

Methanol Elimination at Niron Magnetics

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Driven to DiscoverSM

Company Background



Company Overview

- Startup in Minneapolis, MN
- 90 employees
- 2 facilities; R&D and Pilot Labs
- Planning stage of first manufacturing plant



Company Background

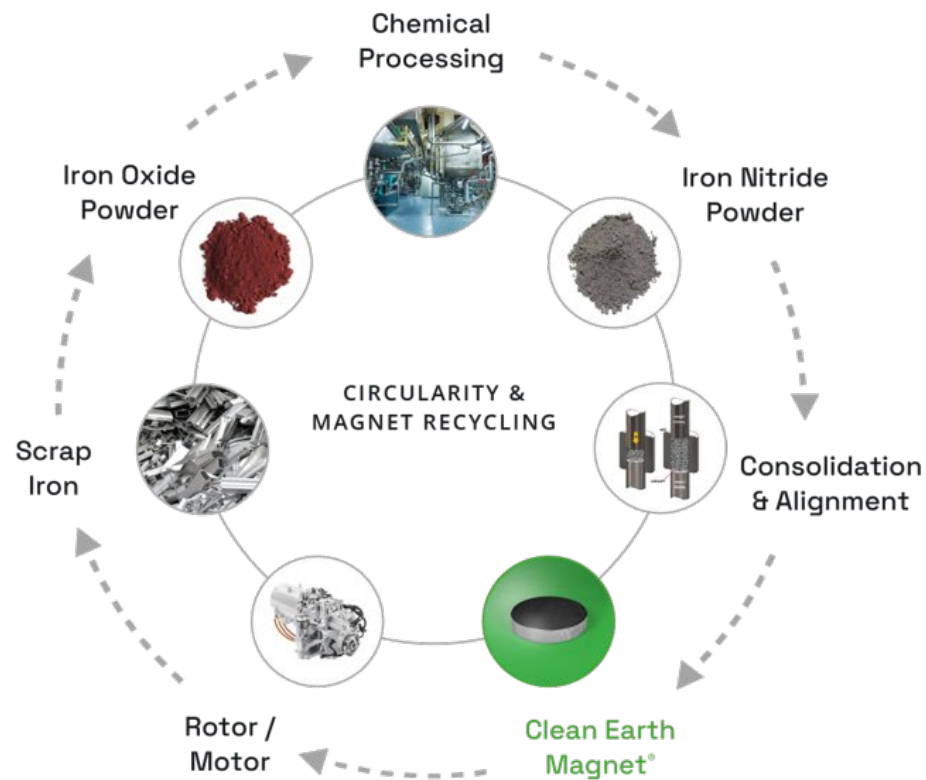
Clean Earth Magnet™

- Magnets made from iron nitride
- First sustainably manufactured high performance permanent magnets
- Use in electronics, speakers, motors, and sensors



The image shows a periodic table of elements. A green arrow points from Nitrogen (N) to Iron (Fe). Nitrogen is highlighted with a green box, and Iron is highlighted with a green box. The arrow starts at Nitrogen and points directly to Iron.

1 H Hydrogen																	2 He Helium						
3 Li Lithium	4 Be Beryllium																	5 B Boron	6 C Carbon	7 N Nitrogen	8 O Oxygen	9 F Fluorine	10 Ne Neon
11 Na Sodium	12 Mg Magnesium																	13 Al Aluminum	14 Si Silicon	15 P Phosphorus	16 S Sulfur	17 Cl Chlorine	18 Ar Argon
19 K Potassium	20 Ca Calcium	21 Sc Scandium	22 Ti Titanium	23 V Vanadium	24 Cr Chromium	25 Mn Manganese	26 Fe Iron	27 Co Cobalt	28 Ni Nickel	29 Cu Copper	30 Zn Zinc	31 Ga Gallium	32 Ge Germanium	33 As Arsenic	34 Se Selenium	35 Br Bromine	36 Kr Krypton						
37 Rb Rubidium	38 Sr Strontium	39 Y Yttrium	40 Zr Zirconium	41 Nb Niobium	42 Mo Molybdenum	43 Tc Technetium	44 Ru Ruthenium	45 Rh Rhodium	46 Pd Palladium	47 Ag Silver	48 Cd Cadmium	49 In Indium	50 Sn Tin	51 Sb Antimony	52 Te Tellurium	53 I Iodine	54 Xe Xenon						
55 Cs Cesium	56 Ba Barium	57 La Lanthanum	58 Ce Cerium	59 Pr Praseodymium	60 Nd Neodymium	61 Pm Promethium	62 Sm Samarium	63 Eu Europium	64 Gd Gadolinium	65 Tb Terbium	66 Dy Dysprosium	67 Ho Holmium	68 Er Erbium	69 Tm Thulium	70 Yb Ytterbium	71 Lu Lutetium							
87 Fr Francium	88 Ra Radium	89 Ac Actinium	90 Th Thorium	91 Pa Protactinium	92 U Uranium	93 Np Neptunium	94 Pu Plutonium	95 Am Americium	96 Cm Curium	97 Bk Berkelium	98 Cf Californium	99 Es Einsteinium	100 Fm Fermium	101 Md Mendelevium	102 No Nobelium	103 Lr Lawrencium							



Incentives to Change

Methanol Use

- Hazardous chemical
- Regulatory constraints

Hazard	GHS Classification
Flammable Liquid	2
Acute Toxicity - Oral	3
Acute Toxicity - Dermal	3
Acute Toxicity - Inhalation	3
Specific Organ Toxicity	1

Other Challenges

- Inhibits inherently safer design
 - Powder must be dried outside of process lines
- Requires recycle system
 - Increased equipment costs, energy use

Methanol Replacement

Methods

- Worked with key contacts & EHS team to determine safer alternatives
 - Solvent SDS, Pharos
- Experimentation within process at R&D scale
- Tested magnetic properties of collected samples



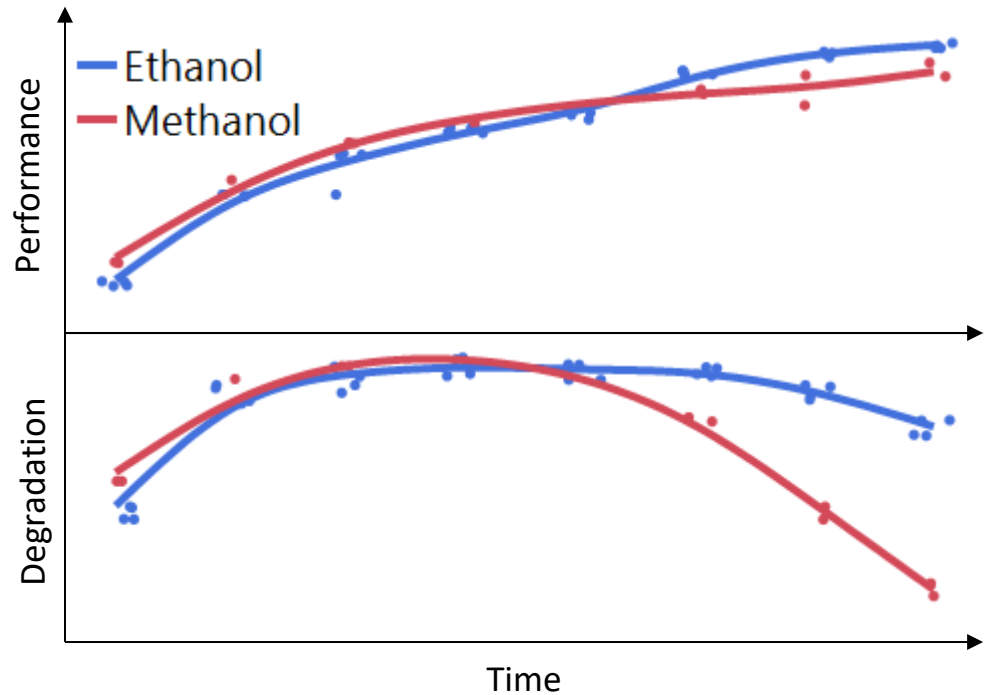
Hazard Comparison Summary

Name	H225 (Flammable Liquid)	H301 (Acute toxicity - oral)	H311 (Acute toxicity - dermal)	H331/332 (Acute toxicity - inhalation)	H370 (Specific target organ toxicity)	H336 (Specific organ toxicity - single exposure)	H319 (Eye irritation)
Methanol	2	3	3	3	1		
Ethanol	2					3	2A
Isopropanol	2						2A
Propylene glycol							

Methanol Replacement

Conclusion

- Ethanol performed best
- Benefits
 - Can be renewably sourced
 - Less regulatory restrictions
 - Less hazardous in terms of health



Economic Comparison

Solvent	Solvent Use	Energy to Recycle	Solvent Waste	Capital Expenses
Methanol	\$1,720,000	\$1,280,000	\$2,480,000	\$16,200,000
Ethanol	\$1,830,000	\$850,000	\$2,480,000	\$16,300,000

Economic Comparison

Solvent	Solvent Use	Energy to Recycle	Solvent Waste	Capital Expenses
Methanol	\$1,720,000	\$1,280,000	\$2,480,000	\$16,200,000
Ethanol	\$1,830,000	\$850,000	\$2,480,000	\$16,300,000
Solventless	N/A	N/A	N/A	\$0*

*Capital expenses are estimated as the costs directly related to solvent use

Solvent Elimination

Methods

- Testing different types of equipment
- Gathering preliminary data involving the effects of changing certain parameters
- Comparing magnetic properties of collected samples

Conclusion

- Still investigating
- Benefits
 - Inherently safer plant design
 - Regulatory advantages
 - Eliminate waste

Solutions

Recommendation	Annual reduction	Capital Savings	Annual savings	Status
Implement Ethanol	4,560,000 kWh	-\$100,000	\$320,000	Implementing
Solventless Process	13,660,000 kWh 3,650,000 lbs	\$16,200,000	\$5,480,000	Investigating

Personal Benefits

- Learned about many different areas of Niron's process
- Fun experience working at a startup company
- Benefit of considering changes from multiple perspectives

