CLAIMS

1. A method for detecting the performance of a crew oxygen system, the method comprising the steps of:

obtaining an oxygen pressure in an oxygen cylinder of the crew oxygen system from a pressure sensor output, an ambient air temperature, and a cockpit temperature;

automatically generating a crew oxygen message, by an aircraft data system, from the obtained oxygen pressure in the oxygen cylinder, ambient air temperature and cockpit temperature, and transmitting the crew oxygen message to a data processing device not located on the aircraft;

calculating a standard state oxygen pressure in the oxygen cylinder under standard temperature from data in the transmitted crew oxygen message; and

analyzing the standard state oxygen pressure to determine a performance level of the crew oxygen system,

wherein the performance level is one of a stable period, a deterioration period, or a failure period.

2. A method according to claim 1, further comprising:

calculating a standard state oxygen pressure in the oxygen cylinder under standard temperature before taking-off; and

calculating a standard state oxygen pressure in the oxygen cylinder under standard temperature after landing.

3. A method according to claim 2, further comprising:

determining that the performance level is a deterioration period if a difference between the standard state oxygen pressures in the oxygen cylinder before taking-off and after landing is greater than 100PSI.

4. A method according to any one of claims 1 to 3, further comprising:

determining that the performance level is a deterioration period if a leakage rate of the oxygen cylinder from taking-off to landing is greater than 48PSI/day.

5. A method according to any one of claims 1 to 4, further comprising:

calculating a slope of a fitting curve through statistical relation between a pressure P_s in the oxygen cylinder under standard temperature and an installation time t_o of the oxygen cylinder.

6. A method according to claim 5, wherein the slope (β2) of the fitting curve is calculated according to the following formula:

$$\beta 2 = \frac{\sum_{I=1}^{n} (t_{oI} - t_{o-avg}) * (P_{sI} - P_{s-avg})}{\sum_{I=1}^{I=n} (t_{oI} - t_{o-avg})^2}$$

where t_{o-avg} is an average value of t_o, P_{s-avg} is an average value of P_s, and n is the number of sampling points.

7. A method according to any one of claims 1 to 6, further comprising:

calculating a set of rolling average leakage rates in a certain period;

comparing the set of rolling average leakage rates with another set of rolling average leakage rates, which serves as a reference; and

determining, by the data processing device, if significant change occurs.

8. A method according to claim 7, further comprising:

calculating a variance of the set of rolling average leakage rates, and a variance of another set of rolling average leakage rates, which serves as a reference; and

determining, by the data processing device, if significant change occurs according to a F distribution which is followed by a ratio of the variance of the set of rolling average leakage rates and the variance of the another set of rolling average leakage rates.

9. A method according to claim 7 or 8, wherein the period is longer than 24 hours.

10. A method according to any one of claims 7 to 9, wherein the rolling average leakage rate is a rolling average leakage rate within 2 to 4 days.

11. A method according to any one of claims 1 to 10, further comprising:

calculating an oxygen temperature in the oxygen cylinder (T) from the obtained ambient air temperature and cockpit temperature in the transmitted crew oxygen message.

12. A method according to claim 11, wherein the oxygen temperature in the oxygen cylinder (T) is calculated according to the following formula:

$$T = \frac{k_1 Tat + k_2 Tc}{2}$$

where Tat is the ambient air temperature or temperature outside of the airplane, Tc is the cockpit temperature, k_1 and k_2 are adjustment parameters, and $k_1 + k_2 = 2$.

13. A method according to claim 12, wherein k_1 is greater than k_2.

14. A method according to claim 12, wherein $k_1 = k_2 = 1$.

15. A method according to any one of claims 1 to 14, wherein the step of obtaining the oxygen pressure in the oxygen cylinder of the crew oxygen system from the pressure sensor output, the ambient air temperature, and the cockpit temperature comprises:

obtaining the oxygen pressure in the oxygen cylinder of the crew oxygen system from the pressure sensor output, the ambient air temperature, and the cockpit temperature at a first time before taking-off.

16. A method according to claim 15, wherein the first time is 1 minute before taking-off.

17. A method according to any one of claims 1 to 16, wherein the step of obtaining the oxygen pressure in the oxygen cylinder of the crew oxygen system from the pressure sensor output, an ambient air temperature, and a cockpit temperature comprises:

obtaining the oxygen pressure in the oxygen cylinder of the crew oxygen system from the pressure sensor output, the ambient air temperature, and the cockpit temperature at the time of 1 minute before taking-off, at the time of 30 seconds before taking-off and at the time of taking-off.

18. A method according to any one of claims 1 to 17, wherein the step of obtaining the oxygen pressure in the oxygen cylinder of the crew oxygen system from the pressure sensor output, an ambient air temperature, and a cockpit temperature further comprises:

obtaining the oxygen pressure in the oxygen cylinder of the crew oxygen system from the pressure sensor output, the ambient air temperature and the cockpit temperature at a second time after landing.

19. A method according to any one of claims 1 to 18, wherein the step of obtaining the oxygen pressure of the oxygen cylinder of the crew oxygen system from the pressure sensor output, the ambient air temperature, and the cockpit temperature comprises:

obtaining the oxygen pressure of the oxygen cylinder of the crew oxygen system from the pressure sensor output, the ambient air temperature and the cockpit temperature at a second time after landing, 30 seconds after the second time, and 60 seconds after the second time.

20. A method according to claim 19, wherein the second time is 1 hour after landing.

21. A method according to claim 19 or 20, wherein the step of obtaining the oxygen pressure in the oxygen cylinder of the crew oxygen system from the pressure sensor output, the ambient air temperature, and the cockpit temperature is performed before re-taking-off, if the aircraft takes off again within 1 hour after landing.

22. A method for generating a crew oxygen message, the method comprising the steps of:

simultaneously obtaining an oxygen pressure in an oxygen cylinder of the crew oxygen system from a pressure sensor output, an ambient air temperature, and a cockpit temperature as a first data set, where the first data set is obtained at three separate time points;

calculating a mean value or a median, for the oxygen pressure in the oxygen cylinder, the ambient air temperature, and the cockpit temperature from the first data set, in an aircraft data system; and

automatically generating a crew oxygen message based on the mean or median of each of the obtained oxygen pressure in the oxygen cylinder, the ambient air temperature, and the cockpit temperature.

23. A method according to claim 22, wherein the three separate time points are 1 minute before taking-off, 30 seconds before taking-off, and at the time of taking-off.

24. A method according to claim 22 or 23, wherein the step of obtaining the oxygen pressure in the oxygen cylinder of the crew oxygen system from the pressure sensor output, the ambient air temperature, and the cockpit temperature as a data set further comprises:

obtaining the oxygen pressure in the oxygen cylinder of the crew oxygen system from the pressure sensor output, the ambient air temperature, and the cockpit temperature as a second data set at three other time points, where the three other time points are a second time after landing, 30 seconds after the second time, and 60 seconds after the second time.

25. A method according to claim 24, wherein the second time is 1 hour after landing.

26. A method according to claim 24 or 25, wherein the step of obtaining the oxygen pressure in the oxygen cylinder of the crew oxygen system from the pressure sensor output, the ambient air temperature, and the cockpit temperature as the second data set is performed before re-taking-off, if the aircraft takes off again within 1 hour after landing.

27. A system for detecting the performance of a crew oxygen system, the system comprising:

a crew oxygen pressure data obtaining device comprising at least a pressure sensor;

a crew oxygen message generating device configured to generate a crew oxygen message according to the obtained oxygen pressure in the oxygen cylinder obtained by the crew oxygen pressure data obtaining device, an ambient air temperature and a cockpit temperature, wherein the crew oxygen messages are transmitted through a crew oxygen messages transmitting device; and

a crew oxygen pressure data processing device configured to receive the crew oxygen messages, determine an oxygen pressure of the oxygen cylinder under standard temperature, and thereby determine the performance of the crew oxygen system.

28. A system according to claim 27, wherein the pressure sensor is installed on a hyperbaric section of the crew oxygen system.

29. A system according to claim 27 or 28, wherein the crew oxygen messages generating device is an aircraft data system or is a part thereof.

30. A system according to any one of claims 27 to 29, wherein the crew oxygen messages generating device is an aircraft data system selected from the following: an aircraft condition monitoring system (ACMS) and an aircraft health monitor (AHM).

31. A system according to any one of claims 27 to 30, wherein the crew oxygen pressure data processing device determines that the performance of the crew oxygen system deteriorates if the crew oxygen pressure data processing device detects a difference of pressures in the oxygen cylinder under the standard temperature between before taking-off and after landing that is greater than 100PSI.

32. A system according to any one of claims 27 to 31, wherein the crew oxygen pressure data processing device determines that the performance of the crew oxygen system deteriorates if the crew oxygen pressure data processing device detects a difference of leakage rates of the oxygen cylinder between before taking-off and after landing that is greater than 48PSI/day.

33. A system according to any one of claims 27 to 32, wherein the crew oxygen pressure data processing device determines a slope of a fitting curve (β2) based on a statistical relation between a pressure P_s in the oxygen cylinder under the standard temperature and an installation time t_o of the oxygen cylinder.

34. A system according to claim 33, wherein the slope (β2) of the fitting curve is determined according to the following formula:

$$\beta 2 = \frac{\sum_{I=1}^{n} (t_{oI} - t_{o-avg}) * (P_{sI} - P_{s-avg})}{\sum_{I=1}^{I=n} (t_{oI} - t_{o-avg})^2}$$

where, t_{o-avg} is an average value of t_o, P_{s-avg} is an average value of P_s, and n is the number of sampling points.

35. A system according to any one of claims 27 to 34, wherein the crew oxygen pressure data processing device calculates a set of rolling average leakage rates in a certain period, and compares the set of rolling average leakage rates with another set of rolling average leakage rates, which serves as a reference, to determine if significant change occurs.

36. A system according to claim 35, wherein the crew oxygen pressure data processing device calculates a variance of the set of rolling average leakage rates, and a variance of another set of rolling average leakage rates which serves as a reference; and determines if an obvious change occurs according to a F distribution which is followed by a ratio of the variance of the set of rolling average leakage rates and the variance of another set of rolling average leakage rates which serves as a reference.

37. A system according to claim 35 or 36, wherein the period is longer than 24 hours.

38. A system according to any one of claims 35 to 37, wherein the rolling average leakage rate is a rolling average leakage rate within 2 to 4 days.

39. A system for detecting the performance of a crew oxygen system, the system comprising:

a pressure sensor configured to measure an oxygen pressure in an oxygen cylinder of the crew oxygen system;

a data management unit (DMU) of an aircraft integrated data system (AIDS) of an aircraft condition monitoring system (ACMS) configured to obtain the oxygen pressure in the oxygen cylinder of the crew oxygen system, an ambient air temperature, and a cockpit temperature, and configured to generate crew oxygen messages, wherein the crew oxygen messages are transmitted through an aircraft communication addressing and reporting system (ACARS); and

a server configured to receive the crew oxygen messages from the ACARS, determine an oxygen pressure in the oxygen cylinder under standard temperature, and determine the performance of the crew oxygen system accordingly.

40. A method for maintaining a crew oxygen system, the method comprising the steps of:

obtaining an oxygen pressure in an oxygen cylinder of the crew oxygen system from a pressure sensor output, an ambient air temperature and a cockpit temperature as a data set;

automatically generating crew oxygen messages, by an aircraft data system, from the obtained oxygen pressure in the oxygen cylinder, the ambient air temperature, and the cockpit temperature, and transmitting the crew oxygen messages to a server not located on an aircraft;

calculating a standard state oxygen pressure in the oxygen cylinder under standard temperature for each data set from the transmitted crew oxygen messages;

analyzing a plurality of standard state oxygen messages to determine whether a performance level of the crew oxygen system is within a deterioration period; and

automatically arranging maintenance for the crew oxygen system when the server determines that the performance level is within the deterioration period.