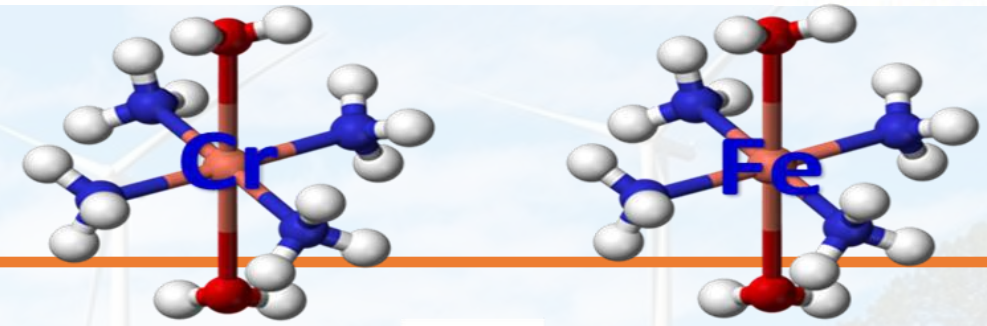


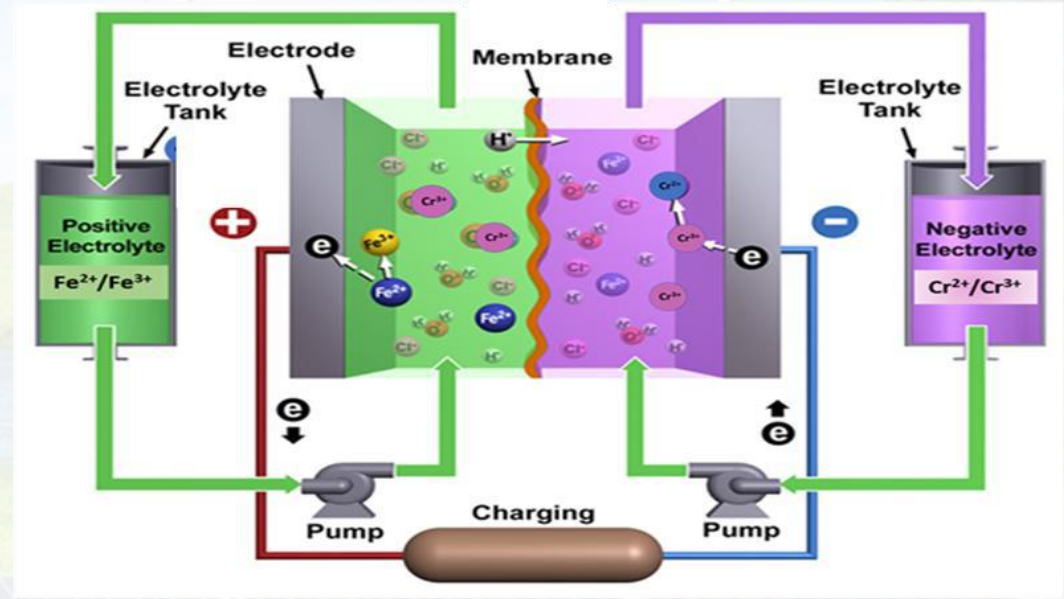


Second Generation

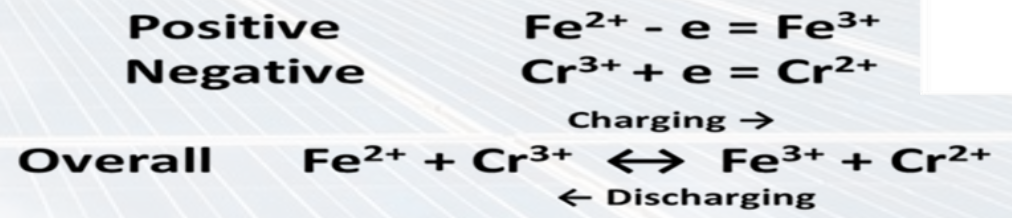


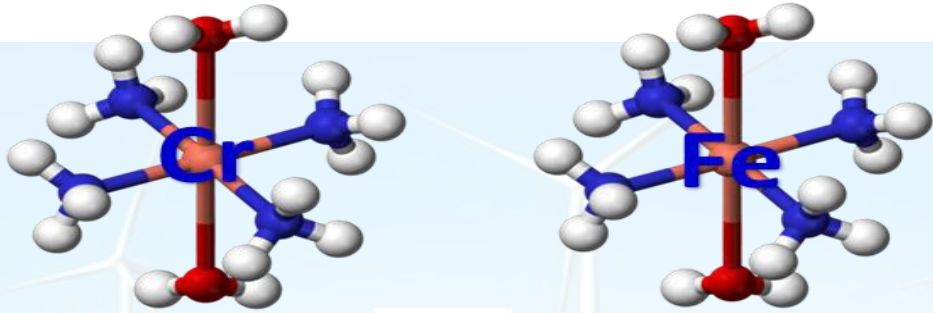
IMABATTERY®

Fe-Cr Flow Battery



Liyu Li, Ph.D. CEO
Cougar Creek Technologies, LLC.

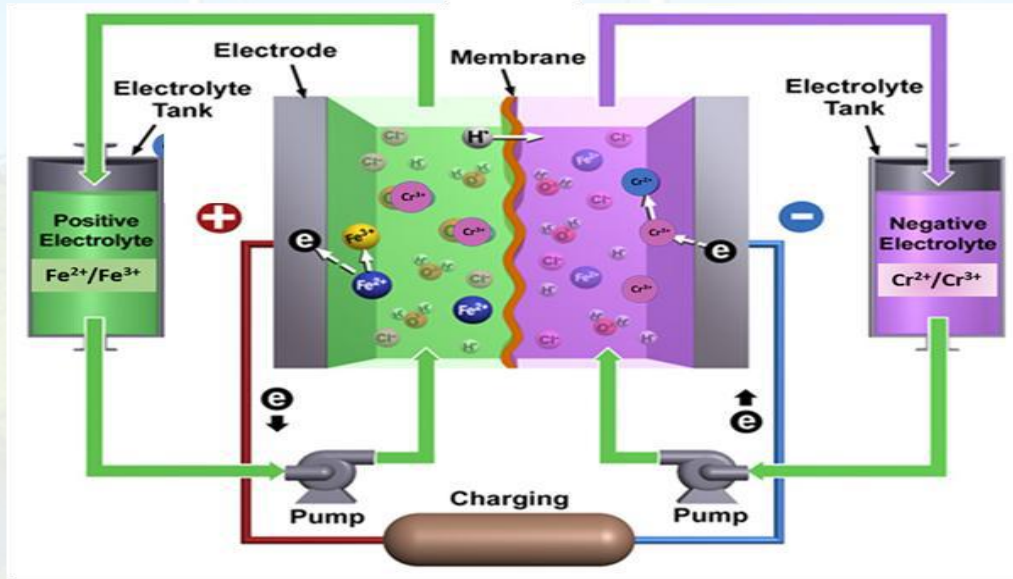




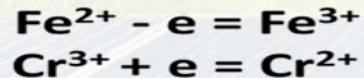
IMABATTERY® Provides Clean Energy Solutions

Cougar Creek Technologies, LLC.

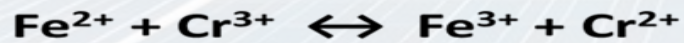
was founded by Dr. Liyu Li in 2018 in Seattle, Washington State, USA.



Positive
Negative



Overall



Charging →

← Discharging

www.imabattery.com

The FeCr HCl system was invented in 1975, but has not been successfully demonstrated



Dr. Lawrence Thaller
Father of redox flow battery
In front of a 250-MWh FeCr system by EnerVault

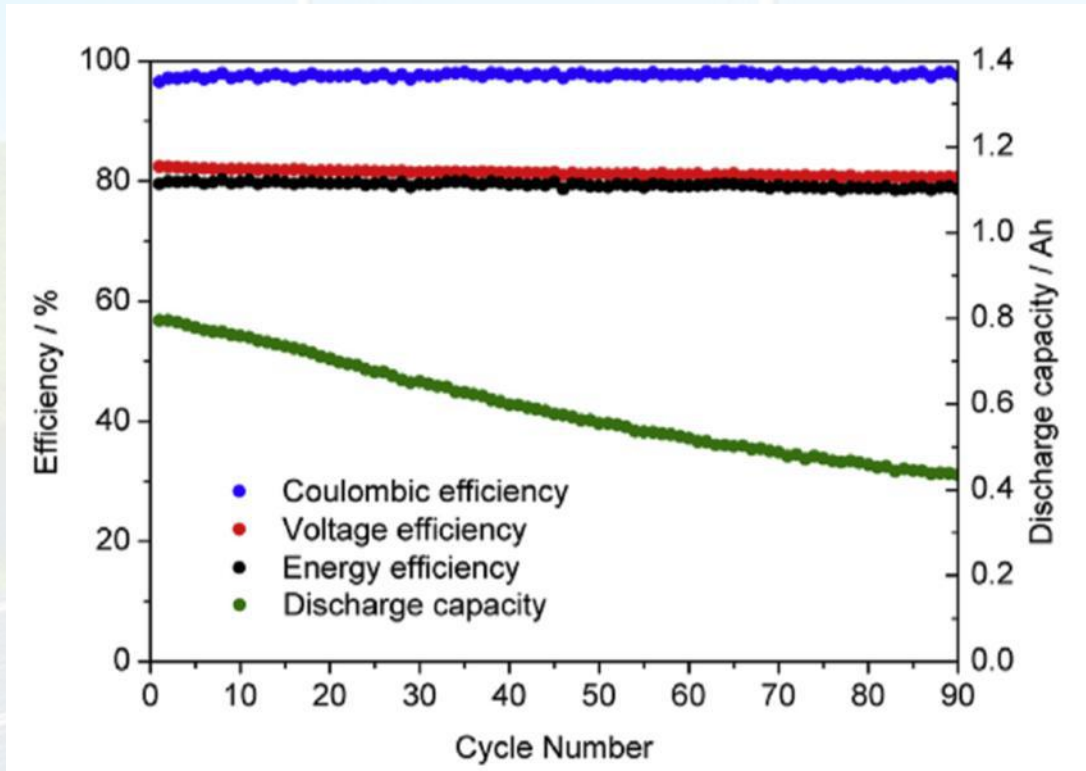
United States Patent [19] **3,996,064** [11]
Thaller [45] **Dec. 7, 1976**

[54] **ELECTRICALLY RECHARGEABLE REDOX FLOW CELL** [57] **ABSTRACT**
 [75] Inventor: **Lawrence H. Thaller, Strongsville, Ohio**
 [73] Assignee: **The United States of America as represented by the Administrator of the National Aeronautics and Space Administration, Washington, D.C.**
 [22] Filed: **Aug. 22, 1975**
 [21] Appl. No.: **606,891**
 [52] U.S. Cl. **320/2; 429/23; 429/34**
 [51] Int. Cl.² **H01M 10/44; H01M 10/00**
 [58] Field of Search **136/86 A; 86 R; 164**

There is disclosed a bulk energy storage system including an electrically rechargeable reduction-oxidation (REDOX) cell divided into two compartments by a membrane, each compartment containing an electrode. An anode fluid is directed through the first compartment at the same time that a cathode fluid is directed through the second compartment, thereby causing the electrode in the first compartment to have a negative potential while the electrode in the second compartment has a positive potential. The electrodes are inert with respect to the anode and cathode fluids used and the membrane is substantially impermeable to all except select ions of both the anode and cathode fluid, whether the cell is fully charged or in a state of discharge.

Case 1. - H ⁺ membrane		Case 2. - Cl ⁻ membrane	
Before discharge		After discharge	
Cr ⁺² - 1.0 N	Fe ⁺³ - 1.0 N	Cr ⁺³ - 1.0 N	Fe ⁺² - 1.0 N
H ⁺ - 1.0 N	Cl ⁻ - 3.0 N	Cl ⁻ - 3.0 N	H ⁺ - 1.0 N
Cl ⁻ - 3.0 N		Cl ⁻ - 3.0 N	Cl ⁻ - 3.0 N

Major issue preventing Cr flow battery from large scale commercialization in the past 50 years $\text{Cr}^{3+}/\text{Cr}^{2+}$ is not active, promoting generation, causing system capa




ChemSusChem Review doi.org/10.1002/cssc.202101798

www.chemsuschem.org

Review of the Development of First-Generation Redox Flow Batteries: Iron-Chromium System

Chuanyu Sun^[b, d] and Huan Zhang^{*[a, c]}



The diagram illustrates the Fe/Cr redox flow battery system. It features two electrolyte reservoirs labeled 'Fe/Cr electrolyte' connected to a central 'Stack' via 'Pump' units. The 'Stack' contains an 'Anode' and a 'Cathode' separated by a 'Membrane', with 'Electrode' components on both sides. A 'charge/discharge' label indicates the operational mode. The background shows wind turbines and solar panels, suggesting a renewable energy source for the battery.

IMABATTERY® Fe-Cr Complex Flow Battery



US011710844B2

(12) **United States Patent**
Li et al.

(10) **Patent No.:** **US 11,710,844 B2**
(45) **Date of Patent:** **Jul. 25, 2023**

(54) **FE-CR REDOX FLOW BATTERY SYSTEMS AND METHODS UTILIZING CHROMIUM COMPLEXES WITH NITROGEN-CONTAINING LIGANDS**

(58) **Field of Classification Search**
CPC H01M 8/18-188; H01M 8/20
See application file for complete search history.

(71) Applicant: **COUGAR CREEK TECHNOLOGIES, LLC**, Kirkland, WA (US)

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(72) Inventors: **Liyu Li**, Bellevue, WA (US); **Qingtao Luo**, Mukilteo, WA (US)

FOREIGN PATENT DOCUMENTS

(73) Assignee: **COUGAR CREEK TECHNOLOGIES, LLC**, Kirkland, WA (US)

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 169 days.

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(21) Appl. No.: **17/362,468**

Johnson and Reid, "Chemical and Electrochemical Behavior of the Cr(III)/Cr(II) Half-Cell in the Iron-Chromium Redox Energy Storage System," J. Electrochem. Soc.: Electrochemical Science and Technology; vol. 132, No. 5; May 1985; pp. 1058-1062.

(22) Filed: **Jun. 29, 2021**



発明の名称
(TITLE OF THE INVENTION) **FE-CRレドックスフロー電池システムおよびこのシステムを使用する方法**

特許権者
(PATENTEE) **アメリカ合衆国 ワシントン州 98034
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国籍・地域 アメリカ合衆国**

**クーガー クリーク テクノロジーズ
リミテッド ライアビリティカン
パニー**

発明者
(INVENTOR) **リ リユ**

ルオ チンタオ

出願番号
(APPLICATION NUMBER) **特願2022-573655**

出願日
(FILING DATE) **令和 3年11月 9日 (November 9, 2021)**

登録日
(REGISTRATION DATE) **令和 6年 4月19日 (April 19, 2024)**

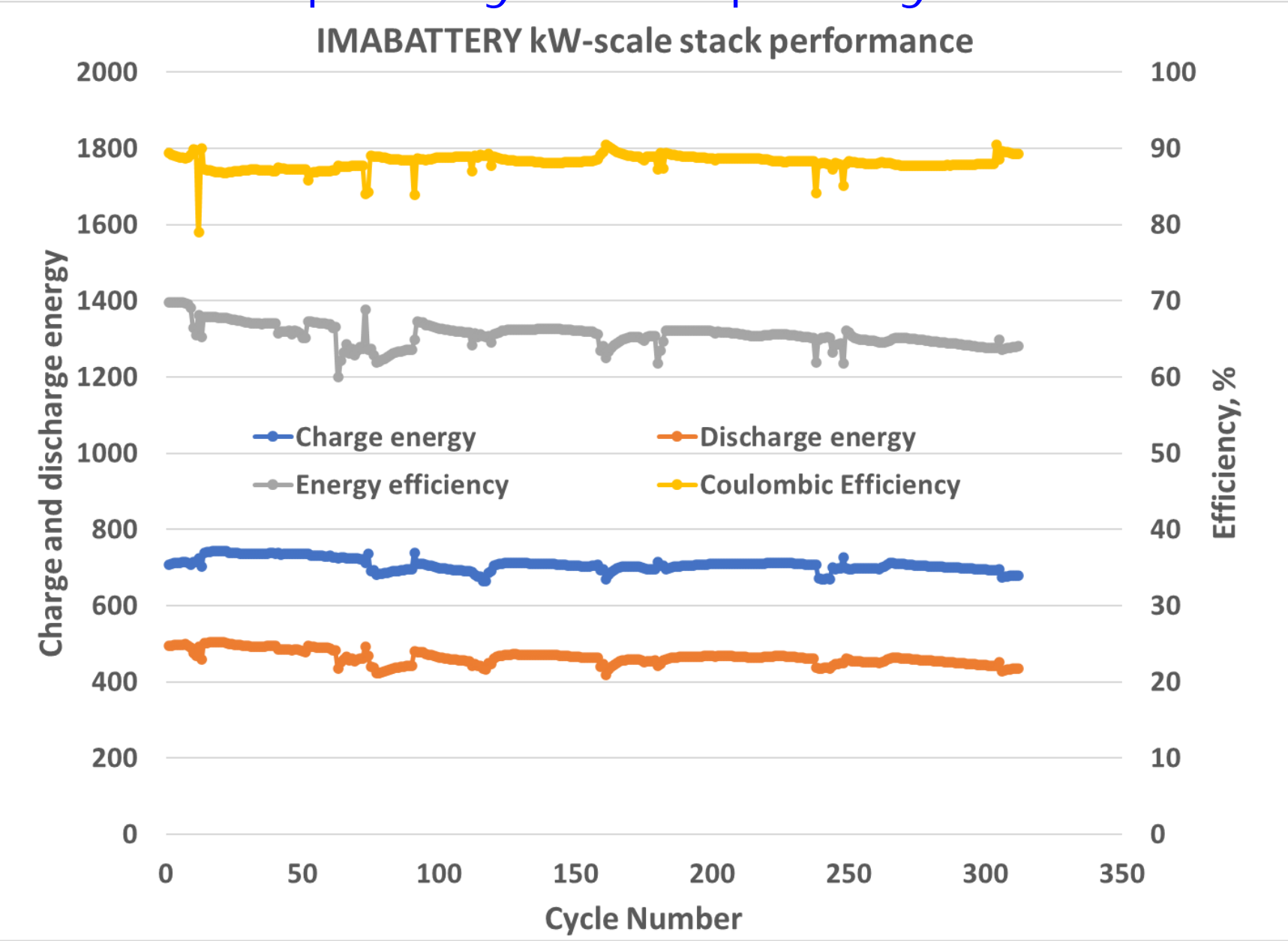
この発明は、特許するものと確定し、特許原簿に登録されたことを証する。
(THIS IS TO CERTIFY THAT THE PATENT IS REGISTERED ON THE REGISTER OF THE JAPAN PATENT OFFICE.)

令和 6年 4月19日 (April 19, 2024)

特許庁長官
(COMMISSIONER, JAPAN PATENT OFFICE)



2020: <10% per cycle capacity loss over 300 cycles



First Generation Demonstration Project: 2MWh System (November 28, 2022)



Chromium Electrolyte Cost and Global Energy Storage Capacity



Cr source	Market Price \$/tonCr	Energy Storage Cc \$/KWhfor Cr	Energy Storage CapacityT(Wh/yr)
$\text{CrCl}_3 \cdot 6\text{H}_2\text{O}$	\$12,500	\$72	<0.1
Sodium dichromate ($\text{Na}_2\text{Cr}_2\text{O}_7$)	\$7,500	\$43	<0.1
Basic chromium sulfate ($\text{Na}_2\text{SO}_4 + \text{Cr}_2(\text{SO}_4)_3$)	\$6,000	\$34	<0.1
Ferrochrome (FeCr) (60wt% Cr)	\$2,000	\$12	2.2
FeCr_2O_4 chromite ore (40wt% Cr)	\$300	\$2	2.4
$\text{Cr}(\text{OH})_3$ waste from leather tanning Cr-deposition industry	\$(-200)	\$0	0.2

2nd Generation Electrolyte from Fe Alloy And OnSite Preparation



2nd Generation Electrolyte-Site Filling



960 small-welded stack used in generation

