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AMIN109000
AiRRmonia
Automated Ammonia Analyzer

INTRODUCTION
During recent years, it has become clear that ammonia is an important gas in relation to different environmental issues, such as acidification, eutrophication, human health and climate change (through particle formation). Therefore, there is a growing need to develop and apply instrumentation suitable for research into emission, dispersion, conversion and deposition of ammonia and ammonium. Recently, Mechatronics has developed the AiRRmonia. This instrument measures concentrations in ambient conditions even at very low levels.

The AiRRmonia finds its application for example in those countries where intensive cattle and poultry farming occurs. By measuring the ammonia concentrations in areas of these activities, a data-supported picture emerges as to the degree of acceptable or unacceptable ammonia concentrations. This data assists in public policy making and the monitoring and regulation surrounding ammonia emissions.

AIRRMONIA MEASURING PRINCIPLE
The air sample is drawn through a folded channel in the sampling block. This channel system is positioned on a Teflon membrane, which is permeable for gasses. On the opposite side of the membrane flows an absorption solution in counter-flow direction. The sampling channel is dimensioned in such a way that all the ammonia will pass the membrane at an airflow rate of 1 l min^{-1} and forms ammonium in the absorption solution.
Almost all aerosols will pass the sampling channel. Aerosols generate 1-% interference in respect to the aerosol ammonium content.
A three-channel syringe pump is used to displace the solutions with a fixed flow rate.
All flows entering the detector block are led through a de-bubbling chamber first. In the detector block a hydroxide solution is mixed with the sample revealing gaseous ammonia again. Then the sampling solution is led along a Teflon membrane again. The gaseous ammonia is able to penetrate the membrane. This is the ammonia selective step in the process, since apart from small volatile amines, no known airborne compounds will be gaseous at this stage. A purified water flow at the opposite side of the membrane dissolves the ammonia that penetrated the membrane. A conductivity cell monitors the initial conductivity. The resulting content of ammonium and hydroxide after the membrane exchange is measured with a second conductivity cell. The conductivity difference is a measure for the original ammonia content in the sampled air. The conductivity is corrected for temperature drifts.
The calibration curve has a second order shape due to the ammonium/ammonia dissociation equilibrium. The detector block is automatically calibrated with standard solutions to determine the curve coefficients a, b and c. The ammonium concentration in the sample solution is given by

ppb(NH_4) = a*(TempCorrCond)^2 + b*TempCorrCond + c

The ammonia concentration in the sampled air in µg m^{-3} is calculated by:

Ammonia = ppb(NH_4) * SampleSolution - Flow I AirFlow * 0.944

The AiRRmonia is installed in an Aluminium, ruggedized, weatherproof box.

AIRRMONIA PERFORMANCE

AiRRmonia	
Air flow (l min^{-1})	1
Solvent flow (ml min^{-1})	0.15
Detection limit (µg m^{-3})	0.05
Accuracy (%)	3
Time resolution (min)	10

REGULATIONS
CE Compliant.

CONNECTIVITY
The AiRRmonia has a standard RS232 data communication with default settings of 19200-8-n-1. The data is standard ASCII format and is readable in any communication software such as ProComm or Hyper Terminal.
The data string is in ASCII format. Data is send every 1-second to the serial output.
A user friendly communication program is under development.

WORK CONDITIONS
The temperature range on the electronics is 0 to 50 °C. Due to the wet chemical method the instrument temperature range will be between 5 and 35 °C. The instrument contains a controlled heater.
The ambient relative humidity can change between 0 and 100%.
The AiRRmonia runs on the mains 240 or 120-volt and on battery power or solar panels.

SERVICE INTERVAL PERIODS
If the AiRRmonia is operated without the extension box, the operational time is one week. After this period, the bottles are empty and the waste container full and require exchange (indicated by level detection).
The optional extension box with larger supply bottles prolongs the service interval period to a month.
The logging interval can be varied. A two-minute interval covers a period of 1.5 month.

MAINTENANCE
Maintenance is required to keep the instrument in good operating conditions. At this moment, the field experience is too limited to produce statistically reliable data on mean times between failure. Mechatronics recommends the following schedule.

Required activities for each maintenance activity:

1 week (without extension box)
Download the data
Replace the reagents
Empty the waste bottle

1 month
Bottle and data handling as above

3 months
Run a service calibration
Exchange or clean the sample block and inlet tube
Replace the syringe pistons that pump the NaOH-solution.
Overall check of instrument

6 months
Replace all syringes
Replace disk filter protecting the mass flow controller

1 year
Exchange detector membrane
Exchange column

DIMENSIONS
Width x depth x height is 60 x 38 x 43 cm.
Weight is 20 kg.
Power requirements are 115-230V, 50-60Hz and 10 Watts (120 Watts including heater).
Maximum noise level is negligible.