

# Recent developments in wedge wire technology.

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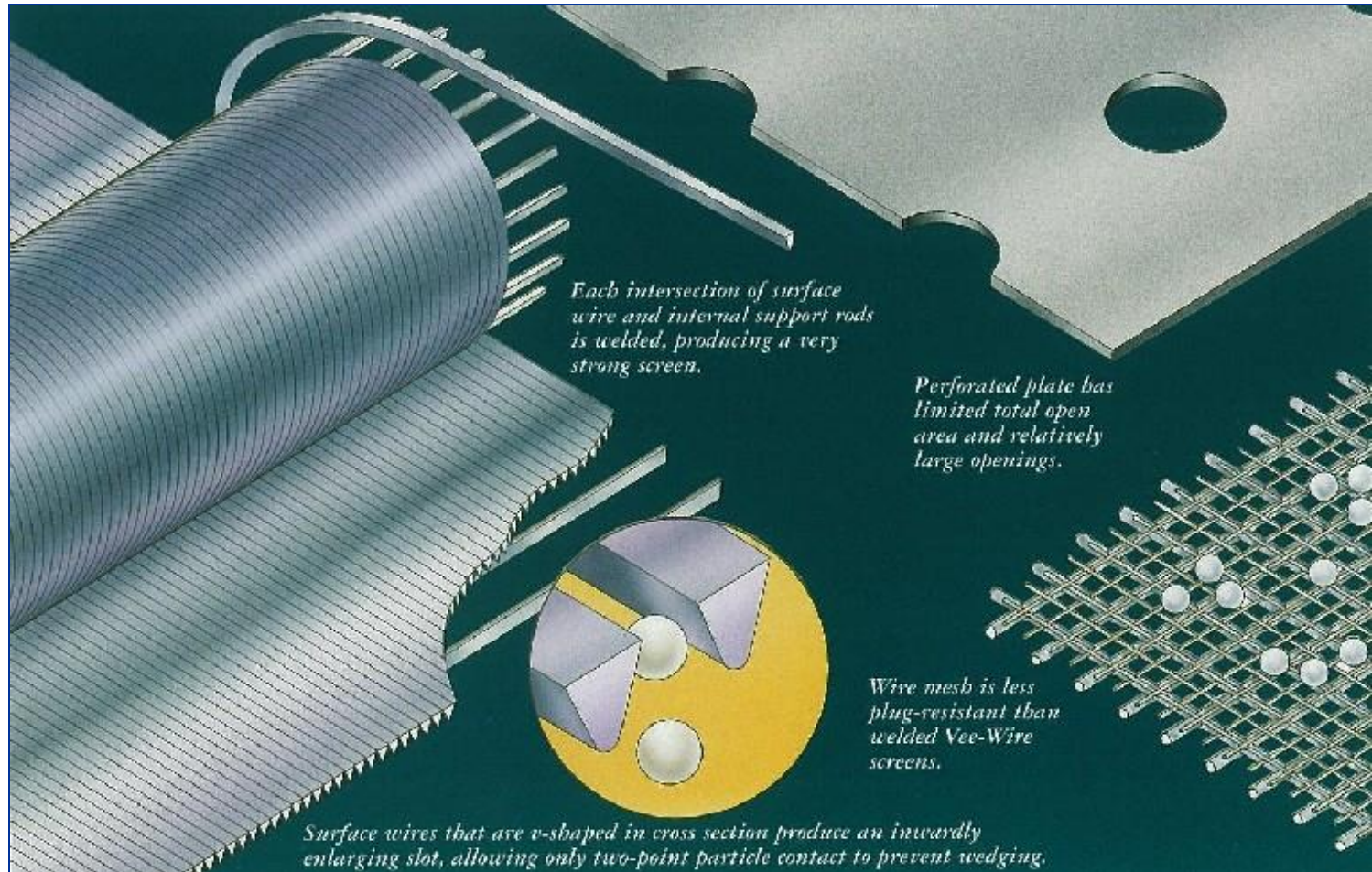
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## Recent developments in wedge wire technology.

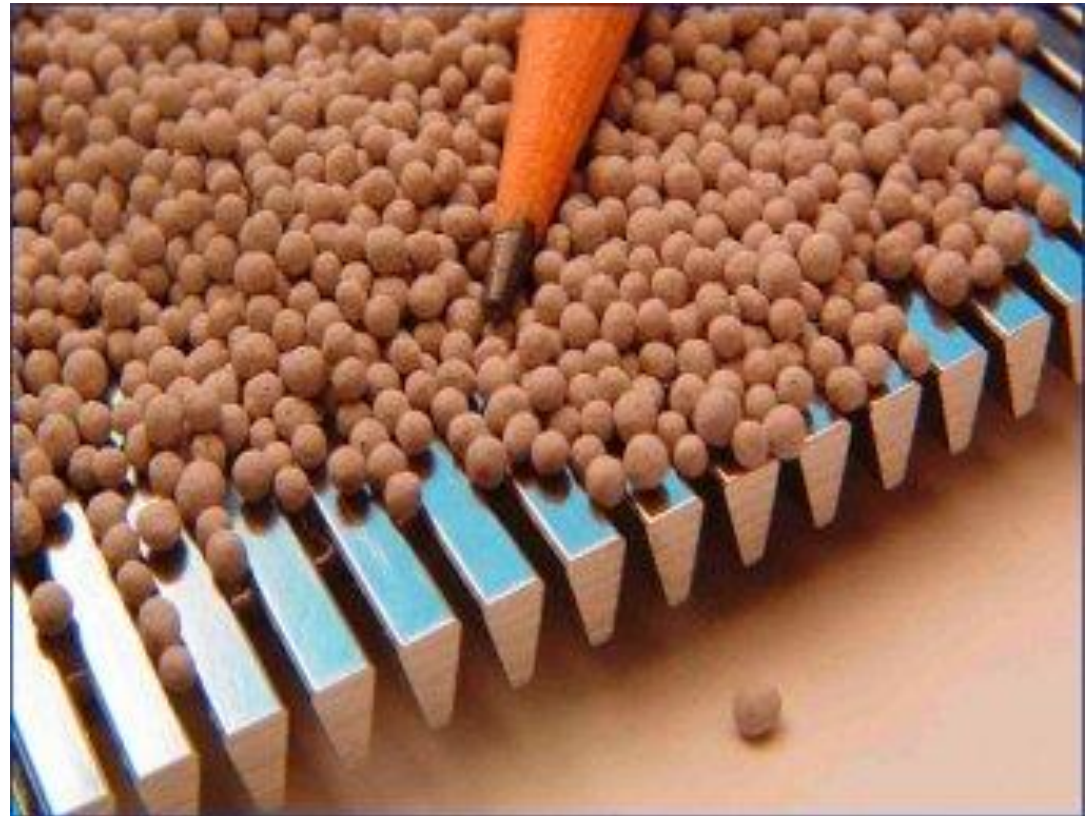
- Wedge wire overview – Pros and cons
- Filtration and retention.



## Recent developments in wedge wire technology

### Pros:

- High Open Area
- Continuous Slot Opening
- Optimized Screen Design
- Quick On-Site Installation
- Vee-Wire Profile
- Two Point Contact of Catalyst
- Smooth Surface
- Strong All-Welded Construction
- Easy Cleaning
- Long life
- Can deliver process improvements



## Recent developments in wedge wire technology

### Cons:

- Long fine fibers will reduce open area, due to hair pinning – difficult to clean.
- Long life can create new issues of contamination – cleaning regime required.
- Initial costs more expensive than alternative technologies.



## Recent developments in wedge wire technology

### Fine profile wire:

- Narrowest wedge wire commercially available today is 0.5mm wide.
- So with slots of 45µm and 60µm, you have % open area of 8.2% and 10.7% respectively.
- $\% \text{ open area} = \text{Slot width} / (\text{profile wire width} + \text{slot width})$ .
- This is typically on a par with alternative technologies such as nickel foils, but wedge wire has the benefit of low pressure drop, low plugging and therefore reduced cleaning.
- There is a demand from the market for increased % open area and so commercialisation of a 0.375mm wide profile wedge wire has commenced.
- With a 45µm and 60µm slot, and a 0.375mm wide profile wire, % open area increases to 10.7% and 13.8% respectively.
- This represents typically a 30% increase in % open area, which would allow a reduction in the overall screening area or increased screening capacity from the existing screening area.
- Additional benefits include a reduced pressure drop, so for example:

Pressure drop (per m<sup>2</sup> of screen) with a 0.5mm wide wedge wire, a 100µm slot opening and a steady state flow of 250 m<sup>3</sup>/h, would generate a 24 mm water column.

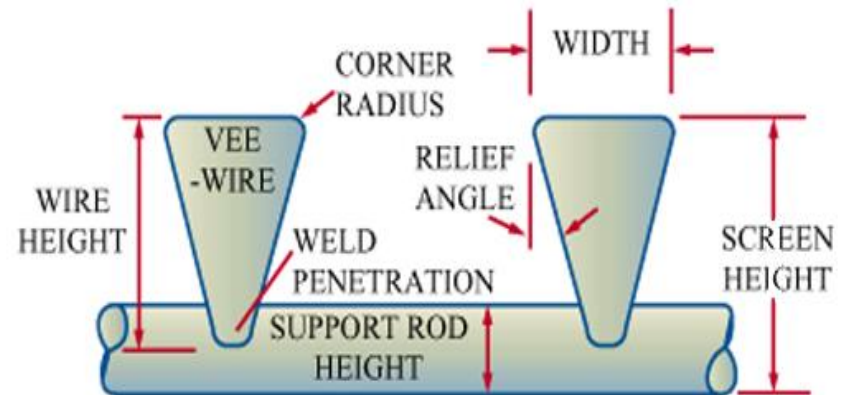
Pressure drop (per m<sup>2</sup> of screen) with a 0.375mm wide wedge wire, a 100µm slot opening and a steady state flow of 250 m<sup>3</sup>/h, would generate a 15mm water column.

- A potential disadvantage of the smaller cross sectional area of the profile wire, is a shorter operating life, caused by erosion of the wedge wire, this then leading to the opening of the slot.

## Recent developments in wedge wire technology

### Fine slots and their tolerances:

- Along with the demand for finer wedge wires, there is a demand for finer slots and tighter tolerances on the slot width.
- There are limitations to the current technology used across the wedge wire industry. Manufacturers of fine slot screens use resistance welding of a wedge wire to a support rod that is rotating in order to create a slotted pipe. The feed mechanism tries to control the pitch between two profile wedge wires.



- There are claims to be able to produce  $10\mu\text{m}$  slots, but the build up of tolerances on the wedge wires, feed mechanism, weld head, weld and tooling, means that tolerances on the slot can be more than  $\pm 10\mu\text{m}$ .
- Johnson screens has recently produced a  $17.5\mu\text{m}$  slot screen with a  $0.375\text{mm}$  wide wedge wire with a standard deviation of  $6.3\mu\text{m}$  maximum and a slot average of  $\pm .0006\mu\text{m}$ . But they believe that this is at the limit of their current manufacturing technology.
- New manufacturing technology is currently being developed by Johnson Screens that should enable slots of less than  $10\mu\text{m}$  to be achieved with much tighter tolerances.

## Recent developments in wedge wire technology

Materials – Increased corrosion resistance, tensile strength and reduced weight.

- 70% of Wedge wire screens are made from 300 series stainless steel alloys.
- Super-Duplex (austenitic –ferritic) alloys have been developed specifically for the oil and gas, petrochemical, seawater cooling, chemical, desalination and pulp and paper industries.
- Super-Duplex alloys have strong resistance to pitting and crevice corrosion, where the PRE number (Pitting Resistance Equivalent) has to exceed 38.
- Wedge wire manufacturers have had to prove that their current manufacturing processes do not damage the corrosion resistance of Super-Duplex alloys by passing the ASTM G48 “Method A” test at a minimum temperature of 50°C. Both Trislot and Johnson Screens have exceeded this requirement.
- As a by-product of this development work, the increased proof and tensile strength of Super – Duplex alloys, versus traditional 300 series stainless steel, (approximately 2.7 times) has become apparent and this has allowed wedge wire screens to be designed with smaller profile wedge wires thereby allowing increased % open area and lower pressure drop, or if profile wedge wire sections are maintained, then higher burst pressures.
- Johnson screens has developed a number of new screening products where a combination of Super-Duplex and 300 series stainless steel alloys has been used to give both flexibility and strength.
- Very recently a new player to the wedge wire market has developed a resistance welding process that works well with Aluminium. Sample panels are currently under evaluation, and results are very promising.

## Recent developments in wedge wire technology

### Surface treatments - increased resistance to erosion

- Reducing the impact of erosion on fine wedge wires, will increase operating life of a wedge wire filter screen.
- Hard chromium plating has been the traditional method of creating a wear resistant coating on the surface of wedge wires. Whilst very effective for industries such as pulp & paper, it has its disadvantages in say the food or beverage industry where cross contamination due to erosion and flaking can occur.
- Johnson Screens has worked with Bodycote to utilise their Kolsterising process, which is a Thermo-chemical diffusion process for carburizing Austenitic stainless steels.
- Carbon is dissolved interstitially in the FCC matrix, causing residual stresses, which increase hardness and anti-galling without a change in corrosion resistance and with no formation of Carbides.
- Johnson screens has produced wedge wire screens which have then been Kolsterised and which display a hardness > 1,000 HV to a depth of 50µm.
- Customers report that Kolsterising wedge wire screens does extend the operating life.



## Recent developments in wedge wire technology

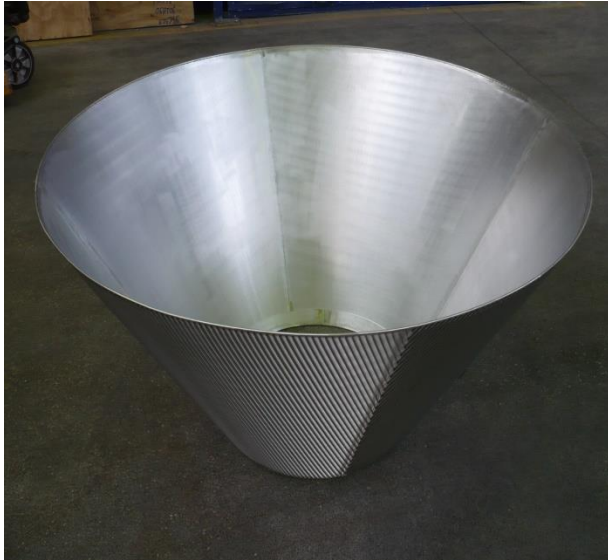
### FEA and CFD analysis

- Advanced computer analysis to reduce cost of prototyping new wedge wire products.
- Advanced Design Methods and Tools
  - Finite Element Analysis (FEA)
  - Computational Fluid Dynamics (CFD)
- FEA - Algor
  - Linear statics – brackets and basic supports
  - Non-Linear statics – large deformations
  - Mechanical Event Simulation –
    - Objects interacting other objects
    - Friction
    - Hyper-elastic materials
  - Thermal expansion
  - Critical buckling analysis
  - Combined elements (solid, beam, other) to get best results
- CFD - Comsol Mutiphysics
  - Turbulent (k-e and k-w) capabilities – can model fast moving flow such as wind
  - Mixed phase flow – water and air
  - Non-Newtonian flows – high viscosity (syrupy) flows
  - Heat transfer
  - Chemical reactions
  - Customized models and results
- CFD - Algor
  - Fluid/structural interactions – Wind on a surface

## Recent developments in wedge wire technology

### Applications in the sugar industry:

- Continuous and batch centrifuge screens



- Wedge wire screens with 0.5mm wide and 0.375mm wide wedge wire with slot width from 18 $\mu$ m to 120 $\mu$ m.
- Long life, typically 3 to 5 seasons.
- Reduced purity of runoff, typically 0.5% to 2%.
- Report produced by Ilovo Ubombo and presented at the South African sugar conference in 2015.



## Recent developments in wedge wire technology

Applications in the sugar industry:

- Continuous and batch centrifuge screens



- Wedge wire panels on test in a batch centrifuge.
- Trials still in process, objective is extended life with a variable slot width.

## Recent developments in wedge wire technology

### Applications in the sugar industry:

- Fine slot sugar trommel.



- Drum dimensions – 2.5m diameter X 6.3m long with 100  $\mu$ m slot.
- Capacity 24,000 TCD. 1000 TCH.
- Thermal insulation around completely enclosed drum.



## Recent developments in wedge wire technology

Applications in the sugar industry:

- Dual skinned filters.



- Polypropylene filters are currently used for sludge juice filtration at 50 $\mu$ m separation.
- Filters have to resist a collapse pressure of 8bar max.
- Current screens have short life, 3 to 6 months max.
- Johnson Screens developed a dual skinned stainless steel filter of exactly the same external dimensions (so no modifications to equipment). The external wedge wire screen used a 0.5mm wide wedge wire with 45 $\mu$ m slot. The Internal screen used a 2.3mm wide wedge wire and a 10mm slot and a push-fit inside the external screen.
- The screen was calculated to resist 10 bar collapse pressure.
- After more than 1 year, the trial screens continue to perform. No failures, the screens clean easily and the lower pressure drop across the screen appears to improve juice flow.



- Questions?

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