CLAIMS

1. A method for detecting addition of engine lubricant for an aircraft engine, comprising:

determining, using an adding detection module, whether the difference value between the lubricant quantity at a first timing and that at a second timing is greater than a first threshold value;

delaying a period and determining, using a verification module, whether the difference value between the lubricant quantity at a third timing and that at a fourth timing is greater than a second threshold value in response to that the difference value between the lubricant quantity at the first timing and that at the second timing is greater than the first threshold value; and

detecting, using an increment calculation module, the lubricant increment in response to that the difference value between the lubricant quantity at the third timing and that at the fourth timing is greater than the second threshold value, wherein the detecting the lubricant increment comprises

obtaining a maximum lubricant value,

delaying a period and re-obtaining a lubricant increment value,

re-obtaining lubricant increment values for multiple times at intervals equivalent to a duration of the period; and

calculating an average increment value of the lubricant increments.

2. The method of claim 1, further comprises: determining whether the detected lubricant increment is greater than a third threshold value.

3. The method of claim 1, wherein the time between the first timing and the second timing is referred to as a first period during which the aircraft is not powered off; and the time between the third timing and the fourth timing is referred to as a second period which is equal to the first period in length.

4. The method of claim 3, wherein the difference value between the lubricant quantity at the first timing and that at a second timing is the difference value between the maximum value and the minimum value of the lubricant quantity during the first period; and the difference value between the lubricant quantity at the third timing and that at the fourth timing is the difference value between the maximum value and the minimum value of the lubricant quantity during the second period.

5. The method of claim 1, wherein the first timing is before the aircraft is powered off, the second timing is after the aircraft is repowered; and the third timing is the same time as the first timing, the fourth timing is later than the second timing.

6. The method of claim 1, wherein each of the first threshold value and the second threshold value is the minimum added amount of lubricant as required in aircraft maintenance.

7. The method of claim 1, wherein the interval between two measurements corresponding to a greater re-obtained lubricant increment is less than that corresponding to a smaller re-obtained lubricant increment.

8. The method of claim 1, further comprising: determining whether the interval between two of the multiple measurements is greater than the maximum value of delayed time, and calculating the average value of the lubricant increments re-obtained previously in response to that the interval between two of the multiple measurements is greater than the maximum value of delayed time.

9. The method of claim 1, further comprising: determining whether the interval between two of the multiple measurements is greater than the determined interval and less than the maximum value of delayed time, and in response to that the interval between two of the multiple measurements is greater than the determined interval and less than the maximum value of delayed time, the lubricant increment re-obtained may be corrected by the following formula: k*DT, wherein DDT refers to the re-obtained lubricant increment, k is a regulation coefficient in the range of 1.05-1.35; and calculating the average value of the lubricant increments re-obtained previously and the corrected re-obtained lubricant increment.

10. The method of claim 1, wherein further comprising: determining whether the interval between two of the multiple measurements is greater than the determined interval and less than the maximum value of delayed time, and in response to that the interval between two of the multiple measurements is greater than the determined interval and less than the maximum value of delayed time, the lubricant increment re-obtained may be corrected by the following formula: k*DT*(AT-T)/(t-T), wherein DT refers to the lubricant increment re-obtained, k is a regulation coefficient which is 1.35, AT is the interval between two measurements, t is the maximum value of delayed time, T is the determined interval; and calculating the average value of the lubricant increments re-obtained previously and the corrected re-obtained lubricant increment.

11. The method of claim 1, further comprising: determining whether the difference value between the lubricant quantity at the first timing and that at the second timing is greater than a predetermined threshold, wherein the first timing is within 8-15 minutes after the engine is shutdown, the second timing is later than the lubricant adding period as required for aircraft maintenance.

12. The method of claim 1, further comprising: determining whether the difference value between the lubricant quantity at a third timing and that at a fourth timing is greater than a predetermined threshold, wherein the third timing is within 8-15 minutes after the engine is shutdown, the fourth timing is within 3-10 seconds before the engine is started.

13. A method for detecting addition of engine lubricant, comprising:

obtaining, using an increment calculation module, a maximum lubricant increment;

delaying a period and re-obtaining an lubricant increment, using the increment calculation module;

determining, using the increment calculation module, an interval between two measurements according to the lubricant increment re-obtained;

re-obtaining, using the increment calculation module, lubricant increments for multiple times according to the determined interval; and

calculating, using the increment calculation module, the average of the lubricant increments re-obtained for multiple times.

14. The method of claim 13, wherein the interval between two measurements corresponds to a greater lubricant increment re-obtained is less than that corresponding to a smaller lubricant increment re-obtained.

15. The method of claim 13, further comprising: determining whether the interval between two of the multiple measurements is greater than the maximum value of delayed time, and calculating the average of the lubricant increments re-obtained previously in response to that the interval between two of the multiple measurements is greater than the maximum value of delayed time.

16. The method of claim 13, further comprising: determining whether the interval between two of the multiple measurements is greater than the determined interval and less than the maximum value of delayed time, and in response to that the interval between two of the multiple measurements is greater than the determined interval and less than the maximum value of delayed time, the lubricant increment re-obtained may be corrected by the following formula: k*DT, wherein DT refers to the lubricant increment re-obtained, k is a regulation coefficient in the range of 1.05-1.35; and calculating the average of the lubricant increments re-obtained previously and the corrected re-obtained lubricant increment.

17. The method of claim 13, further comprising: determining whether the interval between two of the multiple measurements is greater than the determined interval and less than the maximum value of delayed time, and in response to that the interval between two of the multiple measurements is greater than the determined interval and less than the maximum value of delayed time, the lubricant increment re-obtained may be corrected by the following formula: k*DT*(AT-T)/(t-T), wherein DT refers to the lubricant increment re-obtained, k is a regulation coefficient which is 1.35, AT is the interval between two measurements, t is the maximum value of delayed time, Ti is the determined interval; and calculating the average of the lubricant increments re-obtained previously and the corrected re-obtained lubricant increments.

18. The method of claim 13, further comprising:

determining whether the difference value between the lubricant quantity at a first timing and that at a second timing is greater than a first threshold value;

delaying a period and determining whether the difference value between the lubricant quantity at a third timing and that at a fourth timing is greater than a second threshold value in response to that the difference value between the lubricant quantity at the first timing and that at the second timing is greater than the first threshold value; and

detecting the lubricant increment in response to that the difference value between the lubricant quantity at the third timing and that at the fourth timing is greater than the second threshold value.

19. The method of claim 18, further comprises: determining whether the lubricant increment detected is greater than a third threshold value.

20. The method of claim 18, wherein the time between the first timing and the second timing is referred to as a first period during which the aircraft is not powered off; and the time between the third timing and the fourth timing is referred to as a second period which is equal to the first period in length.

21. The method of claim 20, wherein the difference value between the lubricant quantity at the first timing and that at the second timing is the difference value between the maximum value and the minimum value of the lubricant quantity during the first period; and the difference value between the lubricant quantity at the third timing and that at the fourth timing is the difference value between the maximum value and the minimum value of the lubricant quantity during the second period.

22. The method of claim 18, wherein the first timing is before the aircraft is powered-off, the second timing is after the aircraft is repowered; and the third timing is the same time as the first timing, the fourth timing is later than the second timing.

23. The method of claim 18, wherein each of the first threshold value, the second threshold value and the third threshold value is the minimum added amount of lubricant as required for aircraft maintenance.

24. The method of claim 13, further comprising: determining whether the difference value between the lubricant quantity at the first timing and that at the second timing is greater than a predetermined threshold, wherein the first timing is within 8-15 munities after the engine is shutdown, the second timing is later than the lubricant adding period as required for aircraft maintenance.

25. The method of claim 14, further comprising: determining whether the difference value between the lubricant quantity at the third timing and that at the fourth timing is greater than a predetermined threshold, wherein the third timing is within 8-15 munities after the engine is shutdown, the fourth timing is within 3-10 seconds before the engine is started.

26. A system for detecting addition of engine lubricant, comprising:

an adding detection module configured to determine whether difference value between the maximum value and the minimum value of the lubricant quantity during a first period is greater than a first threshold value;

a verification module configured to determine whether the difference value between the maximum value and the minimum value of the lubricant quantity during the second period is greater than a second threshold value in response to that the difference value between the maximum value and the minimum value of the lubricant quantity during the first period is greater than the first threshold value, wherein the second period is later than the first period; and

an increment calculation module configured to detect the lubricant increment in response to that the difference value between the maximum value and the minimum value of the lubricant quantity during the second period is greater than the second threshold value.

27. The system of claim 26, wherein the increment calculation module is configured to obtain the maximum lubricant increment;

delay a period and re-obtain an lubricant increment;

determine an interval between two measurements according to the lubricant increment re-obtained;

re-obtain lubricant increments for multiple times according to the determined interval; and

calculate the average of the lubricant increments re-obtained for multiple times.

28. The system of claim 27, wherein the interval between two measurements corresponding to a greater lubricant increment re-obtained is less than that corresponding to a smaller lubricant increment re-obtained.

29. The system of claim 27, further comprising: the increment calculation module is configured to determine whether the interval between two of the multiple measurements is greater than the maximum value of delayed time, and calculate the average of the lubricant increments re-obtained previously in response to that the interval between two of the multiple measurements is greater than the maximum value of delayed time.

30. The system of claim 27, further comprises: the increment calculation module is configured to determine whether the interval between two of the multiple measurements is greater than the determined interval and less than the maximum value of delayed time, and in response to that the interval between two of the multiple measurements is greater than the determined interval and less than the maximum value of delayed time, the lubricant increment re-obtained may be corrected by the following formula: k*DT, wherein DT refers to the lubricant increment re-obtained, k is a regulation coefficient in the range of 1.05-1.35; and calculate the average of the lubricant increments re-obtained previously and the corrected re-obtained lubricant increment.

31. The system of claim 27, further comprises: the increment calculation module is configured to determine whether the interval between two of the multiple measurements is greater than the determined interval and less than the maximum value of delayed time, and in response to that the interval between is two of the multiple measurements is greater than the determined interval and less than the maximum value of delayed time, the lubricant increment re-obtained may be corrected by the following formula: k*DT*(AT-T)/(t-T), wherein DT refers to the lubricant increment re-obtained, k is a regulation coefficient which is 1.35, AT is the interval between two measurements, t is the maximum value of delayed time, T is the determined interval; and calculate the average of the lubricant increments re-obtained previously and the corrected re-obtained lubricant increment.

32. The system of claim 26, further comprising: a power-off detection module configured to determine whether the difference value between the lubricant quantities after the aircraft is repowered and before the aircraft is powered off is greater than the first threshold value; wherein the verification module is configured to determine whether the difference value between the lubricant quantity after delaying for a period and the lubricant quantity before the aircraft is powered off is greater than the second threshold value in response to that the difference value between the lubricant quantities after the aircraft is repowered and before the aircraft is powered off is greater than the first threshold value; wherein the increment calculation module is configured to detect the lubricant increment in response to that the difference value between the lubricant quantity after delaying for a period and the lubricant quantity before the aircraft is powered off is greater than the second threshold value.

33. The system of claim 26, further comprises: a lubricant consumption calculation module configured to calculating the lubricant consumption rate of the engine according to the lubricant increment obtained from the increment calculation module and the running time of the engine.

34. The system of claim 26, further comprising: a lubricant adding event detection module configured to determine whether the difference value between the lubricant quantity at the first time and that at the second time is greater than a predetermined threshold, wherein the first time is within 8-15 minutes after the engine is shutdown, the second time is later than the lubricant adding period as required for aircraft maintenance.

35. The system of claim 26, further comprising: a lubricant adding event detection module configured to determine whether the difference value between the lubricant quantity at the first time and that at the third time is greater than a predetermined threshold, wherein the first time is within 8-15 munities after the engine is shutdown, the third time is within 3-10 seconds before the engine is started.

36. The method of Claim 2, wherein each of the first threshold value, and the second threshold value and the third threshold value is the minimum added amount of lubricant as required in aircraft maintenance.