Claims

What is claimed is:

1. A subsea wellhead comprising:

a wellhead housing;

a tree block having a lower portion that extends into the wellhead housing, the tree block having a mandrel with a cylindrical exterior and an upward facing support surface extending radially outward from a lower end of the mandrel;

a main bore formed axially through the tree block;

a tubing hanger for supporting a string of production tubing landed in the main bore, the tubing hanger having a tubing hanger production passage with a laterally extending tubing hanger production port;

a tree block production passage within the tree block having a lower inlet that registers with the tubing hanger production port and an upper end that opens at the upward facing support surface;

a valve block having a central opening that slides over the mandrel and a bottom that lands on the support surface;

a valve block production passage within the valve block that has an inlet on the bottom of the valve block and which sealingly registers with the upper end of the tree block production passage; and

at least one valve mounted to the valve block for opening and closing the valve block production passage.

2. The subsea wellhead of claim 1, wherein the valve block central opening and the exterior of mandrel are unsealed to each other.

3. The subsea wellhead of claim 2, wherein the mandrel, tree block, and support surface are formed from a single block of metal.

4. The subsea wellhead of claim 1, wherein the support surface has a maximum dimension from one side to an opposite side that is greater than an outer diameter of the wellhead housing.

5. The subsea wellhead of claim 1, wherein the support surface on the tree block is aligned in a plane substantially perpendicular to the main bore.

6. The subsea wellhead of claim 1, wherein the mandrel from the support surface upward is free of any passages extending through a side wall of the mandrel.

7. The subsea wellhead of claim 1, further comprising:

a tubing annulus passage extending through the tree block, having a lower end at the main bore and an upper end at the support surface.

8. The subsea wellhead of claim 1, further comprising:

a tubing annulus passage extending through a portion of the tubing hanger below seals of the tubing hanger to a side of the tubing hanger, and from the side of tubing hanger, sealingly into the tree block and up to the support surface;

wherein the tubing annulus passage continues from the support surface sealingly into the valve block and to a tubing annulus port within the main bore above the seals of the tubing hanger; and

at least one valve mounted to the valve block for opening and closing the tubing annulus passage.

9. The subsea wellhead of claim 1, further comprising:

a tubing annulus passage extending from a lower tubing annulus port in the main bore of the tree block below seals of the tubing hanger to the support surface, and from the support surface into the valve block and to an upper port within the main bore above the seals of the tubing hanger; and

at least one valve mounted to the valve block for opening and closing the tubing annulus passage.

10. A wellhead assembly for use subsea comprising:

a wellhead housing circumscribing a wellbore opening;

a tree block comprising:

a body;

a main bore formed through the body and aligned with the wellbore;

an annular high pressure housing portion projecting downward from the body and coaxially inserted within the wellhead housing;

an annular mandrel projecting upward from the body and circumscribing the main bore axis, the mandrel having a cylindrical exterior; and

a landing surface on the body upper end at the base of the mandrel in a plane disposed substantially perpendicular to the axis;

a valve block having a central opening that receives the mandrel and a bottom that lands on the landing surface;

a fluid flow passage in the body that passes sealingly through the landing surface into the valve block; and

at least one valve mounted to the valve block for opening and closing the fluid flow passage.

11. The wellhead assembly of claim 10, further comprising:

a tubing hanger landed in the lower production tree and selectively retrievable through the main bore;

a tubing hanger production passage in the tubing hanger having a laterally extending outlet; and

wherein the fluid flow passage comprises a body flow passage that sealingly joins the outlet of the tubing hanger.

12. The wellhead assembly of claim 10, wherein the central opening of the valve block and the mandrel are in non-sealing engagement with each other.

13. The wellhead assembly of claim 10, further comprising a workover passage and an annulus passage formed in the body that extend into the valve block at the landing surface and wherein the fluid flow passage is a production passage so that landing the valve block onto the landing surface seals the passages.

14. . The subsea wellhead of claim 10, wherein the landing surface has a maximum dimension from one side to an opposite side that is greater than an outer diameter of the wellhead housing.

15. The subsea wellhead of claim 10, wherein the mandrel from the support surface upward is free of any passages extending through a side wall of the mandrel.

16. A subsea wellhead comprising:

a wellhead housing;

a tree block having a main bore and a lower portion that extends into the wellhead housing, the tree block having a mandrel with a cylindrical exterior and an upward facing landing surface extending radially outward from a lower end of the mandrel and located in a plane perpendicular to an axis of the mandrel;

a tubing hanger for supporting a string of production tubing landed in the main bore, the tubing hanger having a tubing hanger production passage with a laterally extending tubing hanger production port;

a tree block production passage within the tree block having a lower inlet that registers with the tubing hanger production port and an upper end that faces upward at the upward facing support surface;

upper and lower seals between an exterior of the tubing hanger and the main bore above and below tubing hanger production port, the upper seal being below the plane containing the support surface;

a tree block tubing annulus passage having a lower end in the main bore below the lower seal of the tubing hanger and an upper end facing upward at the support surface;

a tree block workover passage having a lower end in the main bore above the upper seal of the tubing hanger and an upper end facing upward at the support surface;

a valve block having a central opening that slides over the mandrel and a bottom that lands on the support surface;

a valve block production passage within the valve block that has an inlet on the bottom of the valve block and which sealingly registers with the upper end of the tree block production passage;

a valve block tubing annulus passage having a lower end that sealingly registers with the upper end of the tree block tubing annulus passage;

a valve block workover passage having a lower end that sealing registers with the upper end of the workover passage; and wherein

the valve block tubing annulus passage and the valve block workover passage having a junction with each other in the valve block.

CLAIMS

What is claimed is:

1. A subsea wellhead comprising:

a wellhead housing;

a valve support block having a lower portion that extends into the wellhead housing, the valve support block having a mandrel with a cylindrical exterior and an upward facing support surface extending radially outward from a lower end of the mandrel;

a main bore formed axially through the valve support block;

a tubing hanger for supporting a string of production tubing landed in the main bore, the tubing hanger having a tubing hanger production passage with a laterally extending tubing hanger production port;

a valve support block production passage within the valve support block having-a lower inlet that registers with the tubing hanger production port and an upper end that opens at the upward facing support surface;

a valve block having a bottom that lands on the support surface and a central opening that slides over and circumscribes the mandrel when the bottom lands on the support surface;

a valve block production passage within the valve block that has an inlet on the bottom of the valve block and which sealingly registers with the upper end of the valve support block production passage; and

at least one valve mounted to the valve block for opening and closing the valve block production passage.

2. The subsea wellhead of claim 1, wherein the valve block central opening and the exterior of mandrel are unsealed to each other.

3. The subsea wellhead of claim 2, wherein the mandrel, valve support block, and support surface are formed from a single block of metal.

4. The subsea wellhead of claim 1, wherein an outer periphery of the support surface extends radially outward past an outer diameter of the wellhead housing.

5. The subsea wellhead of claim 1, wherein the support surface on the valve support block is aligned in a plane substantially perpendicular to the main bore.

6. The subsea wellhead of claim 1, wherein the mandrel from the support surface upward is free of any passages extending through a side wall of the mandrel.

7. The subsea wellhead of claim 1, further comprising:

a tubing annulus passage extending through the valve support block, having a lower end at the main bore and an upper end at the support surface.

8. The subsea wellhead of claim 1, further comprising:

a tubing annulus passage extending through a portion of the tubing hanger below seals of the tubing hanger to a side of the tubing hanger, and from the side of tubing hanger, sealingly into the valve support block and up to the support surface;

wherein the tubing annulus passage continues from the support surface sealingly into the valve block and to a tubing annulus port within the main bore above the seals of the tubing hanger; and

at least one valve mounted to the valve block for opening and closing the tubing annulus passage.

9. The subsea wellhead of claim 1, further comprising:

a tubing annulus passage extending from a lower tubing annulus port in the main bore of the valve support block below seals of the tubing hanger to the support surface, and from the support surface into the valve block and to an upper port within the main bore above the seals of the tubing hanger; and

at least one valve mounted to the valve block for opening and closing the tubing annulus passage.

10. A wellhead assembly for use subsea comprising:

a wellhead housing circumscribing a wellbore opening;

a valve support block comprising:

a body;

a main bore formed through the body and aligned with the wellbore;

an annular high pressure housing portion projecting downward from the body and

coaxially inserted within the wellhead housing;

an annular mandrel projecting upward from the body and circumscribing an axis of the main bore, the mandrel having a cylindrical exterior: and

a landing surface on the body upper end at the base of the mandrel in a plane disposed substantially perpendicular to the axis;

a valve block having a bottom that lands on the landing surface and a central opening that circumscribes the mandrel when the bottom lands on the landing surface;

a fluid flow passage in the body that passes sealingly through the landing surface into the valve block; and

at least one valve mounted to the valve block for opening and closing the fluid flow passage.

11. The wellhead assembly of claim 10, further comprising:

a tubing hanger landed in the lower production tree and selectively retrievable through the main bore;

a tubing hanger production passage in the tubing hanger having a laterally extending outlet: and

wherein the fluid flow passage comprises a body flow passage that sealingly joins the outlet of the tubing hanger.

12. The wellhead assembly of claim **10**, wherein the central opening of the valve block and the mandrel are in non-sealing engagement with each other.

13. The wellhead assembly of claim **10**, further comprising a workover passage and an annulus passage formed in the body that extend into the valve block at the landing surface and wherein the fluid flow passage is a production passage so that landing the valve block onto the landing surface seals the passages.

14. The subsea wellhead of claim **10**, wherein the landing surface has a maximum dimension from one side to an opposite side that is greater than an outer diameter of the wellhead housing.

15. The subsea wellhead of claim **10**, wherein the mandrel from the support surface upward is free of any passages extending through a side wall of the mandrel.

16. A subsea wellhead comprising:

a wellhead housing;

a tree block having a main bore and a lower portion that extends into the wellhead housing, the tree block having a mandrel with a cylindrical exterior and an upward facing landing surface extending radially outward from a lower end of the mandrel and located in a plane perpendicular to an axis of the mandrel;

a tubing hanger for supporting a string of production tubing landed in the main bore, the tubing hanger having a tubing hanger production passage with a laterally extending tubing hanger production port;

a tree block production passage within the tree block having a lower inlet that registers with the tubing hanger production port and an upper end that faces upward at the upward facing support surface;

upper and lower seals between an exterior of the tubing hanger and the main bore above and below tubing hanger production port, the upper seal being below the plane containing the support surface;

a tree block tubing annulus passage having a lower end in the main bore below the lower seal of the tubing hanger and an upper end facing upward at the support surface;

a tree block workover passage having a lower end in the main bore above the upper seal of the tubing hanger and an upper end facing upward at the support surface;

a valve block having a central opening that slides over the mandrel and a bottom that lands on the support surface;

a valve block production passage within the valve block that has an inlet on the bottom of the valve block and which sealingly registers with the upper end of the tree block production passage;

a valve block tubing annulus passage having a lower end that sealingly registers with the upper end of the tree block tubing annulus passage;

a valve block workover passage having a lower end that sealing registers with the upper end of the workover passage; and wherein

the valve block tubing annulus passage and the valve block workover passage having a junction with each other in the valve block.

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