CLAIMS

1. A method for determining leakage volume of fluid in a transportation pipeline, comprising:

obtaining negative pressure wave signals detected by at least two pressure sensors arranged on the pipeline;

determining pressure signal at leakage location based on the negative pressure wave signals;

determining leakage rate during a leakage period based on the pressure signal at the leakage location according to a leakage model; and

determining the leakage volume of the fluid in the pipeline based on the leakage rate and the leakage period.

2. The method according to claim 1, wherein the at least two pressure sensors comprise the two pressure sensors closest to the leakage location.

3. The method according to claim 1, wherein obtaining the negative pressure wave signals further comprises processing the read negative pressure wave signals by a low pass filter.

4. The method according to any one of claims 1-3, wherein determining the pressure signal at the leakage location comprises:

determining the leakage location based on the negative pressure wave signals; and

determining the pressure signal at the leakage location according to the obtained negative pressure wave signals and the determined leakage location.

5. The method according to claim 4, wherein determining the pressure signal at the leakage location according to the obtained negative pressure wave signals and the determined leakage location comprises: deducing the pressure signal at the leakage location by using a linear model in which the fluid pressure changes linearly along the pipeline, and based on the negative pressure waves signals at the at least two pressure sensors and the distances from the leakage location to the at least two pressure sensors.

6. The method according to any one of claims 1-5, wherein determining the leakage rate during a leakage period comprises: according to a proportional leakage model, determining the leakage rate as being proportional to the pressure intensity at the leakage location.

7. The method according to any one of claims 1-5, wherein determining the leakage

rate during a leakage period comprises:

obtaining the slope information of the pressure signal at the leakage location over time;

according to the slope information, dividing the leakage period into a plurality of time segments; and

according to the leakage model, determining the leakage rate in each time segment.

8. The method according to claim 7, wherein determining the leakage rate in each time segment comprises at least one selected from:

determining the leakage rate according to the ratio of the stable pressure intensity in each time segment to a particular pressure intensity;

estimating the leakage rate according to the stable pressure intensity in each time segment and a fluid function;

determining the leakage rate by referring to a query table.

9. The method according to claim 7, wherein determining the leakage volume of the fluid in the pipeline based on the leakage rate comprises: summating the leakage volumes in each time segment, thus obtaining the total leakage volume during the leakage period.

10. The method according to any one of claims 1-9, further comprising:

providing users with a model library comprising various leakage models and options of leakage models via an appropriate interface; and

receiving the selection of leakage models made by users via the interface.

11. The method according to any one of claims 1, further comprising: receiving the definition of leakage models made by users.

12. An apparatus for determining leakage volume of fluid in a transportation pipeline, comprising:

a signal-obtaining unit, configured to obtain negative pressure wave signals detected by at least two pressure sensors arranged on the pipeline;

a pressure-determining unit, configured to determine pressure signal at leakage location according to the negative pressure wave signals;

a rate-determining unit, configured to determine leakage rate during a leakage period based on the pressure signal at the leakage location according to a leakage model; and

a volume-determining unit, configured to determine the leakage volume of the fluid in the pipeline based on the leakage rate and the leakage period.

13. The apparatus according to claim 12, wherein the at least two pressure sensors comprise the two pressure sensors closest to the leakage location.

14. The apparatus according to claim 12, wherein the signal-obtaining unit is further configured to process the read negative pressure wave signals by a low pass filter.

15. The apparatus according to any one of claims 12-14, wherein the pressure-determining unit comprises:

a location-determining module, configured to determine the leakage location based on the negative pressure wave signals; and

a pressure-determining module, configured to determine the pressure signal at the leakage location according to the obtained negative pressure wave signals and the determined leakage location.

16. The apparatus according to claim 15, wherein the pressure-determining module is configured to deduce the pressure signal at the leakage location by using a linear model in which the fluid pressure changes linearly along the pipeline, and based on the negative pressure waves signals at the at least two pressure sensors and the distances from the leakage location to the at least two pressure sensors.

17. The apparatus according to any one of claims 12-16, wherein the rate-determining unit is configured to, according to a proportional leakage model, determine the leakage rate as being proportional to the pressure intensity at the leakage location.

18. The apparatus according to any one of claims 12-16, wherein the rate-determining unit comprises:

a slope-determining module, configured to obtain the slope information of the pressure signal at leakage location over time;

a time segment-dividing module, configured to divide the leakage period into a plurality of time segments according to the slope information; and

a rate-determining module, configured to determine the leakage rate in each time segment according to the leakage model.

19. The apparatus according to claim 18, wherein the rate-determining module is configured to perform at least one selected from:

determining the leakage rate according to the ratio of the stable pressure intensity in each time segment to a particular pressure intensity;

estimating the leakage rate according to the stable pressure intensity in each time segment and a fluid function;

determining the leakage rate by referring to a query table.

20. The apparatus according to claim 18, wherein the volume-determining unit is

configured to summate the leakage volumes in each time segment, thus obtaining the total leakage volume during the leakage period.

21. The apparatus according to any one of claims 12-20, further comprising:

a model library-providing unit, configured to provide users with a model library comprising various leakage models and options of leakage models via an appropriate interface; and

a model selection-receiving unit, configured to receive the selection of leakage models made by users via the interface.

22. The apparatus according to any one of claims 12-21, further comprising: a model definition-receiving unit, configured to receive the definition of leakage models made by users.

23. A computer program comprising program code adapted to perform the method steps of any of claims 1 to 11 when said program is run on a computer.

CLAIMS

1. A method for determining leakage volume of fluid in a transportation pipeline, comprising:

obtaining negative pressure wave signals detected by at least two pressure sensors arranged on the pipeline;

determining pressure signal at leakage location based on the negative pressure wave signals;

determining leakage rate during a leakage period based on the pressure signal at the leakage location according to a leakage model; and

determining the leakage volume of the fluid in the pipeline based on the leakage rate and the leakage period.

2. The method according to claim 1, wherein the at least two pressure sensors comprise the two pressure sensors closest to the leakage location.

3. The method according to claim 1, wherein obtaining the negative pressure wave signals further comprises processing the read negative pressure wave signals by a low pass filter.

4. The method according to any of claims 1 to 3, wherein determining the pressure signal at the leakage location comprises:

determining the leakage location based on the negative pressure wave signals; and

determining the pressure signal at the leakage location according to the obtained negative pressure wave signals and the determined leakage location.

5. The method according to claim 4, wherein determining the pressure signal at the leakage location according to the obtained negative pressure wave signals and the determined leakage location comprises: deducing the pressure signal at the leakage location by using a linear model in which the fluid pressure changes linearly along the pipeline, and

based on the negative pressure waves signals at the at least two pressure sensors and the distances from the leakage location to the at least two pressure sensors.

6. The method according to any of claims 1 to 5, wherein determining the leakage rate during a leakage period comprises: according to a proportional leakage model, determining the leakage rate as being proportional to the pressure intensity at the leakage location.

7. The method according to any of claims 1 to 5, wherein determining the leakage rate during a leakage period comprises:

obtaining the slope information of the pressure signal at the leakage location over time;

according to the slope information, dividing the leakage period into a plurality of time segments; and

according to the leakage model, determining the leakage rate in each time segment.

8. The method according to claim 7, wherein determining the leakage rate in each time segment comprises at least one selected from:

determining the leakage rate according to the ratio of the stable pressure intensity in each time segment to a particular pressure intensity;

estimating the leakage rate according to the stable pressure intensity in each time segment and a fluid function;

determining the leakage rate by referring to a query table.

9. The method according to claim 7, wherein determining the leakage volume of the fluid in the pipeline based on the leakage rate comprises: summating the leakage volumes in each time segment, thus obtaining the total leakage volume during the leakage period.

10. The method according to any of claims 1 to 9, further comprising:

providing users with a model library comprising various leakage models and options of leakage models via an appropriate interface; and

receiving the selection of leakage models made by users via the interface.

11. The method according to any of claims 1 to 10, further comprising: receiving the definition of leakage models made by users.

12. An apparatus for determining leakage volume of fluid in a transportation pipeline, comprising:

a signal-obtaining unit, configured to obtain negative pressure wave signals detected by at least two pressure sensors arranged on the pipeline;

a pressure-determining unit, configured to determine pressure signal at leakage location according to the negative pressure wave signals;

a rate-determining unit, configured to determine leakage rate during a leakage period based on the pressure signal at the leakage location according to a leakage model; and

a volume-determining unit, configured to determine the leakage volume of the fluid in the pipeline based on the leakage rate and the leakage period.

13. The apparatus according to claim 12, wherein the at least two pressure sensors comprise the two pressure sensors closest to the leakage location.

14. The apparatus according to claim 12, wherein the signal-obtaining unit is further configured to process the read negative pressure wave signals by a low pass filter.

15. The apparatus according to any of claims 12 to 14, wherein the pressure-determining unit comprises:

a location-determining module, configured to determine the leakage location based on the negative pressure wave signals; and

a pressure-determining module, configured to determine the pressure signal at the leakage location according to the obtained negative pressure wave signals and the determined leakage location.

16. The apparatus according to claim 15, wherein the pressure-determining module is configured to deduce the pressure signal at the leakage location by using a linear model in

which the fluid pressure changes linearly along the pipeline, and based on the negative pressure waves signals at the at least two pressure sensors and the distances from the leakage location to the at least two pressure sensors.

17. The apparatus according to any of claims 12 to 16, wherein the rate-determining unit is configured to, according to a proportional leakage model, determine the leakage rate as being proportional to the pressure intensity at the leakage location.

18. The apparatus according to any of claims 12 to 16, wherein the rate-determining unit comprises:

a slope-determining module, configured to obtain the slope information of the pressure signal at leakage location over time;

a time segment-dividing module, configured to divide the leakage period into a plurality of time segments according to the slope information; and

a rate-determining module, configured to determine the leakage rate in each time segment according to the leakage model.

19. The apparatus according to claim 18, wherein the rate-determining module is configured to perform at least one selected from:

determining the leakage rate according to the ratio of the stable pressure intensity in each time segment to a particular pressure intensity;

estimating the leakage rate according to the stable pressure intensity in each time segment and a fluid function;

determining the leakage rate by referring to a query table.

20. The apparatus according to claim 18, wherein the volume-determining unit is configured to summate the leakage volumes in each time segment, thus obtaining the total leakage volume during the leakage period.

21. The apparatus according to any of claims 12 to 20, further comprising:

a model library-providing unit, configured to provide users with a model library comprising various leakage models and options of leakage models via an appropriate interface; and

a model selection-receiving unit, configured to receive the selection of leakage models made by users via the interface.

22. The apparatus according to any of claims 12 to 21, further comprising: a model definition-receiving unit, configured to receive the definition of leakage models made by users.