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Sustainable Nitric Acid Recycling: Converting Glucose-Derived NOx Gas Emissions into Recycled Nitric Acid Resources

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ABSTRACT

Recycled nitric acid was synthesized using NO_x gas generated from the reaction of glucose and nitric acid. The reaction of glucose and nitric acid undergoes a complex oxidation process, in which nitric acid acts as an oxidizing agent and is reduced to form nitrogen dioxide. The flow rate and amount of NO_x gas generated from the reaction of 70% nitric acid aqueous solution and 25-90% diluted glucose were quantitatively evaluated. NO_x gas exists in the form of NO and NO_2, and NO_2 gas reacts with H_2O to synthesize nitric acid. NO gas has low reactivity with H_2O, it was additionally converted to NO_2 gas through a reaction with oxygen. In this study, the ion concentration and oxidation reduction potential(ORP) of the generated solution were measured using a pH meter, and gases were detected using gas analyzer. Nitric acid of various concentrations was successfully synthesized and recycled, suggesting the potential for future development in the aspect of industrial nitrogen oxide recycling.

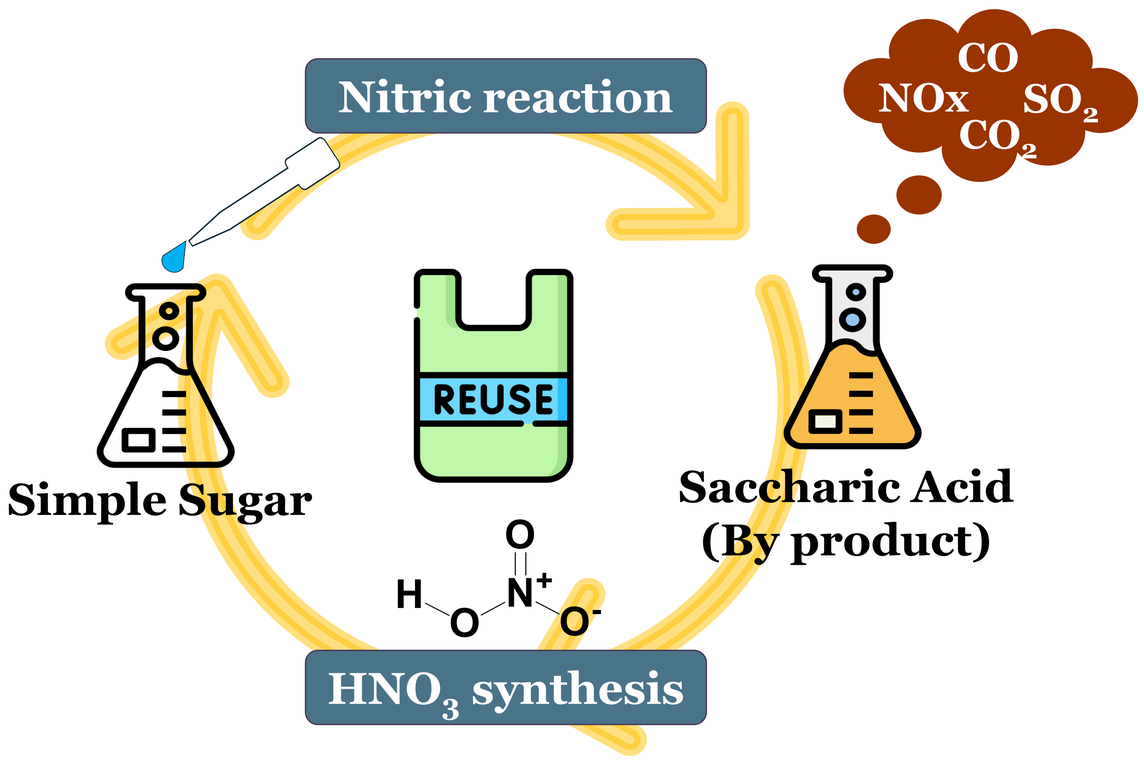
OBJECTIVE

To investigate the generation of NO_x gases from the reaction between monosaccharides and nitric acid, and to explore their subsequent conversion into concentrated nitric acid.

To establish optimal conditions for the nitrification and concentration of NO_x gases generated through monosaccharide–nitric acid reactions, aiming at the regeneration of high-purity nitric acid.

To develop a sustainable process for recovering and concentrating nitric acid via NO_x gas capture and conversion, using monosaccharide-based reactions as a precursor route.

EXPERIMENTAL



Step 1 Reaction of Monosaccharides with Nitric Acid

Step 2 Conversion of pollutant gases into nitric acid through synthetic processes

Step 3 The recycled nitric acid is reused under the same reaction conditions to ensure consistency

Figure 1. Experimental scheme illustrating the closed-loop use of HNO_3 through a recycling and reuse process.

■ Synthesis series

	Dilution w/DI water (%)	Nitiric acid (%)	Temperature (℃)	rpm	Titration (n/sec.)	Reaction Time	
#1	1:1 = 50	69	25	200	2 drop wise / sec	2h	NOx gas X
			25		1 drop wise / sec	40m	NOx gas X
#2			40		2 drop wise / sec	2h	NOx gas X
			40		1 drop wise / sec	40m	NOx gas X
#3	3:1= 75		40		1 drop wise / sec	40m	NOx gas X
			60		1 drop wise / sec	1h30m	NOx gas O

RESULTS

■ Fourier-transform infrared spectroscopy

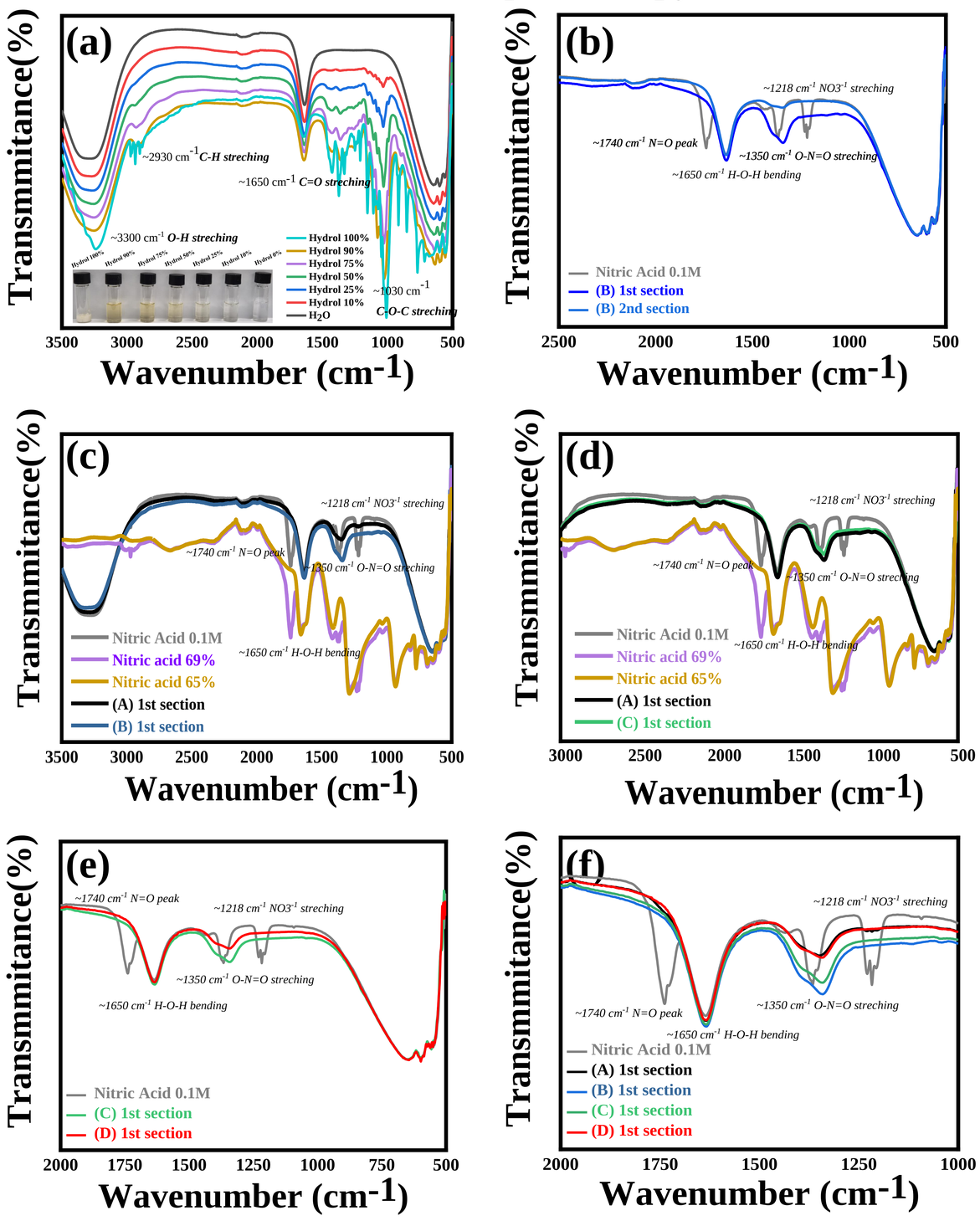
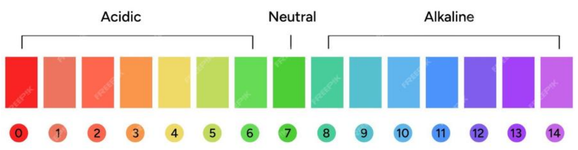


Figure 2. FT-IR analysis results are presented based on: (a) raw material dilution; (b) collection zone; (c) oxygen injection conditions; (d) temperature variation in the collection zone; (e) use of highly concentrated raw materials; and (f) comprehensive integration of remaining variables.

■ pH meter



	Samplig Zone	Test A	Test B	Test C	Test D	0.1M HNO_3	65% HNO_3	69% HNO_3
pH	1st	0.34	**-0.03**	0.06	0.26	1.04	-1.94	-2 ↑
	2nd	0.30	**0.74**	0.62	0.94			

Figure 3. Results of pH concentration analysis of nitric acid formed through the reaction of generated nitrogen oxide gases with water

CONCLUSIONS

- ✓ **This study identified the formation conditions of NO_x gases resulting from the reaction between monosaccharides and nitric acid.**
- ✓ **Specific conditions for NO_x gas collection zones were established, and experiments confirmed the regeneration of nitric acid via reaction with water.**

ACKNOWLEDGEMENT

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