AMALGAMATED RESEARCH INC.
ENGINEERED FLUID TRANSPORTING FRACTALS

Overview

ARi is the inventor of the general concepts for the use of engineered fluid transporting fractals. A few application examples include control of single or multi-phase flows in chromatography, ion exchange, adsorption, absorption, distillation, aeration, scrubbing, extraction, settling, mixing and reactor processes. Other diverse applications include control or suppression of turbulence caused by fluid jets, pluming or wake sources. ARi fractal technology is protected by several patents issued and pending.

Fluid scaling and distribution are general fluid handling requirements and apply to processes that require mixing or geometry transitions. Fractals are, by definition, deeply scaled and therefore address certain related problems, such as uniformity of flow and process scale-up, in a direct and logical manner. In some cases an engineered fractal can be an effective functional substitute for turbulence. With the use of engineered fractals, the random characteristics of the turbulent cascade can be replaced with symmetries. This can result in energy savings, process size reduction and reaction homogeneity. In general, engineered fractals can provide precise control of fluid scaling and distribution and can therefore enhance the efficiency of fluid processes.

ARi designs and implements fractal structures which take advantage of a broad range of possible geometries. For example, devices are constructed to provide surfaces, volumes and non-integer patterns as beneficial for a given process.

A detailed discussion of the use of engineered fractals for controlling fluids and a background of ARi's development of the general concepts concerning these devices can be found at the ARi web site www.arifractal.com.

What are examples of the use of ARi's engineered fluid transporting fractals?

For a given process, fluid properties which can be distributed in a random or uncontrolled manner can include, among others, flow uniformity, eddy size, bubble size, velocity, pressure, temperature, and concentration. Because fluid transporting fractals can be used in general to control the distribution of fluid properties, ARi has designed fractals for use in a diverse range of applications which include:

- Chromatography	- Mixing	- Extraction	- Settling
- Ion exchange	- Distillation	- Scrubbing	- Fluidized beds
- Aeration	- Adsorption	- Combustion	- Membranes
- Reaction	- Absorption	- Turbulence suppression	

General process applications include:

- Liquid processes
- Gas processes
- Liquid/liquid processes
- Liquid/gas processes
- Liquid/solid processes
- Gas/gas processes
- Gas/solid processes
- Liquid/gas/solid processes

How are ARi's fractals designed for a given process?

The goals and required geometry for a process are combined with the use of computational fluid dynamics (CFD) for evaluation of design concepts. This is followed by pilot scale testing with required fluids in the process of interest. Methods of manufacture and materials of construction must be determined for each specific case.

How does ARi provide fractals?

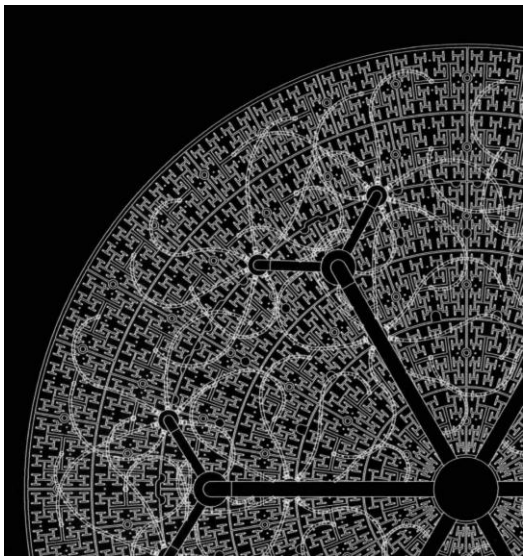
- Fractals are provided with ARi's novel process technology including SMB chromatography, ion exchange, gas/solid, gas/liquid, reactor and other processes.

- Fractals can be designed and manufactured on a contract basis for a user's particular application.

- Fractals can be provided through one of several licensees of ARi fractal technology.

Examples

Following are a few examples of Amalgamated Research Inc. engineered fluid transporting fractals. This is only a sample of the broad range of fractal structures which ARi has designed and implemented since the early 1990s.

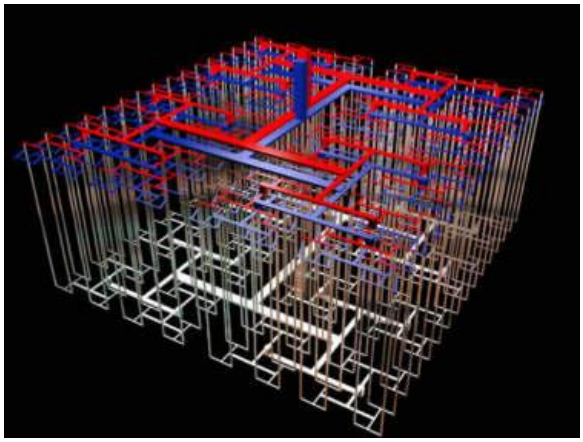


ARi's fractal distribution technology can be used in a variety of applications to provide control over the distribution and/or collection of fluids. ARi has installed over 45,000 ft^2 of fractal distribution/collection structure similar to that illustrated in the figure.

Applications as diverse as chromatography, ion exchange, adsorption, reaction, mixing, gas/liquid and gas/solid processes have been addressed with these structures.

Device size has ranged from a few cm to over 6 meter diameter.

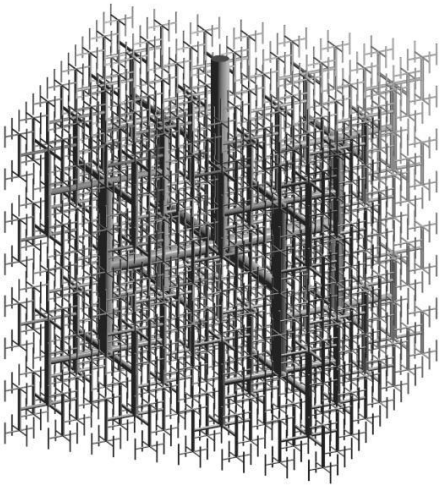
Single and multi-phase processing has included gases, water and organic solvent based solutions, concentrated acids and other corrosive materials.



The figure to the left is one example of ARi's "multiple fractal" technology which can be used in general to scale and distribute two or more fluids simultaneously.

The particular illustrated device can be used for homogenous mixing and/or reaction of two fluids. The device operates with low energy use, eliminates large non-uniform eddies and has near instantaneous response to process alterations (very low process inertia).

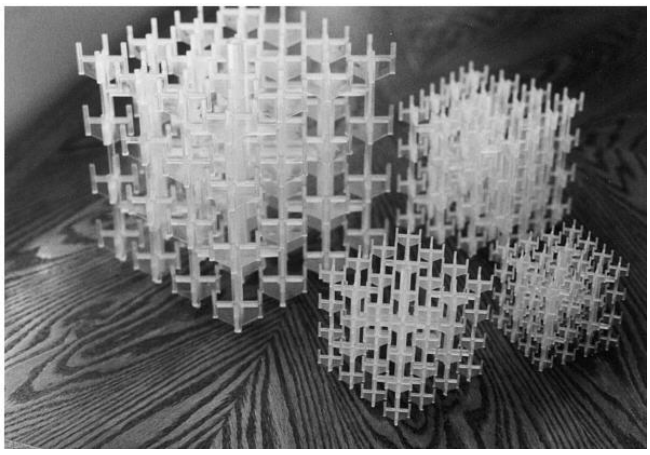
Variations of ARi's multiple fractal technology can be used to address a variety of fluid distribution problems - whenever it is beneficial to precisely control many or all of the fluids in a process.

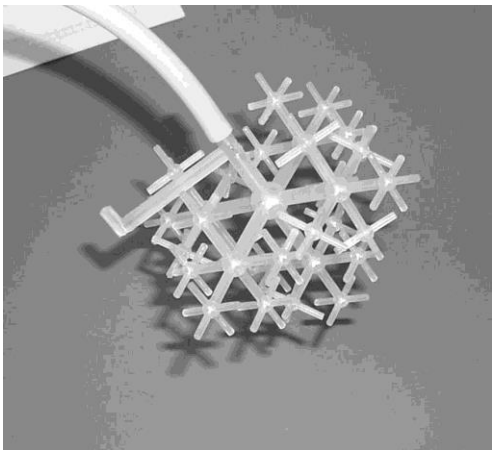


ARi designs and constructs fractals used to distribute and/or collect fluids from a volume. The figure to the left is an example. The photos below show functional devices of this type.

Below-left are a variety of structures with variable space filling density and channel sizing.

Below-right is an example of a volume processing structure constructed with a non-integer pattern (a fractal dimension of 2.32). The fractal dimension effects the space filling characteristics of a device.





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