extruders but it cannot be used on other extruder types and is limited in the degree of restriction it can produce.

[0005] There is accordingly a need in the art for improved extruder injector assemblies that can operate efficiently on high-output, biomass extruder systems without the design and plugging problems of conventional systems.

SUMMARY

[0006] Provided herein is a system for introducing one or more additives into materials, the system comprising: an assembly of injectors, wherein the injectors comprises internal bores of a diameter ranging from 2 to 6 mm; a manifold for controlling flows of substances in said assembly of injectors; valves incorporated into the manifold for each injector to independently control the flows of substances in the injector; and a supply of an additive. In some examples, the additive is a liquid or a steam. In some examples, the additive is water. In some examples, the additive is an acid. In some examples, the additive is a steam and wherein the steam is at a pressure of about 80-600 psi. In some examples, the additive is a steam and wherein the steam is at a pressure of about 150 psi. In some examples, the additive is a steam and wherein the steam is at a pressure of about 200 psi. In some examples, the additive is a steam and wherein the steam is at a pressure of about 250 psi. In some examples, the additive is a steam and wherein the steam is at a pressure of about 300 psi.

[0006a] In one aspect, the present disclosure refers to an extruder comprising: (1) a barrel, wherein the barrel comprises an inner chamber comprising a feeder zone and a reaction zone, wherein the extruder is constructed and arranged such that a steam impervious plug is formed by compacting biomass in a high pressure zone separating the feeder zone and the reaction zone; (2) a discharge valve body at a discharge end of the barrel, wherein the discharge valve body comprises a plurality of injection ports that penetrate an outer wall of the discharge valve body; and (3) a system for introducing one or more additives into materials, the system comprising: an assembly of injectors, wherein the injectors comprises internal bores of a diameter ranging from 2 to 6 mm; a manifold for controlling flows of substances in said assembly of injectors; valves incorporated into the manifold for each injector to independently control the flows of substances in the injector; and a supply of an additive, wherein the injectors are placed into the plurality of injection ports in the outer wall of the discharge valve body.

[0007] In some examples, the materials comprise a biomass. In some examples, the materials comprise a biomass, and wherein the materials are within a conduit. In some examples, the conduit comprises an extruder. In some examples, the conduit further comprises a discharge valve. In some examples, the internal bores of the injectors have a diameter of about 2 mm. In

some examples, the internal bores of the injectors have a diameter of about 2.5 mm. In some examples, the internal bores of the injectors have a diameter of about 3 mm. In some examples, the internal bores of the injectors have a diameter of about 3.5 mm. In some examples, the internal bores of the injectors have a diameter of about 4 mm. In some examples, the internal bores of the injectors have a diameter of about 4.5 mm. In some examples, the internal bores of the injectors have a diameter of about 5 mm. In some examples, the internal bores of the injectors have a diameter of about 5.5 mm. In some examples, the internal bores of the injectors have a diameter of about 6 mm.

[0008] In some examples, the assembly of injectors comprises 2 or more injectors. In some examples, the assembly of injectors comprises 4 or more injectors. In some

examples, the assembly of injectors comprises 6 or more injectors. In some examples, the assembly of injectors comprises 8 or more injectors. In some examples, the assembly of injectors comprises 10 or more injectors. In some examples, the assembly of injectors comprises 12 or more injectors. In some examples, the assembly of injectors comprises 14 or more injectors. In some examples, the assembly of injectors comprises 16 or more injectors. In some examples, the materials consist of biomass within a reaction zone.

[0009] In another aspect, the present disclosure refers to a method of injecting liquid and steam into an extruder having an extruder barrel and a discharge valve body, wherein the extruder barrel comprises an inner chamber comprising a feeder zone and a reaction zone, wherein the extruder is constructed and arranged such that a steam impervious plug is formed by compacting biomass in a high pressure zone separating the feeder zone and the reaction zone, the method comprising: providing a plurality of injection ports, wherein the injection ports penetrate an outer wall of the extruder barrel and an outer wall of the discharge valve body; introducing injectors into the plurality of injection ports; injecting steam into said extruder barrel or said discharge valve body to maintain a pressure between 150 to 800 psi in said extruder barrel or said discharge valve body; and injecting liquid into said discharge valve body.

[00010] The present disclosure also refers to a method of injecting liquid and steam into an extruder barrel or a valve body comprising: providing a plurality of injection ports, wherein the injection ports penetrate the extruder barrel or the valve body; introducing injectors into the plurality of injection ports; and injecting liquid and steam into said extruder barrel or said valve body to maintain a pressure between 150 to 800 psi in said extruder barrel or said valve body.

[00011] In some examples, the injector comprises a nozzle bore with a diameter between 2-6 mm. In some examples, the injector comprises a nozzle bore with a diameter between 2-4 mm. In some examples, the injector comprises a nozzle bore with a diameter between 2-3 mm. In some examples, the injector comprises a nozzle bore with a diameter of about 2 mm. In some examples, for pretreating at least one dry ton of biomass per day, the method further comprising: feeding the biomass at a rate of at least one dry metric ton (MT) of biomass per day into an extrusion system comprising a barrel, wherein the barrel comprises an inner chamber comprising a feeder zone and a reaction zone, wherein the extrusion system is constructed and arranged such that: a steam impervious plug is formed by compacting the biomass in a high pressure zone separating the feeder zone and the reaction zone, and an assembly of steam injectors having an internal nozzle bore diameter of 6 mm or less provide pressure and high temperatures to the reaction zone.

[00012] Disclosed herein is an extruder system comprising an assembly of one or more injectors, wherein the injectors comprise a nozzle bore with a diameter of 6 mm or less. In some

examples, the injectors provide steam at a pressure of 150-800 psi to the extruder bore. In some examples, the injectors have an internal bore diameter of 4 mm or less. In some examples, the injectors have an internal bore diameter of 2 mm or less. In some examples, the extruder system comprises at least 2 assemblies of injectors, at least 3

assemblies of injectors, or at least 4 assemblies of injectors. In some examples, internal bores of the injectors have a diameter of about 2 mm. In some examples, internal bores of the injectors have a diameter of about 2.5 mm. In some examples, internal bores of the injectors have a diameter of about 3 mm. In some examples, internal bores of the injectors have a diameter of about 3.5 mm. In some examples, internal bores of the injectors have a diameter of about 4 mm. In some examples, internal bores of the injectors have a diameter of about 4.5 mm. In some examples, internal bores of the injectors have a diameter of about 5 mm. In some examples, internal bores of the injectors have a diameter of about 5.5 mm. In some examples, internal bores of the injectors have a diameter of about 6 mm. In some examples, the assembly of one or more injectors comprises 2 or more injectors. In some examples, the assembly of one or more injectors comprises 4 or more injectors. In some examples, the assembly of one or more injectors comprises 6 or more injectors. In some examples, the assembly of one or more injectors comprises 8 or more injectors. In some examples, the assembly of one or more injectors comprises 10 or more injectors. In some examples, the assembly of one or more injectors comprises 12 or more injectors. In some examples, the assembly of one or more injectors comprises 14 or more injectors. In some examples, the assembly of one or more injectors comprises 16 or more injectors.

[00013] Disclosed herein is an extruder system comprising a barrel section having spiral or concentric ports for an assembly of injector nozzles. In some examples, the barrel section comprises at least 4 ports. In some examples, the barrel section comprises at least 6 ports. In some examples, the barrel section comprises at least 8 ports. In some examples, the barrel section comprises at least 10 ports. In some examples, the barrel section comprises at least 12 ports. In some examples, the barrel section comprises at least 14 ports. In some examples, the barrel section comprises at least 16 ports. In some examples, the extruder system comprises two or more barrel sections. In some examples, the barrel section is interchangeable with other barrel sections. In some examples, the spiral or concentric ports are perpendicular to the barrel section. In some examples, the injectors are predisposed to inject 30-50% steam per dry weight of material.

[00014] Disclosed herein is a system for introducing one or more additives into materials, the system comprising: at least one assembly of injectors with internal bores of a diameter ranging from 2 to 6 mm; a manifold for controlling the flow of substances in said assembly; valves incorporated into the manifold for each injector to independently control the flow of substances in the injector; and a supply of at least one additive. In some examples, the additive is a liquid or steam. In another example, the additive is water or an acid. In other examples, the additive is steam at a pressure of 80-600 psi. In other examples, the additive is steam at