

MODULAR MANIFOLD OF A WELLSITE FLUID SYSTEM AND METHOD OF USING SAME

BACKGROUND

[0001] The present disclosure relates to the field of well construction equipment. More particularly, the present disclosure relates particularly, but not by way of limitation, to flow control systems and components that may be used for well construction services techniques. The statements in this section merely provides information related to the present disclosure and may not constitute prior art, and may describe some embodiments illustrating the invention.

[0002] Oilfield operations may be performed to locate and gather valuable downhole fluids, such as hydrocarbons. Wellbores may be drilled to reach subsurface reservoirs and draw hydrocarbons to the surface. During drilling, various fluids may be deployed downhole to facilitate drilling, production, stimulation, completion and/or other operations.

[0003] In some cases, devices may be used for storing fluids, mixing fluids, and distributing fluids to the wellbore. Fluids may be passed into the wellbore by surface fluid equipment. Some fluid equipment may have devices, such as valves, pumps, etc., to facilitate flow of fluids. Examples of fluid equipment or techniques are provided in US Patent/Application Nos. 5232279, 20020001255, and 20030161212.

SUMMARY

[0004] This summary is provided to introduce a selection of concepts that are further described below in the detailed description. This summary is not intended to identify key or essential features of the claimed subject matter, nor is it intended to be used as an aid in limiting the scope of the claimed subject matter.

[0005] The techniques disclosed herein relate to a mobile manifold assembly of a fluid system for providing fluid to a wellsite during well construction. The wellsite has a rig positionable about a wellbore. The fluid system includes auxiliary components including at least one fluid source, at least one mixer and at least one high pressure pump. The mobile manifold assembly includes a modular manifold and a mobile frame. The modular manifold includes a plurality of manifold pumps, valves and pipes integrated together for transport.

Connector portions of the pipes extend from the modular manifold in an arrangement corresponding to an arrangement of the auxiliary components to define a plug-in configuration therebetween such that the connector portions of the pipes are positionable in alignment with the auxiliary components for direct and removable connection therewith. The manifold pumps and valves are positioned about the pipes to selectively pump the fluid about the modular manifold and at least one of the auxiliary components. The mobile frame includes a base portion and a carrier portion. The modular manifold is securable to the base portion and the carrier portion of the mobile frame. The modular manifold is liftable via the mobile frame whereby the modular manifold is transportable to the auxiliary components for operable connection therewith.

[0006] The mobile manifold assembly may also include at least one knock off cap, at least one inlet, and/or at least one drain. At least one of the valves includes a butterfly valve. The butterfly valve may be automatically and manually activated. The manifold pumps selectively adjust fluid flow through the pipes. The pipes define a plurality of horizontal pipe portions and a plurality of vertical pipe portion, with the plurality of vertical pipe portions extending between the horizontal pipe portions.

[0007] The valves may be positionable about the pipes and provide selective fluid communication between the pipes and the auxiliary components. The manifold pumps may be positionable about the horizontal or vertical pipe portions. The mobile manifold assembly may also include knock off caps positioned at opposite ends of one of the horizontal portions, and/or inlets positioned between opposite ends of one of the horizontal portions. One of the horizontal portions may extend between a pair of the manifold pumps. Two of the vertical portions may extend between the one horizontal portion with the manifold pumps and another of the horizontal portions. The another of the vertical portions may extend between the another of the horizontal portions and yet another of the horizontal portions.

[0008] The connector portions may extend from one of the horizontal portions of the modular manifold. A portion of the connector portions may extend horizontally from the modular manifold and a portion of the connector portions may extend vertically from the modular manifold. The connector portions of the pipes may be connectable to the fluid source, mixer, and high pressure pump. The carrier portion may extend vertically above the base portion. The carrier portion may have a handle or a grip for lifting the frame.

[0009] In another aspect, the disclosure relates to a well construction fluid system for providing fluid to a wellsite during well construction. The wellsite has a rig positionable about a wellbore. The fluid system includes the auxiliary components and the mobile manifold assembly.

[0010] The auxiliary components may include a mixing portion, and a delivery portion. The delivery portion may include the high pressure pump, a motor, at least one drive shaft, and at least one slurry tank. The mixing portion may include the mixer, at least one mixing tank and at least one fluid source. The fluid source may include an averaging tank, a water/chemical supply, and a mixing water supply. The auxiliary components may include a supply portion, a pumping portion, a transfer portion, and a batch mixer portion. The batch mixer portion may include a batch mixer tank.

[0011] The auxiliary components may include a mixing portion, and the mobile manifold assembly may be integrated with the mixing portion. The mobile manifold assembly and the mixing portion may be positionable on a skid and transportable thereon. The mixer may include a single or a dual mixer.

[0012] Finally, in another aspect, the disclosure relates to a method for providing fluid to a wellsite during well construction. The wellsite has a rig positionable about a wellbore. The method involves providing a fluid system about a wellsite. The fluid system includes the auxiliary components and the mobile manifold assembly. The method also involves transporting the modular manifold to the auxiliary components using the mobile frame, operatively connecting the modular manifold to the auxiliary components, and pumping fluid to the wellbore using the modular manifold.

[0013] The method may also involve mixing the fluid with the at least one mixer, recirculating fluid between the auxiliary components and the modular manifold, and/or transporting the auxiliary components and the modular manifold assembly on a skid. The method may also involve selectively diverting fluid from the modular manifold to a mixing portion, a batch portion and/or a delivery portion of the fluid system. The method may also involve cementing the wellbore using the fluid pumped to the wellbore. The pumping may also involve pumping the fluid to the wellbore using the auxiliary components.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] Embodiments of the method and system for performing well construction are described with reference to the following figures. Like reference numerals are intended to refer to similar elements for consistency. For purposes of clarity, not every component may be labeled in every drawing.

[0015] Figure 1 is a schematic diagram illustrating a wellsite having a fluid system with a modular manifold in accordance with an embodiment of the present disclosure.

[0016] Figure 2.1 is a block diagram illustrating a mixing process for a fluid system in accordance with an embodiment of the present disclosure. Figures 2.2, and 2.2.1-2.2.4 depict a table of various scenarios illustrating operation of the mixing process of Figure 2.1 in accordance with an embodiment of the present disclosure.

[0017] Figure 3 is a block diagram illustrating an overall mixing process for a fluid system with a modular manifold in accordance with an embodiment of the present disclosure.

[0018] Figure 4.1 is a schematic diagram illustrating a modular manifold in accordance with an embodiment of the present disclosure. Figures 4.2 and 4.2.1-4.2.4 depict a table of various scenarios illustrating operation of the modular manifold of Figure 4.1 in accordance with an embodiment of the present disclosure.

[0019] Figures 5.1-5.4 are schematic views illustrating a modular manifold in accordance with an embodiment of the present disclosure.

[0020] Figures 6.1-6.4 are schematic views illustrating another modular manifold in accordance with an embodiment of the present disclosure.

[0021] Figures 7.1 and 7.2 are schematic diagrams illustrating modular single mixer configurations of a fluid system with modular manifold in accordance with an embodiment of the present disclosure.

[0022] Figures 8.1 and 8.2 are schematic diagrams illustrating modular dual mixer configurations of a fluid system with modular manifold in accordance with an embodiment of the present disclosure.

[0023] Figures 9.1-9.3 are schematic diagrams illustrating various views of portions of a modular fluid system with modular manifold in accordance with an embodiment of the present disclosure.

[0024] Figures 10.1 and 10.2 are schematic diagrams illustrating integrated configurations of a fluid system with modular manifold in accordance with an embodiment of the present disclosure.

[0025] Figures 11.1-11.3 are schematic diagrams illustrating various views of portions of an integrated fluid system with modular manifold in accordance with an embodiment of the present disclosure.

[0026] Figures 12.1 and 12.2 are schematic diagrams illustrating modular configurations of a mobile manifold assembly with modular manifold in accordance with an embodiment of the present disclosure.

[0027] Figures 13.1 and 13.2 are schematic diagrams illustrating integrated configurations of a modular manifold in accordance with an embodiment of the present disclosure.

[0028] Figure 14 is a flow chart illustrating a fluid method in accordance with an embodiment of the present disclosure.

DETAILED DESCRIPTION

[0029] Specific embodiments of the present disclosure will be described in detail with reference to the accompanying drawings. Further, in the description of embodiments of the present disclosure, numerous specific details are set forth in order to provide a more thorough understanding of the invention. However, it will be apparent to one of ordinary skill in the art that the embodiments disclosed herein may be practiced without these specific details. In other instances, well-known features have not been described in detail to avoid unnecessarily complicating the description.

[0030] The present disclosure relates to devices and methods for providing fluid at a wellsite. Fluid systems may be provided for facilitating the mixing, pumping and delivery of the fluid. Part or all of the fluid systems may be portable, removable and/or modular. The fluid system may include local equipment, such as a mobile and removable manifold (and associated equipment), and auxiliary equipment, such as mixers, tanks, supplies and/or pumps (and

associated equipment). As used herein, "local" may refer to components or operations of the fluid/slurry mixing manifold, and "auxiliary" may refer to components or operations of the remainder of the fluid system. The fluid system may be used for delivering fluid to the wellbore for performing well construction. As used herein 'well construction' includes operations, such as cementing used in completing the wellbore.

[0031] At least one embodiment of the present disclosure relates to a modular manifold that consolidates piping and flow control components, such as valves, into a compact, portable, modular and stand-alone product that can connect to various related components used for mixing and pumping slurries for well construction services, such as mixers, pumps, mixing and averaging tubs, displacement tanks and batch tanks. The modular manifold may also incorporate logic for mixing and pumping slurries for well construction services, such as recirculation, fluid transfer, gravity feed, and redundancies and backups for pump failures. At least one embodiment of the present disclosure may allow for scalability of multiple mixing systems through the use of one or multiple modular manifolds.

[0032] According to one or more aspects of the present disclosure, a portable and optimized fluid/slurry mixing manifold is provided, enabling flexibility in installations due to, at least, independence and modularity; and enabling a compact bounding volume optimized for transport and installation. According to at least one or more additional aspects of the present disclosure, a method for maintainability is provided for allowing: ease in maintenance and troubleshooting due to, at least, clear overall visual of the modular manifold; minimal volume of flushing/washing fluids due to, at least, compactness of the system; and ease in replacement of piping, if desired. According to at least one or more additional aspects of the present disclosure, a method and system for scalability of multiple mixing systems is provided.

[0033] In accordance with at least one embodiment of the present disclosure, the fluid system and modular manifold may be a modular fluid/slurry mixing (or fluid) system with modular manifold. The fluid system and/or modular manifold may be portable. The modular manifold may be connectable to pumping and mixing components of the fluid system using hoses or hard piping if desired. The modular manifold bounding volume allows the modular manifold to be transportable on trailers, both on land and offshore on shipping racks.

[0034] The bounding volume of the modular manifold may comprise overall dimensions that may be no more than 8 ft (or 2438.4 mm), or any dimension which corresponds with the ISO container width specification – ISO 668: "Series 1 freight containers – Classification, dimensions and ratings," which is subject to change. It should be noted that various industry standards may exist which may dictate certain design requirements and objectives; therefore, the piping and components described herein may be designed and manufactured in accordance with those standards, for example, ASME B31.3.

[0035] The modular manifold may be adapted and re-sized to meet connection (or nozzle) points that may require exceeding the 8 ft (2.44 m) desired dimension. As opposed to having piping run across the skid or tight confined areas, the modular manifold may be easily accessible and visible for maintenance and troubleshooting. This level of modularity can enable the modular manifold to be deployed for various oilfield pumping equipment, and may allow a higher level of standardizing of piping design, for example, piping designed for mixing fluid/slurry. Moreover, the modular manifold, apparatus, systems and methods presented herein may be configured to reduce the learning curve for operators.

[0036] These together with other aspects, features, and advantages of the present disclosure, along with the various features of novelty, which characterize the invention, are pointed out with particularity in the claims annexed to and forming a part of this disclosure. The above aspects and advantages are neither exhaustive nor individually or jointly critical to the spirit or practice of the disclosure. Other aspects, features, and advantages of the present disclosure will become readily apparent to those skilled in the art from the following detailed description in combination with the accompanying drawings. Accordingly, the drawings and description are to be regarded as illustrative in nature, and not restrictive.

[0037] Referring to the drawings, illustrations, pictures and attachments and in particular Figure 1, a wellsite 100 that is an example environment in which the present disclosure may be implemented is depicted. The wellsite 100 is depicted at an offshore location, but may be land-based or in other configurations. The wellsite 100 includes a platform 102 with a rig 104 and a fluid system 106. The platform 102 has a riser 108 extending to a wellbore 110 in the sea floor 112.

[0038] The fluid system 106 includes pumping equipment 114, mixing manifold(s) 118, and mixers 120. The fluid system 106 may be a modular system positionable about the wellsite

100. The fluid system 106 may be fluidly coupled to the riser 108 via surface equipment for providing fluid thereto. The fluid system 106 may be used to mix and pump fluids to the wellbore 110, for example, for drilling, cementing, or other purposes. In an example, the fluid system 106 may be cementing equipment that is used to mix and pump slurries down the well for well construction (e.g., zonal isolation, cementing, etc.).

[0039] Figures 2.1 and 2.2 are block flow diagrams depicting an example fluid system 206 for performing modular fluid/slurry mixing and pumping. The fluid system 206 may be used to provide fluids to a wellbore as shown, for example, in Figure 1.

[0040] The system 206 includes a primary mixing portion 230, a supply portion 232, a pump portion 234, a secondary mixing portion 236, a batch mixing portion 238, and a delivery portion 240. The primary mixing portion 230 includes a mixing water supply 242, a water/chemical supply 244, and an averaging tank 245. The mixing water supply 242, water/chemical supply 244, and the averaging tank 245 may store fluids therein and/or be linked to storage facilities for receiving fluids. The mixing water supply 242 may include water or other fluids defining the mixing water supply 242 fluids. The water/chemical supply 244 may include seawater or other fluids defining the water/chemical supply fluids. The averaging tank 245 may include cement slurries or other fluids defining the averaging tank 245 fluids.

[0041] The mixing water supply 242 is fluidly coupled to mixers 246.1 and 246.2, and mixing tanks 248.1 and 248.2, and delivers the mixing water supply 242 fluids thereto. The mixing water supply 242 fluids may be selectively provided to one or more of the mixers 246.1, 246.2 and/or mixing tanks 248.1, 248.2. The mixers 246.1, 246.2 deliver fluid to the mixing tanks 248.1, 248.2.

[0042] The mixing tanks 248.1, 248.2, water/chemical supply 244, and averaging tank 245 pass fluid to the pumping portion 234 via supply portion 232. The pumping portion 234 includes manifold pumps 250.1, 250.2. The supply portion 232 includes pipes (or flowlines) S1-S4 extending from mixing tank 248.2, averaging tank 245, water/chemical supply 244 and mixing tank 248.1, respectively, to pump 250.2. The supply portion 232 also includes pipes S5-S7 extending from averaging tank 245, water/chemical supply 244 and mixing tank 248.1, respectively, to pump 250.1. The pumps 250.1, 250.2 may be fluid pumps capable of driving

fluid from the initial mixing portion 230 and through the remainder of the fluid system 206 and to the platform 102 for use (see, e.g., Fig. 1).

[0043] Referring still to Figure 2.1, the pump 250.2 is fluidly coupled back to mixer 246.1, 246.2 and mixing water supply 242, respectively, via mixing pipes M1, M2 and M3, respectively, until mixed as desired. The pump 250.1 is fluidly coupled back to the mixer 246.1 via mixing pipe M4 until mixed as desired. Fluid is also pumped from pump 250.2 to the batch mixing portion 238 via pipe B3 and from pump 250.1 to the batch mixing portion 238 via pipe B4.

[0044] The batch mixing portion 238 includes batch mixer tank(s) 252. Fluid from pumps 250.1, 250.2 may be passed to the batch mixer tanks 252 via pipes B3 and B4, respectively. Fluid may also be passed from pumps 250.1 and 250.2 to the batch mixing portion 238 and fluidly coupled to the batch mixer tanks 252 via valve B5. Fluid may also be diverted from the batch mixing tanks 252 back to pumps 250.1, 250.2 via pipes B2 and B1, respectively.

[0045] Fluid may then be passed from the pumps 250.1, 250.2 via pipes D1 and D2 and from batch mixer tank(s) 252 via pipe B5 to intersection I1. From intersection I1, fluid may then flow to the delivery portion 240 via pipes D3 and D4. The delivery portion 240 includes a high pressure pump 254. Fluid may be passed from valve B5 to the high pressure pump 254 via pipe D3. Fluid may also be delivered back to the averaging tank 245 or batch mixer 252, if desired, via pipe D4.

[0046] The pumps 250.1, 250.2 and related equipment, such as pipes (or pipes) S1-S7, M1-M4, B1-B5, D1-D4, may be considered "local" components. Fluid flow relating to these local components may be referred to as "local process flow." The remainder of the components may be considered "auxiliary components." Fluid flow relating to these auxiliary components may be considered "auxiliary process flow."

[0047] While the system 206 depicts certain pipes, tanks, pumps, mixers and other components, the system 206 may include various numbers of the various supplies, pumps, mixers, tanks, etc. Also, various fluid control devices, such as valves, pipes, etc. may be provided to facilitate the flow of fluid through the system 206 as desired. More examples of various fluid systems and manifolds are provided herein.

[0048] Referring to Figures 2.1 and 2.2, the fluid system (and modular fluid/slurry mixing manifold) 206 may be used in various scenarios. Figures 2.2 and 2.2.1 -2.2.4 include a table 251 including various process flow combinations. The table 251 provides examples of various scenarios which may be performed by at least one embodiment of the fluid system disclosed herein. By way of example, scenario D4 is an example process flow that may be used. Scenario D4 involves re-circulating to the averaging tank 245 or batch mixer tank(s) 252.

[0049] As shown in Table 251, scenarios A1-35, B 1-3 and C1-7 are provided along the left side of the Table 251. These scenarios refer to A) scenarios for pumpers where there may be additional pumps and with complete backup or redundancy, B) scenarios with no additional pumps and no backup or redundancy, and C) other scenarios. Along the top of Table 251, pipes S1-S7, M1-M4, B1-B5 and D1-D4 (Figure 2.1) are provided indicating flow for the various scenarios. Below is a summary of the various scenarios, which are neither exhaustive or limiting:

A. Scenarios A1-A35: For pumpers where there may be additional pump(s) to supply mixing water to the mixer(s), the role of the manifold is to facilitate and control the fluid/slurry mixing logic, with complete backup or redundancy. Scenarios 1-8 are depicted as examples for pumpers with a single mixer and mixing tank i.e., mixer 246.1 and mixing tank 248.1; whereas, scenarios 9-35 are depicted as examples for pumpers with dual mixers 246.1, 246.2 and mixing tanks i.e., an additional mixer 246.2 and mixing tank 248.2, and a common averaging tank 245. Dual mixing can also be achieved with two totally independent mixing manifolds. In this case, the mixing logic and redundancies for each system may remain the same as scenarios A1-8. Such dual mixing can also be extended to as many mixing systems as needed. The following example scenarios may be implemented in accordance with at least one embodiment of the present disclosure:

1. Pump 250.1 may be used to re-circulate fluid/slurry between mixing tank 248.1 and mixer 246.1. After the desired density/property is achieved and the fluid/slurry flows to the averaging tank 245, pump 250.2 may be used to transfer fluid/slurry from the averaging tank 245 to the high pressure pump(s) 254.

2. If pump 250.1 is down, pump 250.2 may be used to re-circulate fluid/slurry between mixing tank 248.1 and Mixer 246.1. After the desired density/property is achieved, pump 250.2 may also be used to concurrently transfer fluid/slurry from mixing tank 248.1 to the High pressure pump(s) 254, while maintaining re-circulation.
3. If pump 250.2 is down, pump 250.1 may be used to re-circulate fluid/slurry between mixing tank 248.1 and mixer 246.1. After the desired density/property is achieved, pump 250.1 may also be used to concurrently transfer fluid/slurry from mixing tank 248.1 to the high pressure pump(s) 254, while maintaining re-circulation.
4. Same process objectives as scenario (1), but fluid/slurry is delivered from the averaging tank 245 to the batch mixer tank(s) 252. Pumps from the batch mixer tank(s) 252 may then deliver fluid/slurry to the high pressure pump(s) 254.
5. Same process objectives as scenario (2) but fluid/slurry is delivered from mixing tank 248.1 to the batch mixer tank(s) 252. Pumps from the batch mixer tank(s) 252 may then deliver fluid/slurry to the high pressure pump(s) 254.
6. Same process objectives as scenario (3) but fluid/slurry is delivered from mixing tank 248.1 to the batch mixer tank(s) 252. Pumps from the batch mixer tank(s) 252 may then deliver fluid/slurry to the high pressure pump(s) 254.
7. Same process objectives as scenario (1) but fluid/slurry is delivered from the averaging tank 245 to the batch mixer tank(s) 252, and when batch mixer tank(s) 252 pumps are not available. Pump 250.2 may be used to transfer a fixed desired volume of fluid/slurry to the batch mixer tank(s) 252, subsequently pump 250.2 may also be used to transfer fluid/slurry from the batch mixer tank(s) 252 to the high pressure pump(s) 254.
8. Same process objectives as scenario (1), but fluid/slurry is delivered from the averaging tank 245 to the batch mixer tank(s) 252, and when batch mixer tank(s) 252 pumps are not available. Pump 250.2 may be used to concurrently

transfer fluid/slurry from the averaging tank 245 to the batch mixer tank(s) 252, and from the batch mixer tank(s) 252 to the high pressure pump(s) 254.

9. For the dual mixers option, there may be two additional external pumps used to re-circulate fluid/slurry between mixer 246.1 and mixing tank 248.1, and mixer 246.2 and mixing tank 248.2 respectively. Also, both pump 250.1 and pump 250.2 can be available. When the desired density/property for both mixing tanks is reached and fluid/slurry flows to the averaging tank 245, pump 250.1 or pump 250.2 may be used to transfer fluid/slurry from the averaging tank 245 to the high pressure pump(s) 254.
10. Same process objectives as scenario (9), except that if pump 250.2 is down, pump 250.1 may be used to transfer fluid/slurry from the averaging tank 245 to the high pressure pump(s) 254.
11. Same process objectives as scenario (9), except that if pump 250.1 is down, pump 250.2 may be used to transfer fluid/slurry from the averaging tank 245 to the high pressure pump(s) 254.
12. Same process objectives as scenario (9), except when higher fluid/slurry delivery rates are desired, pump 250.1 and pump 250.2 may both be used to transfer fluid/slurry from the averaging tank 245 to the high pressure pump(s) 254.
13. Same process objectives as scenario (9), if mixer 246.1-mixing tank 248.1 external re-circulation pump is down, pump 250.1 can take over the role of that pump (while mixer 246.2-mixing tank 2 external re-circulation pump can still operate). When the desired density/property for both mixing tanks is reached and fluid/slurry flows to the averaging tank 245, pump 250.2 may be used to transfer fluid/slurry from the averaging tank 245 to the high pressure pump(s) 254.
14. Same process objectives as scenario (9), if mixer 246.2-mixing tank 248.2 external re-circulation pump is down, pump 250.2 can take over the role of that pump (while mixer 246.1-mixing tank 248.1 external re-circulation pump can still operate). When the desired density/property for both mixing tanks is

reached and fluid/slurry flows to the averaging tank 245, pump 250.1 may be used to transfer fluid/slurry from the averaging tank 245 to the high pressure pump(s) 254.

15. For the dual mixers option, if a common averaging tank 245 is not available (e.g., due to space constraints) or both external re-circulation pumps are down, pump 250.1 and pump 250.2 may be used to re-circulate fluid/slurry between mixer 246.1 and mixing tank 248.1, and mixer 246.2 and mixing tank 248.2 respectively. When the desired density/property for both mixing tanks is reached, pump 250.1 and pump 250.2 can transfer fluid/slurry from mixing tank 248.1 and mixing tank 248.2 respectively, to the high pressure pump(s) 254.
16. Same process objectives as scenario (9) but fluid/slurry is delivered from the averaging tank 245 to the batch mixer tank(s) 252. Pumps from the batch mixer tank(s) 252 can then deliver fluid/slurry to the high pressure pump(s) 254.
17. Same process objectives as scenario (10) but fluid/slurry is delivered from the averaging tank 245 to the batch mixer tank(s) 252. Pumps from the batch mixer tank(s) 252 can then deliver fluid/slurry to the high pressure pump(s) 254.
18. Same process objectives as scenario (11) but fluid/slurry is delivered from the averaging tank 245 to the batch mixer tank(s) 252. Pumps from the batch mixer tank(s) 252 can then deliver fluid/slurry to the high pressure pump(s) 254.
19. Same process objectives as scenario (12) but fluid/slurry is delivered from the averaging tank 245 to the batch mixer tank(s) 252. Pumps from the batch mixer tank(s) 252 can then deliver fluid/slurry to the high pressure pump(s) 254.
20. Same process objectives as scenario (13) but fluid/slurry is delivered from the averaging tank 245 to the batch mixer tank(s) 252. Pumps from the batch

mixer tank(s) 252 can then deliver fluid/slurry to the high pressure pump(s) 254.

21. Same process objectives as scenario (14) but fluid/slurry is delivered from the averaging tank 245 to the batch mixer tank(s) 252. Pumps from the batch mixer tank(s) 252 can then deliver fluid/slurry to the high pressure pump(s) 254.
22. Same process objectives as scenario (15) but fluid/slurry is delivered from mixing tank 248.1 and mixing tank 248.2 to the batch mixer tank(s) 252. Pumps from the batch mixer tank(s) 252 can then deliver fluid/slurry to the high pressure pump(s) 254.
23. Same process objectives as scenario (9) but fluid/slurry is delivered from the averaging tank 245 to the batch mixer tank(s) 252, and when batch mixer tank(s) 252 pumps are not available. Pump 250.1 may be used to transfer fluid/slurry from the averaging tank 245 to the batch mixer tank(s) 252. Pump 250.2 may then be used to transfer fluid/slurry from the batch mixer tank(s) 252 to the high pressure pump(s) 254.
24. Same process objectives as scenario (9) but fluid/slurry is delivered from the averaging tank 245 to the batch mixer tank(s) 252, and when batch mixer tank(s) 252 pumps are not available. Pump 250.1 or pump 250.2 may be used to transfer a fixed desired volume of fluid/slurry to the batch mixer tank(s) 252, subsequently pump 250.1 or pump 250.2 may also be used to transfer fluid/slurry from the batch mixer tank(s) 252 to the high pressure pump(s) 254.
25. Same process objectives as scenario (9) but fluid/slurry is delivered from the averaging tank 245 to the batch mixer tank(s) 252, and when batch mixer tank(s) 252 pumps are not available. Pump 250.1 or pump 250.2 may be used to concurrently transfer fluid/slurry from the averaging tank 245 to the batch mixer tank(s) 252, and from the batch mixer tank(s) 252 to the high pressure pump(s) 254.

26. Same process objectives as scenario (10) but fluid/slurry is delivered from the averaging tank 245 to the batch mixer tank(s) 252, and when batch mixer tank(s) 252 pumps are not available. Pump 250.1 may be used to transfer a fixed desired volume of fluid/slurry to the batch mixer tank(s) 252, subsequently pump 250.1 may also be used to transfer fluid/slurry from the batch mixer tank(s) 252 to the high pressure pump(s) 254.
27. Same process objectives as scenario (10) but fluid/slurry is delivered from the averaging tank 245 to the batch mixer tank(s) 252, and when batch mixer tank(s) 252 pumps are not available. Pump 250.1 may be used to concurrently transfer fluid/slurry from the averaging tank 245 to the batch mixer tank(s) 252, and from the batch mixer tank(s) 252 to the high pressure pump(s) 254.
28. Same process objectives as scenario (11) but fluid/slurry is delivered from the averaging tank 245 to the batch mixer tank(s) 252, and when batch mixer tank(s) 252 pumps are not available. Pump 250.2 may be used to transfer a fixed desired volume of fluid/slurry to the batch mixer tank(s) 252, subsequently pump 250.2 may also be used to transfer fluid/slurry from the batch mixer tank(s) 252 to the high pressure pump(s) 254.
29. Same process objectives as scenario (11) but fluid/slurry is delivered from the averaging tank 245 to the batch mixer tank(s) 252, and when batch mixer tank(s) 252 pumps are not available. Pump 250.2 may be used to concurrently transfer fluid/slurry from the averaging tank 245 to the batch mixer tank(s) 252, and from the batch mixer tank(s) 252 to the high pressure pump(s) 254.
30. Same process objectives as scenario (12) but fluid/slurry is delivered from the averaging tank 245 to the batch mixer tank(s) 252, and when batch mixer tank(s) 252 pumps are not available. Pump 250.1 and pump 250.2 may be used to transfer a fixed desired volume of fluid/slurry to the batch mixer tank(s) 252, subsequently pump 250.1 and pump 250.2 may also be used to transfer fluid/slurry from the batch mixer tank(s) 252 to the high pressure pump(s) 254.
31. Same process objectives as scenario (12) but fluid/slurry is delivered from the averaging tank 245 to the batch mixer tank(s) 252, and when batch mixer

tank(s) 252 pumps are not available. Pump 250.1 and pump 250.2 may be used to concurrently transfer fluid/slurry from the averaging tank 245 to the batch mixer tank(s) 252, and from the batch mixer tank(s) 252 to the high pressure pump(s) 254.

32. Same process objectives as scenario (13) but fluid/slurry is delivered from the averaging tank 245 to the batch mixer tank(s) 252, and when batch mixer tank(s) 252 pumps are not available. Pump 250.2 may be used to transfer a fixed desired volume of fluid/slurry to the batch mixer tank(s) 252, subsequently pump 250.2 may also be used to transfer fluid/slurry from the batch mixer tank(s) 252 to the high pressure pump(s) 254.
33. Same process objectives as scenario (13) but fluid/slurry is delivered from the averaging tank 245 to the batch mixer tank(s) 252, and when batch mixer tank(s) 252 pumps are not available. Pump 250.2 may be used to concurrently transfer fluid/slurry from the averaging tank 245 to the batch mixer tank(s) 252, and from the batch mixer tank(s) 252 to the high pressure pump(s) 254.
34. Same process objectives as scenario (14) but fluid/slurry is delivered from the averaging tank 245 to the batch mixer tank(s) 252, and when batch mixer tank(s) 252 pumps are not available. Pump 250.1 may be used to transfer a fixed desired volume of fluid/slurry to the batch mixer tank(s) 252, subsequently pump 250.1 may also be used to transfer fluid/slurry from the batch mixer tank(s) 252 to the high pressure pump(s) 254.
35. Same process objectives as scenario (14) but fluid/slurry is delivered from the averaging tank 245 to the batch mixer tank(s) 252, and when batch mixer tank(s) 252 pumps are not available. Pump 250.1 may be used to concurrently transfer fluid/slurry from the averaging tank 245 to the batch mixer tank(s) 252, and from the batch mixer tank(s) 252 to the high pressure pump(s) 254.

B. Scenarios B1-B3: For pumpers where there may be no additional pump to supply mixing water, and/or where there is no backup or redundancy. The following possible scenarios may be implemented in accordance with at least one embodiment of the present disclosure:

1. Unlike pumper variation A, pump 250.2 may be used to supply mixing water to mixer 246.246.1 and mixing tank 248.1. Pump 250.1 may be used to re-circulate fluid/slurry between mixing tank 248.1 and mixer 246.1. After the desired density/property is achieved, pump 250.1 may also be used to concurrently transfer fluid/slurry from mixing tank 248.1 to the high pressure pump(s) 254, while maintaining re-circulation.
 2. Same process objectives as scenario (B)(1) but fluid/slurry is delivered from mixing tank 248.1 to the batch mixer tank(s) 252. Pumps from the batch mixer tank(s) 252 can then deliver fluid/slurry to the high pressure pump(s) 254.
 3. Same process objectives as scenario (B)(1) but fluid/slurry is delivered from mixing tank 248.1 to the batch mixer tank(s) 252 and when batch mixer tank(s) 252 pumps are not available. Pump 250.1 may be used to transfer a fixed desired volume of fluid/slurry to the batch mixer tank(s) 252, subsequently pump 250.1 may also be used to transfer fluid/slurry from the batch mixer tank(s) 252 to the high pressure pump(s) 254.
- C. Scenarios C1-7: Other possible scenarios related to general fluid/slurry delivery may be implemented in accordance with at least one embodiment of the present disclosure:
1. When higher delivery rates are desired, pumps 250.1, 250.2 may be used to transfer fluids from the water/chemical supply 244 to the high pressure pump(s) 254.
 2. If pump 250.2 is down, pump 250.1 may be used to transfer fluids from the water/chemical supply 244 to the high pressure pump(s) 254.
 3. If pump 250.1 is down, pump 250.2 may be used to transfer fluids from the water/chemical supply 244 to the high pressure pump(s) 254.
 4. When higher delivery rates are desired, pump 250.1 and pump 250.2 may be used to transfer fluids from the water/chemical supply 244 to the high pressure pump(s) 254.
 5. Same process objectives as scenario (1) but fluid from the water/chemical supply 244 may be delivered to the batch mixer tank(s) 252 (or any other destination).

6. Same process objectives as scenario (2) but fluid from the water/chemical supply 244 may be delivered to the batch mixer tank(s) 252 (or any other destination).
7. Same process objectives as scenario (3) but fluid from the water/chemical supply 244 may be delivered to the batch mixer tank(s) 252 (or any other destination).

[0050] Figure 3 is a simplified flow diagram of a fluid system 206 which depicts a mixing modular manifold 336 as an interface between the mixer 330 and high pressure pump(s) 354 that are used to deliver the mixed fluids to the wellsite.

[0051] The mixer 330 includes mixers 246, mixing tanks 248, averaging tanks 245, mixing fluid supply 242 and batch mixer tank 252. The mixer 330 passes fluid to the mixing modular manifold 336. Fluid is recirculated to the mixer via mixing recirculation lines 337 as indicated by the arrows. The fluid may then be passed from the mixing modular manifold 336 to the high pressure pump 354, and on to the wellhead at the wellbore.

[0052] Although the example scenarios have been described in Figures 1-3 are with reference to specific implementations, the present disclosure is not to be limited by or to such implementations and/or embodiments. For example, scenarios may exist where either one or both pumps 250.1, 250.2 are replaced by external pumps to perform substantially similar functions. Moreover, equivalent functional scenarios may be encompassed within the scope of the present disclosure, such as the multiple usages of nozzle points, or the use of pits rather than batch mixer tank(s) 252. Furthermore, subsets of scenarios described above may exist, for example, in scenario (26), a single pump may be utilized to transfer fluid from the batch mixer tank(s) 252 to the high pressure pump(s) 254. In addition, combinations of scenarios or combinations of subsets of scenarios are encompassed in all such modifications, variations and enhancements of at least one embodiment of the present disclosure. Various combinations of the fluid systems (e.g., 106, 206 and/or 306) may be combined as desired to achieve desired configurations.

[0053] Referring now to Figures 4.1 and 4.2, an example design of a modular fluid/slurry mixing modular manifold 436 is depicted in accordance with at least one embodiment of the present disclosure. The modular manifold may include flow control systems and components that may be used for well construction services. The modular manifold 436 as shown in

Figure 4.1 includes pumps 250.1, 250.2, pipes 254.1-254.13, valves V1-V22, and intersections 257.1-257.10. The pipes 254.1-254.13 may have connection points 1-13 (e.g., nozzles, or inlets or other devices), respectively, to manipulate flow into and out of the modular manifold 436 through pipes 254.1-254.13. Connectors (not shown) may be provided for connection to the remainder of the fluid system for fluid communication therewith.

[0054] At connection point 1, pipe 254.1 fluidly couples averaging tank 245 to intersection 257.1 via valve V1. At connection point 2, pipe 254.2 fluidly couples mixing tank 248.1 to intersection 257.2 via valve V9. At connection point 3, pipe 254.3 fluidly couples displacement tank or auxiliary water/chemical supply 244 to intersection 257.1 via valve V14. At connection point 4, pipe 254.4 fluidly couples auxiliary mixer 246.1 to intersection 257.3 via valve V12. At connection point 5, pipe 254.5 fluidly couples averaging tank 245 and batch mixer tank(s) 252 to intersection 257.7 via valve V7 if desired. At connection point 6, pipe 254.6 fluidly couples suction of high pressure pump(s) 254 to intersection 257.7 via valve V8.

[0055] At connection point 7, pipe 254.7 optionally fluidly couples batch mixer tank(s) 252 to intersection 257.4 via valve V16. At connection point 8, pipe 254.8 optionally fluidly couples batch mixer tank(s) 252 and high pressure pump(s) 254 to intersection 257.5 via valve V17. At connection point 9, pipe 254.9 optionally fluidly couples additional mixing tank 248.2 for a dual mixers 446 to intersection 257.9 via valve V18. At connection point 10, pipe 254.10 fluidly couples auxiliary mixer 246.1 for pumper variation B or additional auxiliary mixer 246.2 for dual mixers to intersection 257.8 via valve V19. At connection point 11, pipe 254.11 fluidly couples batch mixer tank(s) 252 to intersection 257.9. At connection point 12, pipe 254.12 fluidly couples batch mixer tank(s) 252 to intersection 257.2. At connection point 13, pipe 254.13 fluidly couples drain 456 to intersection 257.10 via valve V21.

[0056] Pump 250.2 is fluidly coupled to intersection 257.9 via valve V3, and to intersection 257.8 via valve V4. Pump 250.1 is fluidly connected to intersection 257.2 via valve V10, and to intersection 257.3 via valve V11. Valve V15 fluidly couples intersections 257.10 and 257.2. Valve V2 fluidly couples intersections 257.1 and 257.9. Valve V5 fluidly couples intersections 257.8 and 257.9. Valve V6 fluidly couples intersections 257.6 and 257.5. Valve V20 fluidly couples intersections 257.3 and 257.4.

[0057] The modular manifold 436 may also be provided with other fluid control or other devices, such as knock-off caps for cleaning and inspection at strategic points as will be described further herein. Valves V16 and V17 may be optional depending on whether batch mixer tank(s) 252 are used. Valve V18 may be optional depending on whether dual mixers 246.1, 246.2 are used. Valve V19 may be optional depending on whether dual mixers 246.1, 246.2 and/or mixing water supply 242 are used.

[0058] In an example, valve V7 may be adjustable to compensate for increased re-circulation flow to the averaging tank 245 or batch mixer tank(s) 252, and may ensure against insufficient suction pressure at the high pressure pump(s) 254. For conditions where either one of pumps 250.1, 250.2 is down, valve V16 may be adjustable to ensure that maximum supply rate to the batch mixer tank(s) 252 does not come at the expense of insufficient re-circulation rate and pressure for mixing. Valve V6 may be adjustable to optimize re-circulation rate and pressure when it is desired to mix and pressurize high pressure pump(s) 254 simultaneously.

[0059] Referring to Figures 4.2 and 4.2.1-4.2.4, a table 437 is provided depicting possible valve combinations and connection points listed as examples to correspond with at least one of the various scenarios discussed herein. An example logic table is indicated therein by numerical sequence, which may be referenced for logic explanation and not particularly for physical operating sequence. For the valve combinations referenced in table 437, one may assume that the valves are closed by default.

[0060] As shown in table 437, various scenarios are provided for valve combinations involving valves V1-V22 being actuated in the order sequence of 1, 2, 3 and so forth. The scenarios include A1-35, B1-3 and C1-7 as previously described.

[0061] Referring now to Figures 5.1 - 6.4, example modular fluid/slurry mixing modular manifolds are presented therein in accordance with certain embodiments of the present disclosure. Each modular fluid/slurry mixing manifold presented in Figures 4.1 - 5.4 includes a centrifugal pump, for example an RA5X6 (inlet 6 in (15.24) and outlet 5 in (12.70)). Moreover, each modular fluid/slurry mixing manifold presented may be designed to facilitate fluid/slurry mixing logic, and may be modular and compact so as to fit within a specified bounding volume.

[0062] The fluid/slurry mixing manifold constructed in accordance with the present disclosure may be designed and manufactured in accordance to ASME B31.3, having flanges and buttweld fittings designed to meet ASME B16.5 and ASME B16.9 respectively, and welds designed for Non-Destructive Testing (NDT). The nozzles (e.g., N7 and N8) may be arranged such that the batch mixer tank(s) 252 can be installed from either side of the manifold, thereby enhancing flexibility in installations.

[0063] Figures 5.1-5.4 depict front, perspective, rear and side views, respectively, of modular manifold 536 and Figures 6.1-6.4 depict front, perspective, rear and side views, respectively, of modular manifold 636 in a physical configuration removable connectable to a fluid system, such as those described herein. In the examples of modular fluid/slurry mixing manifolds, Figures 5.1-5.4 depict the modular manifold 536 and centrifugal pumps 250.1, 250.2 installed vertically, and Figures 6.1-6.4 depict the modular manifold 636 and centrifugal pumps 250.1, 250.2 installed horizontally in accordance with at least one embodiment of the present disclosure. The modular manifolds 536 and 636 are constructed as unitary component that is transportable and modularly connectable between a mixer 330 and high pressure pumps 354 of a fluid system for passing fluid therebetween as shown, for example, in Figure 3.

[0064] The modular manifolds 536, 636 each include pumps 250.1, 250.2, pipes 254.1-254.13, valves V1-V22, intersections 257.1-257.10, and nozzles N1-13 operable as schematically depicted in Figure 4.1. Inlets 562.1, 562.2 depict options for receiving fluid/slurry from batch mixer tank(s) 252. The modular fluid/slurry mixing manifold is also shown to include knock-off caps 560, which may be placed at strategic locations for cleaning and inspection.

[0065] In the vertical configuration of Figures 5.1-5.4, the modular manifold 536 includes horizontal portions 564.1-564.3 and vertical portions 566.1-566.4. Horizontal portion 564.1 extends from inlet 562.1 to 562.2. Horizontal portion 564.2 extends from knockoff cap 560.1 to knockoff cap 560.2. Horizontal portion 564.3 extends from V4 to V11. Vertical portion 566.1 extends between horizontal portions 564.1, 564.2. Vertical portions 566.2, 566.3 extend between opposite ends of horizontal portions 564.2, 564.3. Centrifugal pumps 250.1, 250.2 are positioned about the vertical portions 566.2, 566.3.

[0066] In the horizontal configuration of Figures 6.1-6.4, the modular manifold 636 includes horizontal portions 664.1-664.3 and vertical portions 666.1-666.4. Horizontal portion 664.1

extends from knockoff cap 660.1 to knockoff cap 660.2. Horizontal portion 664.2 extends from valve V19 to knockoff cap 660.3. Horizontal portion 664.3 extends from valve V18 to knockoff cap 660.34. Vertical portions 666.2, 666.3 extend between opposite ends of horizontal portions 664.1, 664.2. Vertical portion 666.1 extends between horizontal portions 664.2, 664.3. Centrifugal pumps 250.1, 250.2 extend from opposite ends of horizontal portion 664.3.

[0067] The modular manifold 536, 636 may also be provided with connectors 253 for operative connection with portions of the fluid system. The connectors 253 may releasably connect the modular manifold to the fluid system when positioned adjacent thereto. Various connectors may be provided for linking portions of the modular manifold 536, 636 to the various components of the fluid system, such as at connection points 1-13.

[0068] The modular manifolds herein may be used as part of fluid systems, such as those of Figures 1 and 2.1. The fluids system may be configured to receive the modular manifold. Figures 7.1-9.2 depict various configurations of a fluid system 706.1, 706.2, 806.1, 806.2, 906.1, 906.2 with a modular manifold. Each of these fluid systems includes a mixer portion, a modular manifold and a delivery portion.

[0069] Figures 7.1 and 7.2 depict a single mixer configuration. These figures include a horizontal single mixer fluid system 706.1 and a vertical single mixer fluid system 706.2, respectively. As demonstrated by these figures, the fluid system may be in a variety of configurations such that fluid is mixed, pumped and delivered to the wellbore as shown in Figures 1 and 2.1-2.3.

[0070] The fluid system 706.1 includes a mixing portion 730, a modular manifold 736, and a delivery portion 740. The mixing portion 730 includes a mixer 746, an averaging tank 745 and a mixing tank 748. The mixing portion 730 receives and mixes fluids. The mixed fluids are passed from mixer 746 to the averaging tank 745 and the mixing tank 748.

[0071] The modular manifold 736 is removably fluidly coupled to the mixing tank 748 and the averaging tank 745 for receiving fluids therefrom. The modular manifold 736 may recirculate fluid to the mixing portion 730, and then passes the fluid as mixed slurry 753 on to the delivery portion 740. The delivery portion includes high pressure pumps 754 and a motor (e.g., a prime mover engine/motor) 755. Drive shafts 757 may be provided between the motor 755 and the high pressure pumps 754 for driving the pumps 754.

[0072] Figures 8.1 and 8.2 depict a dual mixer configuration. These figures include a horizontal dual mixer fluid system 806.1 and a vertical dual mixer fluid system 806.2, respectively. As demonstrated by these figures, the fluid system may be in a variety of configurations such that fluid is mixed, pumped and delivered to the wellbore as shown in Figures 1 and 2.1-2.3.

[0073] The fluid system 806.1 includes a mixing portion 830, a modular manifold 836, and a delivery portion 840. The mixing portion 830 includes mixers 846, an averaging tank 845 and mixing tanks 848. The mixing portion 830 receives and mixes fluids. The mixed fluids are passed from mixers 846 to the averaging tank 845 and the mixing tank 848.

[0074] The modular manifold 836 is removably fluidly coupled to the mixing tank 848 and the averaging tanks 845 for receiving fluids therefrom. The modular manifold 836 may recirculate fluid to the mixing portion 830, and then passes the fluid as mixed slurry 853 on to the delivery portion 840. The delivery portion includes high pressure pumps 854 and a motor (e.g., a prime mover engine/motor) 855. Drive shafts 857 may be provided between the motor 855 and the high pressure pumps 854 for driving the pumps 854.

[0075] Figures 9.1-9.3 depict an example configuration of the fluid systems 706.1, 706.2, 806.1, and/or 806.2. Figure 9.3 is a plan view of the fluid assembly 706.1, 806.1. Figure 9.1 is a perspective view of the mixing portion 730, 830 removed from the fluid system 706.1, 806.2. Figure 9.2 depicts the modular manifold 736, 836 removed from the fluid system 706.1, 806.1.

[0076] Figures 10.1 and 10.2 depict an integrated manifold configuration. These figures include a horizontal integrated fluid system 1006.1 and a vertical integrated fluid system 1006.2, respectively. As demonstrated by these figures, the fluid system may be in a variety of configurations such that fluid is mixed, pumped and delivered to the wellbore as shown in Figures 1 and 2.1-2.3.

[0077] The fluid system 1006.1 includes an integrated mixing and manifold portion 1031, and a delivery portion 1040. The integrated portion 1031 includes a mixing portion 1030 and modular manifold 1036. The mixing portion 1030 and the modular manifold 1036 may be integrated into a unitary structure for transport. The integrated portion 1031 may be positioned on a skid 1074 movably positionable about the wellsite and/or the delivery portion 1040.

[0078] The mixing portion 1030 includes mixers 1046, an averaging tank 1045 and mixing tanks 1048. The integrated portion 1031 receives and mixes fluids. The mixed fluids are passed from mixers 1046 to the averaging tank 1045 and the mixing tank 1048. The modular manifold 1036 is removably fluidly coupled to the mixing tank 1048 and the averaging tank 1045 for receiving fluids therefrom.

[0079] The modular manifold 1036 may recirculate fluid to the mixing portion 1030, and then passes the fluid on to the delivery portion 1040. The delivery portion includes high pressure pumps 1054 and a motor (e.g., a prime mover engine/motor) 1055. Drive shafts 1057 may be provided between the motor 1055 and the high pressure pumps 1054 for driving the pumps 1054.

[0080] Figures 11.1-11.3 depict an example configuration of the fluid systems 1006.1 and/or 906.2. Figure 11.3 is a plan view of the fluid assembly 1006.1 depicting the pumping equipment. Figure 11.1 is a perspective view of the mixing portion 1030 removed from the fluid system 1006.1. Figure 11.3 depicts the mixing manifold 1036 removed from the fluid system 1006.1.

[0081] Figures 12.1-13.2 depict various configurations of a modular manifold usable with the various fluid systems herein. These figures may use aspects of the manifold configurations described herein, such as the pipe, valves and pumps as previously described. Figures 12.1 and 12.2 show a modular manifold 1236 mounted on a frame 1270 to form a mobile manifold assembly. Figures 13.1 and 13.2 show a modular manifold without a frame.

[0082] Figures 12.1 and 12.2 depict front and rear perspective views, respectively, of the modular manifold 1236. This modular manifold 1236 may be used, for example, with the configurations of Figures 7.1-9.3 and incorporate the valves V1-21, inlets 1-13, pipes 254.1-254.13, and pumps 250.1, 250.2 (only some of which are shown in these figures). In the configuration shown, the modular manifold 1236 includes two pumps 1250.1, 1250.2 fluidly coupled via pipes and valves to auxiliary equipment of the fluid system. A flow control valve 1272 (e.g., butterfly valve with manual lever) is also provided for fluidly coupling to the remainder of the fluid system.

[0083] As shown in Figures 12.1 and 12.2, the modular manifold 1236 fluidly couples to averaging tank 245 at connection point 1, mixing tank 248 at connection point 2, displacement tank or auxiliary water/chemical supply 244 at connection point 3 (not shown),

to auxiliary mixer 246.2 at connection point 4 (not shown), re-circulation to averaging tank 245 or batch mixer tank(s) 252 if required at connection point 5, to densitometer flow meter and suction of high pressure pump(s) 254 at connection point 6, to batch mixer tank(s) 252 (optional) at connection point 7, from batch mixer tank(s) 252 to high pressure pump(s) 254 (optional) at connection point 7, from additional mixing tank 248.2 for dual mixers option (optional) at connection point 9, to auxiliary mixer 246.2 for pumper variation B or to additional auxiliary mixer 246.2 for dual mixers at connection point 10, from batch mixer tank(s) 252 to pump 250.2 at connection point 11, from batch mixer tank(s) 252 to pump 1 at connection point 12, and to drain 456 at connection point 13. Knock-off caps may also be provided for cleaning and inspection at strategic.

[0084] This modular manifold 1236 and the frame 1270 form a mobile manifold assembly for lifting, transporting and supporting the modular manifold 1236. The frame 1270 may be configured for connection to the fluid system. As shown, the frame 1270 includes a base portion 1271, vertical support 1273 and brackets 1275 made up of a plurality of bars forming a grid for supporting the modular manifold 1236. The base portion 1271 may be a frame, skid or other platform for supporting the modular manifold 1236 on the ground or other surface. The carrier portion 1273 is operatively connected to the base portion 1271 and extends a distance above. The carrier portion 1273 may be used to provide support to portions of the modular manifold 1236. The carrier portion 1273 may also be provided with a handle, grips or other devices for lifting the modular manifold 1236. The brackets 1275 are provided to support the pumps 250.1, 250.2. Additional supports, such as brackets 1275 may also be provided for supporting various portions of the modular manifold 1236 on the frame 1270. The modular manifold 1236 may be securable to the base portion 1271 and the carrier portion 1273 of the mobile frame 1270. The modular manifold is liftable via the mobile frame 1270 whereby the modular manifold is transportable to the auxiliary components for operable connection therewith.

[0085] Portions of the modular manifold 1236 may be positioned about the frame 1270 to facilitate transport, delivery, connection and operation of the modular manifold 1236. As shown, the horizontal portions of the pipes extend along linear bars forming the frame. Portions of the modular manifold 1236 extend through the frame 1270 such that a portion of the modular manifold 1236 is on each side of the vertical support 1273. The connector portions of the modular manifold 1236 are positioned on one side of the vertical support 1273

and has connectors extending therefrom for connection with the fluid system. Connector portions of the pipes, such as the portions of the pipes at the connection points, extend from the modular manifold in an arrangement corresponding to an arrangement of the auxiliary components to define a plug-in configuration therebetween such that the connector portions of the pipes are positionable in alignment with the auxiliary components for direct and removable connection therewith. A pump portion of the modular manifold 1236 is positioned on the other side of vertical support 1273. In this configuration, the modular manifold 1236 may be 'plugged in' to the remainder of the fluid system for operation therewith.

[0086] Figures 13.1 and 13.2 depict front and rear perspective views, respectively, of a modular manifold 1336. This modular manifold 1336 may be used, for example, with the configurations of Figures 10.1-11.3. In the configuration shown, the modular manifold includes two pumps 250.1, 250.2 fluidly coupled via pipes 1345 and valves to auxiliary equipment of the fluid system. A flow control valve 1372 (e.g., butterfly valve with pneumatic actuator) is also provided for fluidly coupling to the remainder of the fluid system.

[0087] As shown in Figures 13.1 and 13.2, the modular manifold 1336 fluidly couples to averaging tank 250 at position 1, mixing tank 248 at position 2, displacement tank or auxiliary water/chemical supply 244 at position 3, to auxiliary mixer 246.2 at position 4, recirculation to averaging tank 245 or batch mixer tank(s) 252 if required at position 5, to suction of high pressure pump(s) 254 at position 6, to batch mixer tank(s) 252 (optional) at position 7, from batch mixer tank(s) 252 to high pressure pump(s) 254 (optional) at position 8, from additional mixing tank 248.2 for dual mixers option (optional) at position 9, to auxiliary mixer 246.1 for pumper variation B or to additional auxiliary mixer 246.2 for dual mixers at position 10, from batch mixer tank(s) 252 to manifold/mixing pump 250.2 at position 11, from batch mixer tank(s) 252 to manifold/mixing pump 250.1 at position 12, and to drain 456 at position 13. Knock-off caps may also be provided for cleaning and inspection as needed.

[0088] The manifolds herein are provided with various connectors 253 for operative connection to the remainder of the fluid systems, and fluid control devices, such as pumps for driving fluid, valves for selectively diverting fluid, drains for releasing fluid, and/or other such devices. The manifolds may be pre-assembled in the appropriate configuration for operation with the fluid system and for transport and delivery. The manifolds may be

operatively connected to a frame, skid and/or other transport device to facilitate installation, lifting, and/or transport of the manifold.

[0089] Figure 14 is a method 1400 of providing fluid to a wellsite during well construction. The method 1400 involves (1480) providing a fluid system about a wellsite, the fluid system including auxiliary components (at least one fluid source, at least one mixer and at least one high pressure pump), and a mobile manifold assembly and/or a modular manifold. The fluid system and mobile manifold assembly may be those described herein. The method continues with (1482) transporting the modular manifold to the auxiliary components using the mobile frame, (1484) operatively connecting the connector portions of the modular manifold to the auxiliary components, and (1486) pumping fluid to the wellbore using the modular manifold.

[0090] The method may also involve mixing the fluid with the mixer, recirculating fluid between the auxiliary components and the modular manifold, selectively diverting fluid from the modular manifold to a mixing portion, a batch portion and/or a delivery portion of the fluid system, and/or cementing the wellbore using the fluid pumped to the wellbore. The method may be performed in any order and repeated as desired.

[0091] It should be noted that the valves described and depicted herein may be actuated in a variety of methods, or derivatives thereof. For example: actuation may be in-situ and manually with handles or wheels, remotely via direct pneumatics, remotely and indirectly using electrical solenoids and spools to regulate/control pneumatics (such feature may also enable process control via automated routines written for at least one of the operating scenarios described herein). Moreover, it should also be noted that the pumps may be run in accordance with a variety of methods, or derivatives thereof. For example, running the pumps may comprise drive shafts, electric motors or hydraulic motors. One skilled in the art will recognize that alternative methods can be employed in practicing the present disclosure.

[0092] Although the present disclosure has been described with reference to exemplary embodiments and implementations thereof, the present disclosure is not to be limited by or to such exemplary embodiments and/or implementations. Rather, the systems and methods of the present disclosure are susceptible to various modifications, variations and/or enhancements without departing from the spirit or scope of the present disclosure. Accordingly, the present disclosure expressly encompasses all such modifications, variations and enhancements within its scope.

[0093] The terminology and phraseology used herein is solely used for descriptive purposes and should not be construed as limiting in scope. Language such as "including," "comprising," "having," "containing," or "involving," and variations thereof, is intended to be broad and encompass the subject matter listed thereafter, equivalents, and additional subject matter not recited.

[0094] Moreover, in this description the terms "up" and "down"; "upward" and "downward"; "upstream" and "downstream"; and other like terms indicating relative positions above or below a given point or element are used in this description to more clearly described some embodiments of the invention.

[0095] It should be noted that in the development of any such actual embodiment, numerous implementations and specific decisions may be made to achieve the developer's specific goals, such as compliance with system related and business related constraints, which may vary from one implementation to another. Moreover, it will be appreciated that such a development effort may be complex and time consuming, but may nevertheless be a routine undertaking for those of ordinary skill in the art having the benefit of this disclosure. In addition, the composition used/disclosed herein can also comprise some components other than those cited.

[0096] Each numerical value herein should be read once as modified by the term "about" (unless already expressly so modified), and then read again as not so modified unless otherwise indicated in context. Also, in the disclosure, it should be understood that a concentration range listed or described as being useful, suitable, or the like, is intended that any and every concentration within the range, including the end points, is to be considered as having been stated. For example, "a range of from 1 to 10" is to be read as indicating each and every possible number along the continuum between about 1 and about 10. Thus, even if specific data points within the range, or even no data points within the range, are explicitly identified or refer to only a few specific, it is to be understood that inventors appreciate and understand that any and all data points within the range are to be considered to have been specified, and that inventors possessed knowledge of the entire range and all points within the range.

[0097] Although only a few example embodiments have been described in detail above, those skilled in the art will readily appreciate that many modifications are possible in the

example embodiments without materially departing from this invention. Accordingly, all such modifications are intended to be included within the scope of this disclosure as defined in the following claims. In the claims, means-plus-function clauses are intended to cover the structures described herein as performing the recited function and not only structural equivalents, but also equivalent structures. Thus, although a nail and a screw may not be structural equivalents in that a nail employs a cylindrical surface to secure wooden parts together, whereas a screw employs a helical surface, in the environment of fastening wooden parts, a nail and a screw may be equivalent structures. It is the express intention of the applicant not to invoke 35 U.S.C. § 112, paragraph 6 for any limitations of any of the claims herein, except for those in which the claim expressly uses the words 'means for' together with an associated function.

[0098] In a given example, the modular manifold may have valves and flowlines/pipes positioned on a frame in various configurations and provided with various connectors to facilitate connection to a mixing portion of a fluid system.

CLAIMS

What is claimed is:

1. A mobile manifold assembly of a fluid system for providing fluid to a wellsite during well construction, the wellsite having a rig positionable about a wellbore, the fluid system comprising auxiliary components comprising at least one fluid source, at least one mixer and at least one high pressure pump, the mobile manifold assembly comprising:

a modular manifold comprising a plurality of manifold pumps, a plurality of valves and a plurality of pipes integrated together for transport, connector portions of the plurality of pipes extending from the modular manifold in an arrangement corresponding to an arrangement of the auxiliary components to define a plug-in configuration therebetween such that the connector portions of the plurality of pipes are positionable in alignment with the auxiliary components for direct and removable connection therewith, the plurality of manifold pumps and valves positioned about the plurality of pipes to selectively pump the fluid about the modular manifold and at least one of the auxiliary components; and

a mobile frame comprising a base portion and a carrier portion, the modular manifold securable to the base portion and the carrier portion of the mobile frame, the modular manifold liftable via the mobile frame whereby the modular manifold is transportable to the auxiliary components for operable connection therewith.

2. The mobile manifold assembly of Claim 1, further comprising at least one knock off cap.

3. The mobile manifold assembly of Claim 1, further comprising at least one inlet.

4. The mobile manifold assembly of Claim 1, further comprising at least one drain.

5. The mobile manifold assembly of Claim 1, wherein at least one of the plurality of valves comprises a butterfly valve.

6. The mobile manifold assembly of Claim 5, wherein the butterfly valve is one of automatically and manually activated.

7. The mobile manifold assembly of Claim 5, wherein the plurality of manifold pumps selectively adjust fluid flow through the plurality of pipes.
8. The mobile manifold assembly of Claim 1, wherein the plurality of pipes define a plurality of horizontal pipe portions and a plurality of vertical pipe portion, the plurality of vertical pipe portions extending between the plurality of horizontal pipe portions.
9. The mobile manifold assembly of Claim 8, wherein the plurality of valves are positionable about the plurality of pipes and provide selective fluid communication between the plurality of pipes and the auxiliary components.
10. The mobile manifold assembly of Claim 8, wherein the plurality of manifold pumps are positionable about the plurality of horizontal pipe portions.
11. The mobile manifold assembly of Claim 8, wherein the plurality of manifold pumps are positionable about the plurality of vertical pipe portions.
12. The mobile manifold assembly of Claim 8, further comprising knock off caps positioned at opposite ends of one of the horizontal portions.
13. The mobile manifold assembly of Claim 8, further comprising inlets positioned between opposite ends of one of the horizontal portions.
14. The mobile manifold assembly of Claim 8, wherein one of the plurality of horizontal portions extends between a pair of the plurality of manifold pumps.
15. The mobile manifold assembly of Claim 14, wherein two of the plurality of vertical portions extends between the one of the plurality of horizontal portion with the plurality of manifold pumps and another of the plurality of horizontal portions.
16. The mobile manifold assembly of Claim 15, wherein another of the plurality of vertical portions extends between the another of the plurality of horizontal portions and yet another of the plurality of horizontal portions.

17. The mobile manifold assembly of Claim 8, wherein the connector portions extend from one of the plurality of horizontal portions of the modular manifold.

18. The mobile manifold assembly of Claim 1, wherein a portion of the connector portions extend horizontally from the modular manifold and a portion of the connector portions extend vertically from the modular manifold.

19. The mobile manifold assembly of Claim 1, wherein the connector portions of the plurality of pipe are connectable to at least one fluid source, at least one mixer, and at least one high pressure pump.

20. The mobile manifold of Claim 1, wherein the carrier portion extends vertically above the base portion.

21. The mobile manifold of Claim 1, wherein the carrier portion has one of a handle and a grip for lifting the frame.

22. A well construction fluid system for providing fluid to a wellsite during well construction, the wellsite having a rig positionable about a wellbore, the fluid system comprising:

auxiliary components comprising at least one fluid source, at least one mixer and at least one high pressure pump; and

a mobile manifold assembly, comprising:

a modular manifold comprising a plurality of manifold pumps, a plurality of valves and a plurality of pipes integrated together for transport, connector portions of the plurality of pipes extending from the modular manifold in an arrangement corresponding to an arrangement of the auxiliary components to define a plug-in configuration therebetween such that the connector portions of the plurality of pipes are positionable in alignment with the auxiliary components for direct and removable connection therewith, the plurality of manifold pumps and valves positioned about the plurality of pipes to selectively pump the fluid about the modular manifold and at least one of the auxiliary components; and

a mobile frame comprising a base portion and a carrier portion, the modular manifold securable to the base portion and the carrier portion of the mobile frame, the

modular manifold liftable via the mobile frame whereby the modular manifold is transportable to the auxiliary components for operable connection therewith.

23. The fluid system of Claim 22, wherein the auxiliary components comprise a mixing portion, and a delivery portion.

24. The fluid system of Claim 23, wherein the delivery portion comprises the at least one high pressure pump, a motor, at least one drive shaft, and at least one slurry tank.

25. The fluid system of Claim 23, wherein the mixing portion comprises the at least one mixer, at least one mixing tank and at least one fluid source.

26. The fluid system of Claim 22, wherein the at least one fluid source comprises an averaging tank, a water/chemical supply, and a mixing water supply.

27. The fluid system of Claim 22, wherein the auxiliary components further comprise a supply portion, a pumping portion, a transfer portion, and a batch mixer portion.

28. The fluid system of Claim 27, wherein the batch mixer portion comprises a batch mixer tank.

29. The fluid system of Claim 22, wherein the auxiliary components comprise a mixing portion and wherein the mobile manifold assembly is integrated with the mixing portion.

30. The fluid system of Claim 29, wherein the mobile manifold assembly and the mixing portion are positionable on a skid and transportable thereon.

31. The fluid system of Claim 22, wherein the at least one mixer comprises one of a single mixer and a dual mixer.

32. A method for providing fluid to a wellsite during well construction, the wellsite having a rig positionable about a wellbore, the method comprising:

providing a fluid system about a wellsite, the fluid system comprising:

auxiliary components comprising at least one fluid source, at least one mixer and at least one high pressure pump; and

a mobile manifold assembly, comprising:

- a modular manifold comprising a plurality of manifold pumps, a plurality of valves and a plurality of pipes integrated together for transport, connector portions of the plurality of pipes extending from the modular manifold in an arrangement corresponding to an arrangement of the auxiliary components to define a plug-in configuration therebetween such that the connector portions of the plurality of pipes are positionable in alignment with the auxiliary components for direct and removable connection therewith, the plurality of manifold pumps and valves positioned about the plurality of pipes to selectively pump the fluid about the modular manifold and at least one of the auxiliary components; and
- a mobile frame comprising a base portion and a carrier portion, the modular manifold securable to the base portion and the carrier portion of the mobile frame;

transporting the modular manifold to the auxiliary components using the mobile frame;

operatively connecting the modular manifold to the auxiliary components; and

pumping fluid to the wellbore using the modular manifold.

33. The method of Claim 33, further comprising mixing the fluid with the at least one mixer.

34. The method of Claim 32, further comprising recirculating fluid between the auxiliary components and the modular manifold.

35. The method of Claim 32, further comprising selectively diverting fluid from the modular manifold to one of a mixing portion, a batch portion and a delivery portion of the fluid system.

36. The method of Claim 32, further comprising cementing the wellbore using the fluid pumped to the wellbore.

37. The method of Claim 32, wherein the pumping further comprises pumping the fluid to the wellbore using the auxiliary components.

38. The method of Claim 23, further comprising transporting the auxiliary components and the mobile manifold assembly on a skid.