

UK WATER INDUSTRY RESEARCH LIMITED

INLET SCREEN EVALUATION

YEAR 3 COMPARATIVE REPORT

Executive Summary

Objectives

The objective of the screen process testing and mechanical assessment performed at the National Screen Evaluation Facility (NSEF) at Chester-Le-Street STW, Co. Durham, is to 'type-test' screens under typical operating conditions using raw sewage. The aim of this 'type-testing' process is to confirm that screens will meet minimum standards of mechanical reliability and process effectiveness during service. The intention is not to issue a 'pass or fail' certificate for a particular screen but to provide a quantitative measure of screen process effectiveness.

Conclusions

The following screens were evaluated at the NSEF between April 1998 and March 2001; the screen classifications used below follow the nomenclature used in WIMES 5.03 (Water Industry Specification for Screens for Sewage Treatment):

- *Finescreens (6 off)*: - Three Star Travelling Finescreen, Mk I and II FSM Finescreens, Andritz Aquascreen, Parkwood Escalator Screen, and Jones and Attwood Beltafine Screen.
- *Bandscreens (2 off)*: - Jones and Attwood Hi-flow Screen and Brackett Green CF200 Bandscreen
- *Stepscreens (2 off)*: - Meva Rotoscreen and Huber Technology Stepscreen Flexible (SSF).
- *Combined screen/screenings treatment equipment (5 off)*: - Huber Rotamat Ro 1 (incorporating a primary raked bar screen), Huber Rotamat Ro 9 (incorporating a primary perforated plate screen), Haigh ACE 991 (incorporating a primary perforated plate screen), Mono Inlet Screenings System (incorporating a primary discreen and a secondary perforated plate screen) and Robbins and Myers Auger Monster (incorporating a primary wire screen and a secondary perforated plate screen).

Note: - For the combined screen/screenings treatment equipment, the primary screen is the one that screens most of the process flow.

SCR Results

The average combined SCRs of the test screens were as follows, in descending order:

1. Jones and Attwood Hi-flow screen	81.2 %	Bandscreen
2. Brackett Green CF200 Bandscreen	78.3 %	Bandscreen
3. Three Star Travelling Finescreen	73.3 %	Finescreen
4. Longwood Parkwood Escalator	72.8 %	Finescreen
5. Mk I FSM Finescreen	69.1 %	Finescreen
6. Jones and Attwood Beltafine screen	65.9 %	Finescreen
7. Haigh ACE 991	63.6 %	Combined
8. Mk II FSM Finescreen	62.8 %	Finescreen
9. Andritz Aquascreen	60.5 %	Finescreen
10. Mono Inlet Screenings System	56.1 %	Combined
11. Huber Technology SSF	55.7 %	Stepscreen
12. Huber Rotamat Ro 9	51.9 %	Combined
13. Robbins and Myers Auger Monster	39.5 %	Combined
14. Meva Rotoscreen	34.8 %	Stepscreen
15. Huber Rotamat Ro 1	31.5 %	Combined

Note: - In the third column, the word 'combined' is an abbreviation for combined screen and screening handling equipment.

The Jones and Attwood Hi-flow Bandscreen and Brackett Green CF200 Bandscreen exhibited the highest average combined screen capture ratios (SCRs) of 81.2 % and 78.3 % respectively.

The finescreens exhibited average combined SCRs of between 60.5 % (Andritz Aquascreen) and 73.3 % (Three Star Travelling Finescreen).

The Meva Rotoscreen (aperture size = 5 mm) and Huber Technology SSF stepscreen (aperture size = 3 mm) exhibited average combined SCRs of 34.9 % and 55.7 % respectively, which were in approximately the same ratio as their aperture sizes.

The SCR performance exhibited by the combined screen/screenings treatment equipment, ranged from 63.6 % (Haigh ACE 991 screen) to 31.5 % (Huber Rotamat Ro 1).

For most of the screens evaluated, there was a tendency for SCR to increase slightly with increasing flow rate.

Compared to the performance of the finescreens, the improved performance of the bandscreens is thought to be due to a combination of their better screen curtain sealing and their zero screenings 'carry-over'.

The variation in SCR displayed by the finescreens is attributed to differences in the quality of the lateral sealing between the screen curtains and screen curtain support structures and, for the Mk II FSM finescreen, the quality of the sealing between the discharge chute and the rear of the screen curtain. Variations in the design of the rotating brush and washwater cleaning systems fitted to the finescreens are not thought to have contributed significantly to the observed variations in SCR, except for the Andritz Aquascreen, where the possible adverse effect of the relatively low washwater flow rate on SCR is highlighted.

The relatively low SCRs exhibited by the stepscreens is due to the fact that these screens have slots as apertures, not holes. Hence, they are only able to screen down to a given aperture size in one dimension, not two. The superior performance of the Huber Technology SSF compared to the Meva Rotoscreen is due to its smaller aperture size (3 mm slots as opposed to 5 mm).

The SCR performance of the combined screen/screenings treatment equipment is related to the type of primary screen incorporated in their design. Equipment incorporating perforated plate primary screens (ie holes as apertures) tended to perform better than machines incorporating bar or wire type primary screens (ie long slots as apertures). The Mono Inlet Screening System incorporates a discreen as the primary screen. This has relatively short slots as apertures (compared to the Huber Rotamat Ro 1 and Robbins and Myers Auger Monster) and exhibited comparable SCR performance to the equipment incorporating perforated plate primary screens.

The cause of the inferior SCR performance of the equipment incorporating perforated plate primary screens, compared to the finescreens, is thought to be the mode of operation of their screen curtain cleaning systems. It is postulated that the action of the cleaning brushes may have 'forced' a proportion of the screenings collected on the screen curtain through the screen curtain apertures, thereby reducing the SCR.

Head Loss

The head loss versus flow rate performance of the screens is predominantly a function of the free area of their screen installations and the ability of their screen curtain cleaning systems to keep the screen curtain cleans and prevent blinding.

The Haigh ACE 991, Rotamat Ro 1, Meva Rotoscreen and Huber Technology SSF exhibited the lowest head losses of the screens evaluated, due to the relatively high free areas of their screen 'installations'.

Of the finescreens evaluated, the Three Star Travelling Finescreen exhibited the lowest head losses while the Jones and Attwood Beltafine displayed the highest head losses. The main variables in screen design affecting head loss are the free area of the screen 'installation', the speed at which the 'clean' screen curtain is re-presented to the flow

and the presence of other screen design features which introduce barriers to the flow (seals, chains, guide rails etc.). There was excellent correlation between the observed head losses and trends in these criteria.

The head losses measured for the bandscreens (especially the Brackett Green CF200 Bandscreen) do not reflect the relatively high free areas of their screen 'installations'. This is due to the presence of relatively large 'dead' areas at the base of these screens, which would normally be 'hidden' from the flow in a recess in the channel invert in an actual installation. In an actual installation, these bandscreens would be expected to generate significantly lower head losses than finescreens of equivalent screen curtain widths.

The Huber Rotamat Ro 9 exhibited comparable head loss figures to the Three Star Finescreen and Andritz Aquascreen, despite having a relatively low screen curtain diameter (460 mm). This favorable hydraulic performance was due to the effect of the screen curtain curvature (which increased its 'effective' width) and the relatively shallow angle of the screen curtain to the flow (45° cf. 60°).

The Mono Inlet Screening System (macerator removed) and Robbins and Myers Auger Monster generated relatively high head loss figures (0.21 m and 0.24 m respectively at 100 l/s). The overall head loss values obtained for these pieces of equipment were a function of the 'individual' head losses generated by the discreen/wire screen and the perforated plate screens incorporated in the combined screen/screenings treatment equipment.

Mechanical Assessment

No significant mechanical/operational problems were encountered with the following screen components on any of the test screens:

- Screen curtain support structure;
- Screen curtain chains;
- Screen curtain drive systems (ie motors, gearboxes, couplings, driveshafts, sprockets, chains, bearings, seals etc.); and
- Screen curtain cleaning systems (brushes/washwater systems).

The following 'significant' deficiencies in screen operation/design were noted during the mechanical assessment period:

- The brush seals fitted between the screen curtain and the chain/screen curtain support structure on the FSM Finescreens and the Andritz Aquascreen tended to clog with screenings during operation. This factor is thought to have adversely affected the SCR of these screens.
- The 'kinked band' configuration of the screen drive chain on the Three Star Travelling Finescreen caused relatively heavy wear of the HDPE guide rails at the points where the chain changed direction sharply.

- The front access cover on the FSM finescreens was far too large to be safely handled by one person. Also there were no supporting stays on the heavy upwards opening brush cover.
- Some of the drive pegs in the slide links comprising part of the screen curtain on the Jones and Attwood Hi-Flow Screen became displaced during operation. This problem was, however, later resolved by fixing the pegs in the slide links with grub screws.
- The polymer guide rails which guide the chains at the position where the lifters engage with the drive pegs on the Jones and Attwood Hi-Flow Screen suffered heavy wear during operation. The chains wore grooves in the rails up to 10 mm in depth (two thirds of their original thickness). This problem has now been resolved by Jones and Attwood redesigning this component.
- The edge of the screen curtain on the Jones and Attwood Beltafine screen fractured at a previous repair site after 1983 hrs of operation, causing a tear, several tens of mm, long to form. This tear then snagged on the leading edge of one of the lower, front guide rails, resulting in loss of motion of the screen curtain. The risk of this failure occurring was increased with the screen installed in the NSEF because the belt was 'second-hand' and had already been repaired at the fracture site.

The levels of compliance with WIMES 5.03 were generally good. The areas of non-compliance were as follows:

- Automatic, rechargeable grease dispensers units should be fitted to all bearings requiring lubrication (FSM finescreens and Three Star Travelling Finescreen).
- Access covers should comply with the Manual Handling Regulations (FSM finescreens).
- Hinged covers which open in an upwards direction should be provided with supporting stays (FSM finescreens).
- Adequate access should be provided in the sides of the screen curtain enclosure to facilitate maintenance/removal of trapped screenings (FSM finescreens).
- The lubrication piping was plastic not stainless steel (Jones and Attwood screens).

Recommendations

It is considered outside the scope of this report to make specific recommendations to screen manufacturers relating to how the particular designs of their screens may be modified to improve SCR.

The test results have shown that, where high SCRs (ie in the range 60 - 82 %) are required (to minimise blocking and fouling of down-stream processes and reduce visible and offensive debris in final effluent), finescreens/bandscreens with 6 mm circular apertures should be specified for inlet screen applications.

Where these screens are specified for inlet screen applications, the Purchaser should be aware of the design variations that exist between different manufacturers screens and the likely effect of these variations on SCR.

Following the installation of finescreens/bandscreens for inlet screen applications, proper attention should be given to the planned maintenance of the brush and washwater cleaning systems to maintain high process efficiency.

Further tests should be performed to establish the optimum operating parameters and comparative effectiveness of brush and washwater cleaning systems fitted to finescreens/bandscreens, especially considering the operating costs involved in supplying washwater.

Screens that incorporate slots as apertures (ie stepscreens, raked bar screens, wire screens, discreens) should only be specified for inlet screen applications where:

- a) hydraulic considerations (ie upstream depth/head loss) preclude the use of finescreens/bandscreens;
- b) high SCRs are not required due to the specific nature of the downstream treatment processes and/or the amenity level of the receiving watercourse; and/or
- c) operational costs must be minimised, in which case stepscreens and raked bar screens are likely to confer lower running costs than finescreens/bandscreens due to their lower electricity consumption (the screen curtain drive operates less frequently and there is no brush drive), zero washwater consumption and lower planned maintenance costs.

Benefits

The information generated by tests performed at the NSEF should enable Water plcs to:

- accurately assess the process effectiveness and mechanical reliability of existing and future screen designs;
- select screens to match particular process requirements;
- produce a 'bench-mark' against which future screen performance can be measured;
- develop a realistic performance based purchase specification for screens; and
- identify and design-out (in collaboration with screen manufacturers) specific problem areas in screen design.

**For further information please contact UK Water Industry Research Limited,
1 Queen Anne's Gate, London SW1H 9BT quoting the report reference number**

Table 3.1 - Summary of SCR Data

Screen	Average SCR (On Mode) (%)	Average SCR (Off Mode) (%)	Average Combined SCR (%)
Three Star Travelling Finescreen	74.5	72.0	73.3
Mk I FSM Finescreen	69.5	68.7	69.1
Andritz Aquascreen	61.1	59.9	60.5
Mk II FSM Finescreen	62.1	63.5	62.8
Meva Rotoscreen	25.9	43.8	34.9
Longwood Engineering Parkwood Escalator	70.9	74.6	72.8
Huber Rotamat Ro 1	26.0	37.0	31.5
Huber Rotamat Ro 9	51.2	52.5	51.9
Jones and Attwood Hi-flow	83.0	79	81.2
Jones and Attwood Beltafine	68.1	63.7	65.9
Brackett Green CF200 Bandscreen	77.6	79.0	78.3
Haigh ACE 991 screen	64.7	62.5	63.6
Huber Technology Step Screen Flexible (SSF)	51.9	59.5	55.7
Mono Inlet Screenings System	57.2	55.0	56.1
Robbins and Myers Auger Monster	41.9	37.3	39.6

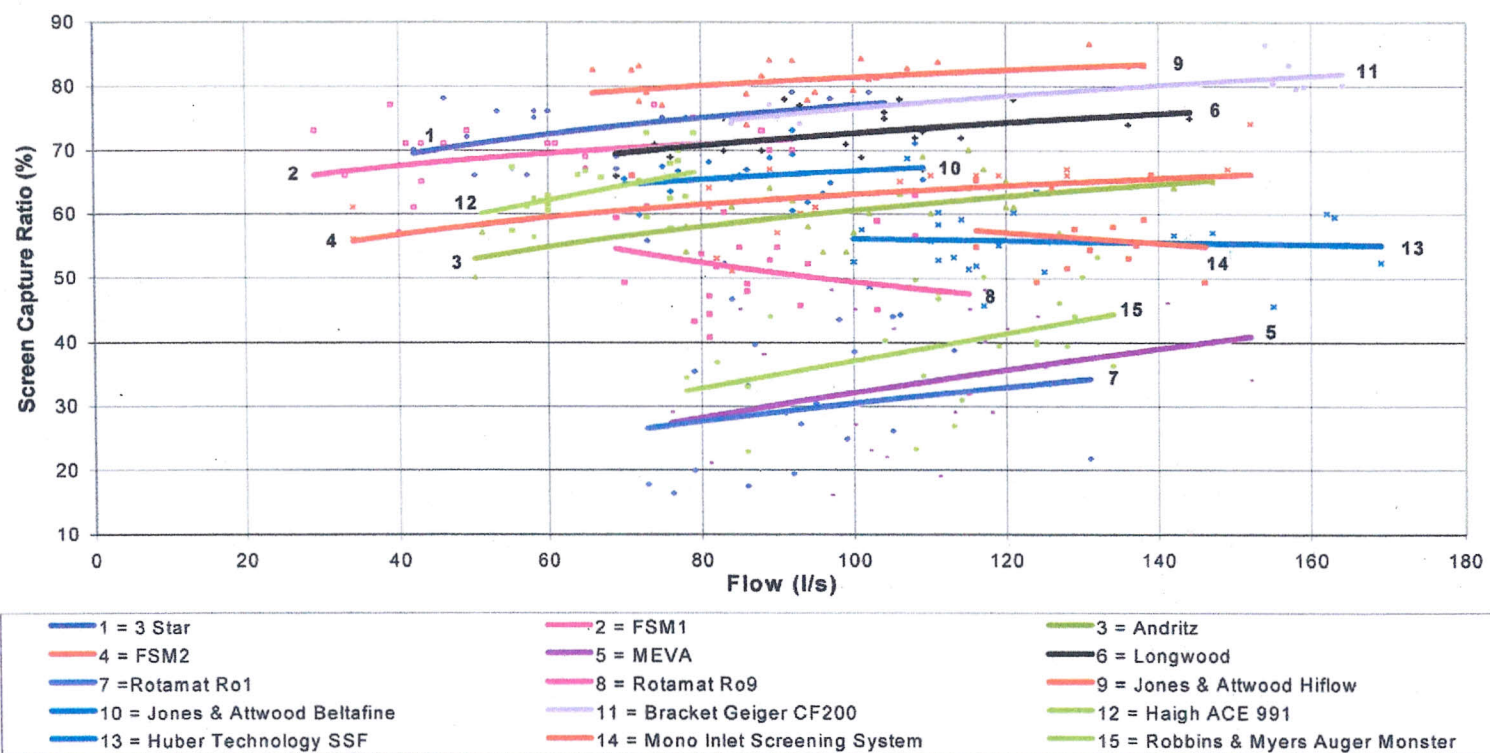


Figure 3.1 - SCR vs. Flow Rate Data