Patented AmmEL Process for the Treatment of Ammonia in Low Temperature Mine Wastewater; Ammonia Converted to Environmentally–Friendly Nitrogen Gas

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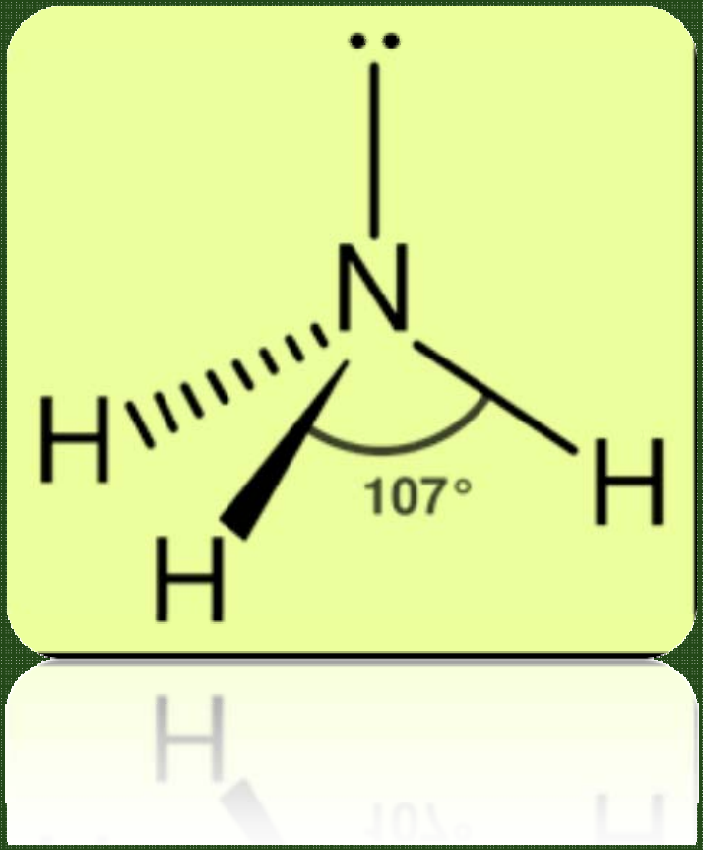
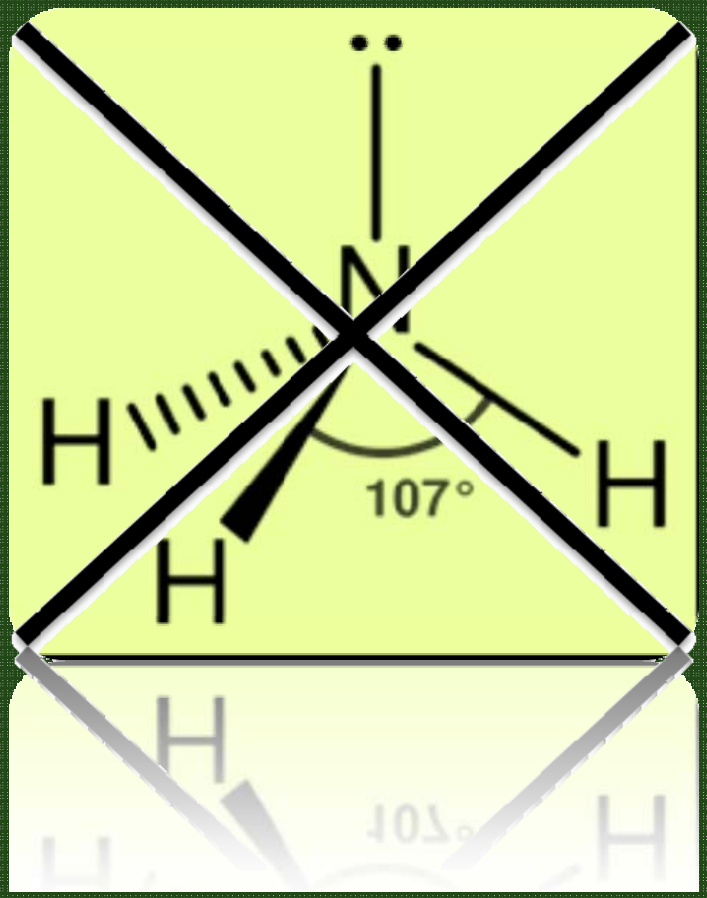
Introduction

- Ammonia listed as a toxic substance by Environment Canada
- One approach employed by the mining industry has been to lower the pH of the wastewater to render it less toxic (due to a shift in the NH_3/NH_4^+ equilibrium)
- While this approach has assisted in meeting acute lethality discharge requirements, the total ammonia-N released into the environment is not reduced
- Current technology for treating ammonia relies heavily on biological activity (e.g. nitrification) to convert ammonia to nitrate

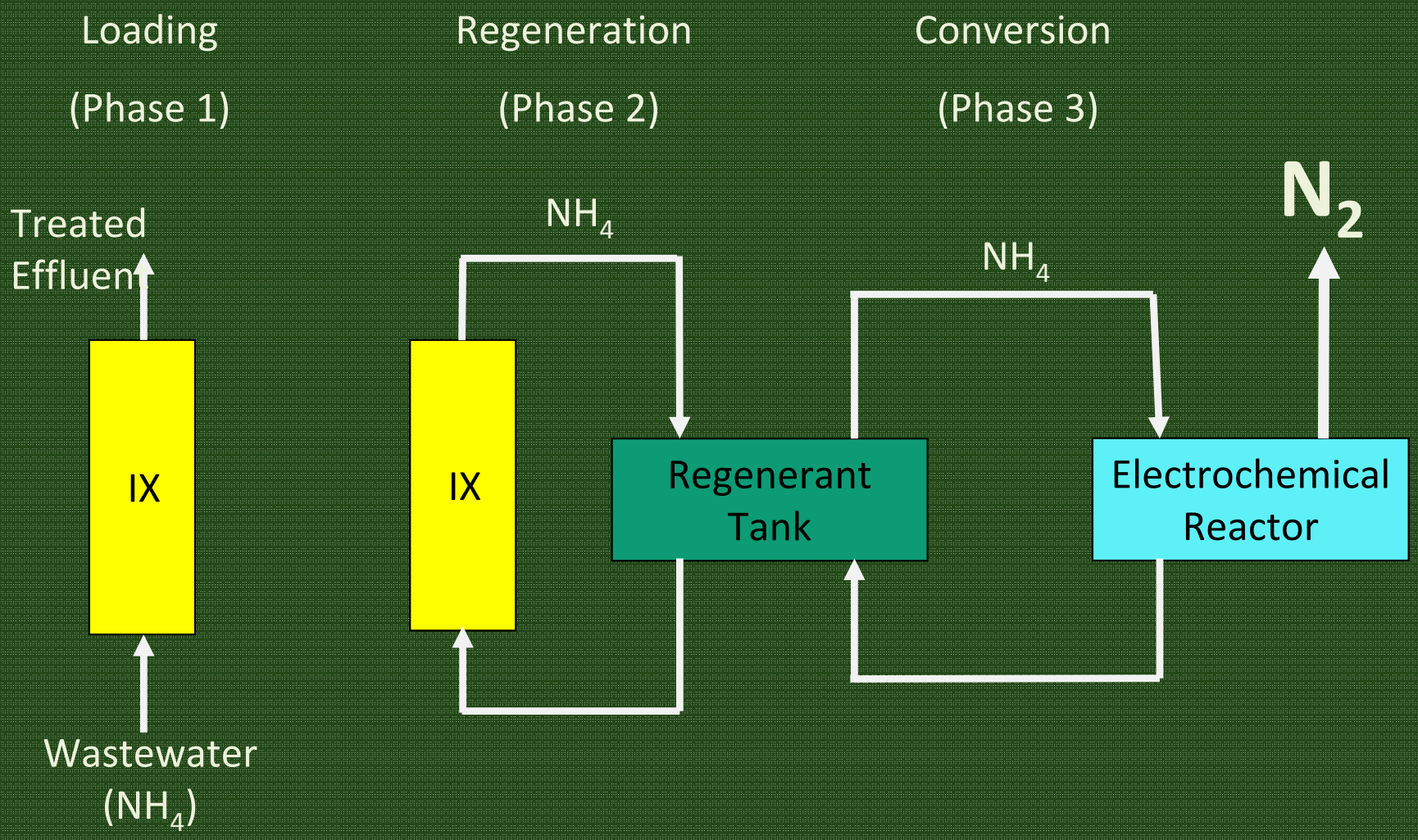


Introduction

- Total nitrogen removal requires additional biological processes to remove nitrate from wastewater prior to discharge
- Biological treatment systems are adversely affected by cold temperatures and changes in effluent composition
- **A novel and patented ion-exchange/electrochemical treatment technology (the AmmEL system) has been developed by Enpar Technologies, Inc. which is not adversely affected by low temperature**



The AmmEL Process



AmmEL Reactions

$$2NH_4^+ \longrightarrow N_2 + 8H^+ + 6e^-$$

$$2Cl^- \longrightarrow Cl_2 + 2e^-$$

$$Cl_2 + H_2O \longrightarrow HOCl + HCl$$

$$2NH_4^+ + 3HOCl \longrightarrow N_2 + 3H_2O + 5H^+ + 3Cl^-$$

The AmmEL Advantage

- Eliminates nitrogen loading by converting ammonia directly into innocuous N_2
- Does not produce nitrate and the GHG nitrous oxide associated with biological treatment
- Not affected by low temperature
- Intermittent operation -- no start-up delays
- Can be fully automated -- low maintenance

System Applications

- Mining effluent or process streams containing ammonia derived from the use of ammonia based blasting powder and/or the oxidation of cyanide
- Tertiary treatment for municipal waste water treatment plants (MWTP) and lagoon systems
- Process streams related to steel, fertilizer and chemical industries

Pilot Study

The *AmmEL-LC* System

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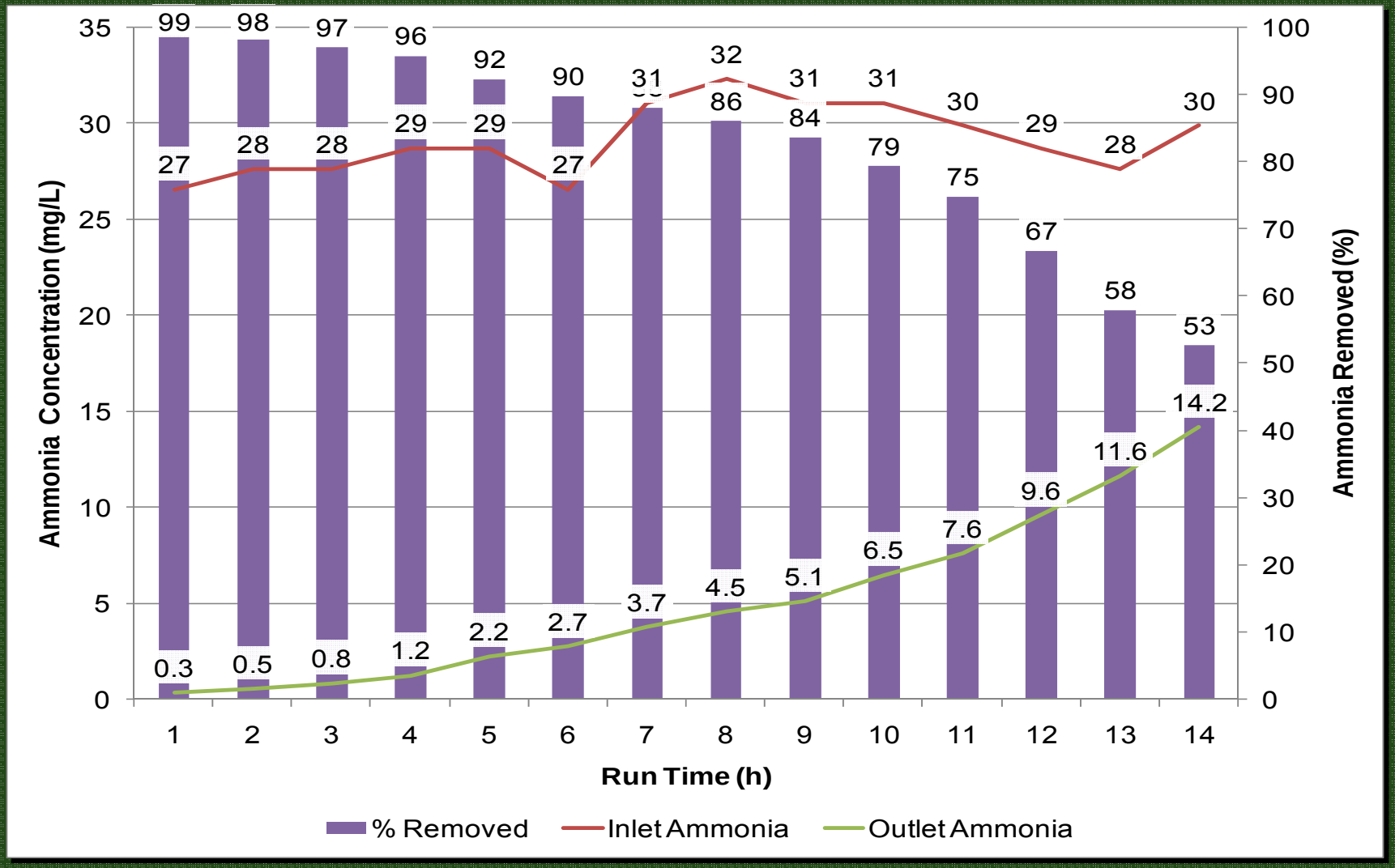
AmmEL-LC Pilot Unit Specifications

- 3-20 cm x 3.05m fluidized bed IX columns, BV = 59.3L
- 1.5 kW electrochemical reactor
- pH adjustment station for the inlet water stream
- The main operating conditions for the system were as follows:
  - Wastewater flow rate: 18-20 L/min
  - Recharge brine flow rate: 8-10 L/min
  - Brine NaCl concentration: 3-4%
  - Cell current: 150 A

- Designed to allow for single column operation as well as series column operation
- Typical treatment mode was to operate the system with two columns in series in a lead-lag arrangement
- Third column was either involved in a regeneration cycle or was in standby
- Following a regeneration cycle, the regenerated column was rinsed with a small amount of treated water to remove any extraneous brine
- The rinse stream was directed into a 200L holding tank for testing prior to release back into the holding pond


IX 3
IX 2
IX 1
Reactor

Single Column Results

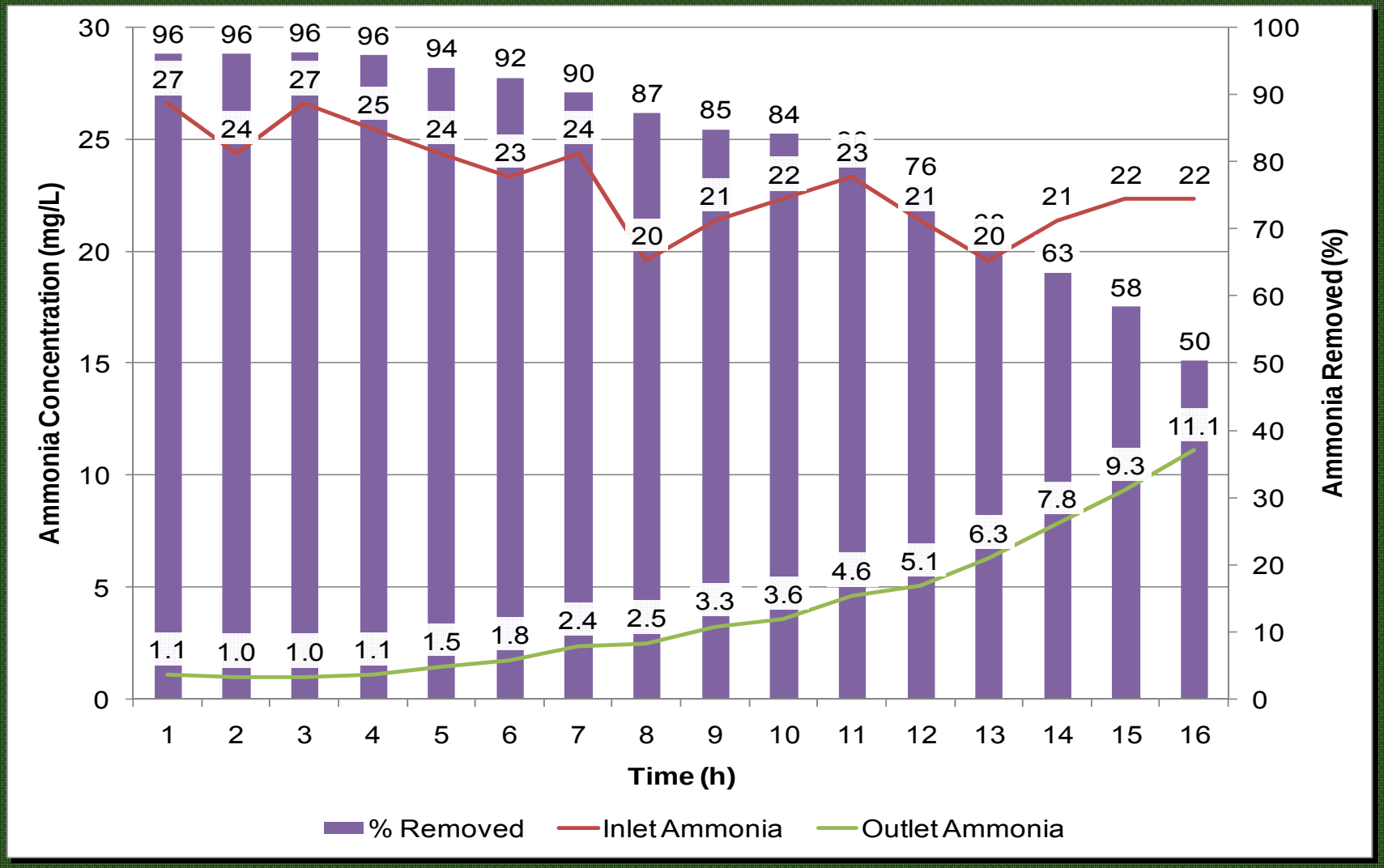


Breakthrough Curve at 18 L/min

Typical Single Column Results

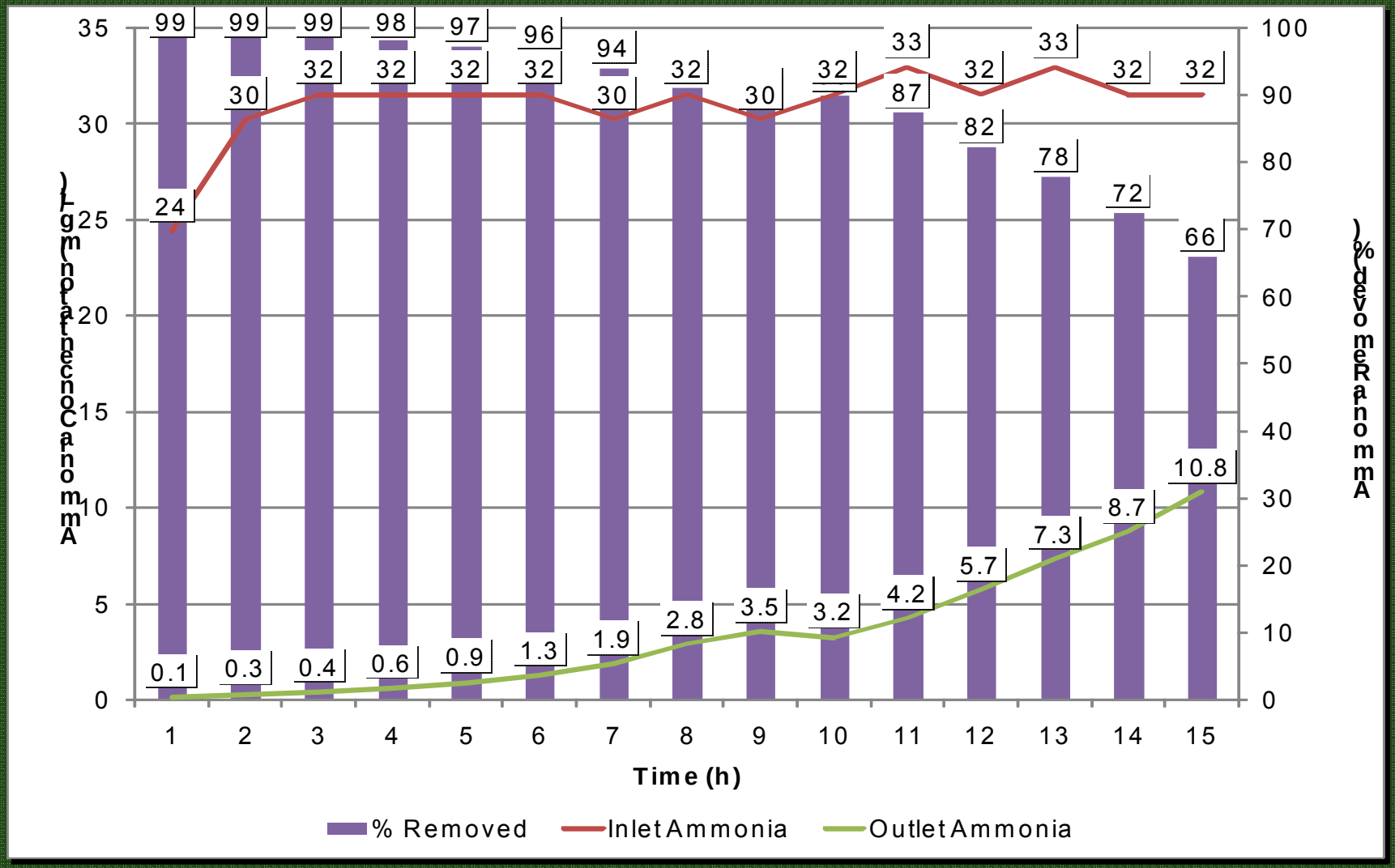
Flow rate (L/min)	18.0
Total run time (h)	14
Total volume treated (L)	15,120
Water temperature (°C)	5.7
Inlet pH	7.76
Outlet pH	7.85
Avg inlet ammonia (mg/L)	29.1
Avg outlet ammonia (mg/L)	5.1

Series Column Results



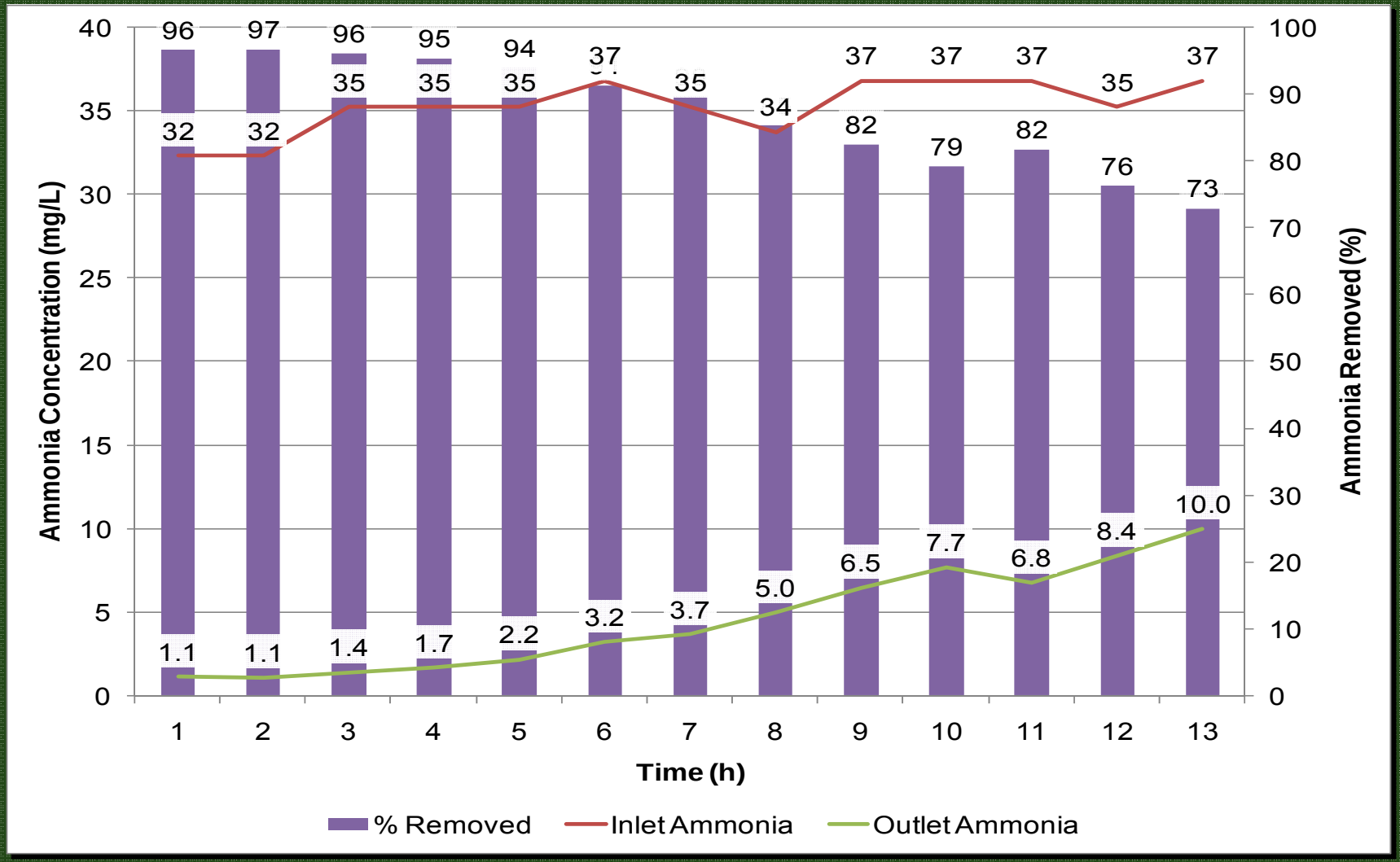
Ammonia Loading, Columns C2 & C1

Series Column Results



Ammonia Loading, Columns C1 & C3

Series Column Results



Ammonia Loading, Columns C3 & C2

Series Column Results

	C_2 & C_1	C_1 & C_3	C_3 & C_2
Flow Rate (L/min)	18.2	18.1	18.3
Total Run Time (h)	16	15	13
Water Temperature (°C)	5.9	6.0	5.9
Inlet pH	7.79	7.84	7.82
Outlet pH	7.86	7.86	7.91
Average Inlet NH_3 (mg/L)	23.0	31.0	35.3
Average Outlet NH_3 (mg/L)	4.0	3.4	4.5

Pilot Study Conclusions

- The AmmEL-LC system can readily remove ammonia from mine waste water to below the discharge requirement of 10 mg/L
- No pretreatment of the stream was required
- The efficiency of the AmmEL-LC was not affected by low water temperatures (>6°C)
- Operating costs were relatively low ($0.10/$m^3$ of water treated)

Full-Scale Installation

- Full-scale installation commissioned March 10, 2010 in Timmins, Ontario
- Three zeolite filled 30 cm (i.d.) x 6 m ion exchange columns
- Electrochemical reactor → 18 m^2 of anode surface area; 16V, 2000A DC rectifier
- Chlorine gas scrubber to comply with Ontario MoE chlorine emission levels
- The system is designed to treat 400 m^3 of mine waste per day containing an average of 30 mg of ammonia-nitrogen/L
- Emission levels are 10 mg NH_3-N/L year round including during the winter months when mine water can reach temperatures slightly above freezing

Ion Exchange Columns

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Electrochemical Reactor

DC Rectifier

Chlorine Gas Scrubber

THANK YOU!

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