

CLAIMS

We claim:

1. A method for monitoring seal life comprising:
 - 5 providing a valve assembly movable from an open position to a closed position and comprising a seal seated within the valve and in contact with a surface of the valve assembly, wherein when the seal is in operation it is subject to degradation;
placing at least one sensor for measuring micro strain on a surface of the valve assembly or within the valve assembly;
 - 10 placing the valve assembly in an operation wherein the seal is subject to degradation and initiating the operation of the valve assembly;
at a time after the operation is initiated, recording micro strain data and at least one other property related to a condition selected from an ambient condition of operation and a condition related to degradation of the seal; and
 - 15 analyzing the recorded data against baseline data associated with 100% seal life to evaluate seal life at the time after the operation is initiated as a percentage of seal life less than 100%.
2. The method according to claim 1, wherein the seal has elastomeric properties.
3. The method according to claim 1, wherein the valve assembly is one of a valve
20 assembly with a door, a pendulum valve assembly, and an isolation valve assembly.
4. The method according to claim 3, wherein the valve assembly is the valve assembly with a door and the door is configured for covering an opening in a process chamber, and the valve assembly further comprises a valve for operating the door from the open position to the closed position and the seal contacts the door.
- 25 5. The method according to claim 4, further comprising placing the at least one sensor on an exterior surface of the door for measuring micro strain.
6. The method according to claim 5, wherein initiating operation of the valve assembly comprises initiating a vacuum process when the door is in the closed position.
7. The method according to claim 5, further comprising evaluating the seal life at the
30 time after the vacuum process is initiated as a percentage of seal life less than 100%.
8. The method according to claim 4, wherein the movable valve door is a bonded slit valve or gate valve.
9. The method according to claim 8, wherein the moveable valve door is a bonded slit valve.

10. The method according to claim 4, wherein the seal is mechanically affixed to a surface of the door.
11. The method according to claim 4, wherein the seal has elastomeric properties.
12. The method according to claim 4, wherein there are two or more sensors for
5 measuring micro strain that are each positioned at different locations on the door.
13. The method according to claim 12, wherein the sensors are bonded to an exterior surface of the door.
14. The method according to claim 12, wherein one or more strain gage rosette pattern is positioned on the door.
- 10 15. The method according to claim 14, wherein there are two or more strain gage rosette patterns and they are positioned in different locations.
16. The method according to claim 4, wherein the baseline data is measured after calibrating the door.
17. The method according to claim 4, wherein the baseline data is measured when a load
15 is applied to the door and then removed, based at least in part on initial micro strain data.
18. The method according to claim 17, wherein the baseline data is created by measuring initial micro strain data at 100% seal life and again at one or more percentages of seal life to create an adjusted range of baseline data.
19. The method according to claim 18, wherein the baseline data is saved and
20 incorporated into a database for predicting seal life for a type of door and seal in a specific process.
20. The method according to claim 1, wherein the at least one sensor is a strain gage.
21. The method according to claim 1, wherein the at least one other property is related to an ambient condition of operation and is selected from one or more of temperature,
25 humidity, and vibration, and monitoring of such condition of operation is used to compensate for ambient noise.
22. The method according to claim 1, wherein at least one sensor is placed to measure each of the at least one other property.
23. The method according to claim 1, wherein the strain gage micro strain data is
30 converted to a digital signal through use of a circuit including a Wheatstone bridge to convert micro strain to data to a change in voltage, conditioning an analog signal from the measured change in voltage, and converting the analog signal to the digital signal.
24. The method according to claim 23, wherein the circuit is incorporated into a printed circuit board.

25. The method according to claim 23, wherein the Wheatstone bridge incorporates high precision resistors of having a tolerance of no greater than about 0.25%.

26. The method according to claim 25, wherein the high precision resistors have a tolerance no greater than of about 0.1%.

5 27. The method according to claim 23, wherein the circuit comprises an amplifier.

28. The method according to claim 1, wherein the baseline data is measured after calibrating the valve assembly.

29. The method according to claim 1, wherein the baseline data is measured after the valve assembly is in operation and the valve is under pressure, based in part on initial micro strain data.
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30. The method according to claim 1, wherein the baseline data is measured when a load is applied to the valve and then removed, based at least in part on initial micro strain data.

31. The method according to claim 30, wherein the baseline data is created by measuring initial micro strain data at 100% seal life and again at one or more percentages of seal life to create an adjusted range of baseline data.
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32. The method according to claim 31, wherein the baseline data is saved and incorporated into a database for predicting seal life for a type of door and seal in a specific process.

33. A system for analyzing seal life, comprising:
20 at least one memory for storing computer-executable instructions; and
 at least one processing unit for executing the instructions stored in the memory, wherein execution of the instructions programs the at least one processing unit to perform operations comprising:
 engaging a valve assembly movable from an open position to a closed position,
25 to place the valve assembly in operation, wherein the valve assembly comprises a seal and the seal is seated within the valve and in contact with a surface of the valve assembly, and wherein pressure is applied to the valve assembly in operation and the seal is subject to degradation;

 receiving from a circuit a signal from a change in voltage, wherein the circuit is
30 in communication with at least one sensor for measuring micro strain on a surface of the valve assembly or within the valve assembly;

 recording micro strain data and at least one other property related to a condition selected from an ambient condition of operation and a condition related to degradation of the seal after operation of the valve assembly is initiated; and

analyzing the recorded data against baseline data associated with 100% seal life to evaluate seal life at the time after the operation of the valve assembly is initiated as a percentage of seal life less than 100%.

34. The system according to claim 33, wherein the seal has elastomeric properties.

5 35. The system according to claim 33, wherein the valve assembly is one of a valve assembly with a door, a pendulum valve assembly, and an isolation valve assembly.

36. The system according to claim 35, wherein the valve assembly is the valve assembly with a door and the door is configured for covering an opening in a process chamber, and the valve assembly further comprises a valve for operating the door from the open position
10 to the closed position and the seal contacts the door.

37. The system according to claim 36, wherein at least one sensor is placed on an exterior surface of the door for measuring micro strain.

38. The system according to claim 37, wherein operation of the valve assembly is initiated by initiating a vacuum process when the door is in the closed position.

15 39. The system according to claim 38, wherein the seal life is evaluated at the time after the vacuum process is initiated as a percentage of seal life less than 100%.

40. The system according to claim 36, wherein the movable valve door is a bonded slit valve or gate valve.

41. A self-sensing valve assembly, comprising:

20 a valve assembly movable from an open position to a closed position, comprising a seal which is seated within the valve assembly and is in contact with a surface of the valve assembly, wherein in operation of the valve assembly, the seal is under pressure and is subject to degradation; and

at least one sensor for measuring micro strain on a surface of the valve assembly
25 or within the valve assembly, and at least one sensor for measuring at least one other property related to a condition selected from an ambient condition of operation and a condition related to degradation of the seal in operation, wherein the sensor is in communication with a circuit capable of sending a signal from a change in voltage.

42. The self-sensing valve assembly of claim 41, further comprising a thermocouple in
30 communication with one of the sensors measuring micro strain on the exterior surface of the valve assembly.

43. The self-sensing valve assembly of claim 41, wherein the seal has elastomeric properties.

44. The self-sensing valve assembly of claim 41, wherein the valve assembly is one of a
35 valve assembly with a door, a pendulum valve assembly, and an isolation valve assembly.

45. The self-sensing valve assembly of claim 44, wherein the valve assembly is the valve assembly with a door and the door is configured for covering an opening in a process chamber, and the valve assembly further comprises a valve for operating the door from the open position to the closed position and the seal contacts the door.

5 46. The self-sensing valve assembly of claim 45, wherein at least one sensor is placed on an exterior surface of the door for measuring micro strain.

47. The self-sensing valve assembly of claim 45, wherein operation of the valve assembly is initiated by initiating a vacuum process when the door is in the closed position.

10 48. The self-sensing valve assembly of claim 47, wherein the seal life is evaluated at the time after the vacuum process is initiated as a percentage of seal life less than 100%.

49. The self-sensing valve assembly of claim 45, wherein the movable valve door is a bonded slit valve or gate valve.