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Whitten et al.

(54) **BAFFLE FOR DISTRIBUTION OF EXHAUST FLOW**

(76) Inventors: **Matthew S. Whitten**, St. Paul, MN (US); **Bruce Bernard Hoppenstedt**, Lakeville, MN (US)

Correspondence Address:
MERCHANT & GOULD PC
P.O. BOX 2903
MINNEAPOLIS, MN 55402-0903 (US)

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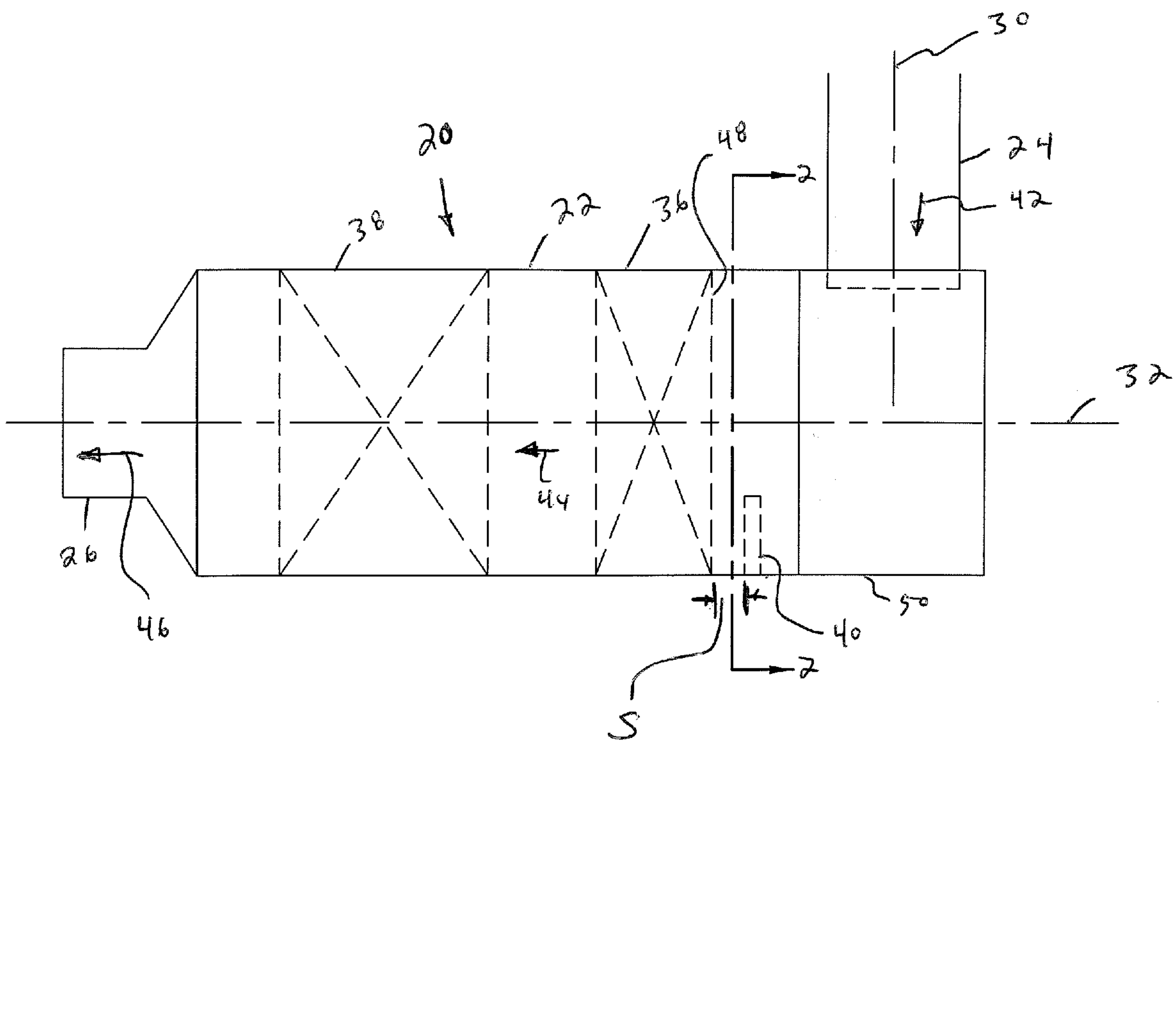
(57) **ABSTRACT**

The present disclosure relates to an diesel exhaust treatment device including a main body having a central longitudinal axis that extends between first and second ends of the main body. A catalyzed substrate is positioned within an interior of the main body. A side inlet is positioned at a side of the main body for directing exhaust gas into the interior of the main body. A flow distribution element is positioned within the interior of the main body at a location between the side inlet and an upstream face of the substrate. The flow distribution element extends across a direction of exhaust flow through the main body and is mounted at a side of the main body that is opposite the side inlet.



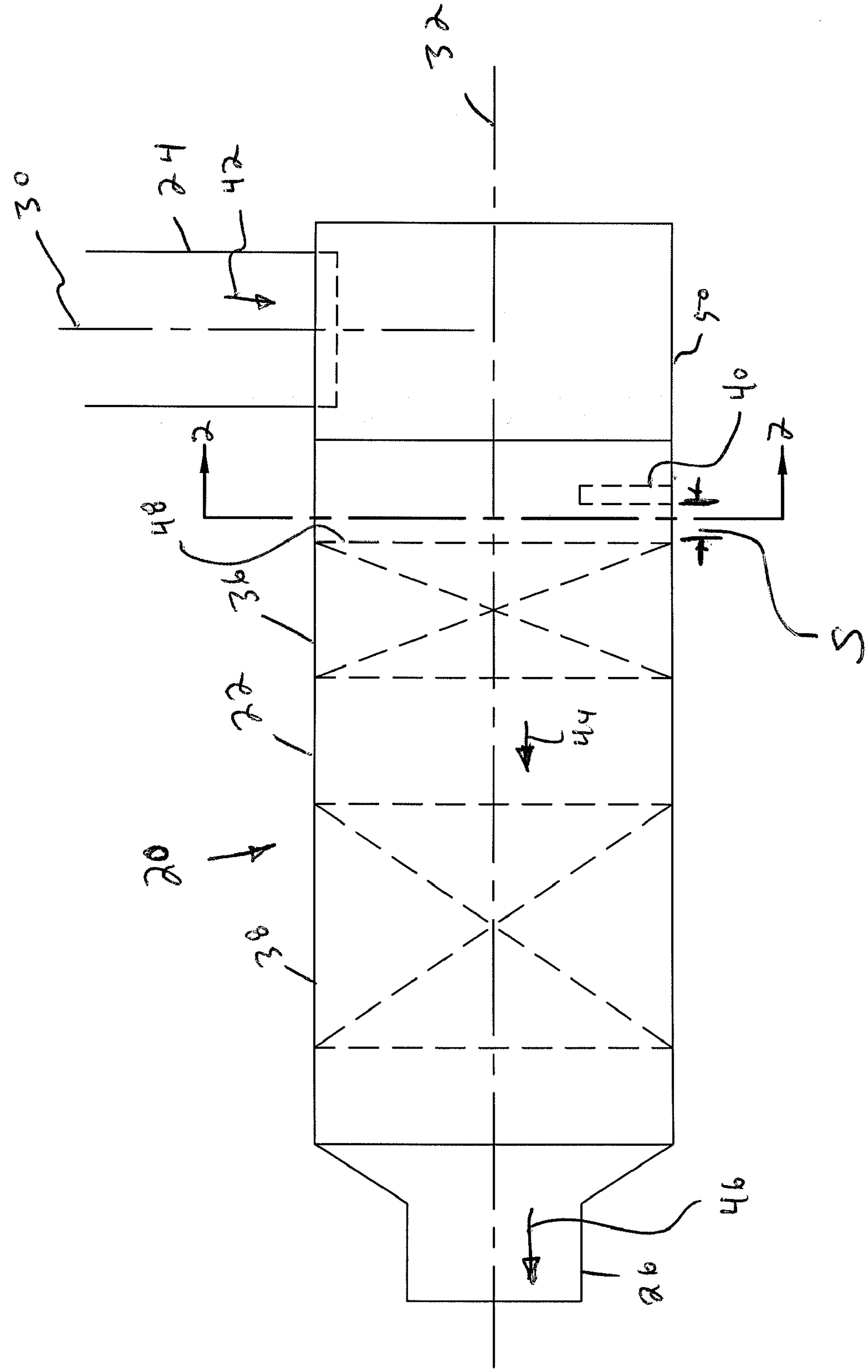
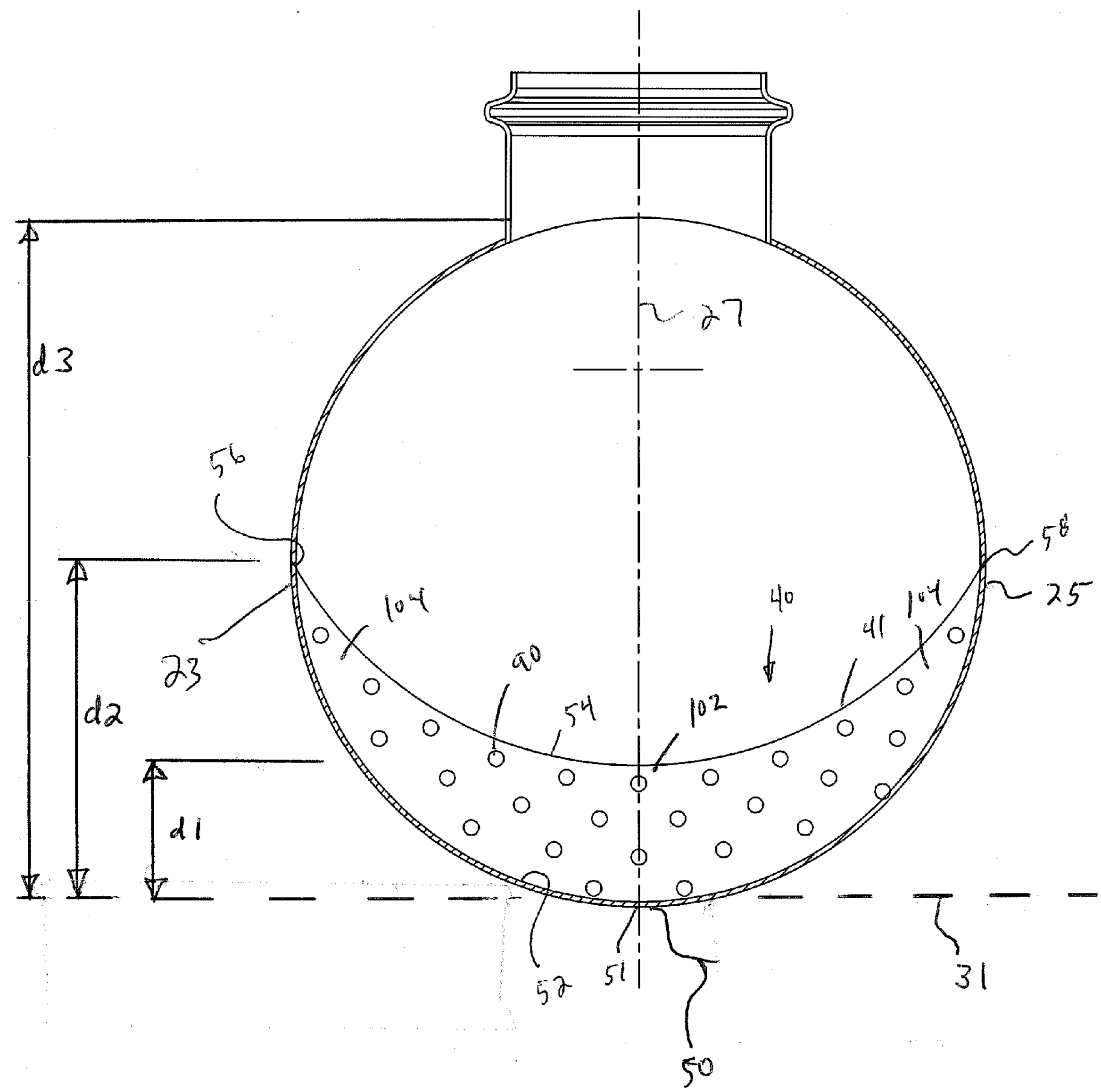


FIG. 1

FIG. 2



BAFFLE FOR DISTRIBUTION OF EXHAUST FLOW

CROSS REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit of U.S. Provisional Patent Application Ser. No. 61/119,243, filed Dec. 2, 2008, which application is hereby incorporated by reference in its entirety.

TECHNICAL FIELD

[0002] The present disclosure relates generally to an exhaust flow distribution device. More particularly, the disclosure relates to a device capable of altering the exhaust gas velocity profile upstream of an exhaust aftertreatment device.

BACKGROUND

[0003] Vehicle exhaust components for treating diesel engine exhaust often include a housing (e.g., a muffler body) containing an exhaust aftertreatment substrate (e.g., a catalytic converter substrate, a lean NOx catalyst substrate, an selective catalytic reduction (SCR) substrate, a NOx trap substrate or a diesel particulate filter substrate). The housing often includes either a side inlet or an axially in-line inlet. A side inlet is generally aligned perpendicular to a central axis of the housing, while an axially in-line inlet is generally co-axially aligned with a central axis of the housing.

[0004] The natural velocity profile of exhaust gas at the upstream face of an exhaust aftertreatment substrate positioned within a housing having an axial in-line inlet resembles a parabolic curve with the velocity maximum at the center of the flow distribution and decreasing significantly outwardly towards the periphery of the flow distribution. The natural velocity profile of exhaust gas at the upstream face of an exhaust aftertreatment substrate positioned within a side inlet housing has a maximum velocity at the half of the substrate located opposite from the inlet side of the housing. Non-uniform velocity flow distribution shortens the useful lives of the aftertreatment substrates and reduces their operational efficiency.

[0005] Various flow distribution devices have been used to create a more uniform velocity flow profile. U.S. Pat. Nos. 5,355,973; 5,732,555; 5,185,998; and 4,797,263 disclose exemplary flow distribution devices that can be used to prolong the useful life and efficiency of exhaust aftertreatment devices. However, these flow distribution devices typically either impede fluid flow causing an undesirable increase in backpressure or do not adequately distribute flow across the face of their corresponding exhaust aftertreatment device. Consequently, there is a need for improved flow distribution devices that provide an effective flow distribution without substantially increasing backpressure.

SUMMARY

[0006] One aspect of the present disclosure is to provide a flow distribution device that is constructed such that it effectively distributes flow without generating unacceptable levels of backpressure. In one embodiment, the flow distribution device is adapted to distribute flow effectively in a side inlet vehicle exhaust component.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] FIG. **1** is a schematic view of a vehicle exhaust system component assembly having a flow distributor that includes features that are examples of inventive aspects in accordance with the principles of the present disclosure; and

[0008] FIG. **2** is a cross-sectional view taken along section line **2**-**2**.

DETAILED DESCRIPTION

[0009] FIG. **1** is a schematic illustration of a vehicle exhaust system component **20** (e.g., a muffler or other enclosure in which one or more exhaust aftertreatment devices are contained) having features that are examples of inventive aspects in accordance with the principles of the present disclosure. The component **20** includes a main body **22** (e.g., a shell, housing, conduit, tube, etc.) having a side inlet **24** and a co-axial outlet **26**. The main body **22** can be constructed of one or more pieces. The side inlet **24** has an axis **30** that is generally perpendicular to a central axis **32** of the main body **22**. The outlet **26** and the main body **22** are depicted sharing the same axis **32**. Aftertreatment devices are shown mounted within the main body **22**. For example, a catalytic converter **36** and a diesel particulate filter **38** are shown mounted within the main body **22**. A flow distribution element **40** is shown positioned upstream from the catalytic converter **36**. Flow arrows **42**, **44**, and **46** illustrate that the direction of exhaust gas flow is from the inlet **24** to the outlet **26**. As used herein, the term "generally perpendicular" means perpendicular or close to perpendicular.

[0010] The flow distribution element **40** is preferably configured to improve exhaust flow uniformity across an upstream face **48** of the catalytic converter **36** without generating significant backpressure in the exhaust system **10**. In alternative embodiment, the flow distribution device can be used to distribute flow provided to other types of aftertreatment devices such as diesel particulate filters, deNOx catalysts, lean NOx catalyst devices, selective catalytic reduction (SCR) catalyst devices, lean NOx traps, or other devices for removing pollutants from the exhaust stream.

[0011] Catalytic converters are commonly used to convert carbon monoxides and hydrocarbons in the exhaust stream into carbon dioxide and water. Diesel particulate filters are used to remove particulate matter (e.g., carbon based particulate matter such as soot) from an exhaust stream. SCR systems are systems that selectively catalytically promote the reduction of NOx to N_2. Lean NOx catalysts are catalysts capable of selectively catalytically promoting the reduction of NOx to N_2 in an oxygen rich environment with the use of hydrocarbons as reductants. For diesel engines, hydrocarbon emissions are too low to provide adequate NOx conversion, thus hydrocarbons are typically required to be injected into the exhaust stream upstream of the lean NOx catalysts. Other SCR's use reductants such as urea or ammonia that are injected into the exhaust stream upstream of the SCR's and that react with NOx at catalyzed surfaces of the SCR's to cause the reduction of NOx to $N_{2\ and\ H2}O$. NOx traps use a material such as barium oxide to absorb NOx during lean burn operating conditions. During fuel rich operations, the NOx is desorbed and the selective reduction of NOx to N_2 in the presence of hydrocarbons is promoted via catalysts within the NOx traps.

[0012] Diesel particulate filters can have a variety of known configurations. An exemplary configuration includes a monolith ceramic substrate having a "honey-comb" configuration of plugged passages as described in U.S. Pat. No. 4,851,015 that is hereby incorporated by reference in its entirety. Wire mesh configurations can also be used. In certain embodiments, the substrate can include a catalyst. Exemplary catalysts include precious metals such as platinum, palladium and rhodium, and other types of components such as base metals or zeolites.

[0013] For certain embodiments, diesel particulate filters can have a particulate mass reduction efficiency greater than 75%. In other embodiments, diesel particulate filters can have a particulate mass reduction efficiency greater than 85%. In still other embodiments, diesel particulate filters can have a particulate mass reduction efficiency equal to or greater than 90%. For purposes of this specification, the particulate mass reduction efficiency is determined by subtracting the particulate mass that enters the filter from the particulate mass that exits the filter, and by dividing the difference by the particulate mass that enters the filter.

[0014] Catalytic converters can also have a variety of known configurations. Exemplary configurations include substrates defining channels that extend completely therethrough. Exemplary catalytic converter configurations having both corrugated metal and porous ceramic substrates/cores are described in U.S. Pat. No. 5,355,973, that is hereby incorporated by reference in its entirety. The substrates preferably include a catalyst that promotes an oxidation reaction at the catalytic converter. For example, the substrate can be made of a catalyst, impregnated with a catalyst or coated with a catalyst. Exemplary oxidation catalysts include precious metals such as platinum, palladium and rhodium, and other types of components such as base metals or zeolites.

[0015] In one non-limiting embodiment, a catalytic converter can have a cell density of at least 200 cells per square inch, or in the range of 200-400 cells per square inch. A preferred catalyst for a catalytic converter is platinum with a loading level greater than 30 grams/cubic foot of substrate. In other embodiments the precious metal loading level is in the range of 30-100 grams/cubic foot of substrate. In certain embodiments, the catalytic converter can be sized such that in use, the catalytic converter has a space velocity (volumetric flow rate through the catalytic converter/volume of the catalytic converter) less than 150,000/hour or in the range of 50,000-150,000/hour.

[0016] Referring to FIGS. **1** and **2**, the flow distribution element **40** of the component **20** is positioned adjacent a portion **50** of the main body **22** that is opposite from the inlet **24**. The flow distribution element **40** is depicted as a baffle **41** having a curved first edge **52** that matches the inner diameter of the main body **22**. The baffle **41** also includes a second edge **54** that extends from one end **56** of the first edge **52** to an opposite end **58** of the first edge **52**. In the depicted embodiment, the second edge **54** has a concave curvature while the first edge **52** has a convex curvature, and the edges cooperate to provide the baffle **41** with a crescent shaped outline/profile. In certain embodiments, the second edge **54** is defined by a radius that is in the range of 1.1 to 1.3 times as large as the inner radius of the main body **22**.

[0017] When mounted in the main body **22**, the first edge **52** matches the inner diameter of the main body **22** and extends from a first side **23** of the main body **22** to a second side **25** of the main body **22**. The first and second sides **23**, **25** are positioned on opposite sides of a central reference plane **27** that bisects the main body **22** along its length and also bisects the inlet pipe **24**. The second edge **54** traverses an interior region of the main body **22** and extends from the first side **23** of the main body **22** across the central reference plane **27** to the second side **25** of the main body **22**. The second edge **54** intersects with the first edge **52** at the first and second sides **23**, **25** of the main body **22**.

[0018] The first edge **52** of the baffle **41** preferably seats against the inner diameter of the main body **22** at the portion **50** of the main body **22** that is opposite from the location of the inlet **24**. The reference plane **27** is shown passing through portion **50** at location **51**. As shown at FIGS. **1** and **2**, the baffle **41** is located at the bottom of the main body **22** and the inlet is located at the top of the main body **22**. The baffle **41** is shown having a height that extends upwardly from the bottom of the main body **22** toward the top of the main body **22** (e.g., the height dimension extends generally toward the inlet). The baffle **41** is shown aligned along a plane that is generally perpendicular to the central axis **32** of the main body **22**. While the baffle **41** is shown as a flat plate, the baffle **41** could also be curved.

[0019] In use, the exhaust gases are directed into the main body **22** through the inlet **24**. Upon entering the main body **22**, the exhaust flow encounters the flow distribution device **40**. The flow distribution element **40** forms a mixing wall/barrier positioned at the portion **50** of the main body **22** upon which flow from the inlet **24** impinges. The exhaust gases then flow over/through the flow distribution device **40** to the catalytic converter **36**. At the upstream face of the catalytic converter, flow is fairly evenly distributed by virtue of the flow distribution element **40**. Upon exiting the catalytic converter, the exhaust flow travels through the diesel particulate filter and exits the main body **22** through the outlet **26**.

[0020] The flow distribution element **40** can also be referred to as a flow distribution plate, a flow distributor, a flow distribution member, a flow distribution structure or like terms. The main body **22** can also be referred to as a housing, an aftertreatment device housing, an enclosure, a conduit, or like terms.

[0021] In certain embodiments, the inlet **24** can include a cylindrical inlet pipe, and the main body **22** can also be cylindrical in shape. In one example embodiment, the inlet **24** can have a diameter in the range of 4-6 inches and the main body can have a diameter in the range of 9-12 inches.

[0022] The flow distribution element **40** is preferably configured to provide generally uniform flow distribution across the upstream face of the catalytic converter **36** without causing additional backpressure. In one example embodiment, the flow distribution element **40** is configured to provide a γ value greater than or equal to 0.95. γ is a calculated value representative of flow speed uniformity across the upstream area/face of a substrate (e.g., a catalytic converter substrate, a DPF substrate, an SCR substrate, a NOx absorber substrate, a lean NOx catalyst substrate, etc.). When γ is equal to 1, perfect flow uniformity exists across the entire upstream face/area of the substrate. γ is calculated according to the following formula:

$$\gamma = 1 - \frac{\sum_{i=1}^{n} \sqrt{(V_i - V_A)^2} \times A}{2 \times A \times V_A}$$

[0023] In the above formula, A is the total area of the upstream face of the substrate. The total area A is formed by n discrete/localized areas. Vi is the exhaust flow velocity at each of the n discrete/localized areas, and V_A is the average exhaust flow velocity across the total area A.

[0024] A variety of factors control the effectiveness of the distribution element **40** for providing substantially uniform flow. Example factors include a spacing S defined between the distribution element **40** and the upstream face of the catalytic converter **36** and dimensions d**1** and d**2** of the distribution element. The dimensions d**1**, d**2** are measured relative to a reference line **31** that is tangent to the inner diameter of the main body **22** at the location **50**. The dimension d**1** corresponds to the dimension of the distribution element **40** measured along the central reference plane **27** of the main body from the reference line **31** to the second edge **54** (i.e., at the center of the distribution element **40**). The dimension d**2** corresponds to the dimension of the distribution element **40** measured from the reference line **31** to the second edge **54** at locations that are laterally farthest from the central reference plane **27** (e.g., at peripheral/side portions of the distribution element **40** such as intersection points **56** and **58**). The dimensions defined between the reference line **31** and the second edge **54** preferably gradually increase as the second edge extends away from the central reference plane **27**. In the depicted embodiment, maximum dimensions are defined at the intersections between the edges **52**, **54** of the distribution element **40** at the sides of the main body **22** and a minimum dimension is defined at the central reference plane **27**. It has been determined by the inventors that the larger dimensions provided at the peripheral portions of the distribution element **40** assist in reducing the likelihood or magnitude of "hot-spots" caused by disproportionate amounts of flow at the lower peripheral regions of the catalytic converter.

[0025] The sizes of the spacing S and the dimensions d**1** and d**2** are dependent on the flow distribution desired and the size and arrangement of the inlet **24** and the main body **22**. In certain embodiments, the spacing S is less than 3 inches, or less than 2 inches, or less than 1 inch, or lest than ¾ inch or about ⅝ inch. In other embodiments, the dimension d**1** is less than 50, 40 or 30 percent of a cross-dimension d**3** measured along the central reference plane **27**. In the depicted embodiment, the cross-dimension d**3** corresponds to the inner diameter of the main body **22** or the outer diameter of the catalytic converter **36**. In other embodiments, the dimension d**1** is in the range of 10-40 percent, or 10-30 percent, or 20-40 percent, or 20-30 percent of the cross-dimension d**3**. In certain embodiments, the dimension d**1** is less than 5 inches, or less than 4 inches, or less than 3 inches, or in the range of 1-5 inches, or in the range of 1-4 inches, or in the range of 2-4 inches or in the range of 2-3 inches. In still other embodiments, the spacing S is less than 20 percent of the cross-dimension d**3**, or less than 15 percent of the cross-dimension d**3**, or less than 10 percent of the cross-dimension d**3**, or less than 5 percent of the cross-dimension d**3**. The dimension d**2** is preferably greater than the dimension d**1**. In certain embodiments, the dimension d**2** is at least 1.25 times, or at least 1.5 times, or at least 1.75 times, or at least 2 times, or at least 2.5 times or at least 3 times as large as the dimension d**1**. In one embodiment, the dimension d**1** is in the range of 10-30 percent of the cross-dimension d**3**, and the dimension d**2** is in the range of 40-60 percent of the cross-dimension d**3**.

[0026] To further enhance flow distribution, the distribution element **40** can define a plurality of openings **90** (e.g., perforations) that allow exhaust to flow through the distribution element. In one embodiment, the openings **90** each have a diameter of about 0.25 inches and are spaced apart from one another by 0.375 inch measured center-to-center.

[0027] In certain embodiments, no portion of the flow distribution element **40** extends past a mid-line **100** of the main body **22**, and the flow distribution element **40** is shaped such that a central portion **102** of the flow distribution element **40** is spaced farther from the mid-line **100** than side portions **104** of the flow distribution element.

[0028] It will be appreciated that flow distribution elements in accordance with the principles of the present disclosure can also be used in conduits having non-round (e.g., oval) cross-sectional shapes.

[0029] From the forgoing detailed description, it will be evident that modifications and variations can be made in the devices of the disclosure without departing from the spirit or scope of the invention.

What is claimed is:

1. A diesel exhaust treatment device comprising:

a main body having a central longitudinal axis that extends between first and second ends of the main body;

a catalyzed substrate positioned within an interior of the main body, the substrate having an upstream face;

a side inlet positioned at a side of the main body for directing exhaust gas into the interior of the main body; and

a flow distribution element positioned within the interior of the main body at a location between the inlet and the upstream face of the substrate, the flow distribution element extending across a direction of exhaust flow through the main body, the flow distribution element being positioned at a portion of the main body that is opposite the side inlet, the flow distribution element including a first edge that contacts the main body and a second edge that traverses an interior region of the main body, the flow distribution element having a central portion defining a first dimension measured along a reference plane that bisects the main body and the side inlet, the first dimension being less than 50 percent of a cross-dimension of the main body measured along the reference plane, the flow distribution element also including side portions that define second dimensions that are larger than the first dimension, the second dimensions being measured in an orientation parallel to the reference plane, the second dimensions being measured from a reference line tangent to a location wherein the first edge intersects the reference plane to the second edge.

2. The diesel exhaust treatment device of claim **1**, wherein the flow distribution element is crescent-shaped.

3. The diesel exhaust treatment device of claim **1**, wherein the flow distribution element is perforated.

4. The diesel exhaust treatment deice of claim **1**, wherein the first edge has a convex curvature that matches a curvature of the side of the main body, and the second edge has a concave curvature.

5. The diesel exhaust treatment device of claim **4**, wherein the first and second edges intersect at opposite sides of the reference plane.

6. The exhaust treatment device of claim **1**, wherein first dimension is less than 40 percent of the cross-dimension the main body.

7. The exhaust treatment device of claim **1**, wherein first dimension is less than 30 percent of the cross-dimension the main body.

8. The exhaust treatment device of claim **1**, wherein the first dimension is in the range of 10-40 percent of the cross-dimension of the main body.

9. The exhaust treatment device of claim **1**, wherein the first dimension is in the range of 10-30 percent of the cross-dimension of the main body.

10. The exhaust treatment device of claim **1**, wherein a spacing between the flow distribution element and the upstream face of the substrate is less than 1 inch.

11. The exhaust treatment device of claim **1**, wherein the second dimensions are measured at lateral-most locations of the second edge where the second edge intersects with the first edge.

12. The exhaust treatment device of claim **1**, wherein the second dimensions are at least 1.25 times as large as the first dimension.

13. The exhaust treatment device of claim **1**, wherein the second dimensions are at least 1.5 times as large as the first dimension.

14. The exhaust treatment device of claim **1**, wherein the second dimensions are at least 2 times as large as the first dimension.

15. A diesel exhaust treatment device comprising:

a main body having a central longitudinal axis that extends between first and second ends of the main body;

a catalyzed substrate positioned within an interior of the main body, the substrate having an upstream face;

a side inlet positioned at a side of the main body for directing exhaust gas into the interior of the main body; and

a flow distribution element positioned within the interior of the main body at a location between the inlet and the upstream face of the substrate, the flow distribution element extending across a direction of exhaust flow through the main body, the flow distribution element being positioned at a portion of the main body that is opposite the side inlet, wherein no portion of the flow distribution element extends past a mid-line of the main body, and wherein the flow distribution element is shaped such that a central portion of the flow distribution element is spaced farther from the mid-line than side portions of the flow distribution element.

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