Fractal Shallow Bed (FSB) Technology: Increasing the system flow rate results in less resin required for the same application. By shortening the overall path length through the resin bed, the cross-sectional velocity is reduced gaining superior performance due to improved kinetics. System pressure drop is reduced even if Kinetically Enhanced Resins are used or viscous media are processed.

Current conventional fluid distributor designs prevent uniform residence time within the distributor, reducing process efficiency. Fractals eliminate this problem. Uniform residence time and hydraulic equivalency to all distribution points create a Perfect Plug Flow with virtually no mixing or turbulence.

**FEATURES & CHARACTERISTICS**

- Significant reduction in process size
- Scaling accomplished using engineered symmetry
- Hydraulically equivalent distribution
- Unmatched performance at large turn-down ratios
- Process intensification
- Process characteristics maintained through all scales
- Zero pressure drop
- Low pressure systems

**APPLICATIONS & PROCESSES**

- Fluid distributors and collectors
- High performance mixers & reactors
- Shallow bed IEX columns
- SMB chromatography columns
- Adsorption & absorption
- Aeration & gassing
- Other

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**What are Fractals?**
Fractals can be defined as “Self-Similar Objects”: Each iteration results in a smaller and exact reproduction of the larger object. When fractal geometry is applied to Fluid Distribution, the resulting distributor exit points over the entire surface have equal path lengths and Hydraulic Equivalence from the central entry point.

**Engineered Fluid Transporting Fractals**
Amalgamated Research LLC (ARI) is the inventor of the general concepts for the use of engineered fluid transporting fractals. Applications include control of single or multi-phase flows in:

- Chromatography
- Ion Exchange
- Fluidized Beds
- Combustion
- Reaction

ARI fractal technology is protected by several Patents issued and pending. ESCON, as worldwide ARi licensee, supplies engineered fractals – as part of the FSB ion exchange and SMB chromatography technology or designed and manufactured on a contract basis for a user’s particular application.

**Benefits** of fractals in fixed resin bed systems in brief:

- Hydraulically equivalent distribution
- Uniform and increased resin utilization
- Less resin inventory → smaller systems
- Shallow resin bed design → low pressure drop
- Reduced cross-sectional velocities → favorable kinetics
- Sharp fraction cut-off → reduced dilution, waste and energy
- Large flow turn-down ratio → multiple-use systems
- Inherent process scaling → easy scale-up & expandability
- Less system space demand / reduced building requirements

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Optimized Space Filling Characteristics

Fluid Inlets (Liquids and/or Gases) for Turbulence Free Mixing or Defined Reaction

First Iteration

Second Iteration

Centre Inlet or Outlet

Fractal Reactor / Mixer Design

Engineered Fractal for Fluid Distribution and Collection in a Cylindrical Column

Merging Level of the two Fluids

Product Outlet

Fractal Collector Tiles in a 160 m³/h FSB Softener Cell

Fractal Distributor Tiles installed in a Flat Head Toroid Cell for SMB Chromatography

Fractal Top Distributor Tiles of a Square Shaped FSB Softener Cell

Fractal Collector Tiles in an Engineered Fractal FSB Softener Cell