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Selection and Design Criteria for Sand Control Screens

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Sand Control Methods

- No control
- Slotted Liner / Punched Slot Liner
- Wire-Wrapped Screen
- Pre-Packed Screen
- Shrouded Metal Mesh Screen
- Expandable Screen
- In Situ Consolidation (Resin)
- Oriented & Selective Perforating
- OHGP & IGP
- Frac Pack (Including Extension Pack or HRWP)
- Screenless Frac Pack

Screen Selection

Screens are an integral part of most downhole sand control strategies.

Common applications include:

- Stand alone (open and cased hole)
- Combined with gravel or frac packs, extension packs and HRWP
- Remedial or artificial lift protection applications

Screen Selection

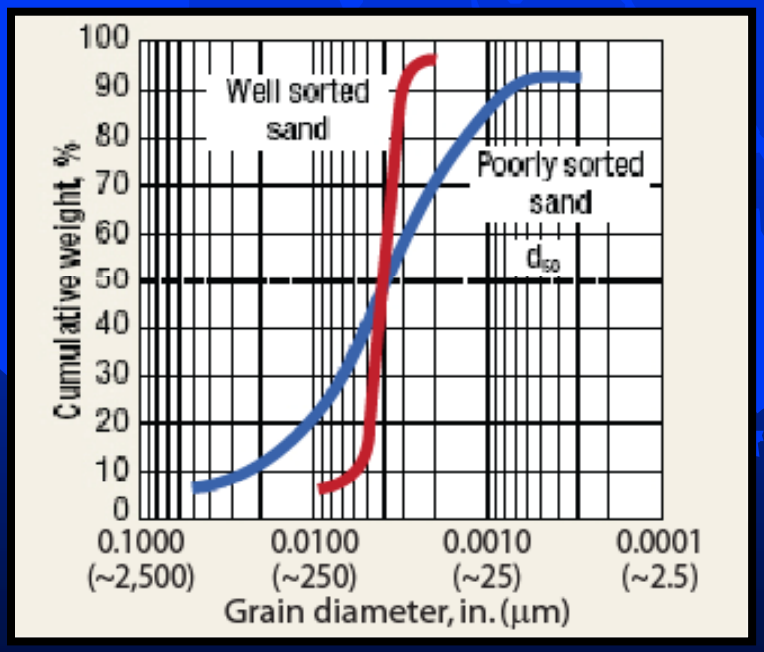
Screen should be selected for maximum sand retention and minimum productivity impairment

NOTE: potentially conflicting criteria

- Formation Particle Size Distribution (PSD)
- Correct slot or micron rating (empirical methods)
- Screen Permeability
- SAND Software
- Sand Retention Tests

Screen Selection
Using Sieve Analysis Techniques

- Formation Sand Sampling
- Sieve Analysis Techniques
  - Dry Sieving
  - Laser Light Scattering (LPSA)
- Particle Size Distribution (PSD)

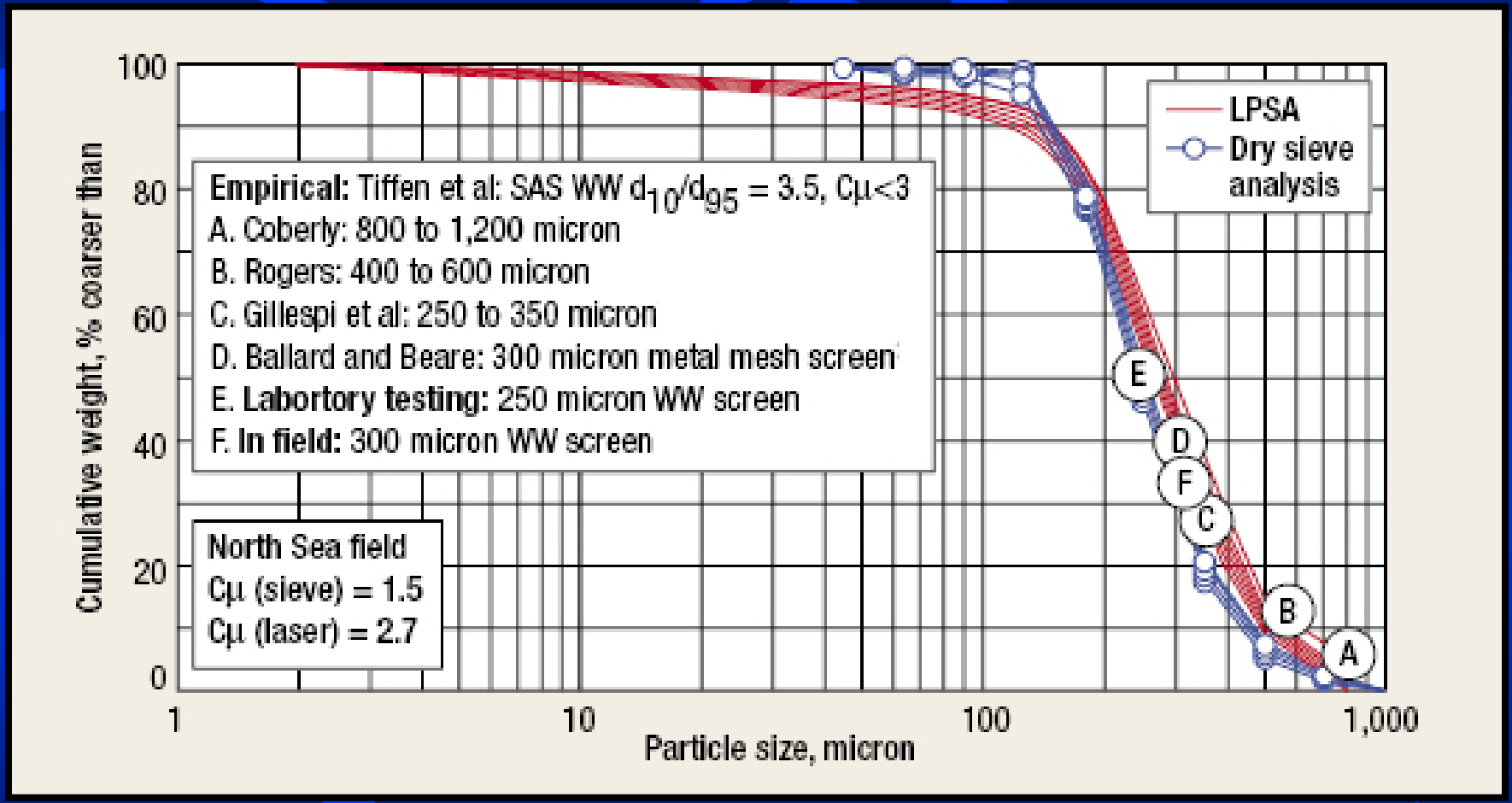


PSD Relationships with Slot Width and Screen Micron Rating

Screen opening (slot/micron rating) is dependent on particle size distribution (PSD)

- **Important parameters are:**
  - d_{50}, d_{10}, d_{90}, d_{95},, d_{40}, d_5 Sorting Coefficient (S_c) – d_{10}/d_{95}, Uniformity Coefficient (U_c) – d_{40}/d_{90}
- **Empirical selection criteria:**
  - COBERLY (ROGERS): 2 to 1 x d_{10} (largest 10%)
  - SAUCIER: ~ 6.5 x d_{50}
  - GILLESPI et al: $U_c < 2$ use d_{50}, $U_c \sim 2$ use d_{40}, $U_c > 2$ use d_{30}
  - SCHWARTZ: $U_c < 3$ use d_{10}, $U_c > 5$ use d_{40}, $U_c > 10$ use d_{70}
  - BALLARD AND BEARE: d_5 or d_{10} of finest sand that fails
- **Semi-empirical method:**
  - SAND Software (developed by International Research Institute of Stavanger [IRIS])

Particle Size Distribution (PSD)



Comparison of Methods for Stand Alone Screen Selection

Screen Permeability

- Any screen is permeable media through which flow penetrates under certain hydraulic conditions
- Major importance is to determine screen permeability
  - True indicator of inflow capacity
  - Interface with formation, not open area, which is only part of the screen structure
- Permeability is 3D; open area 2D
- Comparison criteria – Screen permeability, not % open area

SAND Software

Sieve Analysis data from various measured depths (right) are input into Sand Software

Results presented in graph (below)

Smallest slot opening where continuous sand production expected to occur

Smallest slot opening where no plugging is expected to occur

Largest slot opening where severe plugging is expected to be frequent

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Correct Slot Width or Micron Rating

Many operators do not use published empirical or semi-empirical selection methods

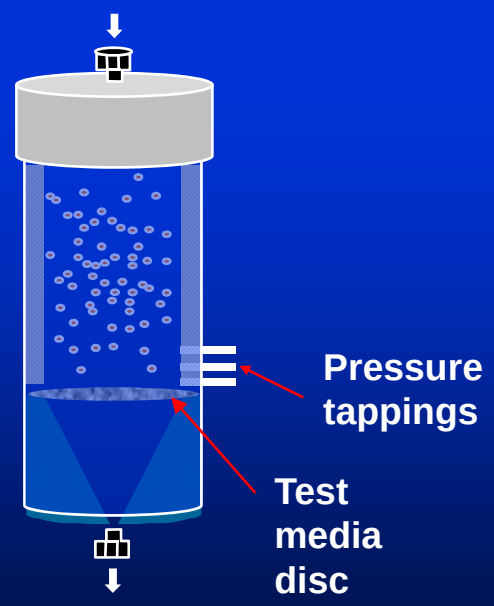
- Coberly and Rogers - do not give reliable results
  - **No accounting for sorting or uniformity of sand**
- Gillespi et al, Schwartz and Ballard & Beare – better
  - **Account for sand sorting and uniformity**
- SAND does not work with LPSA due to high percentage of fines measured

Standard practice – perform sand retention tests with real or simulated formation sand

Sand Retention Test Methods

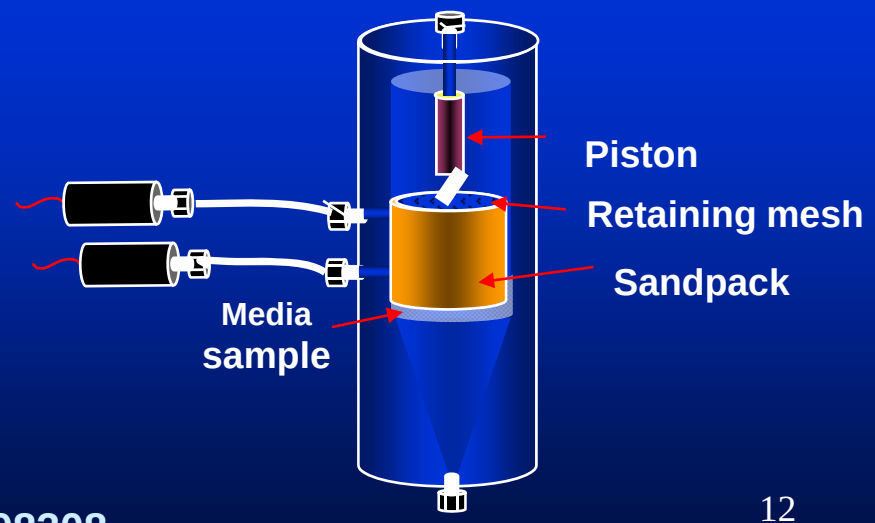
SLURRY TESTS

- Sand in slurry and flow onto screen
- Weigh sand passing through
- Log pressure



SANDPACK TESTS

- Place sand directly on screen and flow through sand pack
- Weigh sand passing through
- Log pressure

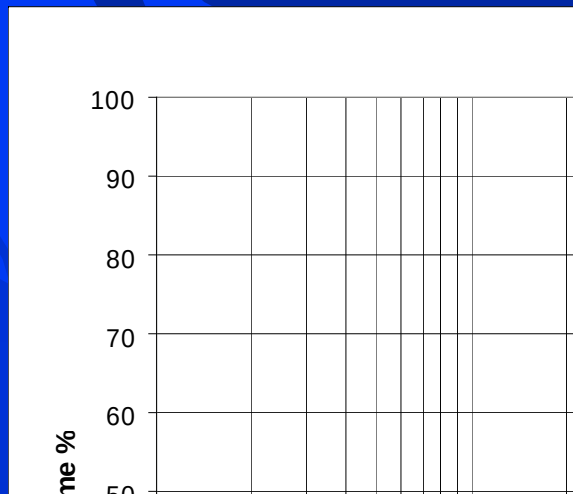


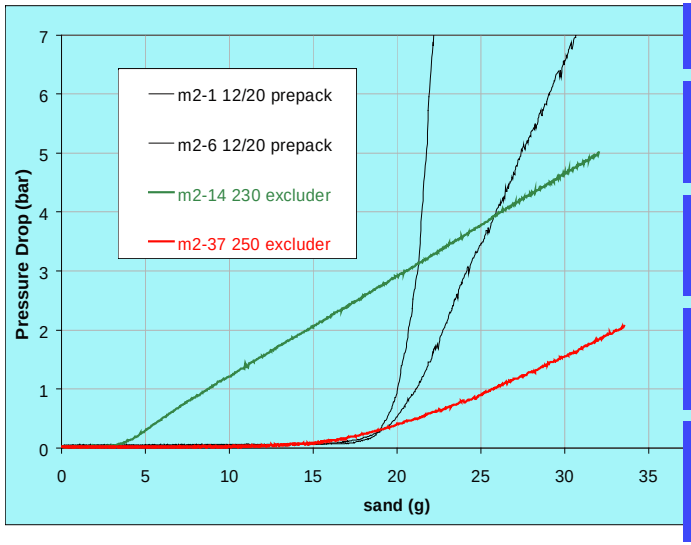
Factors Affecting Sand Retention Tests

- Sand retention testing not easy
- Tests do not relate to real world and subject to experimental artefacts
- View results with caution
- Factors affecting test results:
  - Wetting fluid
  - Flow rate
  - Channelling

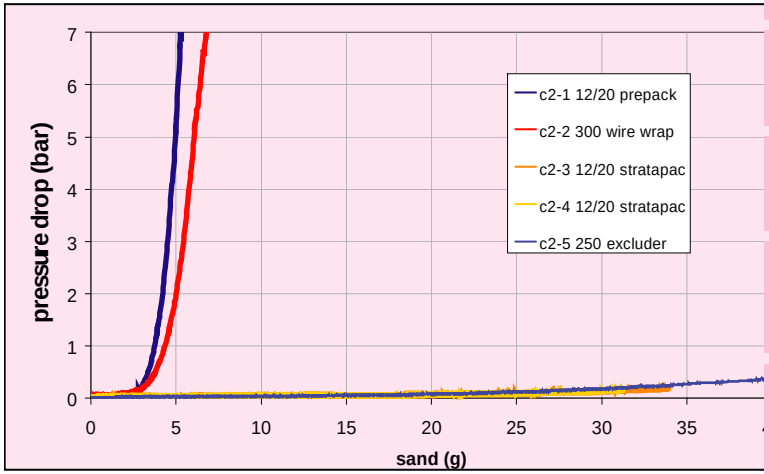
Correct Slot Width or Micron Rating

***Results*: Differential Pressure and Sand Retention**

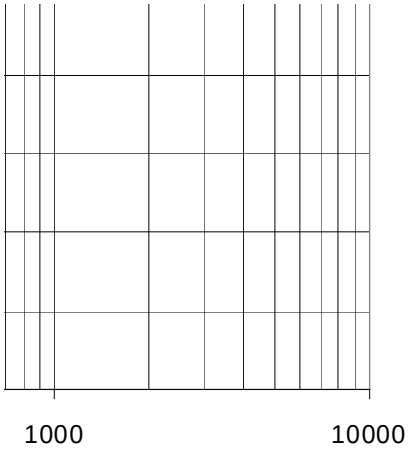




Screen	Retntn (@ P)
12/20 Prepack	40 %
230 Excluder	70 %
250 Excluder	46 %
12/20 Stratapac	70 %

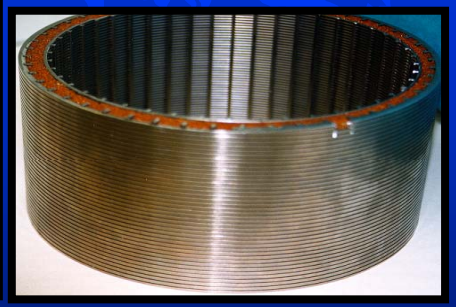


Screen	Retntn (@ P)
12/20 Prepack	94 %
250 Excluder	94 %
12/20 Stratapac	95 %
300µm Baker sww	87 %



Sand Exclusion Devices (Filters)

- Based on Slots
  - Slotted Liner
  - Punched Slot Liner
  - Wire-Wrapped Screen
- Based on Pores
  - Pre-Packed Screen
  - Shrouded Metal Mesh Screen
  - Expandable Screen
- Other



Sand Exclusion Devices (Filters)

ISO Sand Control Screens Standard, ISO 17824

Scheduled to be sent to ballot in February 2008

ISO Sand Control Screens Standard, ISO 17824

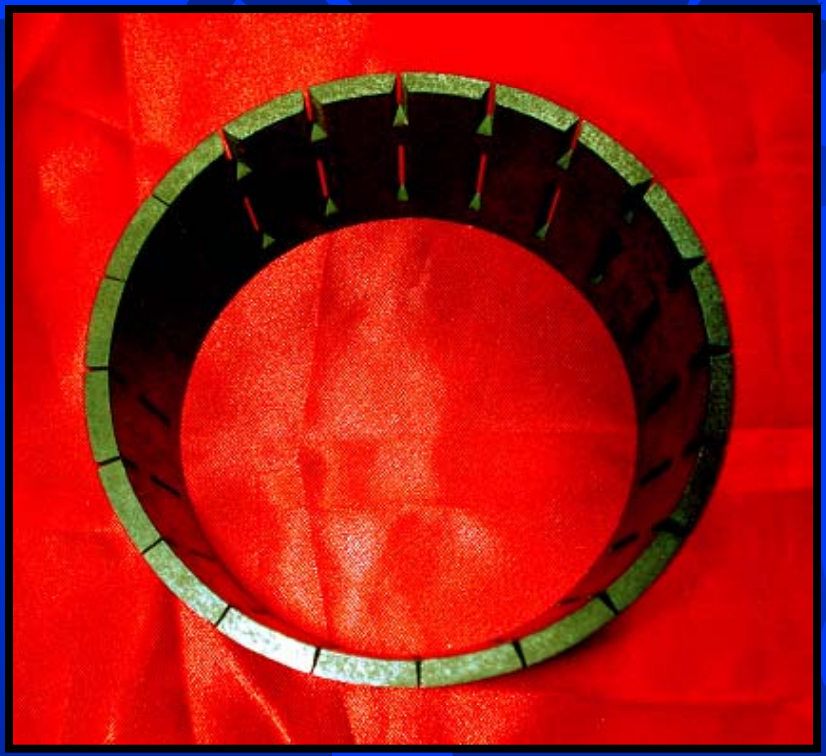
Scope: Sand Control Screens are mechanical filtration or retention devices to:

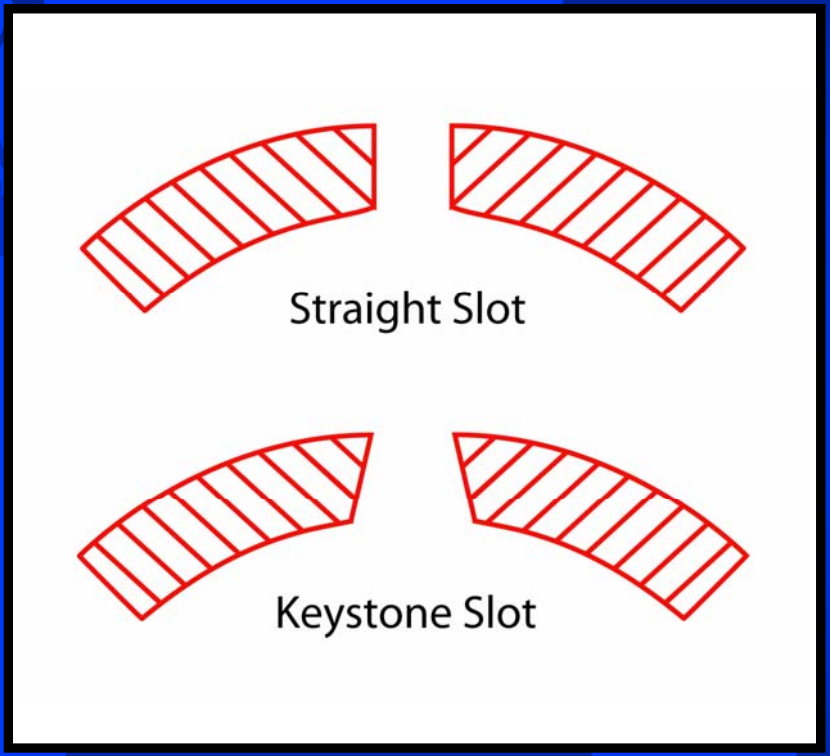
- Provide sand retention of the gravel pack and/or formation sand
- Allow passage of fluids during well clean up, production or any stimulation activities

Products covered:

- Wire wrap screens
- Pre-pack screens
- Metal mesh screens

Slotted Liner





Straight and Keystone Slots

Punched Slot Liner

Stainless Steel
Filtration Jacket

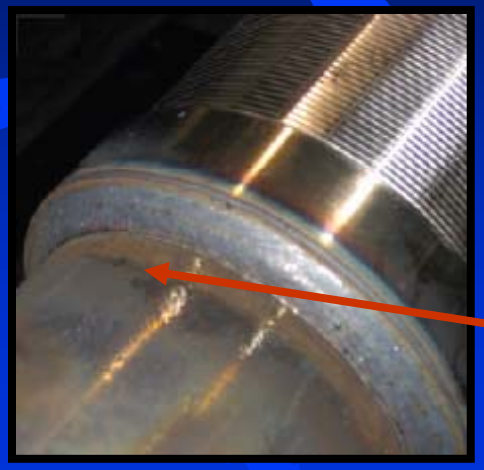
Support Ring

Base Pipe

Wire-Wrapped Screen

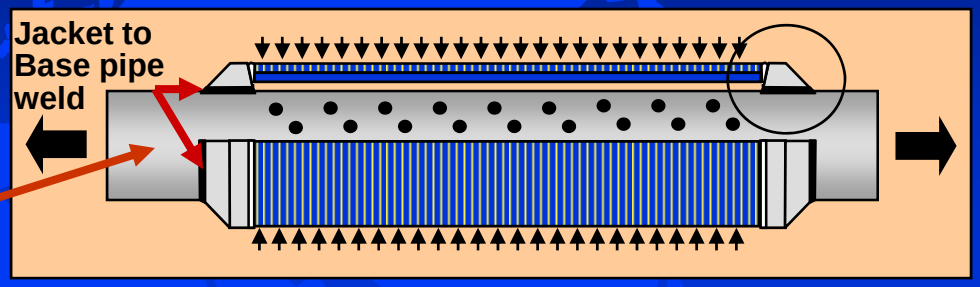
- Came out in 1970s
- Advantages
  - Keystone slots
  - High manufacturing efficiency
  - Profile materials can be stainless steel
- Disadvantages
  - Inaccurate wire spacing can allow production of formation sand or plugging
  - Can be damaged when installed through doglegs, high angle and horizontal sections because of vertical orientation between wrapped wires and support rods

Wire-Wrapped Screen



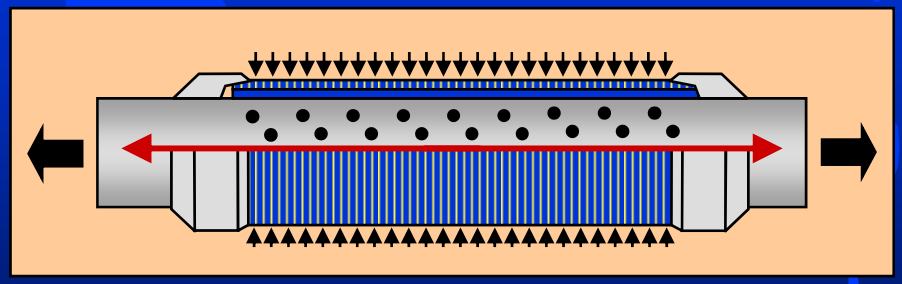
Base Pipe

Slip-on screen jacket construction



All forces transferred through end connections

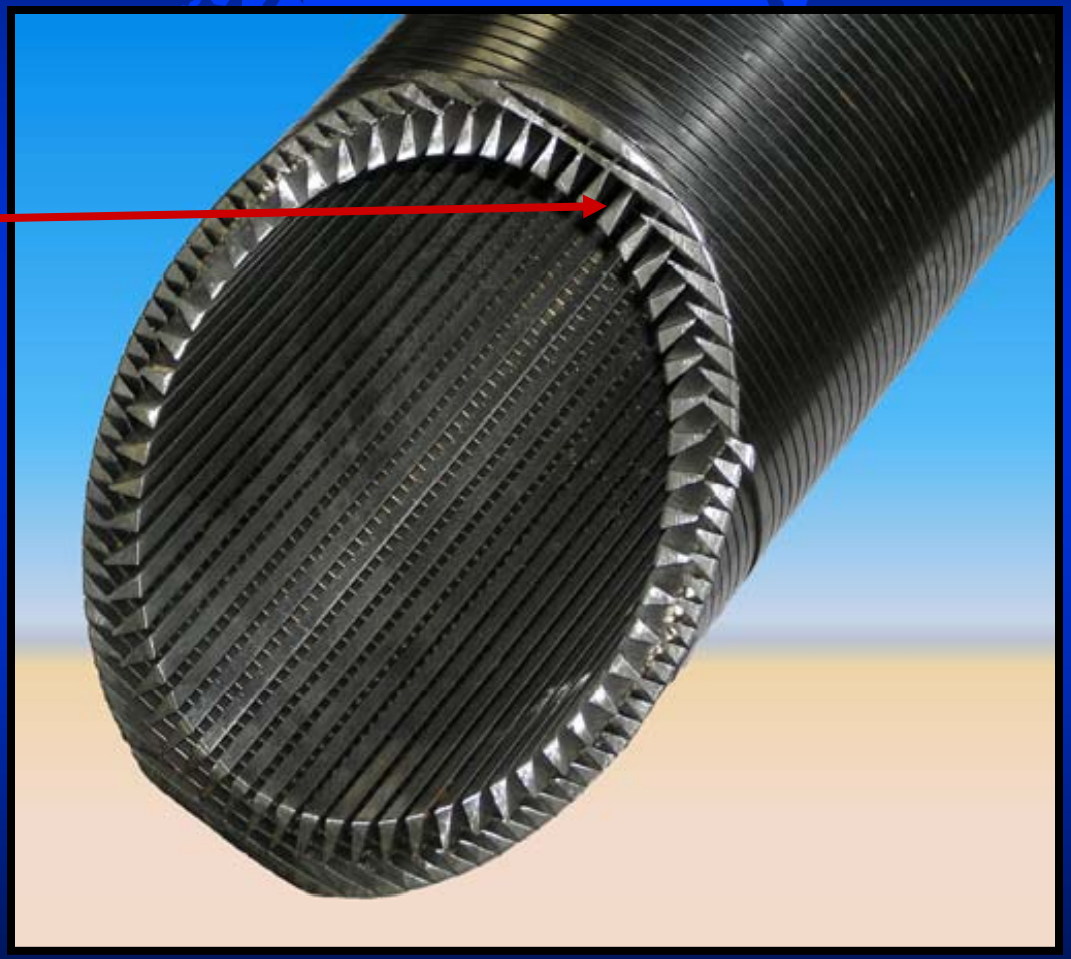
Tight Fit wrap-on-pipe construction



All forces are transferred to base pipe, and screen and base pipe behave as one unit

Rod Based – Wire-Wrapped Screen

Wedge Wire (no base pipe)



Pre-Packed Screens

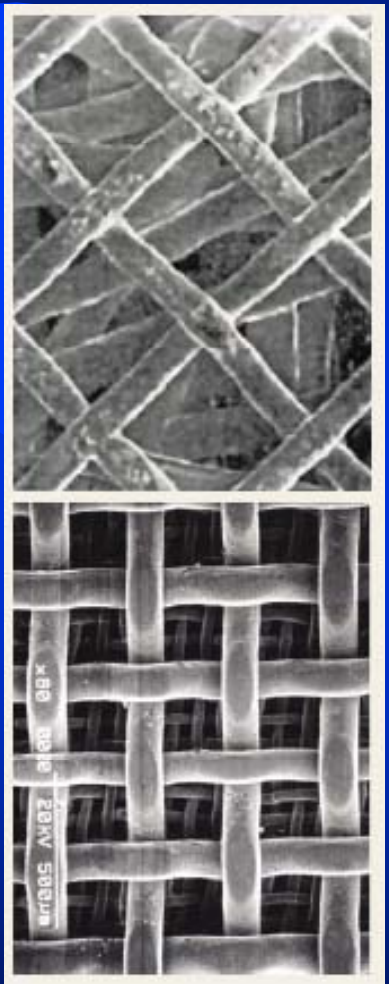
Dual-screen prepack

Single-screen prepack

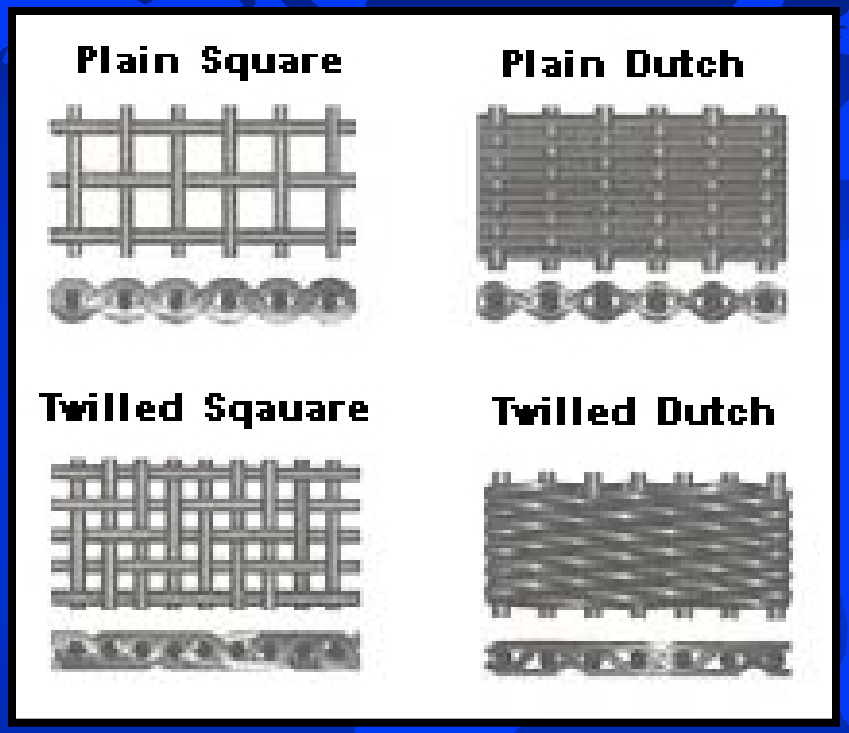
Slim-Pak

Metal Mesh

- **Stainless steel mesh developed in 1980s**
  - Consists of base pipe, layered filtration jacket (uneven pore structure) and outer shroud
  - Less damage occurs during installation
  - Corrosion resistance of stainless steel mesh
- **Sintered (diffusion bonded) stainless steel mesh introduced in 1990s**
  - Consists of base, multi-layer sintered metal mesh jacket (uniform pore structure) and outer shroud
  - Similar damage and corrosion resistance to non-sintered
  - High pore size accuracy, even 100 μm diameter sand can be controlled



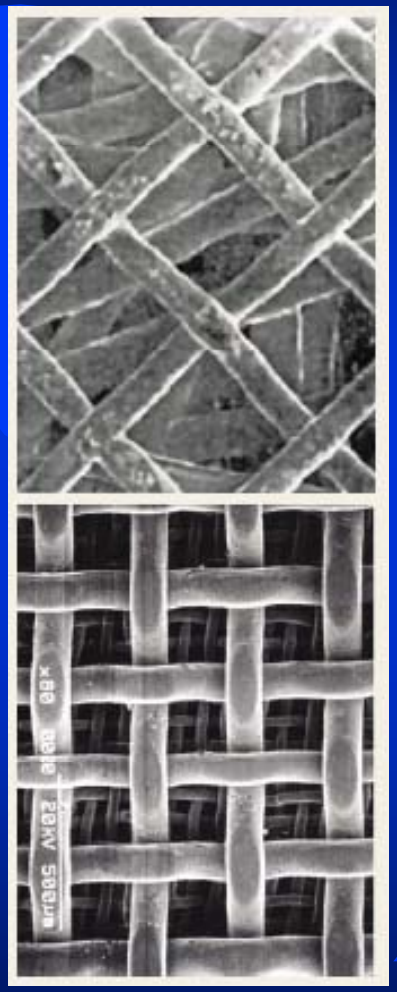
Metal Mesh



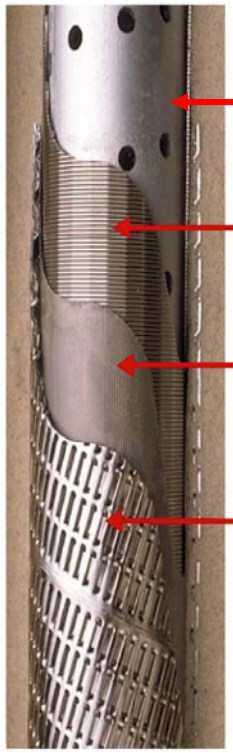
Weave Patterns

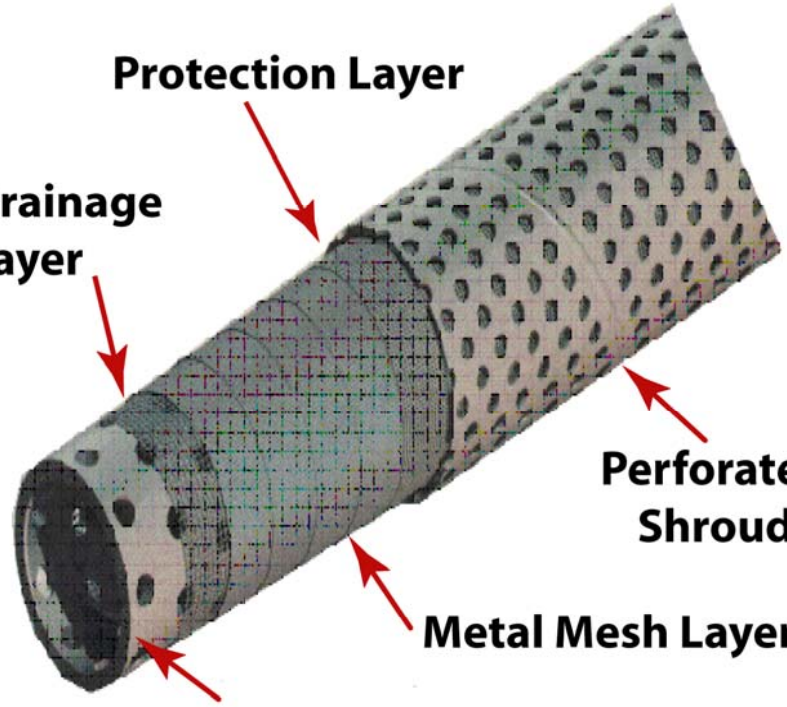
Layered with Non Uniform Pores

Sintered Laminate with Uniform Pores



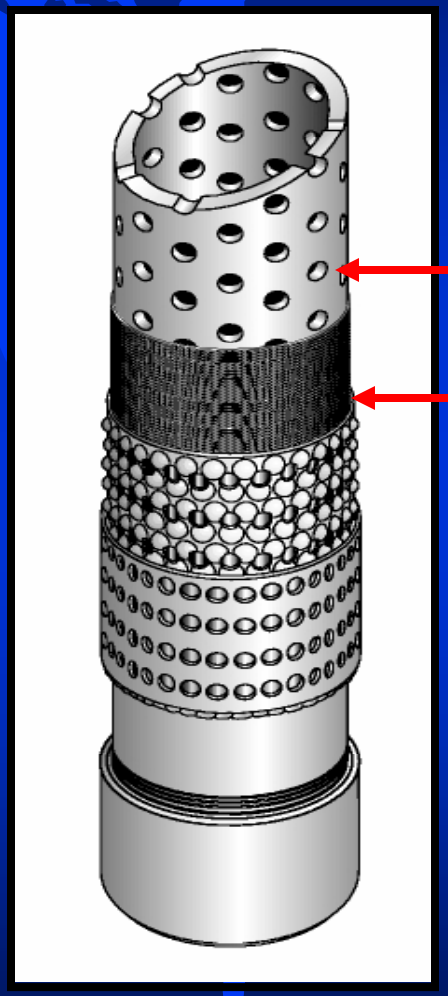
Shrouded Metal Mesh Screens





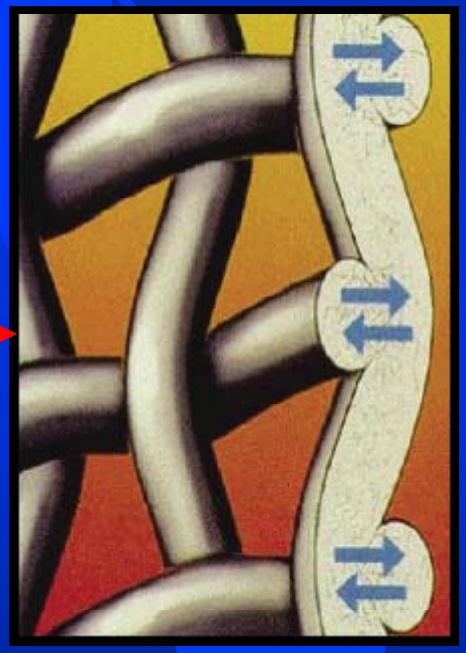
Base Pipe

Shrouded Metal Mesh – Sintered Screen



Base Pipe

Sintered Laminate Filter Media



Diffusion of Metal Molecules

Sintered Screen Filter Media

Filter Mesh Weave Pattern	Plain Square						Plain Dutch					
Support Screen Weave Pattern	Plain Square						Plain Square					
Nominal Filter Rating, micron	140	175	200	250	300	400	50	80	95	125	175	250
Number of Layers	4	4	4	4	4	4	4	3	3	3	3	3
Min. Pore, micron	100	125	150	180	240	240	40	50	65	90	150	200
Max. Pore, micron	175	225	250	320	380	400	70	100	120	150	250	300
Min. Air Permeability, Darcy	600	600	600	700	700	700	320	325	400	400	450	400
Min. Porosity, %	58	58	58	58	57	57	58	60	58	53	54.8	52

Technical Specification Summary

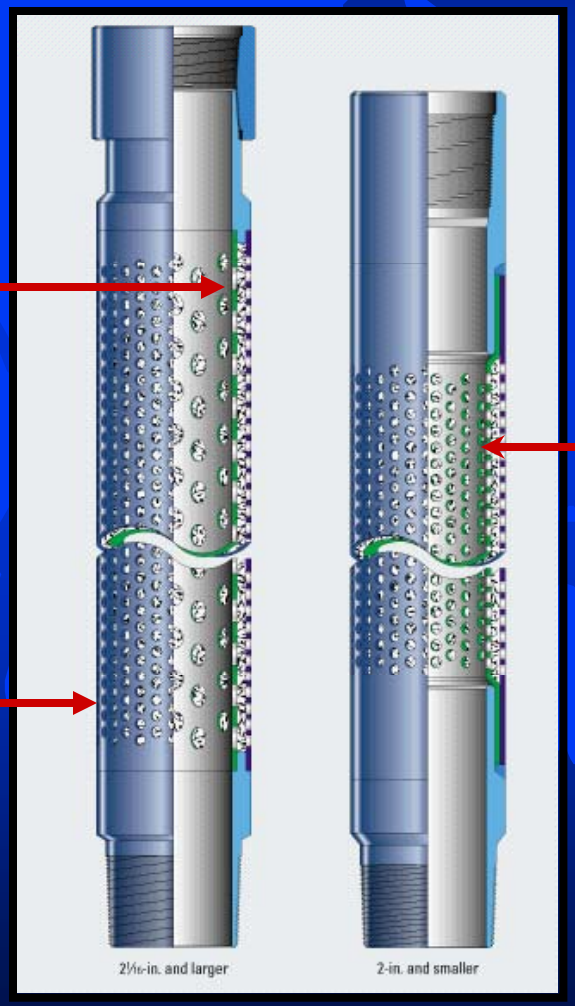
Shrouded Metal Mesh – Non-Sintered Screen

- Introduced in China circa 2000
- Uniform micropore weave composite jacket on base pipe
  - Special welding technique eliminates costly sintering (diffusion bonding)
  - Double-layer media and uniform pores improves performance

Shrouded Metal Mesh Screen

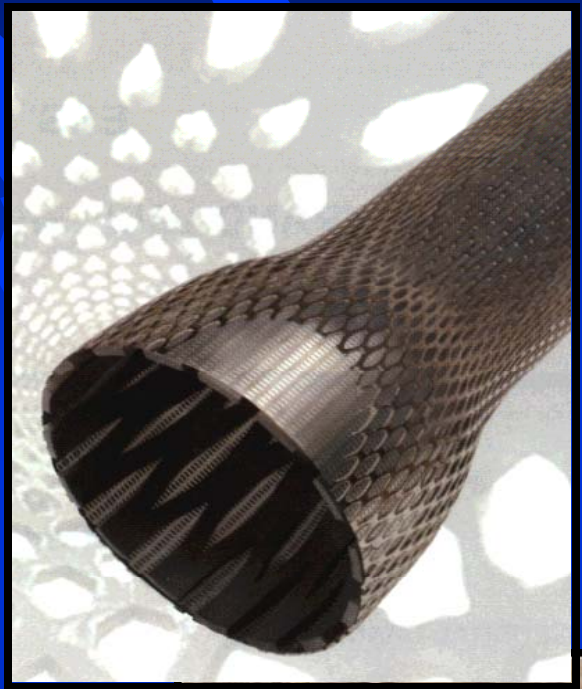
Stainless Steel Wool ~ 600 Darcy

Perforated Jacket



Base Pipe

Expandable Screens



Next Generation Self-Expanding Screen

Guidelines for Screen Selection

- Select largest slot size or micron rating possible (under confines of required retention efficiency)
- Determine screen permeability if convenient
- Larger open area of screen is better
- Screen strength should be considered (protective shrouds, etc.)