EVALUATION OF SOUTH EAST QUEENSLAND WASTEWATER PLANTS' INLET SCREENS PERFORMANCE

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ABSTRACT

The removal of screenings in a wastewater treatment plant pre-treatment facility is crucial to protect and prolong the life of downstream equipment - a pre-requisite for reliable plant performance. Unfortunately reliable, unbiased full-scale operations performance data for such vital equipment is scarce. There are a number of limitations preventing the accurate calculation of screenings capture rates, primarily the inability to quantify the total flux of screenings into a wastewater treatment plant with the raw sewage. In a cooperative effort between SEQ local governments, these limitations have been managed by averaging the performance of each generic type of screen across a range of catchments, resulting in the compilation of meaningful screening removal performance data. Analysis of the data collected from 31 wastewater treatment plants found no evidence of a clearly superior screen type, although band screens, spiral sieves and step screens all performed well. Neither average dry weather flow nor screen aperture size alone were found to correlate with screen performance.

KEYWORDS

Pre-treatment; screening; screenings capture rate; wastewater.

1.0 INTRODUCTION

The removal of screenings in a wastewater treatment plant (WWTP) pre-treatment facility is crucial to protect and prolong the life of downstream equipment such as pumps, mixers, air diffusers and membranes, to reduce maintenance costs and to minimise equipment down-time, which are critical pre-requisites for reliable plant performance to produce high quality effluent and biosolids. Unfortunately reliable, unbiased full-scale operations performance data for such vital equipment is scarce. The only notable study to quantify inlet screens capture rates was carried out by UK Water Industry Research.

In a cooperative effort between the South-East Queensland (SEQ) local governments of Sunshine Coast, Brisbane, Redlands and Gold Coast, data was collected on the inlet screens at 31 WWTPs, which were classified into these six categories:

- Drum
- Band
- Step
- Bar
- Spiral sieve
- Sack

UK Water Industry Research reported that band screens exhibited the highest specific capture rate at approximately 80% to 90%, followed by fine screens with 60% to 80%, step screens captured 35%, and the bar screens performed worst with 32% capture. The fine screens referred to are orientated the same as step screens, but with a perforated mesh screen similar to band screens. Based on these findings, band screens capture more than twice the quantity of screenings as step screens or bar screens.

Furthermore it was found there was "a tendency for the screenings capture rate (SCR) to increase slightly with increasing flow rate". In light of this research, the performance of inlet screens has been assessed to determine the validity of these findings in SEQ.

2.0 RESULTS AND DISCUSSION

There are a number of limitations in producing accurate screenings capture rate (SCR) data, foremost is the inability to quantify the total flux of screenable solids into a wastewater treatment plant. In other words, it is known what screenings are captured but not what is missed. Furthermore, the composition of wastewater varies between catchments making the comparison of different screens in different catchments difficult. Ideally, a number of different screen types could be operated at the same treatment plant, as was done by UK Water Industry Research, however this would be an expensive and time consuming exercise. The best practical approach was to collect and average as much data as possible for each type of screen over a range of catchments, thereby minimising the errors caused by variations in the catchments.

One limitation on the accuracy of the data that was compiled was related to the fact that most Councils record the volume of screenings removed from site but not the weight. In order to convert the volume of screenings into a mass the bulk density of screenings samples was measured. Another limitation is the variation in the dewatering of screenings between plants. This can be overcome by measuring the total solids (% dry weight) of screenings samples to give an estimate of the specific capture rate (SCR) in dry kg per ML of flow treated for each set of screens. The heterogeneous nature of screenings makes it difficult to collect a representative sample for total solids dryness testing and replicate samples were generally tested to reduce this source of error.

The mean specific capture rate for each type of screen is presented in
Figure **1**, including the number of plants with each type of screen. The specific capture rate of the band screens at the Landsborough plant was 39.2 dry kg/ML – twice that of the next highest – and has been excluded as an outlier. It is possible that a high proportion of tankered waste containing lots of rag has caused this very high result.

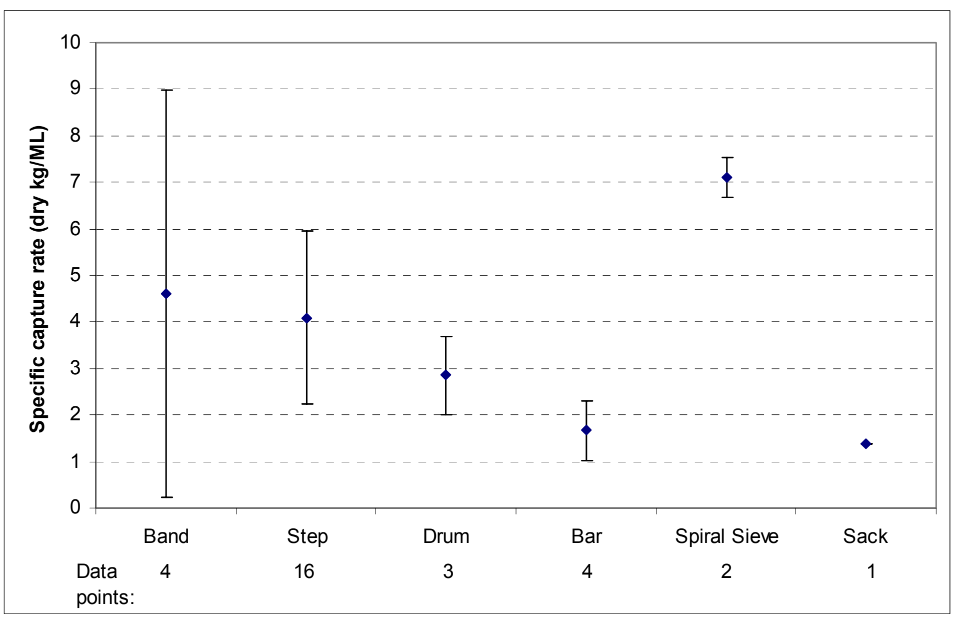

Figure 1: ***SEQ screen type capture rate comparison***

An exceptionally large standard error is apparent for the group of four band screens, hence comparison of its mean specific capture rate is not meaningful and definitively conclusive. However, it is possible to qualitatively conclude that generally band screens, spiral sieve screens and step screens have performed most effectively. Furthermore bar screens and sack screens performed least effectively, and drum screens were moderately effective.

Figure 2 below addresses the relationship between plant inflow (log scale) and specific capture rate.

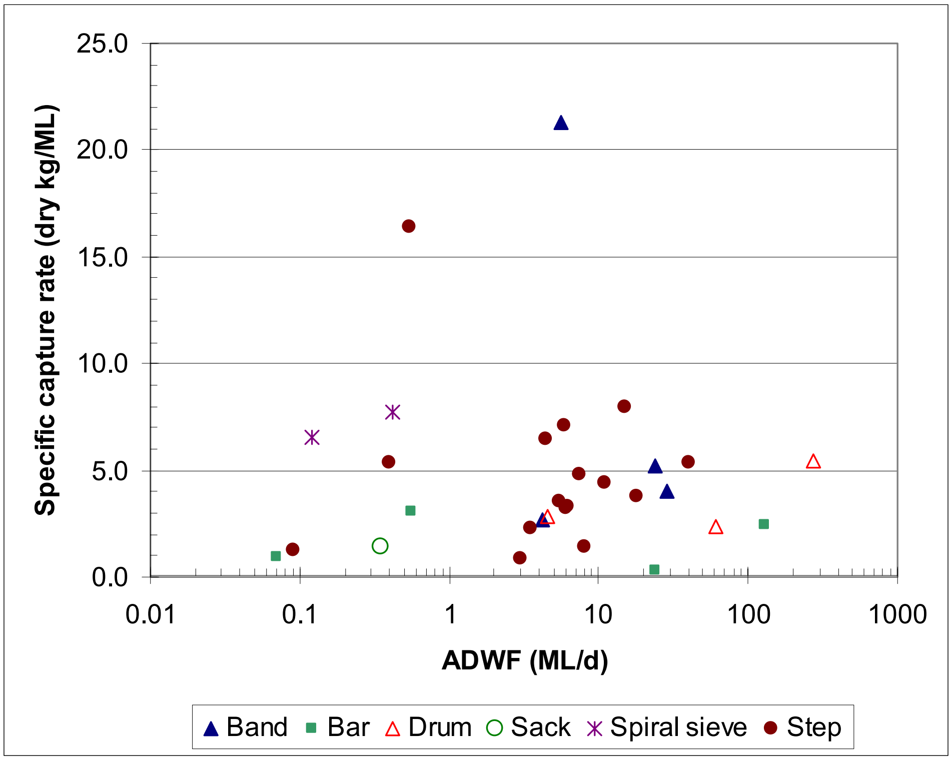

Figure 2: ***SEQ screen type comparison relative to flow treated***

The popular step screen has been used in several mid-sized plants and achieved a wide range of capture rates for a given flow. Similarly none of the other types of screens appear to exhibit a consistent relationship between flow and specific capture rate. Most treatment plants have multiple screens so comparison based on flow should perhaps be undertaken on a flow per screen basis. However some screens are designed to treat higher flow than others, so comparison based on the flow per screen as a proportion of manufacturer specified maximum flow may be most appropriate, but would require further collection of data and analysis.

The aperture size of the screen should intuitively impact on the capture rate, with smaller aperture screens expected to produce higher capture rates.
Figure **3** presents the capture rate of each screen in relation to its screen aperture.

Some 15 mm aperture bar screens have capture rates similar to, and even better than, some 3 mm step and drum screens. The most widely used screen apertures in the range of 3 mm to 6 mm have a wide range of specific capture rates, demonstrating that the aperture size alone does not determine the capture rate of the screen.

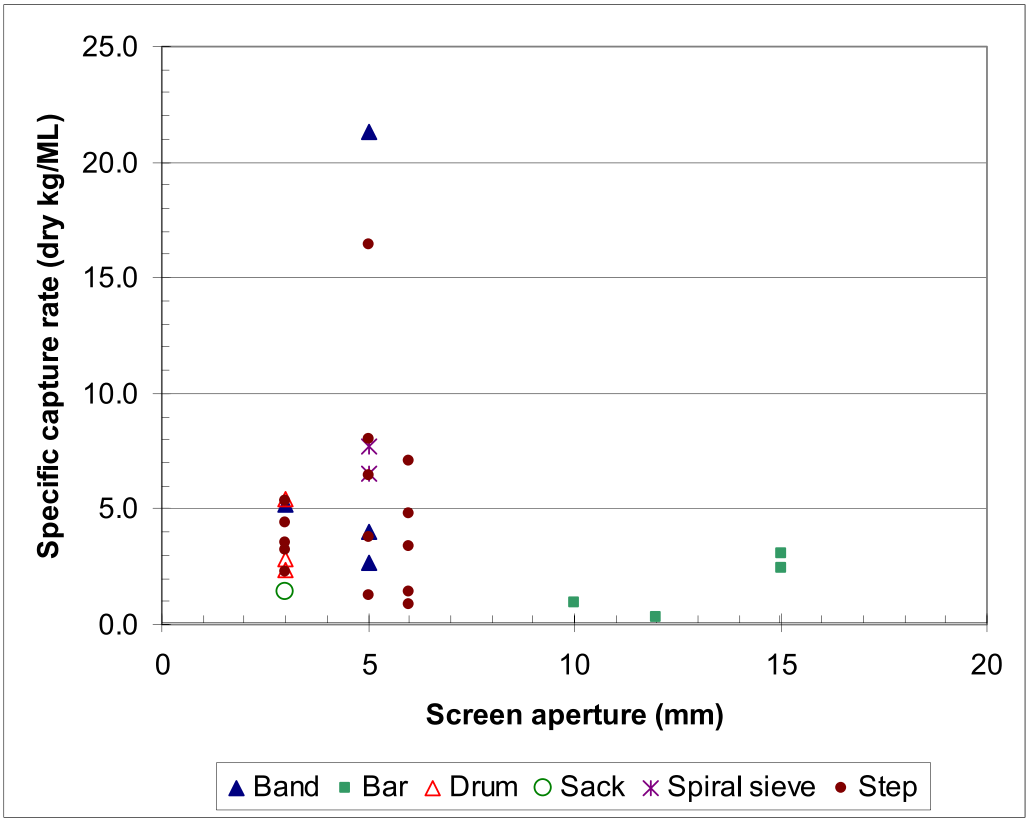

Figure 3: ***SEQ screen type comparison relative to screen aperture size***

This analysis has found that the capture rate performance of the screens was not solely dependent on either the aperture size or the average dry weather flow.

The most critical flow parameter influencing the performance of the screen could be the flow per screen as a proportion of the maximum design flow, the influent approach velocity, or it could be related to the magnitude and frequency of fluctuations in flow caused by the intermittent pumping from sewage pump stations. Other factors that could be expected to affect the performance of screens are the level of maintenance and the specific design of the make and model of screen in use. Analysis of these parameters was beyond the scope of this assessment.

It was also noted during this study that in-process screens capture a significant amount of screenings in relation to the inlet screens. In-process screens were installed on the return activated sludge (RAS) or activated primary tank (APT) sludge recirculation at several plants in this study. Where in-process screens were installed they always captured a significant amount of screenings, even when the in-process screens had a larger size aperture than the inlet screens. In fact the in-process screens captured from approximately one third the mass of the inlet screenings to the same as the mass of the inlet screenings, indicating that the inlet screens are likely to capture only about half the total raw sewage screenings load. Based on these observations it would appear that fine fibres and hair can pass through the inlet screens and then bind together or agglomerate to form large enough lumps that they can then be readily removed by a further screening process.

It is recommended that in-process screens should be considered for installation at any WWTPs that are susceptible to significant maintenance issues associated with screenings fouling equipment. The recommended location for installation of in-process screens may be on any process with sludge recirculation e.g. activated primary tanks, RAS or mixed liquor recycle, or digester sludge recirculation.

3.0 CONCLUSIONS

The data from SEQ wastewater treatment plants does not permit a conclusive quantitative ranking of screen types. The UK Water Industry Research finding that band screens capture more than twice the quantity of screenings than step or bar screens was not supported by the data collected in SEQ, but cannot be rejected either.

A qualitative ranking of the screening capture performance of different generic types of screens is possible from the results of this study. Generally band screens, spiral sieve screens and step screens have performed most effectively, drum screens were moderately effective, and bar screens and sack screens performed least effectively.

4.0 ACKNOWLEDGEMENTS

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5.0 REFERENCES

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