

IN THE UNITED STATES DISTRICT COURT
FOR THE SOUTHERN DISTRICT OF TEXAS
HOUSTON DIVISION

UNITED STATES COURTS
SOUTHERN DISTRICT OF TEXAS
FILED

BL DEC 2 - 2004

Michael N. Milby, Clerk of Court

UNICAT CATALYST TECHNOLOGIES, INC.,

Plaintiff,

v.

CRYSTAPHASE PRODUCTS, INC., AND JOHN
GLOVER,

Defendants.

C.A. NO. _____

H-04-4541

JURY TRIAL DEMANDED

COMPLAINT

Plaintiff Unicat Catalyst Technologies, Inc. ("Unicat") brings this action against Defendant Crystaphase Products, Inc. ("Crystaphase") and John Glover ("Glover") and alleges as follows:

THE PARTIES

1. Plaintiff Unicat is a corporation organized and existing under the laws of the State of Texas with a principal place of business at 1600 Highway 6 East, Suite 320, Alvin, Texas 77511.

2. On information and belief, Defendant Crystaphase is a corporation organized and existing under the laws of the State of Texas, with its principal office of business at 16945 Northchase Dr., 1610, Houston, Texas 77060.

3. On information and belief, Defendant John Glover is an individual who is a resident of Texas, and may be served at his place of business at 16945 Northchase Dr., 1610, Houston, Texas 77060.

JURISDICTION AND VENUE

4. This is an action that arises under the Patent Laws of the United States, Title 35, United States Code § 1 et seq., and under the Federal Declaratory Judgment Act, 28 U.S.C. §§ 2201, et seq. Subject matter jurisdiction is proper under 28 U.S.C. §§ 1331, 1338 and 1367.

5. Venue is proper in this Court under 28 U.S.C. § 1391.

BACKGROUND

6. Unicat is a small company in Alvin, Texas in the business of selling catalysts and other products for the hydrocarbon and refining industry.

7. Unicat has suppliers overseas that provide Unicat with materials and products from which Unicat derives its inventory of saleable products.

8. Because Unicat is a very small company, Unicat relies heavily in marketing and selling its products on getting references from or making appearances with larger, industry-recognized, marketing and petrochemical companies who endorse Unicat's products at trade shows and conferences or who join Unicat in publishing industry papers. Moreover, Unicat relies on its reputation of honesty and of selling products that are untainted by claims of infringement in order to sell its products to customers.

9. One of the products that Unicat sells is its AFSTM (Active Filtration System) line of products. While Unicat's principals, James McKimmy and Mani Erfan, have made improvements to this product to increase its performance as a catalyst and provided the marketing name AFSTM to such products, McKimmy and Erfan learned about the basic AFSTM product in 1998 and 1999, prior to the time Unicat was even established. At that time, an overseas manufacturer of catalysts and filters provided McKimmy and Erfan samples of AFSTM products, marketing photographs of AFSTM products as well as catalogs that displayed AFSTM

products, which described their use as a bed topping, catalyst support and filtration system for the petrochemical and refining industry, including for use with hydrocarbons and other organic streams as a filter and flow distributor.

10. McKimmy and Erfan learned at this time that their suppliers and related companies have been using this and similar products in the petrochemical industry since the mid-1990s.

11. Indeed, McKimmy and Erfan have since learned that overseas companies have numerous published patent applications and/or public catalogs on similar shaped ceramic products for use in the petrochemical industry as a filter and flow distributor, many of which date before 1997.

12. In January 2000, McKimmy and Erfan finalized the formation of Unicat and began marketing products made by its overseas suppliers. At that time Unicat planned to sell AFS™ catalyst systems manufactured by its overseas suppliers and displayed in their public catalogs sometime in the future. Unicat initially began its small business venture by primarily selling hydrogen plant catalysts and bed topping for refineries. Later, Unicat began selling AFS™ systems as catalysts that served as filtration and distribution systems, as generally depicted in the catalogs of their suppliers.

13. McKimmy and Erfan developed a marketing strategy to sell AFS™ products by, as mentioned earlier, getting references from or making appearances with larger, industry-recognized, marketing and petrochemical companies who would agree to endorse Unicat's products at trade shows and conferences or who would join Unicat in publishing industry papers on AFS™ products.

14. Crystaphase and its President, John Glover, saw that Unicat began enjoying a measure of success with its AFS™ products and concocted schemes to hinder and attempt to destroy that business. Indeed, they knew that Unicat's AFS™ products were superior products that competed with Crystaphase's CatTrap products, and that if Crystaphase did not somehow stop Unicat from fairly competing, Crystaphase would lose market share and business. Thus, Crystaphase and Glover initiated a scheme to cause Unicat to lose business through business disparagement, defamation, unfair competition and interference with business relations.

15. In furtherance of that scheme, Crystaphase and Glover targeted major industry players, including customers of Unicat, that had seen the merit and superiority of Unicat's AFS™ technology and had decided to purchase AFS™ products from Unicat and had agreed to act as a reference for Unicat's AFS™ products.

16. For example, Unicat was successful in obtaining the confidence and business of ConocoPhillips, a major industry player in the petrochemical industry.

17. ConocoPhillips was also a customer of Crystaphase and purchased Crystaphase's CatTrap products.

18. But when Crystaphase saw that ConocoPhillips was purchasing AFS™ products, Crystaphase and Glover maligned Unicat, its principals and its products in order to stop the growth of Unicat's sales of AFS™ products to ConocoPhillips.

19. Crystaphase and/or its agents conveyed to ConocoPhillips that Unicat's AFS™ products infringed one or more of Crystaphase's patents.

20. Specifically, Crystaphase holds U.S. Patent Nos. 6,258,900 (Ex. A) and 6,291,603 (Ex. B) (collectively, the "Crystaphase Patents"). Crystaphase and its agents conveyed to

ConocoPhillips that ConocoPhillips would need a license under the Crystaphase Patents if ConocoPhillips continued to purchase Unicat's AFS™ products.

21. The statements referenced in ¶¶ 18-19 that Crystaphase and its agents made to ConocoPhillips were false.

22. Crystaphase and Glover know that the claims of the Crystaphase Patents are limited to filtration methods that employ a "reticulated ceramic material."

23. Crystaphase and Glover also know that the ordinary and customary meaning of the term "reticulated ceramic" in the chemical industry is limited to ceramic foams.

24. Further, Crystaphase and Glover know that the named inventor of the Crystaphase Patents, Glover, did not contemplate at the time Glover filed and prosecuted his alleged invention claimed in the Crystaphase Patents that honeycomb ceramics was included within the meaning of reticulated ceramics, as used in the Crystaphase Patents.

25. Crystaphase and Glover also know that the Crystaphase Patents disclose only ceramic foams as "reticulated ceramic materials."

26. Specifically, the figures in the Crystaphase Patents all depict ceramic foams.

27. The claims in the Crystaphase Patents only refer to ceramic foams.

28. U.S. Patent No. 6,258,900 discloses the use of ceramic foams to remove contaminants from an organic based feed stream.

29. U.S. Patent No. 6,258,900 discloses the use of ceramic foams to distribute the flow of an organic based feed stream.

30. U.S. Patent No. 6,258,900 does not disclose the use of honeycomb ceramics to remove contaminants from an organic based feed stream.

31. U.S. Patent No. 6,258,900 does not disclose the use of honeycomb ceramics to distribute the flow of an organic based feed stream.

32. U.S. Patent No. 6,291,603 discloses the use of ceramic foams to remove contaminants from an organic based feed stream.

33. U.S. Patent No. 6,291,603 discloses the use of ceramic foams to distribute the flow of an organic based feed stream.

34. U.S. Patent No. 6,291,603 does not disclose the use of honeycomb ceramics to remove contaminants from an organic based feed stream.

35. U.S. Patent No. 6,291,603 does not disclose the use of honeycomb ceramics to distribute the flow of an organic based feed stream.

36. And the only example of a specific, suitable “reticulated ceramic material” disclosed in the Crystaphase Patents is a ceramic foam from SELEE Corporation.

37. Crystaphase and Glover also know that Unicat’s AFS™ products are not ceramic foams.

38. Crystaphase and Glover also know that nothing in the Crystaphase Patents references honeycomb ceramics.

39. Consequently, Crystaphase and Glover know that Unicat’s AFS™ products are not “reticulated ceramic materials” as that term is used in the Crystaphase Patents, and that neither Unicat nor any of its customers infringe the Crystaphase Patents by using AFS™ products as filtration materials.

40. The statements that Crystaphase and its agents made to ConocoPhillips were malicious and made with bad intent.

41. Indeed, Crystaphase and Glover knew that the statements conveying to ConocoPhillips that Unicat's AFS™ products infringed the Crystaphase Patents were false.

42. Alternatively, Crystaphase made such statements to ConocoPhillips without regard to whether those statements were true or false and while having no opinion on whether Unicat's AFS™ products actually infringe the Crystaphase Patents.

43. Crystaphase and Glover also told ConocoPhillips and/or other actual or potential customers of Unicat that Unicat allegedly developed its AFS™ products through trade secrets misappropriated from Crystaphase.

44. Crystaphase and Glover also told ConocoPhillips and/or other actual or potential customers of Unicat that Crystaphase had sued Unicat for allegedly misappropriating Crystaphase's alleged trade secrets related to Unicat's AFS™ products.

45. Crystaphase sued Unicat in Texas state court (164th Judicial District Court of Harris County, Texas; cause no. 2003-39398) for allegedly misappropriating Crystaphase's alleged trade secrets related to Unicat's AFS™ products.

46. The trade secrets that Crystaphase alleges Unicat stole from Crystaphase includes the alleged idea that honeycomb ceramic filters can be used as a filter and flow distribution device in the petrochemical and refining industry.

47. The trade secrets that Crystaphase alleges Unicat misappropriated in the state court suit are not disclosed in the Crystaphase Patents.

48. Crystaphase and Glover know that the trade secrets that Crystaphase alleges Unicat misappropriated in the state court suit are not disclosed in the Crystaphase Patents.

49. Notwithstanding this, Crystaphase and Glover are maliciously accusing Unicat of infringing Unicat's patents through the use of the same alleged trade secrets made the basis of

Crystaphase's state court suit, knowing that such secrets are not disclosed in Crystaphase's Patents (and thus, there can be no infringement), or alternatively, having no opinion whether the alleged trade secrets are disclosed in Crystaphase's Patents.

50. Crystaphase and Glover are telling actual and/or potential customers of Unicat that Crystaphase has sued Unicat for misappropriation of trade secrets related to the AFS products to create fear and to unjustly intimidate Unicat's customers (or potential customers) into believing Crystaphase's message that (1) Crystaphase's Patents cover Unicat's AFS products – when Crystaphase and Glover know that this is false or they have no belief whether it is false or not, and (2) Crystaphase will enforce the Crystaphase Patents against Unicat and its customers or potential customers.

51. Crystaphase and Glover are thus trying to scare away Unicat's actual and/or potential customers from doing business with Unicat or from expanding their business with Unicat.

52. As another example, ConocoPhillips had also agreed to co-author an industry paper on AFS™ products and ConocoPhillips' use of AFS™ products, which would be used to market AFS™ products and obtain substantial business for Unicat in the industry. As a result of Crystaphase's, Glover's and their agents' conduct described above, however, ConocoPhillips refused to participate in the paper, resulting in more damage to Unicat.

53. Indeed, as a result of Crystaphase's and Glover's conduct, ConocoPhillips has demanded that Unicat provide ConocoPhillips a complete indemnity against any alleged infringement of the Crystaphase patents as a condition for Unicat to continue doing business with ConocoPhillips.

54. Indeed, Crystaphase's and Glover's words and actions have infected the marketplace with uncertainty and insecurity regarding Crystaphase's veiled threats that Unicat's AFS™ products infringe the Crystaphase patents. Unicat and its customers have thus had a reasonable apprehension of a patent infringement suit from Crystaphase – even though Crystaphase and Glover know that the Crystaphase Patents do not cover AFS™ products and that the Crystaphase Patents are invalid.

55. Upon information and belief, this pattern of malicious conduct by Crystaphase and Glover has continued with other existing and potential customers of Unicat, such that Unicat has lost business in an amount that exceeds well over \$1,000,000. These existing and potential customers include Valero Energy in Benicia CA, which caused Unicat at least \$200,000 in damages; M Chemical, with losses in excess of \$70,000; Lyondell Citgo, with losses in excess of \$1,000,000; Univar, with losses in excess of \$500,000; and others.

COUNT ONE
DECLARATORY JUDGMENT: NONINFRINGEMENT

56. Unicat incorporates paragraphs 1-55 by reference as if expressly set forth herein.

57. Crystaphase claims to be the assignee of the Crystaphase Patents and claims to be the holder of the exclusive right to sue under those patents.

58. Crystaphase has repeatedly conveyed by its words and actions that Unicat and its customers infringe the Crystaphase Patents.

59. By these words and actions, Crystaphase has threatened to sue Unicat and/or its customers for infringement of the Crystaphase Patents.

60. Unicat has not infringed and does not infringe any claim of either of the Crystaphase Patents.

61. Accordingly, a case of actual controversy exists with respect to which Unicat requests declaratory judgment in its favor.

COUNT TWO
DECLARATORY JUDGMENT: PATENT INVALIDITY

62. Unicat incorporates paragraphs 1-61 by reference as if expressly set forth herein.

63. Each of the Crystaphase Patents is invalid under the patent laws of the United States for failure to satisfy at least one of the requirements for patentability set forth in chapter 2 of Title 35, United States Code, including at least sections 101, 102, 103, and/or 112 thereof.

64. Accordingly, a case of actual controversy exists with respect to which Unicat requests declaratory judgment in its favor

COUNT THREE
BUSINESS DISPARAGEMENT

65. Unicat incorporates paragraphs 1-64 by reference as if expressly stated herein.

66. Crystaphase and Glover have falsely, and with malicious intent, published statements (written and/or oral) asserting that Unicat infringes the Crystaphase Patents.

67. Crystaphase and Glover have intended to intimidate Unicat's customers to terminate or limit their business dealings with Unicat. Crystaphase and Glover have intended to intimidate potential customers of Unicat for the same purpose.

68. Crystaphase's and Glover's allegations are false.

69. Crystaphase made the allegations with malice and without privilege.

70. Crystaphase and Glover have caused businesses to terminate or curtail their business relationships with Unicat or to refrain from initiating business relationships that otherwise would have been initiated.

71. As a proximate result of Crystaphase's and Glover's conduct, Unicat has suffered substantial losses.

COUNT FOUR
DEFAMATION

72. Unicat incorporates paragraphs 1-71 by reference as if expressly stated herein.

73. Crystaphase and Glover acted with actual malice, or alternatively, with negligence in publishing the above identified statements.

74. Crystaphase's and Glover's statements not only harmed Unicat economically but also damaged its business reputation.

75. Such allegations were a direct attack upon Unicat and/or implied that Unicat is dishonest and unethical in its business dealings and injured its professional reputation. Indeed, these allegations impugned Unicat's honesty, integrity and overall reputation and resulted in financial injury.

76. As a result of the attack on Unicat's reputation, Unicat suffered financial injuries. In fact, after the other business entities terminated or curtailed their business relationships with Unicat, Unicat lost in excess of one million dollars in sales or potential sales.

77. Unicat has thus suffered specific, actual loss as a result of these allegations.

78. Accordingly, Crystaphase and Glover are liable for defamation (per se and/or per quod). In addition, Crystaphase and Glover are liable for statutory libel pursuant to § 73.001 of the Texas Civil Practice and Remedies Code.

COUNT FIVE
TORTIOUS INTERFERENCE WITH EXISTING CONTRACT

79. Unicat incorporates paragraphs 1-78 by reference as if expressly stated herein.

80. At least one of the business entities (i.e. distributors and customers) to whom Crystaphase and Glover made all of their false statements had existing, valid agreements with Unicat.

81. Crystaphase and Glover intentionally and willfully interfered with these agreements by communicating their false allegations to these business entities.

82. Crystaphase and Glover intended that these entities terminate their agreements as a result of their allegations.

83. At least one of these entities did in fact terminate an agreement with Unicat as a result of Crystaphase's and Glover's allegations.

84. Unicat suffered substantial damages in lost sales as a result of Crystaphase's and Glover's conduct.

COUNT SIX
TORTIOUS INTERFERENCE WITH PROSPECTIVE RELATIONS

85. Unicat incorporates paragraphs 1-84 by reference as if expressly stated herein.

86. Several of the business entities to which Crystaphase and Glover published its allegations concerning Unicat did not have existing contractual relationships with Unicat but had a high probability of entering into contractual relationships with Unicat.

87. Crystaphase's and Glover's actions, which were independently tortious and/or unlawful, prevented these relationships from occurring.

88. Crystaphase and Glover performed its acts with a conscious desire to prevent the relationships from occurring or knew the interference was certain or substantially certain to occur as a result of its conduct.

89. Unicat suffered substantial damages as a result of Crystaphase's and Glover's conduct.

COUNT SEVEN
UNFAIR COMPETITION

90. Unicat incorporates paragraphs 1-89 by reference as if expressly stated herein.

91. Crystaphase's and Glover's conduct as set forth above was independently tortious and/or unlawful and interfered with Unicat's ability to conduct their business for catalysts and filtration materials.

92. Unicat has suffered harm in the form of lost sales as a result of these acts of unfair competition.

JURY DEMAND

93. Pursuant to Rule 38(b), Fed. R. Civ. P., Plaintiff requests a trial by jury.

PRAYER FOR RELIEF

WHEREFORE, Unicat respectfully requests that this Court:

- (i) Assess damages against Crystaphase and Glover in an amount to be proved at trial;
- (ii) Declare the Crystaphase Patents not infringed;
- (iii) Declare the Crystaphase Patents invalid;
- (iv) Declare that this is an exceptional case under 35 U.S.C. § 285;
- (v) Award Unicat its attorneys' fees and costs of this action;
- (vi) Award punitive damages;
- (vii) Permanently enjoin Crystaphase, Glover and their agents and all others acting in active concert or participation with either of them against any future allegations of patent infringement of the Crystaphase Patents;
- (viii) Order Crystaphase and Glover to contact each individual to whom such allegations have been made and to affirmatively withdraw such allegations; and

(ix) Grant Unicat any and all additional relief to which this Court finds that Unicat is entitled.

DATED: 12-1-04

By 

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US006258900B1

(12) **United States Patent**
Glover

(10) **Patent No.:** **US 6,258,900 B1**
(45) **Date of Patent:** **Jul. 10, 2001**

(54) **FILTRATION AND FLOW DISTRIBUTION METHOD FOR CHEMICAL REACTORS**

(75) Inventor: **John N. Glover**, Spring, TX (US)

(73) Assignee: **Crystaphase International, INC**, Houston, TX (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/116,863**

(22) Filed: **Jul. 16, 1998**

(51) **Int. Cl.**⁷ **C08F 2/00**

(52) **U.S. Cl.** **526/67; 526/71; 526/64**

(58) **Field of Search** **526/67, 64, 71**

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Primary Examiner—David W. Wu

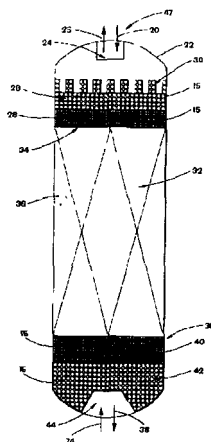
Assistant Examiner—Ling-Siu Choi

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(57) **ABSTRACT**

A method for removing contaminants from an organic-based feed stream which includes the use of a layer of reticulated ceramic material to filter the organic-based feed stream and to provide liquid distribution upstream of the catalyst bed.

43 Claims, 7 Drawing Sheets



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U.S. PATENT DOCUMENTS

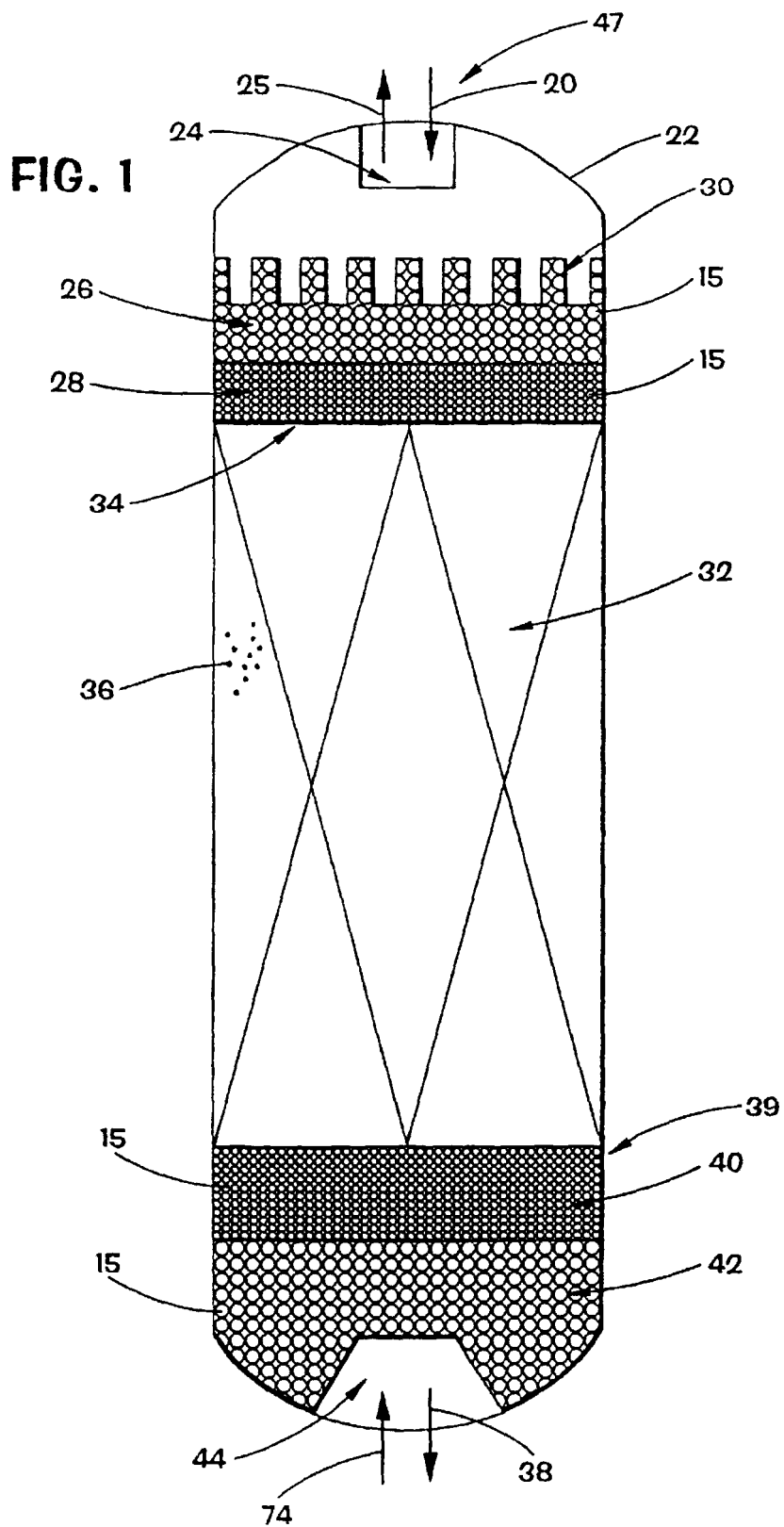
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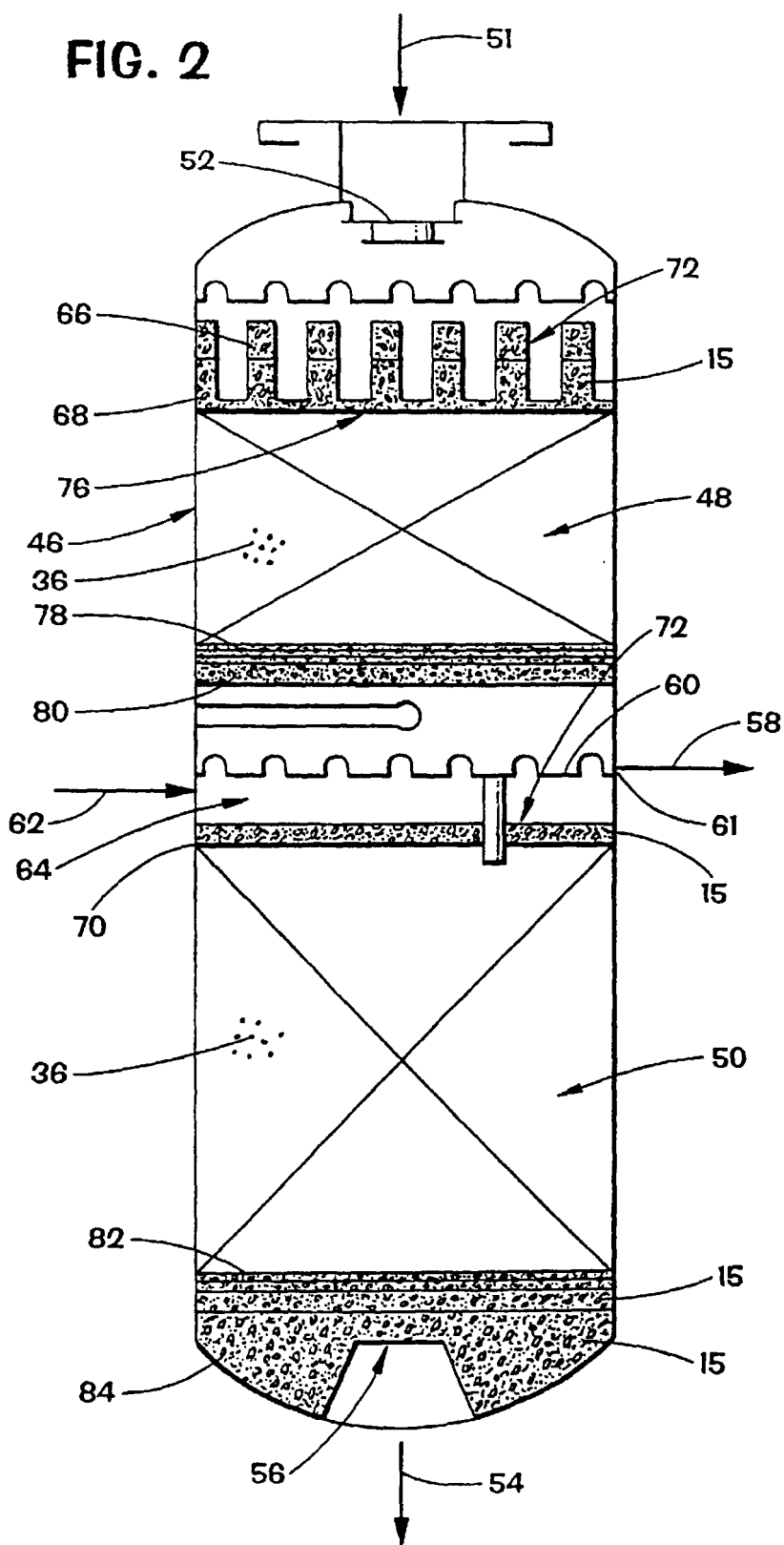


FIG. 3

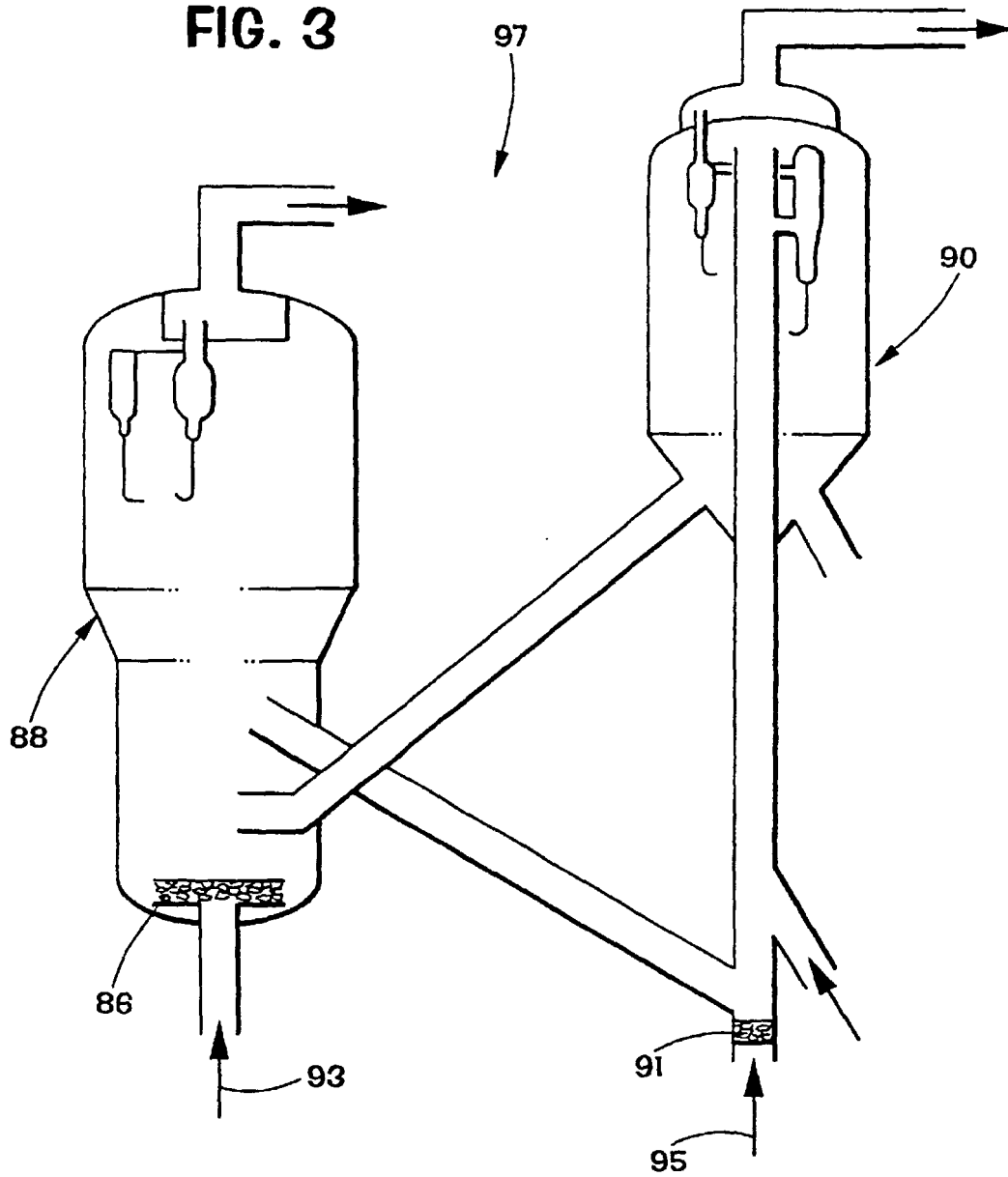


FIG. 4

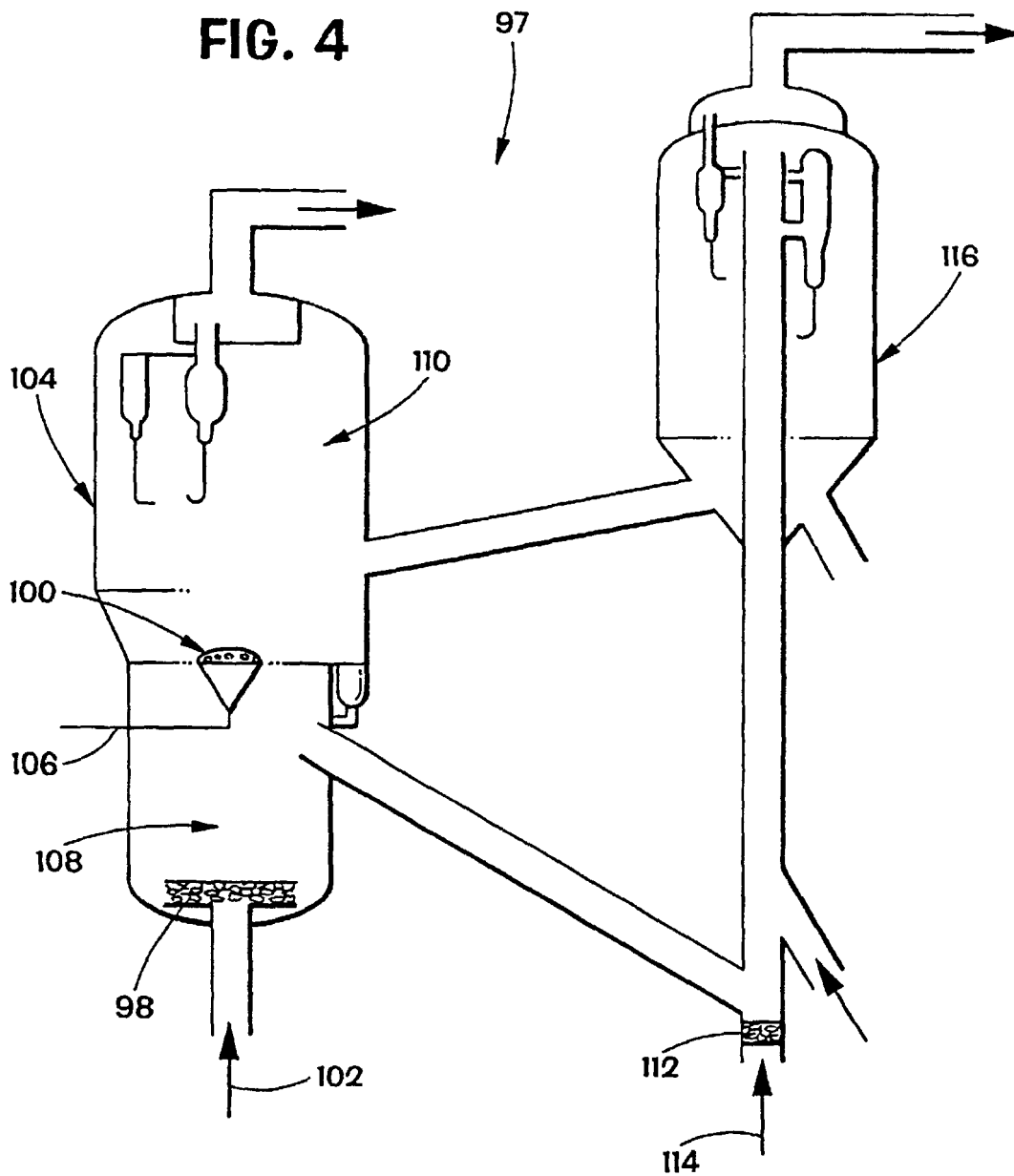
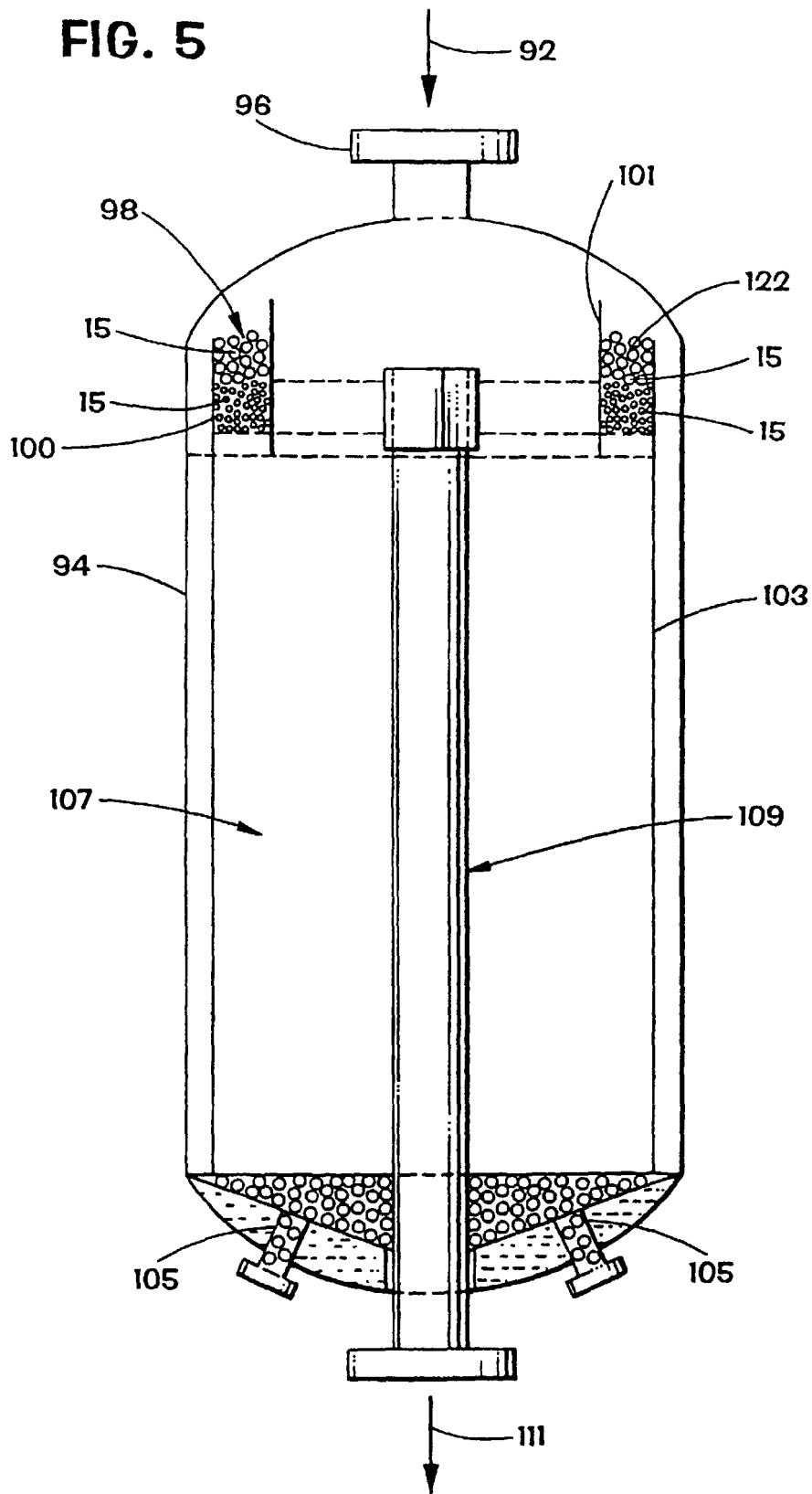


FIG. 5



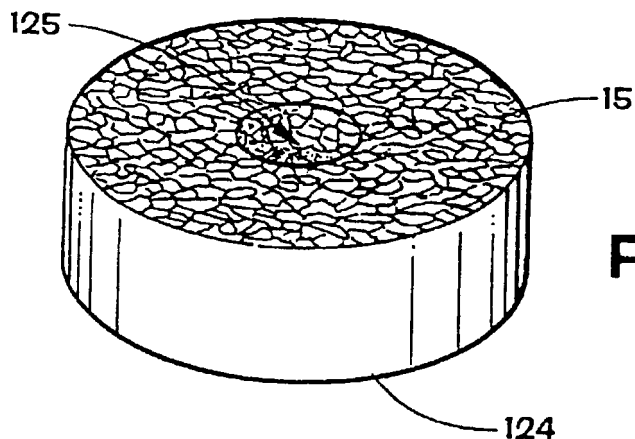


FIG. 6

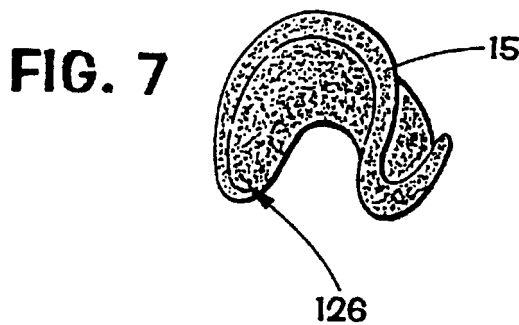


FIG. 7

FIG. 8

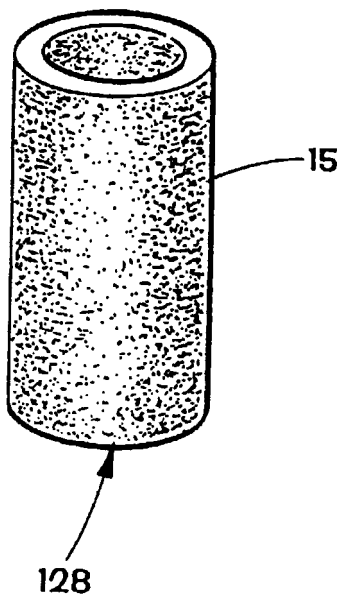
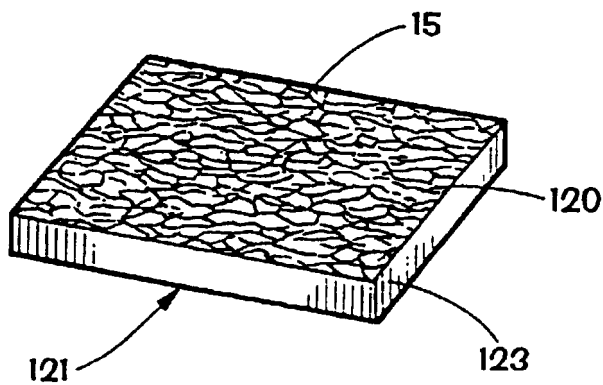


FIG. 9



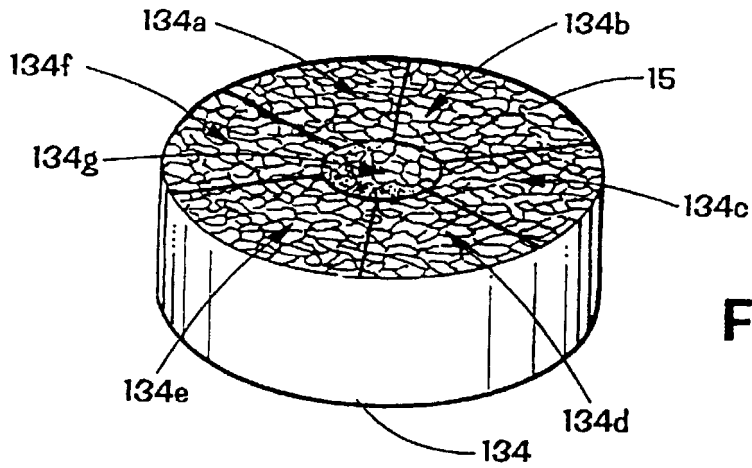


FIG. 10

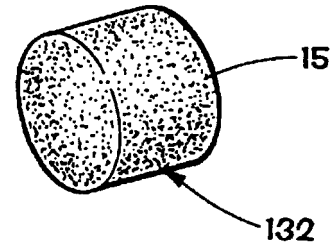
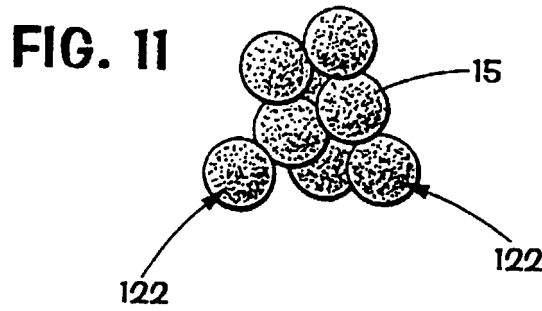
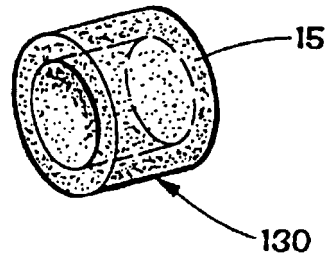


FIG. 12

FIG. 13



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**FILTRATION AND FLOW DISTRIBUTION
METHOD FOR CHEMICAL REACTORS****RELATED APPLICATIONS**

This application claims the benefit of U.S. Provisional Application No. 60/052,969, filed Jul. 18, 1997.

BACKGROUND OF THE INVENTION**1. Field of the Invention**

The invention relates to a method of providing filtration of solids from organic-based feed streams to chemical reactors. In another aspect, this invention relates to a method for providing flow distribution of organic-based feed streams to chemical reactors. More particularly, the invention relates to a method for filtering solids and providing liquid distribution for organic-based feed streams that are subsequently processed in chemical reactors having discrete solid element catalyst bed(s). In another aspect, the invention is directed toward distributing inlet air or vapors, particularly for fluidized bed reactors. A further aspect of the invention relates to a method for partially reacting polymer precursors in organic-based feed streams to chemical reactors to reduce fouling of the solid element catalyst bed(s).

2. Description of Related Art

Typically chemical reactor beds include discrete solid catalyst particles contained in one or more fixed beds. Often these beds are supported, or retained, at their inlet and/or outlet by materials which are inert to the reaction. These inert materials may trap all or some solid contaminants such as dirt, iron oxide, iron sulfide, asphaltenes, coke fines, catalyst fines, sediments or other entrained foreign particulate material in the reactor feed stream. The trapping of the contaminants is to prevent undesirable material from plugging, poisoning or otherwise deactivating the catalyst bed. The inert materials, or inerts, traditionally used are typically made of conventional ceramic materials in the form of pellets or spheres and typically must be resistant to crushing, high temperatures and/or high pressures. In addition, these materials may facilitate distribution of the feed stream across the catalyst bed in such a manner to reduce channeling through the catalyst bed.

To increase the efficiency of the inerts, graduated layers of inerts in different sizes and shapes along with perforated discs, or screen baskets, have been used to retard the surface of a catalyst bed from becoming plugged with contaminants such as dirt, iron oxide, iron sulfide, asphaltenes, coke fines, catalyst fines, sediments, or other entrained foreign particulate material. Skimming, or removal, of the top portion of the catalyst is required when the filtering capacity of the inerts is exhausted resulting in the catalyst itself being used as a filter. In addition to catalyst fouling by particulate matter in the organic-based stream, polymerization of polymer precursors, e.g., diolefins, found in the organic-based feed stream may also foul the catalyst. In particular, two mechanisms of polymerization, free radical polymerization and condensation-type polymerization, may cause catalyst bed fouling, gumming or plugging. The addition of antioxidants to control free radical polymerization has been found useful where the organic-based feed stream has encountered oxygen. Condensation polymerization of diolefins typically occurs after the organic-based feed is heated. Therefore, filtering prior to the organic-based feed stream entering the reactor may not be helpful to remove these foulants as the polymerization reactions generally take place in the reactors.

It is highly desirable to increase the efficiency of the inert bed filtration and to control the rate of reaction of the

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diolefins or other polymer precursors. Thus, the development of a method of filtration that increases the efficiency of the filtering of the contaminated feed stream may also reduce the volume of inerts required to protect the catalyst bed from solid deposition, as well as reduce the pressure drop associated with plugging. The method of the present invention for filtration and flow distribution for chemical reactors, when compared with previously proposed prior art methods, has the advantages of: providing more efficient filtering; increasing catalyst life; decreasing catalyst losses; and reducing the need to take the reactor off-line for maintenance when removal or replacement of the inert material or any catalyst that is plugged is required. These benefits may result in both capital and operating savings.

Disadvantages associated with current liquid distribution designs and methods in fixed bed chemical reactors may result in poor liquid distribution to the catalyst bed. Partial plugging of the catalyst bed with contaminants, or gumming by reactive diolefins or other polymer precursors, may also cause maldistribution. The maldistribution may result in channeling and corresponding bypassing of portions of the catalyst bed, reducing the catalyst efficiency. Usually, a maldistribution problem is evidenced by radial temperature differences. Therefore, the art has sought a flow distribution method that may spread the liquid more uniformly through the catalyst bed, provide efficient filtering and reduce fouling caused by undesired polymerization reactions.

Accordingly, prior to the development of the present invention, there has been no method for filtering and/or distributing organic-based feed streams to chemical reactors which: may capture a mixture of large and small contaminants without plugging or blinding; does not cause relatively large pressure drops across the filtering and/or distribution media; does not require excessive capital and operating costs; and does not cause process safety and environmental concerns arising from maintenance required shutdowns and start-ups. Therefore, the art has sought a method for extending the run life of catalyst beds by filtering and distributing organic-based feed streams to chemical reactors which: does not require excessive amounts of catalyst; does not require the use of relatively large amounts of inert material; does not cause relatively large pressure drops across the bed; does not require relatively large capacity circulation pumps or compressors; and does not cause process safety and environmental concerns arising from reactor shutdowns and start-ups.

SUMMARY OF INVENTION

In accordance with the invention, the foregoing advantages have been achieved through the present method of filtering and distributing an organic-based feed for chemical reactors. The present invention for removing contaminants from an organic-based feed stream may include the steps of providing a layer of reticulated ceramic material in a chemical reactor, the layer of reticulated ceramic material being in an amount sufficient to filter some or all of the contaminants from the organic-based feed stream; and passing the organic-based feed stream through the layer of reticulated ceramic material. The reticulated ceramic material may be made from any commercially available materials, for example, ZTA. The ZTA may have a product composition of ZrO_2/Al_2O_3 and is available from SELEE Corporation headquartered in Hendersonville, N.C. The organic-based feed stream may be an organic-based liquid, a vapor phase, or both, and the contaminants may include dirt, iron oxide, iron sulfide, asphaltenes, coke fines, catalyst fines, sediments or other entrained foreign particulate matter, or polymer precursors

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such as diolefins. The reticulated ceramic material should be provided in a layer in an amount sufficient to remove some or all of the contaminants from the organic-based feed stream. Another feature of the present invention for removing contaminants from a contaminated organic-based feed stream in a chemical reactor includes the steps of providing a layer of reticulated ceramic material in the chemical reactor and contacting the contaminated organic-based feed stream with the reticulated ceramic material to remove the contaminants from the contaminated organic-based feed stream. Another feature of the present invention may include the step of providing a decontaminated organic-based feed stream for further processing.

More particularly, the invention relates to a process for improving feed quality of organic-based feed streams to chemical reactors. Preferably, the chemical reactors use discrete solid element catalyst beds. The chemical reactors may include hydrotreater, hydrorefiner, hydrocracker, reformer, alkylation, isomerization, and polymerization reactors. The discrete solid catalyst particles may be contained in one or more fixed beds and in either an upflow, downflow or radial flow design.

In accordance with another aspect of the present invention, the present method of flow distribution in a chemical reactor includes the steps of: providing a layer of reticulated ceramic material in the chemical reactor, the reticulated ceramic material having a plurality of web members defining a plurality of flow passageways through the reticulated ceramic material; contacting an organic-based feed stream with the layer of reticulated ceramic material; and subdividing the organic-based feed stream into a plurality of smaller fluid streams by passing the organic-based feed stream through the plurality of flow passageways defined by the web members of the reticulated ceramic material. A further feature of this aspect of the present invention may include the steps of removing contaminants from a contaminated organic-based feed stream; and providing a decontaminated and uniformly spread organic-based feed stream to a catalyst bed for further processing in the chemical reactor.

An additional feature of the present invention may include the step of using reticulated ceramics in a variety of shapes and porosities. The shapes may include substantially spherical-shaped balls, raschig rings, saddles, hollow cylinders, perforated disks, disks, single sheets, and solid cylinders, among others. Each shape may be sized to individual specifications. Sizes for the shapes used may include substantially spherical balls of about $\frac{1}{8}$ to 2-inch diameters; raschig rings with inside diameters of about $\frac{1}{8}$ to 1 inch and outside diameters of about $\frac{1}{4}$ to $1\frac{1}{2}$ inches, and heights of about $\frac{1}{4}$ to 2 inches; saddle shapes with radii of about $\frac{1}{4}$ to 2 inches; hollow cylinders having inside diameters of about $\frac{1}{8}$ to $1\frac{1}{4}$ inches, outside diameters of about $\frac{1}{4}$ to 2 inches, and heights of about $\frac{1}{4}$ to 3 inches; and solid cylinders having diameters of about $\frac{1}{8}$ to 1 inch and heights of about $\frac{1}{4}$ to 2 inches. Custom-made one-piece disks or single sheet construction may be custom-fit to the physical configuration of a reactor. A further feature of this aspect of the present invention is that the reticulated ceramic material may be formed in either a disk or single sheet, each optionally having perforations. An additional feature of the present invention is that the reticulated ceramic material when constructed may be formed into a plurality of segments in order to form an assembled sheet or disk that is custom-fit to the reactor's physical configuration. Porosities of the reticulated ceramic material may range from 10 to 800 pores per linear inch ("ppi"). Preferably the pore distribution may

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range from about 10 to 80 ppi. More preferably, the pore distribution may range from about 20 to 60 ppi. This enables customization of the size and shape of the reticulated ceramic material for the application, particulate loading and pressure drop constraints.

In accordance with another aspect of the present invention, entrance losses may be reduced for vapor feed streams to chemical reactors, preferably fluidized bed reactors. This advantage of the present invention may be achieved by reducing the turbulence in the vapor and air inlets to the reactors. This aspect of the present invention may include the steps of: providing a layer of reticulated ceramic material in a vapor inlet to the chemical reactor, the reticulated ceramic material having a plurality of web members defining a plurality of flow passageways through the reticulated ceramic material; passing a vapor feed stream through the vapor inlet to the chemical reactor with the reticulated ceramic material; subdividing the feed stream into a plurality of smaller fluid streams by passing the feed stream through the plurality of flow passageways defined by the web members of the reticulated ceramic material; and discharging the streamlined vapor feed stream into the chemical reactor. The method of the present invention for distributing turbulent air or vapor flows to a reactor inlet has the advantages of reducing maldistribution and entrance losses, thus allowing for reduced compressor horsepower usage or allowing for larger flow rates, depending on the process constraints of the compressor and associated piping.

In accordance with another aspect of the present invention, the step of contacting the contaminated organic-based feed stream with the reticulated ceramic material may include depositing a catalyst on the reticulated ceramic material prior to contacting the contaminated organic-based feed stream. Another feature of this aspect of the present invention may include the use of a reticulated ceramic material as a substrate having a substantially uniform coating of a selected catalyst including a porous alumina coating with a Group VI-B metal or a Group VIII metal, or both. Preferably, the Group VI-B metal is molybdenum and preferably, the Group VIII metal is either nickel or cobalt. More preferably, the Group VI-B metal and Group VIII metal are impregnated into the reticulated ceramic material. The method of the present invention is useful to extend the run life of the catalyst bed. The catalytically active reticulated ceramic material may be utilized to react diolefins or other polymer precursors and also to act as a filter and distributor. By filtering solids and partially reacting any polymer precursors, e.g., diolefins, fouling of the bed is reduced, effectively extending the run time of the reactor.

In accordance with another aspect of the present invention, the filtration method may include the step of retaining the solid particulate catalyst or sediments that form in a chemical reactor in order to reduce catalyst losses and fouling or plugging of downstream equipment. This aspect of the present invention may include the steps of: providing a layer of reticulated ceramic material;

contacting an organic-based feed stream containing the catalyst material with the reticulated ceramic material; removing the catalyst material from the organic-based feed stream; and providing a relatively catalyst-free organic-based stream for further processing.

The method of the present invention for filtering organic-based feed streams in chemical reactors, when compared with prior art methods, has the advantages of: reducing the volume of inert materials required; lowering capital costs; improving the filtration of the solid particular matter from

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the feed streams; decreasing the pressure drop across the system; increasing run time of the reactor; lowering operating costs; increasing process safety; and reducing environmental concerns.

BRIEF DESCRIPTION OF DRAWINGS

In the drawings:

FIG. 1 is partial a cross-sectional side view of a single fixed bed chemical reactor showing a specific embodiment of the present invention;

FIG. 2 is a partial cross-sectional side view of a multiple fixed bed chemical reactor showing another embodiment of the present invention;

FIG. 3 is a partial cross-sectional side view of a combustor-style regenerator fluidized bed reactor;

FIG. 4 is a partial cross-sectional side view of a two-stage regenerator fluidized bed reactor;

FIG. 5 is a partial cross-sectional side view of a radial flow reactor showing another embodiment of the present invention;

FIG. 6 is a perspective view of a perforated disk made of reticulated ceramic material in accordance with the present invention;

FIG. 7 is a perspective view of a saddle made of reticulated ceramic material in accordance with the present invention;

FIG. 8 is a perspective view of a hollow cylinder made of reticulated ceramic material in accordance with the present invention;

FIG. 9 is a perspective view of an example of a one-piece sheet made of reticulated ceramic material in accordance with the present invention;

FIG. 10 is a perspective view of an assembled disk made of reticulated ceramic material in accordance with the present invention;

FIG. 11 is a perspective view of balls made of reticulated ceramic material in accordance with the present invention;

FIG. 12 is a perspective view of a solid cylinder made of reticulated ceramic material in accordance with the present invention; and

FIG. 13 is a perspective view of a hollow cylinder made of reticulated ceramic material in accordance with the present invention.

While the invention will be described in connection with the preferred embodiment, it will be understood that it is not intended to limit the invention to that embodiment. On the contrary, it is intended to cover all alternatives, modifications, and equivalents, as may be included within the spirit and the scope of the invention as defined by the appended claims.

DETAILED DESCRIPTION AND SPECIFIC EMBODIMENTS

With reference to FIG. 1, for treatment of an organic-based feed stream a single fixed bed chemical reactor 22 with reticulated ceramic material 15 in the shape of substantially spherical balls 122 (FIG. 11) will be described, although as previously discussed other shapes of the reticulated ceramic material 15 may be used. If the reactor 22 is of a downflow configuration, the contaminated organic-based feed stream 20 will enter the reactor 22 at the inlet 24. The invention may be used in either fixed beds or fluidized bed chemical reactors. Preferably, the present invention is used in one or more fixed beds, in either an upflow or

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downflow or radial flow configuration. Preferably, the chemical reactors include hydrotreater, hydrorefiner, hydrocracker, reformer, alkylation, isomerization and polymerization reactors. Contaminants typically found in the feed stream include dirt, iron oxide sulfide, asphaltenes, coke fines, catalyst fines, sediments or other entrained foreign particulate material. A layer 26, preferably layers 26, 28, of reticulated ceramic material 15 is provided in the vessel in an amount sufficient to filter the contaminants from the organic-based feed stream 20. Preferably, multiple layers 26, 28 may be provided wherein the size of the articles of reticulated ceramic material 15 such as balls 122 is graduated from a larger size in layer 26 to a smaller size in layer 28 as the incoming organic-based feed stream flows through the reticulated ceramic material 15. The reticulated ceramic material may be made from any commercially available materials, for example, ZTA. The ZTA may have a product composition of ZrO_2/Al_2O_3 and is available from SELEE Corporation headquartered in Hendersonville, N.C. The graduated sizing of the reticulated ceramic material 15 from large sizes to small sizes lessens the pressure drop through the reactor attributable to filtering of the suspended solids. Optionally, the pore size of the reticulated ceramic material may also be graduated from large pores (low ppi) to small pores (high ppi) to lessen the pressure drop through the reactor attributable to filtering of the suspended solids. Optionally, the present invention may be practiced with or without conventional basket screens 30.

Still with reference to FIG. 1, unless otherwise noted, in addition to filtering the contaminated organic-based feed stream 20, the reticulated ceramic material 15 may also enable a uniform distribution and flow of the incoming organic-based feed stream 20 to the catalyst bed 32. By passing the organic-based feed stream through a plurality of flow passageways 120 (FIG. 9) defined by web members 123 (FIG. 9) of the reticulated ceramic material 15 in layers 26, 28, the incoming organic-based feed stream 20 may also be distributed by subdividing the incoming organic-based feed into a plurality of smaller fluid streams and then resubdividing, a plurality of times, the smaller streams so that the incoming organic-based feed stream is spread uniformly across the fluid entry cross-section 34 of the catalyst bed 32. The organic-based feed stream 20 is reacted in the catalyst bed 32. Preferably the catalyst bed 32 contains discrete solid catalyst particles 36.

The reticulated ceramic material 15 may be used to filter and retain catalyst 36 from the outgoing reacted organic-based stream 38. Small particles of the catalyst material 36 which may be entrained in the reacted organic-based stream may be filtered, or captured, from the reacted organic-based stream 38 and retained by reticulated ceramic material layers 40, 42. Preferably, the size of the reticulated ceramic material in layers 40, 42 is graduated from a smaller size in layer 40 to a larger size in layer 42 at the outlet 44 of the reactor 22 to effectively retain the catalyst 36. In addition, sediments of material may form in the reactor bed, e.g., sediments formed by excessive hydrocracking of residual oils, that may plug or foul downstream equipment. These sediments may be filtered from the outgoing reacted organic-based stream 38 by the reticulated ceramic material 15. Preferably, the size of the reticulated ceramic material in layers 40, 42 is graduated from a smaller size in layer 40 to a larger size in layer 42 at the outlet 44 of the reactor 22 to effectively retain the catalyst 36, while the pore size of the reticulated ceramic material is inversely graduated, preferably about 10 to 30 ppi to filter the sediments. More preferably, the pore size range is about 40 to 80 ppi. Alternately, the invention

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may also be used in an upflow reactor configuration wherein the contaminated organic-based feed 74 would instead enter the vessel at the outlet 44 at the lower end 39 and the reacted organic-based stream 25 would exit the reactor at the inlet 24 at the upper end 47 of reactor 22.

As previously discussed, another advantage of the present invention is to react partially activated or activated reticulated ceramic material 15 with polymer precursors in a contaminated organic-based feed stream 20. Condensation polymerization of diolefins may occur in the reactor bed 32 after the contaminated organic-based feed stream 20 is heated, generally prior to introduction into the chemical reactor 22, thereby forming foulants in the reactor bed 32 itself which may gum or plug the bed 32. As the foulants form in the bed, they cannot be filtered from the contaminated organic-based feed stream 20 before flowing across the fluid entry cross-section 34. Therefore, the layer or layers 26, 28, 40, 42 of reticulated ceramic material 15 may be coated with an alumina powder which may also act as a substrate for catalyst materials to form partially activated reticulated ceramic material. As used herein, an "activated support" means a reticulated ceramic material which has been impregnated with catalyst materials, or a reticulated ceramic material which may be an oxide, nitride, or carbide of a metal or a reticulated ceramic material which contains zeolite or inorganic oxides, e.g., alumina, silica, silica-alumina, magnesia, silica-magnesia or titania. As used herein, a "partially activated support" means an activated support material which has been purposefully made less active or partially deactivated in order to achieve a slower reaction rate or to partially react the materials contacted.

Coated reticulated ceramic material 15 may also be used, wherein the coating may comprise one of several conventional catalysts. Alumina may be used as an active coating, optionally but preferably, alumina may be used as a support. The catalyst according to this invention preferably comprises a metal of Group VI-B or a member of Group VII, or both, impregnated into an alumina-based support. Accordingly, the catalyst may comprise at least one of chromium, molybdenum and tungsten in combination with at least one of iron, nickel, cobalt, platinum, palladium and iridium. Of the Group VI-B metals, molybdenum is most preferred. The catalyst preferably will contain from about 2% to about 14% by weight of Group VI-B metal. Of the Group VIII metals, nickel and cobalt are most preferred. The amount of Group VIII metal in the catalyst is preferably from about 0.5% to about 10% by weight.

With reference to FIG. 2, a multiple fixed bed chemical reactor 46 having two fixed catalyst beds 48, 50 with reticulated ceramic material 15 in the shape of saddles 126 (FIG. 7) will be described. The reactor 46 is illustrated in a downflow configuration, wherein the contaminated organic-based feed stream 51 will enter the reactor 46 at the inlet 52 and the reacted organic-based stream 54 will exit the reactor at the outlets 56, 61. A partially reacted organic-based stream 58 may be accumulated at the outlet 61 of the first fixed bed 48 and withdrawn at the collector tray 60. The partially reacted organic-based stream 58 may be heated or quenched or otherwise treated before reintroduction into the reactor 46 as a partially reacted organic-based feed stream 62 at the mixing chamber 64. The partially reacted organic-based stream 58 may be removed for redistribution, heating, or other processing steps as required before reintroducing the partially reacted organic-based feed stream 62 into the reactor 46 for reaction with a succeeding catalyst bed 50. An additional layer 70 of reticulated ceramic material 15 may be provided for filtration and distribution to remove any con-

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taminants entrained from or formed by the processing equipment used in the additional processing steps such as dirt, iron oxide, iron sulfide, asphaltene, coke fines, catalyst fines, sediments, or other entrained foreign particulate material.

Layers 66, 68, 70 of reticulated ceramic material 15 are provided in the reactor 46 below the inlet 52 and mixing chamber 64 in an amount sufficient to filter the organic-based feed stream 51 and the partially reacted organic-based feed stream 62. Preferably, the multiple layers 66, 68, 70 are provided such that the size of the reticulated ceramic material 15 is graduated from a larger size in layer 66 to a smaller size in layer 68 as the incoming contaminated organic-based feed flows through the reticulated ceramic material 15. Optionally, the present invention may be practiced with or without conventional basket screens 72. Preferably, the fixed catalyst beds 48, 50 contain discrete solid catalyst particles 36.

As previously discussed, an advantage of the present invention is that it may also be used to distribute the organic-based feed stream. The organic-based feed stream 51 may also be distributed while being filtered by subdividing the incoming organic-based feed into a plurality of smaller fluid streams by passing the organic-based feed stream through a plurality of flow passageways 120 (FIG. 9) defined by the web members 123 (FIG. 9) of the reticulated ceramic material 15; then resubdividing, a plurality of times, the smaller streams so that the incoming organic-based feed stream is spread uniformly across the fluid entry cross-section of the catalyst bed 76. The organic-based feed 51 is then reacted in the catalyst bed 48, before being withdrawn as a partially reacted organic-based stream 58 at the collector tray 60. The method of filtration and distribution is then repeated for the partially reacted organic-based feed stream 62 as it flows into the mixing chamber 64 and passes through the reticulated ceramic material layer 70.

Another feature of the present invention is that the reticulated ceramic material 15 may also be used to capture and retain catalyst particles 36 from the outflowing partially reacted organic-based stream 58 and the reacted organic-based stream 54. The small reticulated ceramic material saddles 126 in layers 78, 80 at the outlet 61 of the first fixed bed 48 and the small saddles 126 in layers 82, 84 at the outlet 56 of the second fixed bed 50 are used to filter and retain catalyst particles 36 which may be entrained in the partially reacted organic-based stream 58 or reacted organic-based stream 54. As discussed with reference to FIG. 1, for capturing and retaining catalyst 36 from a partially reacted or a reacted outflowing organic-based stream in either a single or a multiple fixed bed chemical reactor, the reticulated ceramic material 15 is preferably graduated from small to larger sizes as shown in FIG. 2 for layers 78, 80 and 82, 84, respectively for each bed 48, 50. Optionally, the pore size of the reticulated ceramic material may also be graduated from small pores to large pores. Alternatively, the pore size of the reticulated ceramic material may be inversely graduated from large pores to small pores to filter sediments that may form in the catalyst bed.

A further advantage of the present invention is that the reticulated ceramic material 15 may be activated or impregnated with catalyst to react with polymer precursors in organic-based feed streams 51, 62. As depicted in FIG. 2, layers 66, 68, 70 of reticulated ceramic material 15 may contain an activated support including inorganic oxides preferably selected from the group consisting of alumina, silica, silica-alumina, magnesia, silica-magnesia or titania or zeolites preferably selected from the group consisting of

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zeolite L, zeolite X, and zeolite Y, which may be added to the reticulated ceramic material as a substrate for catalyst materials. Optionally, the reticulated ceramic material may be impregnated with catalyst materials or the reticulated ceramic material may be an oxide, nitride, carbide or boride of a metal as disclosed in U.S. Pat. No. 5,399,535, which is hereby incorporated by reference to the extent it is not inconsistent with the present invention.

Activated or partially activated reticulated ceramic material as described above may be used to control the hydrogenation rate of the diolefins or other polymer precursors to prevent fouling or gum formation. When endothermic reactions require the addition of heat to the partially reacted organic-based stream 58, preferably the reticulated ceramic material 15 of layer 70 is also activated or partially activated. The invention may also be practiced with coated reticulated ceramic material, wherein the coating may comprise one of several conventional catalysts. Alumina may be used on an active coating or support. The catalyst according to this invention preferably comprises a metal of Group VI-B or a member of Group VIII, or both, impregnated into the reticulated ceramic material, inorganic oxide or zeolite. Accordingly, the catalyst may comprise at least one of chromium, molybdenum and tungsten in combination with at least one of iron, nickel, cobalt, platinum, palladium and iridium. Of the Group VI-B metals, molybdenum is most preferred. The catalyst preferably will contain from about 2% to about 14% by weight of Group VI-B metal. Of the Group VIII metals, nickel and cobalt are most preferred. The amount of Group VIII metal in the catalyst is preferably from about 0.5% to about 10% by weight.

FIG. 3 illustrates a conventional combustor-style fluidized bed reactor 88, 90. Layers 86, 91 of reticulated ceramic material 15 may be used in fluidized bed chemical reactors 90 and in a combustor, or regenerator 88, to reduce entrance losses and maldistribution of the vapor or air flows. The inlet air 93 to the combustor or regenerator 88 is flowed through the reticulated ceramic material layer 86 to subdivide the stream into a plurality of smaller flowing streams. The reticulated ceramic material 15 may be a single circular disk 124 (FIG. 6) without the illustrated perforation 125; however it may be an oval or square sheet 121 (FIG. 9), or any geometric configuration desired including an assembled disk 134 (FIG. 10). Optionally, multiple disks 86, 91 (FIG. 3) may be used. Also, the disk 124 (FIG. 6) or sheet 121 (FIG. 9) may optionally contain perforations. The subdivision of the vapor or air flows may reduce the turbulence of the incoming vapor or air streams, thus reducing the compressor horsepower usage or allowing for an increase in flow rate, depending on the process constraints of the particular combustor-style fluidized bed reactor (FIG. 3). A further advantage of the present invention is that the subdivided vapor or air flows may more uniformly distribute the vapor or air 93 throughout the combustor or regenerator 88. In addition, another layer 91 of reticulated ceramic material 15 may be used to uniformly distribute any fluffing vapors 95 used in the fluidized bed reactor 90.

Alternatively, in FIG. 4 which depicts a conventional two-stage regenerator fluidized bed reactor 97, layers 98, 112 of the reticulated ceramic material 15 may be used similarly as discussed in FIG. 3 for a single-stage combustor or regenerator. The turbulent inlet air 102 to the combustor or regenerator first stage 108 is flowed through the layer 98 of reticulated ceramic material 15 to subdivide the stream, preferably into a plurality of smaller flowing streams. Preferably, the reticulated ceramic material 15 is a single circular disk 124 (FIG. 6) without the perforations 125;

however it may be an oval or square sheet 121 (FIG. 9), or any geometric configuration desired including an assembled disk 134 (FIG. 10). Optionally, multiple disks 98, 112 (FIG. 4) may be used. Also, the disk 124 (FIG. 6) or sheet 121 (FIG. 9) may optionally contain perforations. Similarly, for the second-stage 110, the turbulent inlet air 106 may be flowed through the layer 100 of reticulated ceramic material 15 to subdivide the stream into a plurality of smaller flowing streams. The subdivision of the vapor or air flows may reduce the turbulence of the incoming vapor or air streams, thus reducing the compressor horsepower usage or allowing for an increase in flow rate, depending on the process constraints of the two-stage regenerator 104 or fluidized bed reactor 116. A further advantage of the present invention is that the subdivided vapor or air flows may more uniformly distribute the vapor or air throughout the combustor or regenerator chambers 108, 110. In addition, another layer 112 of reticulated ceramic material 15 may be used to uniformly distribute any fluffing vapors 114 used in the fluidized bed reactor 116.

With reference to FIG. 5, for treatment of a contaminated organic-based feed in vapor form, a radial flow fixed bed chemical reactor 94 with reticulated ceramic material 15 in the shape of substantially spherical balls 122 (FIG. 11) is illustrated, although as previously discussed, other shapes may be used. The contaminated organic-based feed in vapor form 92 will enter the radial flow reactor 94 at the inlet 96. A layer 98 of reticulated ceramic material 15, more preferably layers 98, 100 of reticulated ceramic material 15, is provided in the vessel between the deflection baffle 101 and the scallop 103. The layers of 98, 100 reticulated ceramic material 15 aid in filtering contaminants such as entrained dirt, iron oxide, iron sulfide, asphaltene, coke fines, catalyst fines, sediments, or other foreign particulate material entrained in the contaminated organic-based vapor feed 92 before reaction in the fixed catalyst bed 107 and discharge through the center pipe 109 as the reacted organic stream 111. Also as previously discussed, an advantage of the present invention is that the reticulated ceramic material 15 may be used to capture and retain catalyst from outlet streams, shown here in the unloading tubes 105.

FIG. 6 illustrates a specific embodiment of the present invention as a reticulated ceramic material disk 124. Optionally, the disks may have perforations 125. Preferably, multiple perforations are used to accommodate screen baskets which may optionally be filled with reticulated ceramic material. Other shapes may include saddles 126 (FIG. 7), hollow cylinders 128 (FIG. 8), single sheets 121 of reticulated ceramic material 15 (FIG. 9), disks 134 formed from a plurality of segments 134 a-g (FIG. 10), substantially spherical balls 122 (FIG. 11), solid cylinders 132 (FIG. 12), and raschig rings 130 (FIG. 13). Each shape may be sized to individual specifications. Sizes for the shapes used may include substantially spherical balls of about 1/8 to 2 inch diameters; raschig rings with inside diameters of about 1/8 to 1 inch and outside diameters of about 1/4 to 1 1/2 inches and heights of about 1/4 to 2 inches; saddle shapes with radii of about 1/4 to 2 inches; hollow cylinders having inside diameters of about 1/8 to 1/4 inches, outside diameters of about 1/4 to 2 inches, and heights of about 1/4 to 3 inches; and solid cylinders having diameters of about 1/8 to 1 inch and heights of about 1/4 to 2 inches. Custom-made one-piece disks 124 or single sheet 121 construction may be custom-fit to the physical configuration of a reactor. A further feature of this aspect of the present invention is that the reticulated ceramic material 15 may be formed in either a disk 124 or single sheet 121 having perforations 125. An additional feature of

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the present invention is that the reticulated ceramic material when constructed may be formed into a plurality of segments in order to form an assembled sheet or disk that is custom-fit to the reactor's physical configuration. Porosities of the reticulated ceramic material may range from 10 to 800 ppi. Preferably, the pore distribution may range from about 10 to 80 ppi. More preferably, the pore distribution may range from about 20 to 60 ppi. This enables customization of the size and shape of the reticulated ceramic material for the application, size, particulate loading and pressure drop constraints. The ceramic material surrounding the pores, or openings, of the reticulated ceramic material is from the web members 123 (FIG. 9) which in turn define the flow passageways 120 (FIG. 9).

It is to be understood that the invention is not to be limited to the exact details of construction, operation, exact materials, or embodiments shown and described, as obvious modifications and equivalents will be apparent to one skilled in the art. For example, special liquid distributors or conventional liquid distributors could be used to facilitate the spreading of the liquid across the catalyst bed; however, the reticulated ceramic material could be used only for particulate removal. Accordingly, the invention is therefore to be limited only by the scope of the appended claims.

What is claimed:

1. A method of removing contaminants from a contaminated organic-based feed stream, comprising the steps of:

(a) providing a layer of reticulated ceramic material in a chemical reactor, the layer of reticulated ceramic material being in an amount sufficient to filter the contaminant from the organic-based feed stream and the reticulated ceramic material having a pore distribution range of about 10 to 800 pores per linear inch; and

(b) passing the contaminated organic-based feed stream through the layer of reticulated ceramic material.

2. A method of removing contaminants from a contaminated organic-based feed stream in a chemical reactor, comprising the steps of:

(a) providing a layer of a reticulated ceramic material, the reticulated ceramic material having a pore distribution range of about 10 to 800 pores per linear inch in the chemical reactor; and

(b) contacting the contaminated organic-based feed stream with the reticulated ceramic material to remove the contaminants from the contaminated organic-based feed stream.

3. The method of claim 2, including the step of providing a decontaminated organic-based feed stream for further processing in the chemical reactor.

4. The method of claim 2, wherein the step of contacting the contaminated organic-based feed stream with the reticulated ceramic material includes depositing a catalyst on the reticulated ceramic material prior to contacting the contaminated organic-based feed stream.

5. The method of claim 2, wherein the reticulated ceramic material has a pore distribution range of about 10 to 80 pores per linear inch.

6. The method of claim 2, wherein the reticulated ceramic material has a pore distribution range of approximately 20 to 60 pores per linear inch.

7. The method of claim 2, wherein the reticulated ceramic material is a plurality of substantially spherical shaped balls, each ball having a diameter range of about $\frac{1}{8}$ to 2 inches.

8. The method of claim 2, wherein the reticulated ceramic material is a plurality of raschig rings, each raschig ring having an inside diameter of about $\frac{1}{8}$ to 1 inch and an

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outside diameter of about $\frac{1}{4}$ to $\frac{1}{2}$ inches and a height of about $\frac{1}{4}$ to 2 inches.

9. The method of claim 2, wherein the reticulated ceramic material is formed into a plurality of saddle shaped pieces, each piece having a radius of about $\frac{1}{4}$ to 2 inches.

10. The method of claim 2, wherein the reticulated ceramic material is formed into a single sheet.

11. The method of claim 10 wherein the reticulated ceramic material is formed having perforations.

12. The method of claim 2, wherein the reticulated ceramic material is formed into a single disk.

13. The method of claim 12 wherein the reticulated ceramic material is formed having perforations.

14. The method of claim 2, wherein the reticulated ceramic material is formed into a plurality of segments forming an assembled sheet when constructed, which is custom-fit to the reactor's physical configuration.

15. The method of claim 2, wherein the reticulated ceramic material is formed into a plurality of segments forming an assembled disk that when constructed, is custom-fit to the reactor's physical configuration.

16. The method of claim 2, wherein the reticulated ceramic material is formed into a plurality of hollow cylinders, each hollow cylinder having an inside diameter of about $\frac{1}{8}$ to $\frac{1}{4}$ inches and an outside diameter of about $\frac{1}{4}$ to 2 inches and a height of about $\frac{1}{4}$ to 3 inches.

17. The method of claim 2, wherein the reticulated ceramic material is formed into a plurality of solid cylinders, each solid cylinder having a diameter of about $\frac{1}{4}$ to 1 inch and a height of about $\frac{1}{4}$ to 2 inches.

18. The method of claim 2, wherein the chemical reactor is a hydrotreater reactor.

19. The method of claim 2, wherein the chemical reactor is a hydrorefiner.

20. The method of claim 2, wherein the chemical reactor is a hydrocracker reactor.

21. The method of claim 2, wherein the chemical reactor is a reformer reactor.

22. The method of claim 2, wherein the chemical reactor is an alkylation reactor.

23. The method of claim 2, wherein the chemical reactor is an isomerization reactor.

24. The method of claim 2, wherein the chemical reactor is a polymerization reactor.

25. The method of claim 2, wherein the reticulated ceramic material comprises a substrate of reticulated ceramic material having a substantially uniform coating of a selected catalyst including a porous alumina coating with one Group VI-B metal.

26. The method of claim 25, wherein the Group VI-B metal is molybdenum.

27. The method of claim 2, wherein the reticulated ceramic material comprises a substrate of reticulated ceramic material having a substantially uniform coating of a selected catalyst including a porous alumina coating with one Group VIII metal.

28. The method of claim 27, wherein a Group VIII metal is nickel or cobalt.

29. The method of claim 2, wherein a Group VI-B metal is impregnated into the reticulated ceramic material.

30. The method of claim 2, wherein a Group VIII metal is impregnated into the reticulated ceramic material.

31. The method of claim 2, wherein the reticulated ceramic material comprises a porous inorganic oxide selected from the group consisting of alumina, silica, silica-alumina, magnesia, silica-magnesia and titania.

32. The method of claim 2, wherein the reticulated ceramic material comprises a metal oxide selected from the

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group consisting of titanium, tin, lead, zirconium, ruthenium, tungsten, yttrium, nickel, magnesium, calcium, aluminum, silicon or boron.

33. The method of claim 2, wherein the reticulated ceramic material comprises a metal nitride selected from the group consisting of titanium, zirconium, tungsten, silicon or boron.

34. The method of claim 2, wherein the reticulated ceramic material comprises a metal carbide selected from the group consisting of titanium, zirconium, tungsten, silicon or boron.

35. The method of claim 2, wherein the reticulated ceramic material comprises a metal boride selected from the group consisting of titanium, zirconium or tungsten.

36. The method of claim 2, wherein the reticulated ceramic material comprises a zeolite selected from the group consisting of zeolite L, zeolite X and zeolite Y.

37. A method of fluid distribution in a chemical reactor comprising the steps of:

(a) providing a layer of reticulated ceramic material in the chemical reactor, the reticulated ceramic material having a plurality of web members defining a plurality of flow passageways through the reticulated ceramic material;

(b) contacting an organic-based feed stream with the layer of reticulated ceramic material; and

(c) subdividing the organic-based feed stream into a plurality of smaller fluid streams by passing the organic-based feed stream through the plurality of flow passageways defined by the web members of the reticulated ceramic material.

38. The method of claim 37 including the steps of: removing contaminants from a contaminated organic-based feed stream;

and providing a decontaminated and uniformly spread organic-based feed stream to a catalyst bed for further processing in the chemical reactor.

39. A method of retaining catalyst material forming a fixed catalyst bed comprising the steps of:

(a) providing a layer of reticulated ceramic material the reticulated ceramic material having a pore distribution range of about 10 to 800 pores per linear inch;

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(b) contacting an organic-based feed stream containing the catalyst material with the reticulated ceramic material;

(c) removing the catalyst material from the organic-based feed stream; and

(d) providing a relatively catalyst-free organic-based stream for further processing.

40. A method of filtering sediments formed in a fixed catalyst bed comprising the steps of:

(a) providing a layer of reticulated ceramic material the reticulated ceramic material having a pore distribution range of about 10 to 800 pores per linear inch;

(b) contacting an organic-based feed stream containing the sediments with the reticulated ceramic material;

(c) removing the sediments from the organic-based feed stream; and

(d) providing a relatively sediment-free organic-based stream for further processing.

41. A method of streamlining turbulent flow of a vapor to a chemical reactor having a vapor; comprising the steps of:

(a) providing a layer of a reticulated ceramic material in a vapor inlet to the chemical reactor, the reticulated ceramic material having a plurality of web members defining a plurality of flow passageways through the reticulated ceramic material;

(b) passing a vapor feed stream through the vapor inlet to the chemical reactor with the reticulated ceramic material;

(c) subdividing the feed stream into a plurality of smaller fluid streams by passing the feed stream through the plurality of flow passageways defined by the web members of the reticulated ceramic material; and

(d) discharging the streamlined vapor feed stream into the chemical reactor.

42. The method of claim 41, wherein the vapor feed stream is air.

43. The method of claim 41, wherein the chemical reactor is a fluidized bed reactor.

* * * * *

Tab B



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(12) **United States Patent**
Glover

(10) **Patent No.: US 6,291,603 B1**
(45) **Date of Patent: Sep. 18, 2001**

(54) **FILTRATION AND FLOW DISTRIBUTION METHOD FOR CHEMICAL REACTORS USING RETICULATED CERAMICS WITH UNIFORM PORE DISTRIBUTIONS**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

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(22) Filed: **May 7, 1999**

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(60) Provisional application No. 60/052,969, filed on Jul. 18, 1997.
(51) **Int. Cl.⁷** **C08F 2/00**
(52) **U.S. Cl.** **526/71; 526/64; 526/67; 422/216; 422/217; 422/191**
(58) **Field of Search** **526/67, 64, 71; 422/217, 191, 216**

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Primary Examiner—David W. Wu
Assistant Examiner—Ling-Siu Choi
(74) *Attorney, Agent, or Firm*—Bracewell & Patterson L.L.P.

(57) **ABSTRACT**

A method for removing contaminants from an organic-based feed stream which includes the use of a layer of reticulated ceramic material to filter the organic-based feed stream and to provide liquid distribution upstream of the catalyst bed.

16 Claims, 7 Drawing Sheets

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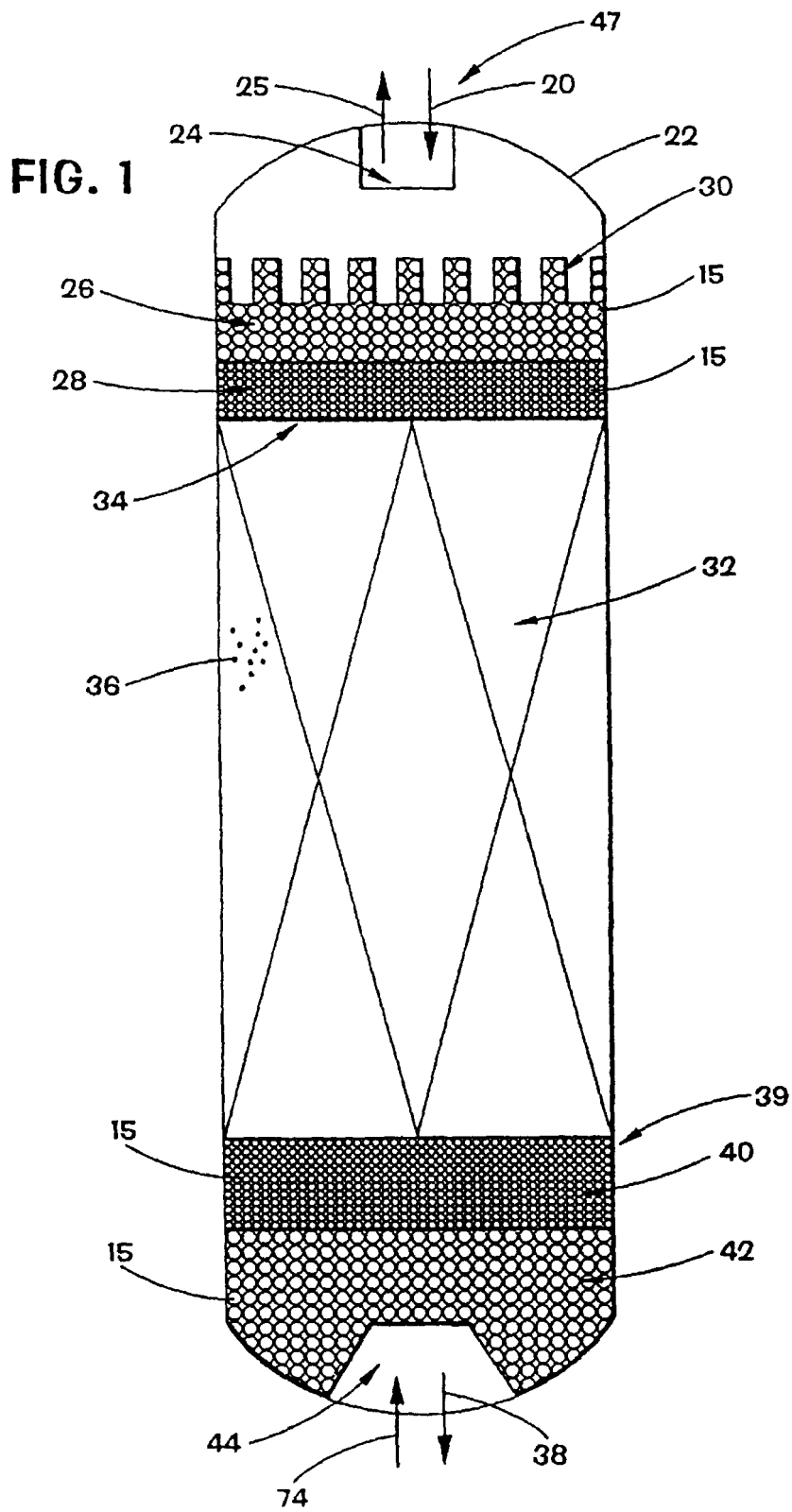
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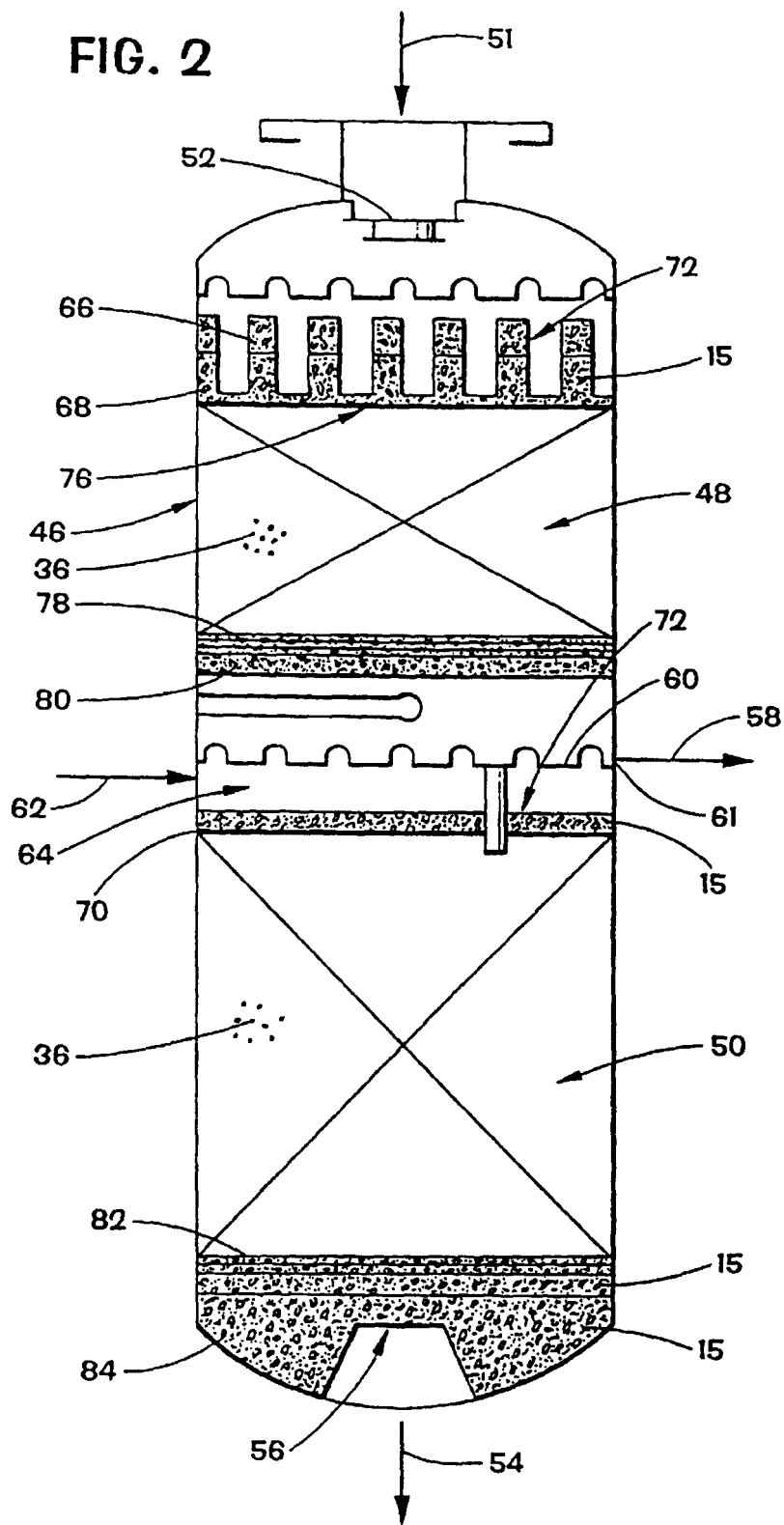


FIG. 3

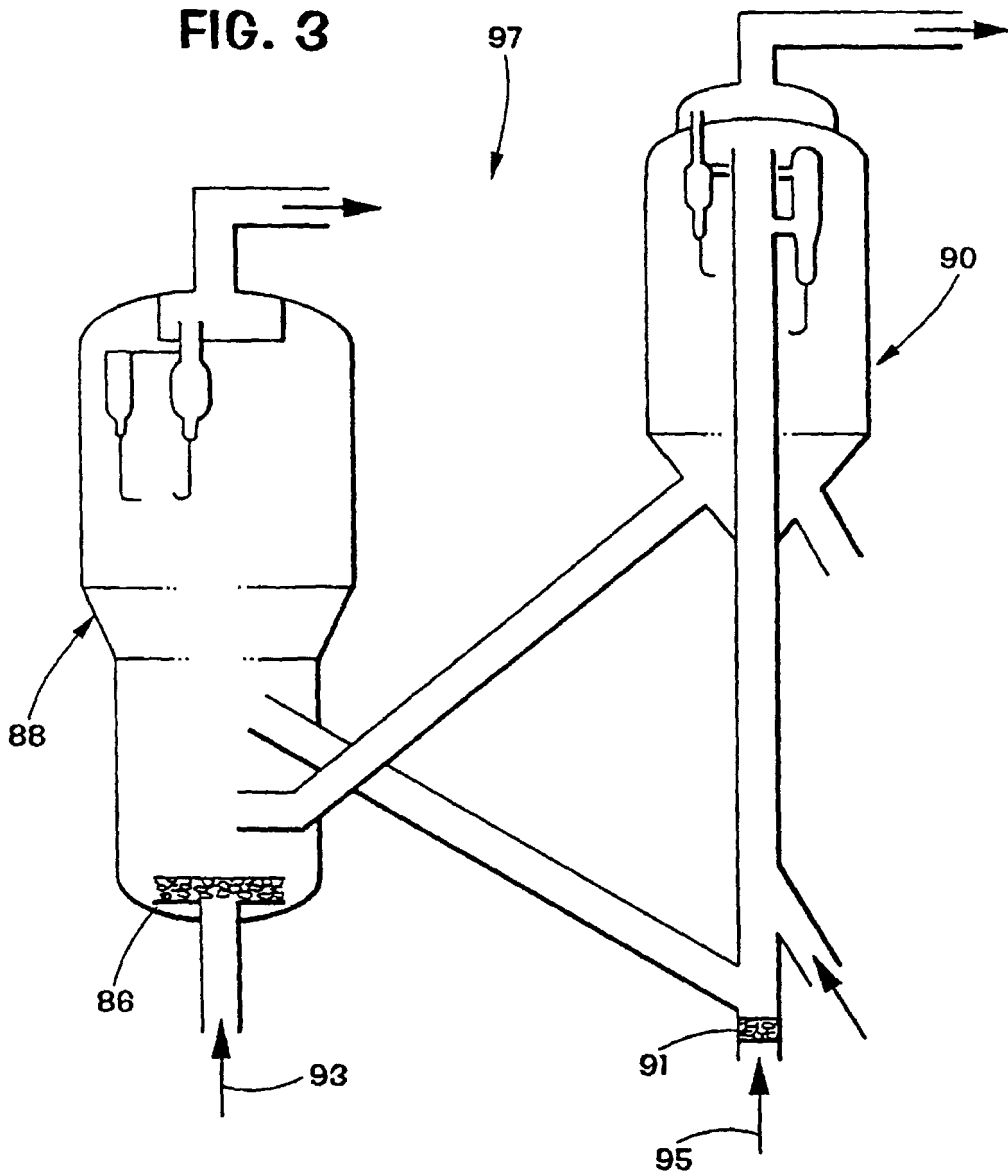


FIG. 4

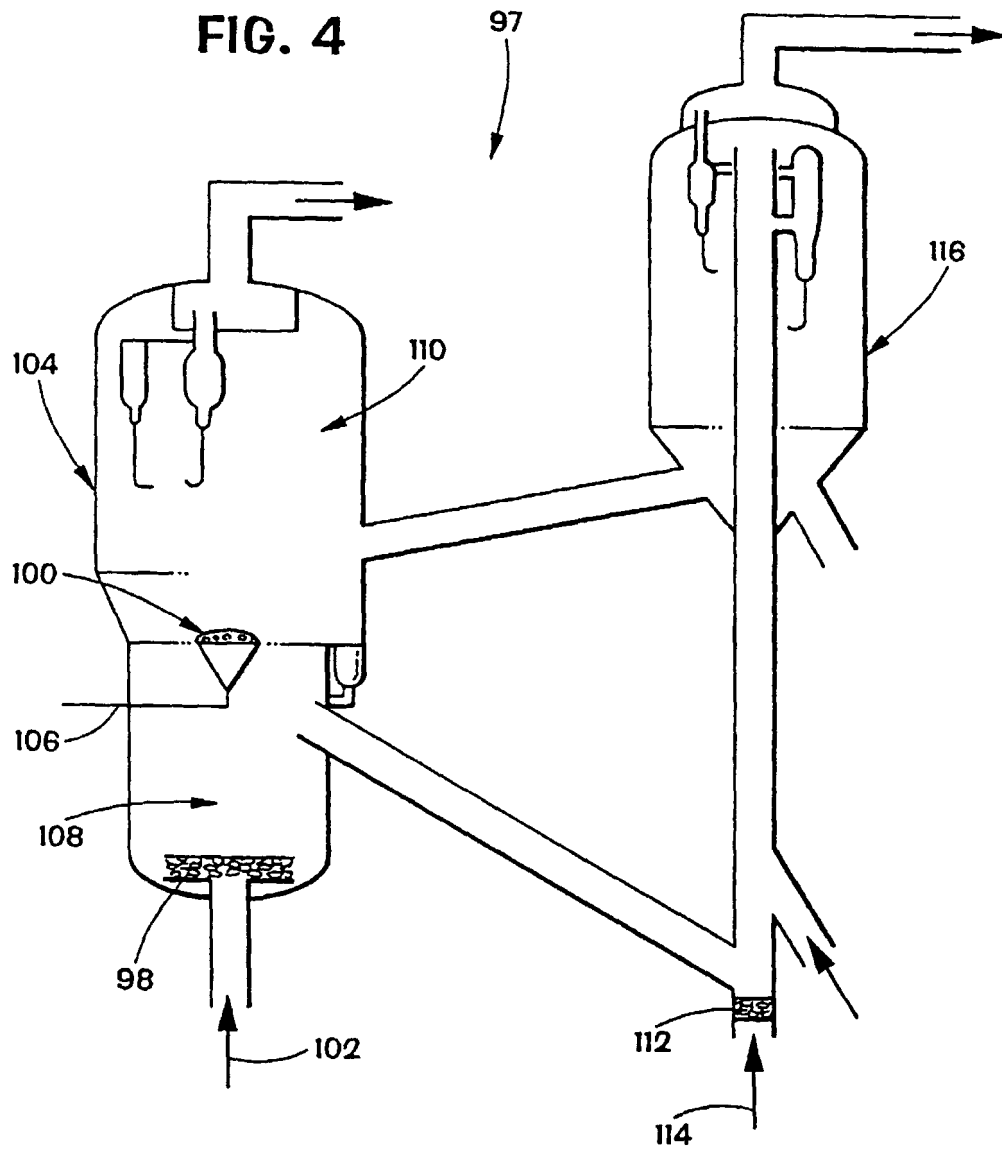
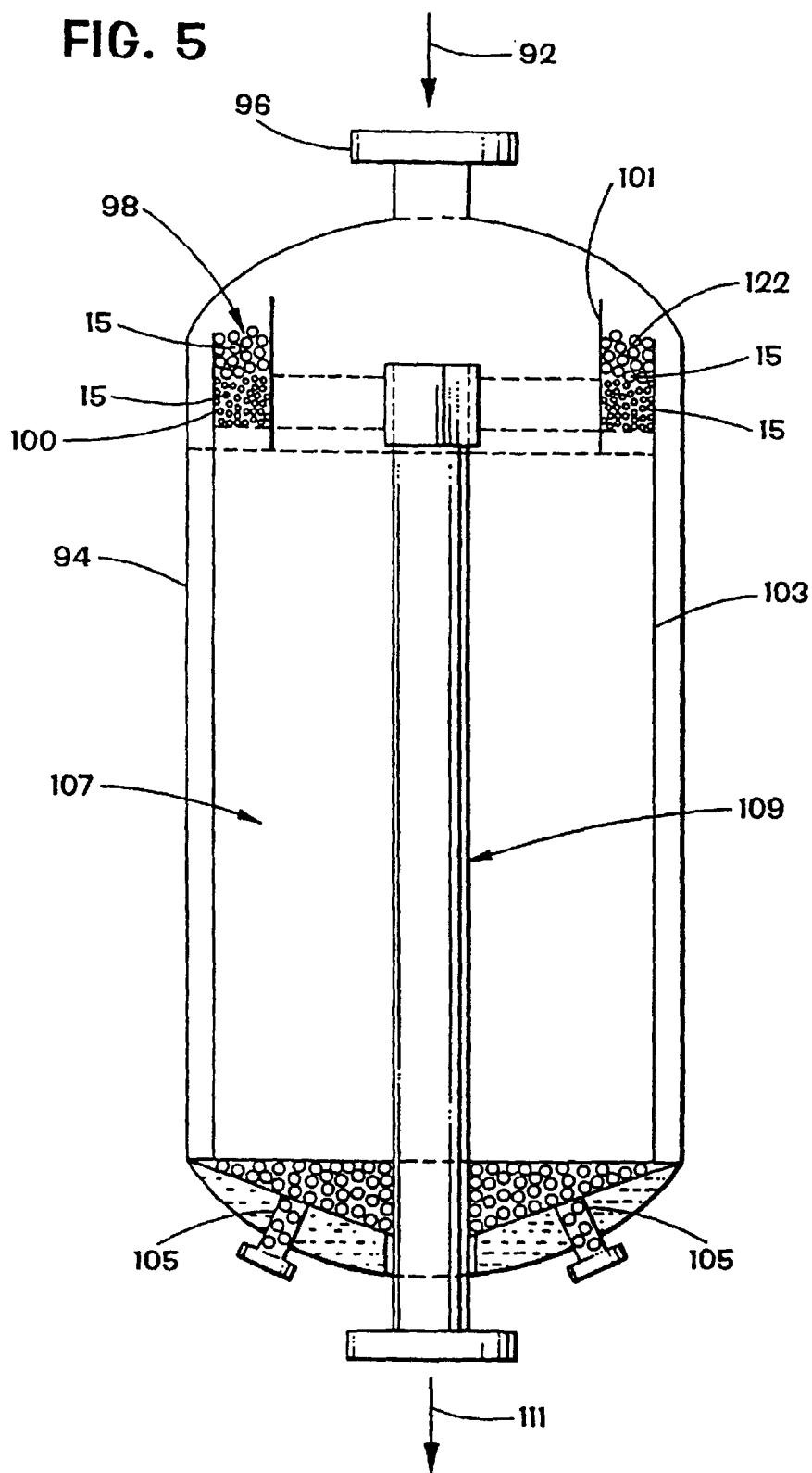


FIG. 5



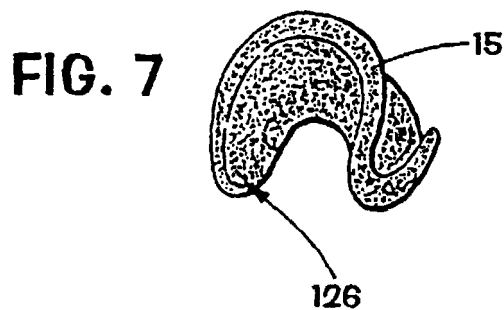
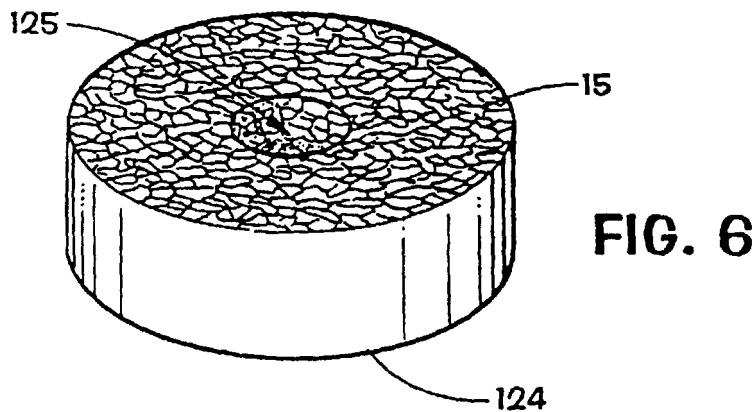


FIG. 8

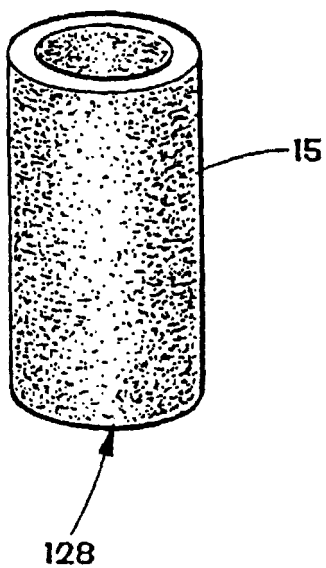


FIG. 9

