end of the extruder, wherein the valve assembly forms a downstream end of the reaction zone and adds a liquid to the reaction zone, wherein the valve assembly comprises: a valve body comprising a large circular section, an intercalary conical section, and a small circular collar containing one or more nozzles for liquid input, the valve body having a chamber formed therein that connects an input end and a discharge end of the valve body, wherein the small circular collar is smaller in inner diameter than the large circular section; a valve needle axially displaceable within the chamber of the valve body; and a housing attached to the discharge end of the valve body and enclosing the valve needle when the valve needle is disengaged with the valve body.

[0005] In another example, provided herein is a system for pretreating a biomass comprising: an extruder comprising one or more screws, wherein an internal plug of the biomass is formed due to action of the one or more screws, thereby forming an upstream end of a pressurized reaction zone for pretreatment of the biomass; and a valve assembly attached at an output end of the extruder, wherein the valve assembly comprises: a valve body comprising a large circular section, an intercalary conical section, and a small circular collar containing one or more nozzles for liquid input, the valve body having a chamber formed therein that connects an input end and a discharge end of the valve body, wherein the small circular collar is smaller in inner diameter than the large circular section; a valve needle axially displaceable within the chamber of the valve body; and a housing attached to the discharge end of the valve body and enclosing the valve needle when the valve needle is disengaged with the valve body.

[0006] In some examples, the biomass is selected from the group consisting of: silage, agricultural residues, com stover, bagasse, sorghum, nuts, nut shells, coconut shells, Distillers Dried Solubles, Distillers Dried Grains, Condensed Distillers Solubles Distillers Wet Grains, Distillers Dried Grains with Solubles, woody materials, sawdust, wood chips, wood pellets, timber slash, mill scrap, municipal waste, waste paper, recycled toilet papers, yard clippings, and energy crops such as poplars, willows, switchgrass, alfalfa, and prairie bluestem, non-woody plant matter, cellulosic material, lignocellulosic material, hemicellulosic material, carbohydrates, corn, sugar cane, grasses, high biomass sorghum, bamboo, corncobs, and peels and pits. In some examples, the biomass is treated for less than 60, 55, 50, 45, 40, 35, 30, 25, 20, 19, 18, 17, 16, 15, 14, 13, 12, 10, 9, 8, 7, 6, 5, 4, 3, 2, or 1 second in the reaction zone. In some examples, temperature in the reaction zone is elevated to 50-500 °C, 75-400 °C, 100-350°C, 150-300°C, 200-250°C, or 150-300°C, and pressure in the reaction zone is elevated to 50-1000 PSI, 100-750 PSI, 200-600 PSI, 300-500 PSI or 350-450 PSI. In some examples, the system further comprises a mean for supplying steam and one or

more chemicals to the reaction zone. In some embodiments, the one or more chemicals comprise an acid. In some examples, the acid is sulfuric acid.

[0007] In some examples, the valve assembly comprises: a valve body comprising a large circular section, an intercalary conical section, and a small circular collar containing one or more nozzles for liquid input, the valve body having a chamber formed therein that connects an input end and a discharge end of the valve body, wherein the small circular collar is smaller in inner diameter than the large circular section; a valve needle axially

displaceable within the chamber of the valve body; and a housing attached to the discharge end of the valve body and enclosing the valve needle when the valve needle is disengaged with the valve body. In some examples, the housing contains a removable discharge ring. In some examples, the discharge ring is tapered. In some examples, the valve body contains an annular ring. In some examples, the annular ring is removable. In some examples, there is an annular space formed in the chamber between the valve body and the valve needle when the valve needle is closed on the valve body. In some examples, the nozzles for liquid input transfer water into the chamber. In some examples, the nozzles for liquid input transfer a liquid other than water into the chamber. In some examples, the liquid is selected from the group consisting of: an acid, a base, an alcohol, a ketone, an aldehyde, a solvent, or a combination thereof. In some examples, an inner diameter of the housing at an end of the housing abutting the valve body is at least 7% larger than an inner diameter of the valve body at its discharge end. In some examples, an inner diameter of the housing at an end of the housing abutting the valve body is about 7% larger than an inner diameter of the valve body at its discharge end. In some examples, the valve needle has a cone with a wide end opposing to its conical tip. In some examples, the cone is tapered in a range of from 45 degrees to 75 degrees. In some examples, the cone is tapered about 45 degrees. In some examples, the valve needle has a diameter at the wide end that is at least 4% larger than an inner diameter of the valve body at its discharge end. In some examples, the valve needle has a diameter at the wide end that is about 4% larger than an inner diameter of the valve body at its discharge end. In some examples, the extruder is a twin screw extruder. In some examples, the extruder has ports for adding steam and/or acid.

[0008] In another aspect, the present disclosure refers to a method of pretreating a biomass through the system disclosed herein.

[0009] In yet another aspect, the present disclosure refers to a method of pretreating a biomass, the method comprising: conveying the biomass through an extruder from a feeder zone of the extruder to a reaction zone of the extruder, wherein the feeder zone and the reaction zone are separated by a biomass plug formed downstream of the input zone and upstream from the reaction zone; adding steam and/or a chemical to the biomass in the reaction zone to partially treat the biomass, wherein the valve assembly comprises: a valve body comprising a large circular section, an intercalary conical section, and a small circular collar containing one or more nozzles for liquid input, the valve body having a chamber formed therein that connects an input end and a discharge end of the valve body, wherein the small circular collar is smaller in inner diameter than the large circular section; a valve needle axially displaceable within the chamber of the valve body; and a housing attached to the discharge end of the valve body and enclosing

the valve needle when the valve needle is disengaged with the valve body; conveying the partially-treated biomass into a valve assembly attached to an output end of the extruder, and treating the partially-treated biomass in the valve assembly, thereby producing a pretreated biomass; and discharging the pretreated biomass through the valve assembly.

[00010] In some examples of the method, the biomass is conveyed through the extruder at a velocity same as a velocity at which the partially-treated biomass is conveyed through the