

## Claims

What is claimed is:

- 5    1.    A method comprising:  
operating a processor to perform operations including:  
applying a continuous string model to a completion string having  
a plurality of components including an off-center component;  
conducting a force analysis at the off-center component and at a  
10    number of the components of the plurality of components based on the  
continuous model;  
preparing and solving a force balance equation set based on the  
force analysis; and  
determining a side force on the off-center component and on each  
15    of the number of components based on the force balance equation set.
2.    The method of claim 1, applying a continuous string model includes  
applying a five component model.
- 20    3.    The method of claim 1 or 2, wherein the method includes determining a  
drag force on the completion string based on determining the side forces.
4.    The method of claim 1 or 2, wherein the method includes performing a  
stress analysis on the completion string based on determining the side forces.
- 25    5.    The method of claim 1 or 2, wherein the method includes using a soft  
string model, a stiff string model, a finite element model, or a multi-body system  
model to perform a drag force analysis or a stress analysis.
- 30    6.    The method of claim 1 or 2, wherein the method includes determining a  
minimum displacement between components of the completion string based  
whether a failure criterion is satisfied based on determining the side force on the  
off-center component and on each of the number of components.

7. The method of claim 6, wherein determining the minimum displacement is an iterative process in which distance between components of the completion string is increased in the continuous string model until the failure criterion is met.
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8. A non-transitory machine-readable storage device having instructions stored thereon, which, when performed by a machine, cause the machine to perform operations, the operations comprising:
- 10 applying a continuous string model to a completion string having a plurality of components including an off-center component;
- conducting a force analysis at the off-center component and at a number of the components of the plurality of components based on the continuous model;
- 15 preparing and solving a force balance equation set based on the force analysis; and
- determining a side force on the off-center component and on each of the number of components based on the force balance equation set.
9. A system comprising:
- 20 a processor; and
- a memory unit arranged such that the processor and the memory unit are arranged to:
- apply a continuous string model to a completion string having a plurality of components including an off-center component;
- 25 conduct a force analysis at the off-center component and at a number of the components of the plurality of components based on the continuous model;
- prepare and solve a force balance equation set based on the force analysis; and
- 30 determine a side force on the off-center component and on each of the number of components based on the force balance equation set.

10. The system of claim 9, the system includes a communications unit to receive data generated from one or more sensors disposed in a wellbore.
- 5 11. The system of claim 10, the one or more sensors include a fiber optic sensor, a pressure sensor, or a strain gauge to provide monitoring drilling and production associated with the wellbore.
- 10 12. The system of claim 9, wherein the processor and the memory unit are arranged to apply the continuous string model includes the processor and the memory unit are arranged to apply a five component model.
13. The system of claim 9 or 12, wherein the processor and the memory unit are arranged to determine a drag force on the completion string based on the determination of the side forces.
- 15 14. The system of claim 9 or 12, wherein the processor and the memory unit are arranged to perform a stress analysis on the completion string based on on the determination of the side forces.
- 20 15. The system of claim 9 or 12, wherein the processor and the memory unit are arranged to include use of a soft string model, a stiff string model, a finite element model, or a multi-body system model to perform a drag force analysis or a stress analysis.
- 25 16. The system of claim 9 or 12, wherein the processor and the memory unit are arranged to determine a minimum displacement between components of the completion string based whether a failure criterion is satisfied based on the determination of side force on the off-center component and on each of the number of components.
- 30 17. The system of claim 16, wherein determination of the minimum displacement is an iterative process in which distance between components of

the completion string is increased in the continuous string model until the failure criterion is met.

18. The non-transitory machine-readable storage device of claim 8, wherein  
5 applying a continuous string model includes applying a five component model.

19. The non-transitory machine-readable storage device of claim 8 or 18,  
wherein the operations include determining a drag force on the completion string  
based on determining the side forces.

10 20. The non-transitory machine-readable storage device of claim 8 or 18,  
wherein the operations include performing a stress analysis on the completion  
string based on determining the side forces.

15 21. The non-transitory machine-readable storage device of claim 8 or 18,  
wherein the operations include using a soft string model, a stiff string model, a  
finite element model, or a multi-body system model to perform a drag force  
analysis or a stress analysis.

20 22. The non-transitory machine-readable storage device of claim 8 or 18,  
wherein the operations include determining a minimum displacement between  
components of the completion string based whether a failure criterion is satisfied  
based on determining the side force on the off-center component and on each of  
the number of components.

25 23. The non-transitory machine-readable storage device of claim 22, wherein  
determining the minimum displacement is an iterative process in which distance  
between components of the completion string is increased in the continuous  
string model until the failure criterion is met.

## CLAIMS

1. A method comprising:  
  
operating a processor to perform operations including:  
  
applying a continuous string model to a completion string having a plurality of components including an off-center component;  
  
conducting a force analysis at the off-center component and at a number of the components of the plurality of components based on the continuous model;  
  
preparing and solving a force balance equation set based on the force analysis;  
and  
  
determining a side force on the off-center component and on each of the number of components based on the force balance equation set; and  
  
wherein the method further comprising the step of determining a minimum displacement between components of the completion string based on whether a failure criterion is satisfied by determining the side force on the off-center component and on each of the number of components.
2. The method of claim 1, wherein determining the minimum displacement is an iterative process in which distance between components of the completion string is increased in the continuous string model until the failure criterion is met.
3. The method of claim 1, applying a continuous string model includes applying a five component model.
4. The method of claim 1 or 3, wherein the method includes determining a drag force on the completion string based on determining the side forces.
5. The method of claim 1 or 3, wherein the method includes performing a stress analysis on the completion string based on determining the side forces.

6. The method of claim 1 or 3, wherein the method includes using a soft string model, a stiff string model, a finite element model, or a multi-body system model to perform a drag force analysis or a stress analysis.

7. A non-transitory machine-readable storage device having instructions stored thereon, which, when performed by a machine, cause the machine to perform operations, the operations comprising:

applying a continuous string model to a completion string having a plurality of components including an off-center component;

conducting a force analysis at the off-center component and at a number of the components of the plurality of components based on the continuous model;

preparing and solving a force balance equation set based on the force analysis;  
and

determining a side force on the off-center component and on each of the number of components based on the force balance equation set; and

wherein the operations further comprising determining a minimum displacement between components of the completion string based on whether a failure criterion is satisfied by determining the side force on the off-center component and on each of the number of components.

8. A system comprising:

a processor; and

a memory unit arranged such that the processor and the memory unit are arranged to:

apply a continuous string model to a completion string having a plurality of components including an off-center component;

conduct a force analysis at the off-center component and at a number of the components of the plurality of components based on the continuous model;

prepare and solve a force balance equation set based on the force analysis;  
and

determine a side force on the off-center component and on each of the number of components based on the force balance equation set; and

wherein the processor and the memory unit are arranged to determine a minimum displacement between components of the completion string based on whether a failure criterion is satisfied by determining the side force on the off-center component and on each of the number of components.

9. The system of claim 8, the system includes a communications unit to data generated from one or more sensors disposed in a wellbore.

10. The system of claim 9, the one or more sensors include a fiber optic sensor, a pressure sensor, or a strain gauge to provide monitoring drilling and production associated with the wellbore.

11. The system of claim 8, wherein the processor and the memory unit are arranged to apply the continuous string model includes the processor and the memory unit are arranged to apply a five component model.

12. The system of claim 8 or 11, wherein the processor and the memory unit are arranged to determine a drag force on the completion string based on the determination of the side forces.

13. The system of claim 8 or 11, wherein the processor and the memory unit are arranged to perform a stress analysis on the completion string based on the determination of the side forces.

14. The system of claim 8 or 11, wherein the processor and the memory unit are arranged to include use of a soft string model, a stiff string model, a finite element model, or a multi-body system model to perform a drag force analysis or a stress analysis.

15. The system of claim 8, wherein determination of the minimum displacement is an iterative process in which distance between components of the completion string is increased in the continuous string model until the failure criterion is met.
16. The non-transitory machine-readable storage device of claim 7, wherein applying a continuous string model includes applying a five component model.
17. The non-transitory machine-readable storage device of claim 7 or 16, wherein the operations include determining a drag force on the completion string based on determining the side forces.
18. The non-transitory machine- read able storage device of claim 7 or 16, wherein the operations include performing a stress analysis on the completion string based on determining the side forces.
19. The non-transitory machine-readable storage device of claim 7 or 16, wherein the operations include using a soft string model, a stiff string model, a finite element model, or a multi-body system model to perform a drag force analysis or a stress analysis.
20. The non-transitory machine-readable storage device of claim 7, wherein determining the minimum displacement is an iterative process in which distance between components of the completion string is increased in the continuous string model until the failure criterion is met.