low values were given for the energy and momentum ratio, and this is despite the high feed solids and high dilution liquor flows. Although most of the feed energy was dissipated in the feedwell the shear rates were moderate in most regions. Importantly the shear rates in the exit region were moderate, avoiding potentially disruptive aggregate breakage.

By keeping most of the energy dissipation and shear high in the feedwell, around the shelf and vanes, mixing was provided early in the flocculation process to aid flocculant dispersion and effective dilution.

In addition, the final configuration gave good turn-down in relation to throughput. However, the good turn-down required the feed velocity to be maintained at  $1.8 \text{ m s}^{-1}$ . If the flow was turned down with a fixed inlet area, the resulting low flow velocity gave poor feedwell performance. It is therefore advised that methods for maintaining the feed velocity be investigated.”

## Conclusion

The vane feedwell represents a significant step forward for thickener technology and is being applied today.

Further improvements are always possible and Outotec continues its R&D efforts on feedwell innovation as well as many other innovations for thickener performance improvements.

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*Richard Triglavcanin is currently a Director of Outotec Australia and Global Technology Manager – Thickeners. As GTM – Thickeners Richard is responsible for global thickener technology development and support. Richard has a Mechanical Engineering degree from Curtin University and has some 20 years experience in design and implementation of Outotec’s minerals processing technologies. As part of his specialisation Richard oversees Outotec’s thickener R&D efforts and holds a number of patents in this field.*

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