ALÜMİNYUM VE ALÜMİNYUM SEKTÖRÜNÜN KARBONSUZLAŞTIRILMASI

TALSAD / Seminer, İstanbul

TALSAD 50 YIL
TÜRKİYE ALÜMİNYUM SANAYİCİLERİ DERNEĞİ

Erman Car

Ahmet Turan

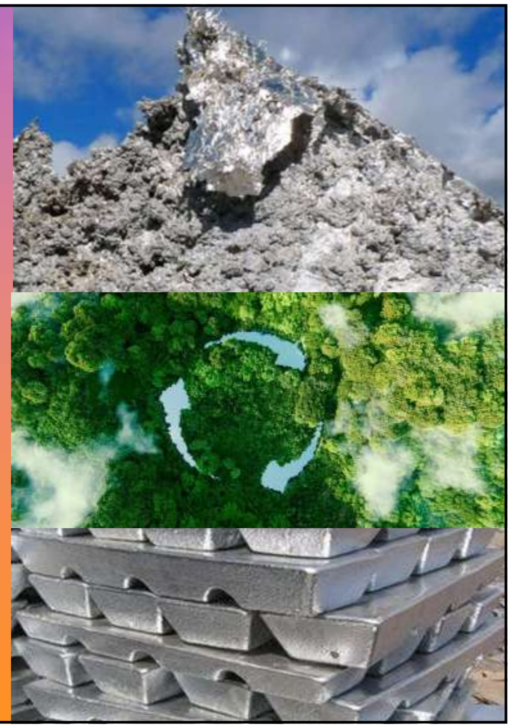
Onuralp Yücel

22 Mayıs 2023

METEM
TMMOB METALURJİ VE MALZEME MÜHENDİSLERİ ODASI EĞİTİM MERKEZİ

YEDİTEPE ÜNİVERSİTESİ

YUTTO



About 70% of the aluminium beverage cans produced are recycled!!!

The energy saved by recycling 1 beverage can is equal to the energy required to charge 20 smartphones!!!

How to Reach Sustainability and Zero-Carbon in Metallurgy

- Reuse/Recycling/Recovery
- New Processes
- Energy Efficiency
- Modified Processes
- Alternative Resources
- CO_2 capture
- Light Weighing
- Aluminium in Renewable Energy
- Renewable Energy Source

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SÜRDÜRÜLEMEZLİK HÂLİ - GÜNDEM

ABD Ulusal Mühendislik Akademisi’nin kısa ve uzun vadeli öncelikler listesi

Kısa vadeli öncelikler (2030’a kadar)	Uzun vadeli öncelikler (2050’ye kadar)
Endüstriyel enerji verimliliği	**Enerji depolama (piller)**
Taşıtlarda enerji verimliliği *(Lightweighing: Yük. mukavemet - düş. yoğunluk)*	**Nükleer enerji**
Nükleer enerji	**Hidrojen ve yakıt pilleri**
Enerji depolama (piller)	**Güneş enerjisi**
Malzeme geridönüşümü ve yeniden kullanımı *(recycling-reuse)*	**Endüstriyel enerji verimliliği**
Güneş enerjisi	**Karbon salınımı yönetimi**
Karbon salınımı yönetimi	**Taşıtlarda enerji verimliliği** *(Lightweighing: Yük. mukavemet - düş. yoğunluk)*
Biyokütle enerjisi	**Biyokütle enerjisi**

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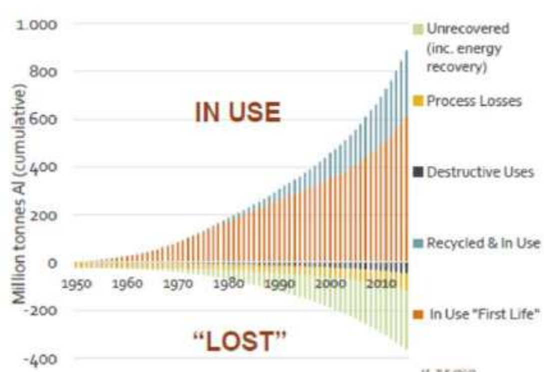
sürdürülebilir bir yaşam kurmak için gerekli «anahtar» malzemelerden bir tanesidir:

- Düşük karbon salınımı, verimli yakıt kullanımı ve darbeleri sönümleme yeteneği sayesinde taşımacılık sektöründe, hızlı trenler ve uçaklar da dahil tercih edilen bir malzemedir,
- Enerjiyi ekonomik tüketen, estetik bina ve diğer inşaat tasarımları için uygundur,
- Çok az miktarda alüminyum kullanılarak, güvenli gıda paketlemesi yapmak mümkündür,
- Özgün niteliklerini çok büyük ölçüde koruyarak defalarca geridönüşüm işlemi uygulanabildiği için, döngüsel ekonomi amacı için değerli bir malzemedir,
- Alüminyum ürünlerinin kullanım ömrü uzundur. Örneğin, yapı endüstrisinde yaklaşık 50 yıl, otomotiv endüstrisinde 15 yıldır.

*European Aluminium Association, Vision 2050 European Aluminium's Contribution to EU's Mid-Century Low-Carbon Roadmap, https://www.european-aluminium.eu/media/2545/sample_vision-2050-low-carbon-strategy_20190401.pdf

Tüm Alüminyumun Dörtte Üçü Hala Verimli Kullanımda!!!

- **1888'den beri üretilen 1,5 milyar ton alüminyumun 1,1 milyar tonu hala kullanımdadır.**
- **2000'den beri yaklaşık 900 milyon ton birincil üretim gerçekleştirilmiştir.**
- **Uzun ömürlü ürünler, kısa ömürlü uygulamalara göre daha yüksek geridönüşüm oranlarına sahip olma eğilimindedir.**



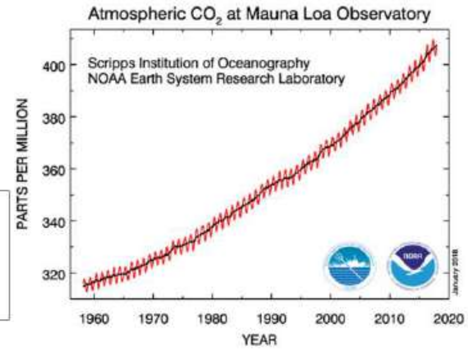
*Bayliss, Bertram, Nunez, Tsesmells&Wu, Long Term Sustainability of the Aluminium Sector (2020-2050), International Aluminium Institute, ICSOBA Virtual Conference, 16-18 November 2020

Latest

Daily CO_2

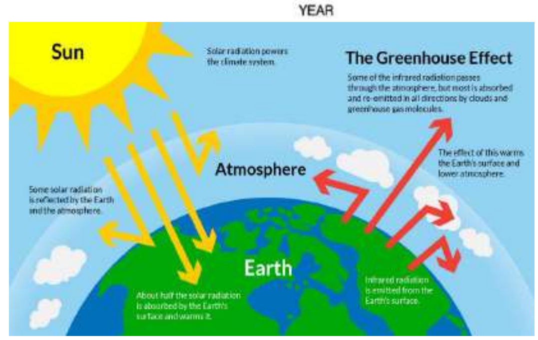
A leading signal of environmental, economic and social changes ahead.

May. 3, 2023	423.84 ppm
May. 3, 2022	420.48 ppm
1 Year Change	3.36 ppm (0.80%)



Greenhouse Gases

- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxide (N_2O)
- Fluorinated gases



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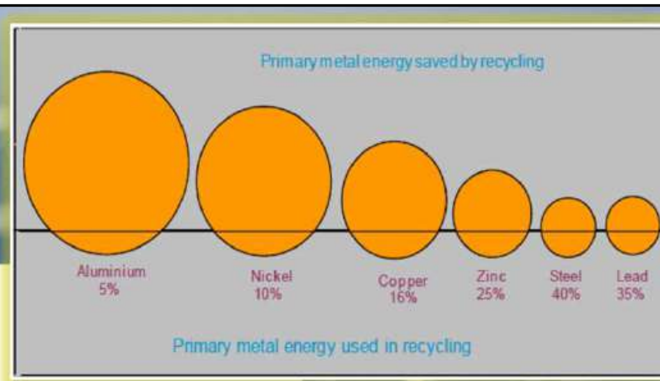
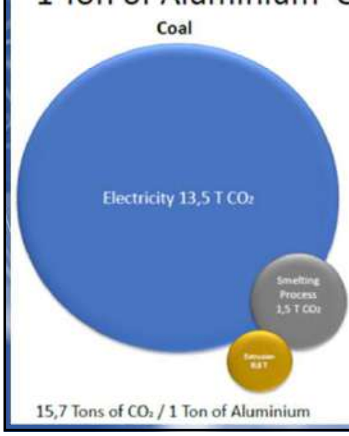
ENERJİ

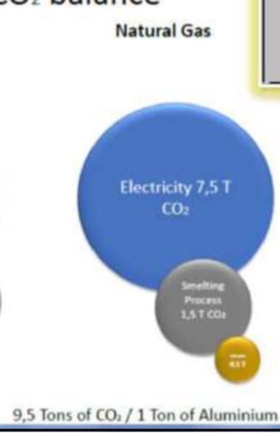
Marc Gillis, Aluminium Making: CO_2 Free and Fully Digital – The Hurdless and the Solutions, Future Aluminium Forum Digital, December 2020.



Terry Norgate, Metal Recycling: The Need for a Life Cycle Approach, CSIRO, May 2013.

1 Ton of Aluminium CO_2 balance





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IEA, Global CO2 emissions from energy combustion and industrial processes, 1900-2022, IEA, Paris https://www.iea.org/data-and-statistics/charts/global-co2-emissions-from-energy-combustion-and-industrial-processes-1900-2022, IEA. Licence: CC BY 4.0

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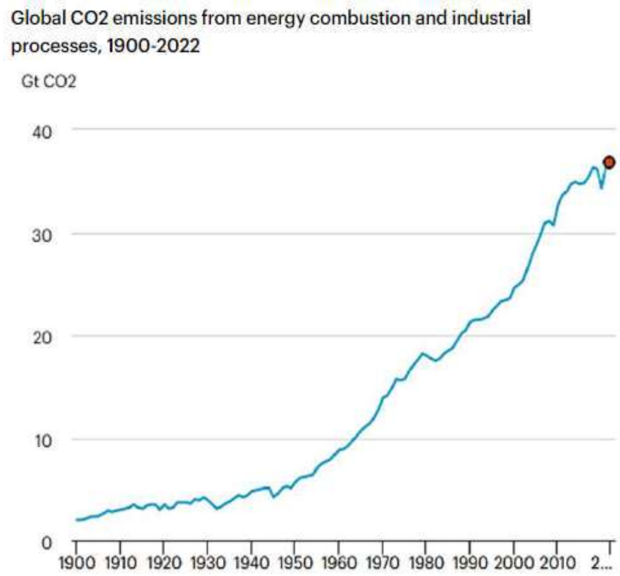
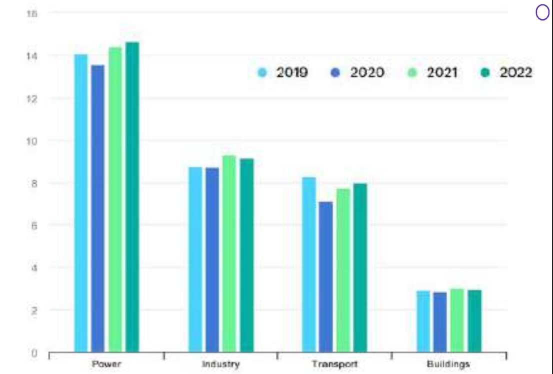


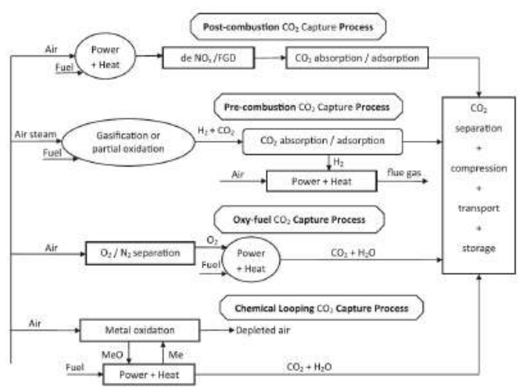


#	Country	CO2 Emissions (tons, 2016)	1 Year Change	Population (2016)	Per capita	Share of world
1	China	10,432,751,400	-0.28%	1,414,049,351	7.38	29.18%
2	United States	5,011,686,600	-2.01%	323,015,995	15.52	14.02%
3	India	2,533,638,100	4.71%	1,324,517,249	1.91	7.09%
4	Russia	1,661,899,300	-2.13%	145,275,383	11.44	4.65%
5	Japan	1,239,592,060	-1.21%	127,763,265	9.70	3.47%
16	Turkey	368,122,740	5.25%	79,827,871	4.61	1.03%

Steel Industry: 7%
Aluminium Industry: 2%

How to mitigate CO_2 level, and thereby, how to stop Global Warming???

- Improve energy efficiency and promote energy conservation,
- Increase usage of low carbon fuels, including natural gas, hydrogen or nuclear power,
- Deploy renewable energy, such as solar, wind, hydropower and bioenergy,
- Apply geoengineering approaches, e.g. afforestation and reforestation,
- **CO_2 capture, utilization and storage (CCS).**



SEPARATION SCIENCE AND TECHNOLOGY
2023, VOL. 58, NO. 3, 573–585
https://doi.org/10.1080/01496395.2022.2136577

Taylor & Francis
Taylor & Francis Group

Solution combustion synthesis derived Li_4SiO_4 for post-combustion carbon capture

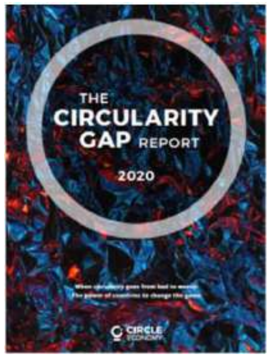
Kagan Benzesik[a], Ahmet Turan[a], Şeref Sönmez[a], Maria Teresa Izquierdo[c], and Onuralp Yücel[a]

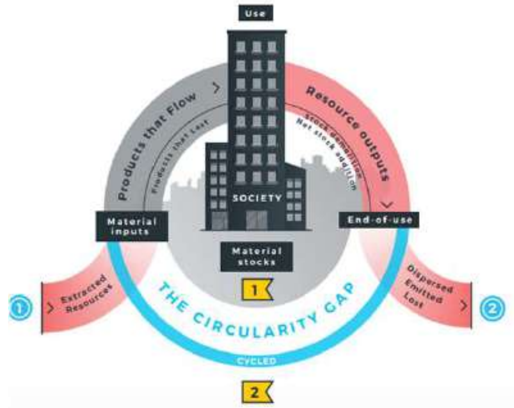
[a]Faculty of Chemistry & Metallurgy, Metallurgical and Materials Engineering Department, Istanbul Technical University, Istanbul, Turkey; [b]Materials Science and Nanotechnology Engineering Department, Faculty of Engineering, Yeditepe University, Istanbul, Turkey; [c]Energy and Environment Department, Instituto de Carboquímica, ICB-CSIC, Zaragoza, Spain

ABSTRACT
Lithium-based sorbents are considered as promising candidates for post-combustion carbon capture because of their superior stability compared to CaO. In the present study, Li_4SiO_4 powders were synthesized by Solution Combustion Synthesis (SCS) technique using $LiNO_3$ as lithium source, TEOS as silicon source and citric acid as the fuel. CO_2 sorption tests were carried out for the synthesized samples and, powder prepared at 650°C during 4 h, which has 17 µm of particle size, 5.2 $m^2 g^{-1}$ of specific surface area, 85.2% Li_4SiO_4 phase purity with 97 nm of crystallite size showed a sorption performance as 29.5 wt% CO_2 uptake value, in thermobalance test under 92 vol% CO_2 (N_2 balance) gas concentration at 600°C. The sample had a CO_2 uptake value of 21.4 wt% under 20 vol% CO_2 concentration which was chosen to simulate industrial off-gas conditions. Also, the same sample showed a good cyclic durability during the sorption/desorption tests. The sample maintained its cyclic CO_2 uptake capability range between 21 and 24 wt% for 15 cycles.

ARTICLE HISTORY
Received 29 April 2022
Accepted 7 October 2022

KEYWORDS
Solution combustion synthesis; lithium orthosilicate; solid sorbent; CO_2 capture



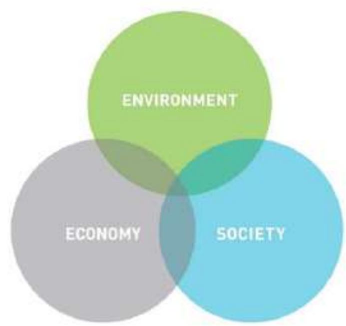


Today, the global economy is only 8.6% circular — just two years ago it was 9.1%. There are reasons for this negative trend, but the result remains the same: the news is not just bad, it is worse. This negative trend can be explained by three key related, underlying trends: high rates of extraction; ongoing stock build-up; and, increasing (but still low) levels of end-of-use processing and cycling. These underlying trends are deeply embedded within the 'take-make-waste' tradition of the linear economy — the problems are hardwired. As such, the outlook for closing the circularity gap looks bleak under the dead hand of business as usual. We desperately need transformative and correctional solutions; change is a must.

What is sustainability?

Sustainability means meeting our own needs without compromising the ability of future generations to meet their own needs. In addition to natural resources, we also need social and economic resources. Sustainability is not just environmentalism. Embedded in most definitions of sustainability we also find concerns for social equity and economic development.

1987, Brundtland Commission Report: Our Common Future



Easter Island: An historical example for sustainability… AD 1000-1600.

Some Important Points

2015	With the Paris Agreement, it is aimed to keep the global temperature increase below +2˚C until 2050.
2030	The IPPC (Intergovermental Panel on Climate Change: Integrated Pollution and Control) aims to reduce human-induced carbon dioxide emissions by 45% in 2030 compared to 2010 values and to be net zero by 2050.
2050	The Paris Agreement envisages keeping the global temperature rise below 2˚C and even not exceeding the 1.5˚C limit. Spain, France and the UK have committed to achieving net 0 carbon emissions by 2050, Finland by 2035 and Sweden by 2045. However, some countries, especially Russia, have not yet ratified this understanding. Turkey signed it on April 22, 2016 and ratified by the Turkish Grand National Assembly on October 6, 2021.

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Marc Gillis, Aluminium Making: CO_2 Free and Fully Digital – The Hurdless and the Solutions, Future Aluminium Forum Digital, December 2020

EU Green Deal

European Commision; iMMiB; iSO; BDDK

- The EU is aiming to be the CARBON NEUTRAL continent till 2050.
- Till 2030, the GHG emissions will be reduced 55% in comparison to 1990 (Fit for 55).
- The EU Green Deal is a road map to make European economy sustainable (climate target, circular economy, energy efficiency etc.).
- EU Emissions Trading System (EU ETS) was started in 2005 in the union zone.
- Carbon Border Adjustment Mechanism (CBAM) is a tax imposed on imported goods to equalize the cost of carbon emissions between domestic and foreign producers (context: cement, iron and steel, aluminium, fertilisers, electricity and hydrogen; 1 October 2023 and 3-years transition period).

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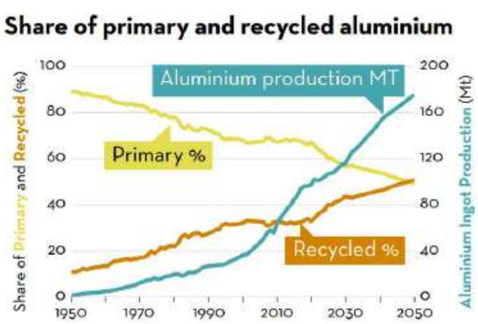
Facts and Figures on the Aluminium



Aluminium - (MAL3)

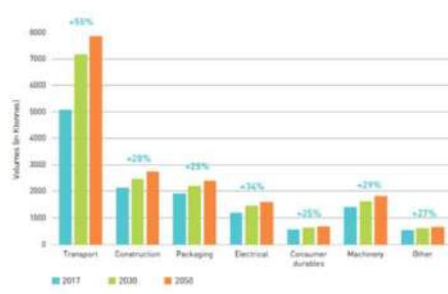
investing.com
12.March.23

Real-time capital.com

2,312.00 -16.00 (-0.69%)

- Closed. Currency in USD (Disclaimer)

Prev. Close: **2,313.00** | Open: **2,330.00** | Day's Range: **2,290.50 - 2,331.00**



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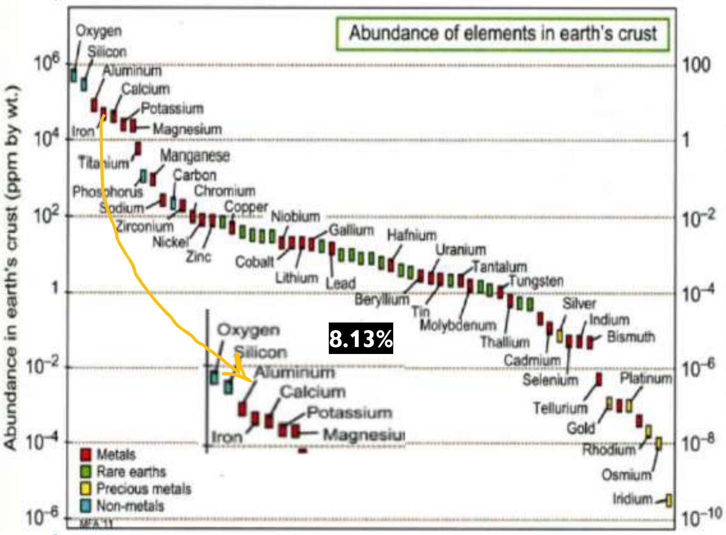
Abundancy of Aluminium in Earth's Crust



Study on the EU's list of Critical Raw Materials (2020)

Final Report

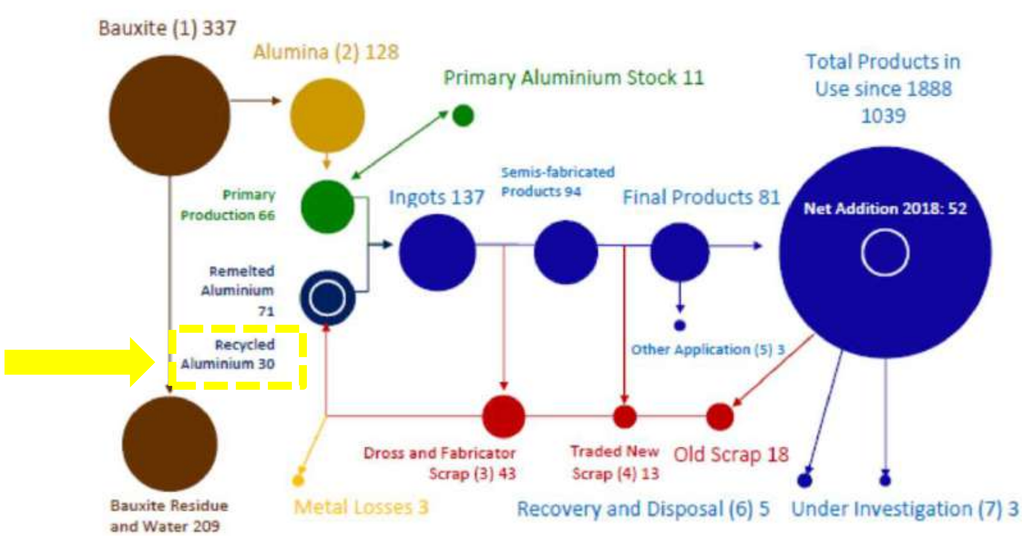
Boksit, artık AB için kritik hammadde!

2020 CRMs vs. 2017 CRMs			
Antimony	Germanium	PGMs	Bauxite
Baryte	Hafnium	Phosphate rock	Lithium
Beryllium	HREEs	Phosphorus	Titanium
Bismuth	LREEs	Scandium	
Borate	Indium	Silicon metal	
Cobalt	Magnesium	Tantalum	Strontium
Coking Coal	Natural Graphite	Tungsten	
Fluorspar	Natural Rubber	Vanadium	
Gallium	Niobium	~~Helium~~	

Legend:

Black: CRMs in 2020 and 2017
Red: CRMs in 2020, non-CRMs in 2017
Green: CRMs assessed in 2020 that were not assessed in 2017
~~Strike:~~ Non-CRMs in 2020 that were critical in 2017

KÜRESEL ALÜMİNYUM AKIŞI 2018



*www.aluminiuminsider.com

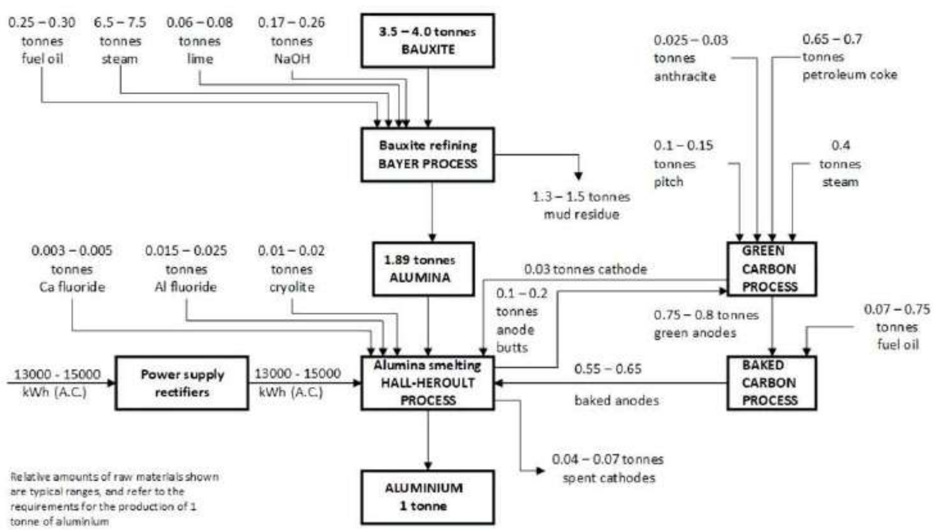
BİRİNCİL ALÜMİNYUM ÜRETİMİ

Birincil alüminyum üretimi, birbirinden bağımsız 4 süreçten oluşur :

1. Boksit madenciliği,
2. Boksit cevherlerinden Bayer Prosesi ile alümina üretimi,
3. Alüminadan Ergimiş Tuz Elektrolizi ile metalik alüminyum üretimi,
4. Enerji üretimi ya da temini.

*Erman Car, Ahmet Turan, Alüminyum Ergitme ve Sıvı Metal Rafinasyonu Eğitim Notları, TMMOB Metalurji ve Malzeme Mühendisleri Odası Eğitim Merkezi, 2019

Integrated Primary Aluminium Production from Bauxite: Mass and Energy Balance



*Ian Polmear, David StJohn, Jian-Feng Nie, Ma Qian, Light Alloys: Metallurgy of the Light Metals, Fifth Edition, Elsevier 2017.

The Bayer Process

1. Digestion

Bauxite$[Al_2O_3]_{(s)}$ + $2NaOH_{(liq)} \rightarrow Na_2Al_2O_{4(liq)} + H_2O_{(liq)}$

$2NaAlO_2(liq)$

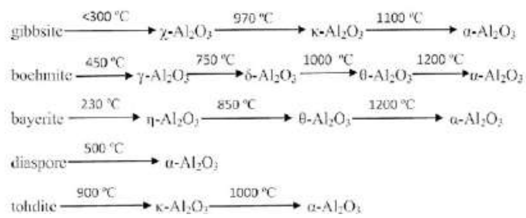
2. Precipitation (through crystallization)

$2NaAlO_{2(liq)} + 4H_2O_{(liq)} \rightarrow 2Al(OH)_{3(s)} + 2NaOH_{(liq)}$

3. Calcination

$2Al(OH)_{3(s)} \rightarrow Al_2O_{3(s)} + 3H_2O_{(g)}$

1010-1260°C, in a rotary kiln or fluidized bed calciners!!!



Bauxite Mineral	Chemical Formula	Leaching Temperature, °C	Leaching Pressure, atm
Gibbsite	$Al(OH)_3$	150	~ 8
Boehmite	AlOOH	250	~ 54
Diaspore	AlOOH	> 260	~ 60

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*Erman Car, Ahmet Turan, Alüminyum Ergitme ve Sıvı Metal Rafinasyonu Eğitim Notları, TMMOB Metalurji ve Malzeme Mühendisleri Odası Eğitim Merkezi, 2019.

CO_2 Emissions of Primary Aluminum Industry

Energy for electrolysis

Coal:	**12-16 kg CO_2/kg Al**
Natural gas:	**5-8 kg CO_2/kg Al**
Renewable:	**0 kg CO_2/kg Al**

Electricity

Total

Coal:	**17-25 kg CO_2/kg Al**
Natural gas:	**8-15 kg CO_2/kg Al**
Renewable:	**3-6 kg CO_2/kg Al**

1.1-5 kg CO_2/kg Al

Alumina

$2Al_2O_3 + 3C \rightarrow 4Al + 3CO_2$

1.5-3.5 kg CO_2/kg Al

Anode

0.2 kg CO_2/kg Al

Sustainable Automotive Material Selection from a Carbon Fıootprint Perspective, HYDRO, AIT, Eylül 2020

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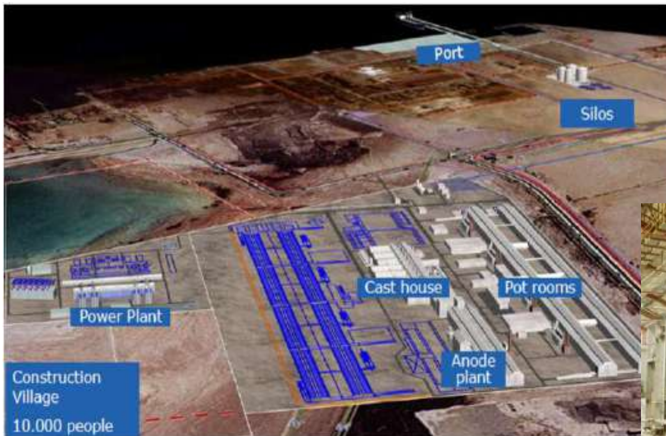
The Molten Salt Electrolysis of the Aluminium
[The Hall-Héroult Process]



In a primary aluminium plant:

- **Energy plant,**
- **Anode plant,**
- **Electrolysis plant,**
- **Casthouse.**

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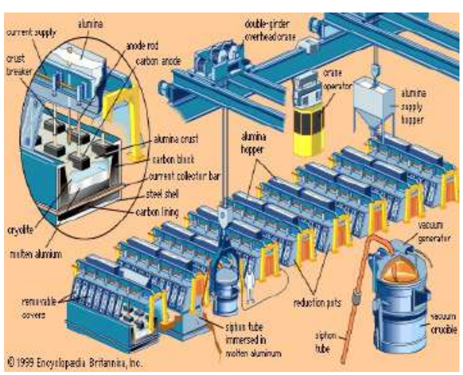
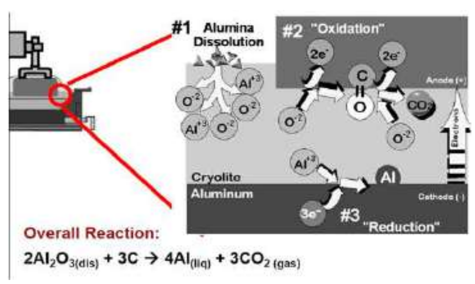
*Erman Car, Ahmet Turan, Alüminyum Ergitme ve Sıvı Metal Rafinasyonu Eğitim Notları, TMMOB Metalurji ve Malzeme Mühendisleri Odası Eğitim Merkezi, 2019.

Electrolysis Cell and Electrolysis Plant





Current stops in cells if the reactions below do not happen:

Anode: $Al_2O_3 + 6NaF + 3/2C \rightarrow 2AlF_3 + 3/2\ CO_2 + 6Na^+ + 6e$

Cathode: $2AlF_3 + 6Na^+ + 6e \rightarrow 2Al + 6NaF$

Overall Reaction: $Al_2O_3 + 3/2C \rightarrow 2Al + 3/2\ CO_2$

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*Erman Car, Ahmet Turan, Alüminyum Ergitme ve Sıvı Metal Rafinasyonu Eğitim Notları, TMMOB Metalurji ve Malzeme Mühendisleri Odası Eğitim Merkezi, 2019.

Green Transformation of Primary Aluminum Industry
[Inert Anode Technologies]

Potential Anode Materials:
- **Ceramics:** $NiFe_2O_4$, SnO_2, $NiO\text{-}Li_2O$ etc.
- **Metals:** Al-bronze, Cu-Ni-Fe, Ni-Fe etc.
- **Cermets:** Fe-($NiFe_2O_4$+NiO), Cu-Fe-$NiFe_2O_4$, Cu-$NiFe_2O_4$, Cu-Cu_2O etc.

Eliminating all direct greenhouse gases from aluminium smelting has taken a major step forward today with the start of construction on the first commercial-scale prototype cells of ELYSIS inert anode technology, at Rio Tinto's Alma smelter in Saguenay-Lac-Saint-Jean, Quebec.
ELYSIS is a joint venture company led by Alcoa and Rio Tinto that is developing a new breakthrough technology, known as inert anode, that eliminates all direct greenhouse gases (GHGs) from the traditional smelting process and instead produces oxygen.
ELYSIS is working to complete the technology demonstration by 2024 followed by the commercialization activities.

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Green Transformation of Primary Aluminum Industry
[Solar Energy Use]

On January 18, 2021, the United Arab Emirates became the first country in the world to produce aluminum using solar energy, according to Emirates Global Aluminum (EGA) and Dubai Electricity and Water Authority (DEWA).

The process is called **CelestiAL** and, its annual aluminium production capacity is around 40.000 tonnes.

https://www.alcircle.com/news/ega-dewa-places-the-uae-as-first-country-to-produce-aluminium-using-solar-energy-62285

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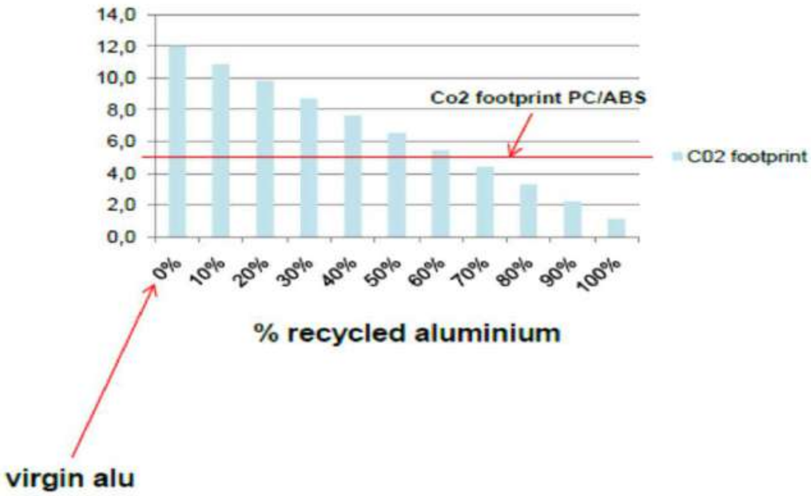
ÇEVRE

CO_2 Ayak İzi



*Tom Devoldere, The Reason for Recycled Aluminium in Flat TV's: The Phillips Econova Case, , OEA Recycling Conference, February 2011, Vienna/Austria

HURDA HAZIRLAMA

Optimum ikincil kaynak kullanımı da en az geridönüşüm kadar değerlidir.

Hurda hazırlama ile;

- Doğru bir reçete ile hedef alaşımların kimyasal bileşimini yakalamak mümkün olmaktadır,
- Ergitme verimi artmaktadır,
- Takip eden işlemler için gerekliliktir (termal boya/lak giderme, kurutma ve ince kesitli hurda şarjı),
- Taşıma ve navlun kolaylaşmaktadır,
- Patlayıcı özelliği taşıyan yabancı maddeler uzaklaştırılmaktadır:
  - Yağlar,
  - Nitrat ve sülfat gibi atıklar ve diğer oksitleyici maddeler,
  - Su ve diğer uçucu sıvılar,
  - Flaks artıkları,
  - Şişeler, basınçlı kaplar ve diğer patlayıcılar.
- Radyoaktif atıklar, poliklorlu bifeniller (PCB) gibi tehlikeli kimyasallar ve selenyum, kadmiyum, kurşun, civa, arsenik, berilyum ve antimon gibi tehlikeli elementler uzaklaştırılmaktadır.

Geridönüşümün Temelleri

- Alüminyumun geridönüşümü, birincil metal üretmek için gereken enerjinin yüzde %92-95'i kadar tasarruf sağlamaktadır.
- Günümüzde tüketici sonrası hurdaların geridönüşümü, yaklaşık 20 milyon ton birincil alüminyum ihtiyacını ikame etmekte, 80 milyon ton boksit cevherinden tasarruf sağlamakta, 22-25 milyon ton kırmızı çamur oluşumuna engel olmakta ve dolayısıyla yaklaşık 300 milyon ton CO_2 emisyonunu ortadan kaldırmaktadır.
- Yapı endüstrisinde ve otomotiv endüstrisinde yüksek geridönüşüm oranları (>%90) bulunmaktadır. Bazı bölgelerde içecek kutularının geridönüşümü yaklaşık %100'dür.

Bayliss, Bertram, Nunez, Tsesmells & Wu, Long Term Sustainability of the Aluminium Sector (2020-2050), International Aluminium Institute, ICSOBA Virtual Conference, 16-18 November 2020.

Tedarik zinciri ya da yaşam döngüsü sona erdiğinde malzemeler «atık» haline gelirler.

- Geridönüşüm (recycling) süreci, atık malzemenin yeniden işlenerek, orijinal ya da farklı amaçlarla kullanılmak üzere «gerikazanımı (recovery)»,
- Gerikazanım (recovery) ise atığın, atık niteliğinden ayrılarak, kısmen ya da tamamen yararlı amaçlar için kullanılabilir hale getirilmesidir.

Bu tanımlamadaki ana ayrım, geridönüşüm ile döngüye yeni bir ürün, malzeme ya da madde katılırken, gerikazanım ile atık, yararlı amaçlar için kullanılabilir hale getirilmektedir. ***The Waste Framework Directive (2008/98/EC)***

Comparision of Recycling Technologies

Parameters	factor	Decoating line+ side-well Reverb furnaces	ranking		Decoating line+ induction furnaces	ranking		Rotary Furnace	ranking		Multi-Chamber Furnace	ranking	
Technological	**5**												
Temperature control		**Excellent**	**3**	**15**	**Excellent**	**3**	**15**	**Moderate**	**2**	**10**	**Moderate**	**2**	**10**
Oxygen level control		**Excellent**	**3**	**15**	**Excellent**	**3**	**15**	**Excellent**	**3**	**15**	**Moderate**	**2**	**10**
Residence time		**Excellent**	**3**	**15**	**Excellent**	**3**	**15**	**Excellent**	**3**	**15**	**Excellent**	**3**	**15**
Gas/metal contact		**Excellent**	**3**	**15**	**Excellent**	**3**	**15**	**Moderate**	**2**	**10**	**Poor**	**1**	**5**
Energy consumption	**4**	**Moderate**	**2**	**8**	**Moderate**	**2**	**8**	**Low**	**1**	**4**	**Low**	**1**	**4**
Heat generation from VOCs in scrap	**3**	**No**	**1**	**3**	**No**	**1**	**3**	**Yes**	**3**	**9**	**Yes**	**3**	**9**
Scrap preparation	**4**	**Required**	**1**	**4**	**Required**	**1**	**4**	**No need**	**3**	**12**	**No need (preferable)**	**2**	**8**
Operation&maintenance	**3**	**Moderate**	**2**	**6**	**Moderate**	**2**	**6**	**Moderate**	**2**	**6**	**Sophisticated**	**1**	**3**

Comparision of Recycling Technologies

Parameters	factor	Decoating line+ side-well Reverb furnaces	ranking		Decoating line+ induction furnaces	ranking		Rotary Furnace	ranking		Multi-Chamber Furnace	ranking	
Melting philosophy	3	Submerging of scrap	3	9	Submerging with natural strring effect	3	9	Under salt bath	1	3	Submerging of scrap	3	9
Labour	2	Moderate	2	4	Moderate	2	4	Low	3	6	Low	3	6
Fluxing requirement	2	Low	3	6	Low	3	6	High	1	2	Low	3	6
Dross formation	5	Low	3	15	Low	3	15	High	1	5	Moderate	2	10
Dross quality	3	White/black dross	2	6	White dross	3	9	Salt cake	1	3	White/black dross	2	6
Processing mode	4	Continuous	3	12	Batch	1	4	Batch	1	4	Continuous	3	12
Alloying conditions	3	Easily	3	9	Easily	3	9	No	1	3	Easily	3	9
Alloy change	3	Limited	2	6	Easily	3	9	Easily	3	9	Limited	1	3

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Comparision of Recycling Technologies

Parameters	factor	Decoating line+ side-well Reverb furnaces	ranking		Decoating line+ induction furnaces	ranking		Rotary Furnace	ranking		Multi-Chamber Furnace	ranking	
Parameters	factor	Decoating line+ side-well Reverb furnaces	ranking		Decoating line+ induction furnaces	ranking		Rotary Furnace	ranking		Multi-Chamber Furnace	ranking	
Melting capacity	4	High	3	12	Low	1	4	Low	1	4	High	3	12
Metal quality	5	Acceptable	3	15	Acceptable	3	15	Low	1	5	Acceptable	3	15
Melt rate	4	High	3	12	Low	1	4	Low	1	4	High	3	12
Ecological impact	4	Moderate	2	8	Moderate	2	8	Problematic (salt cake)	1	4	Moderate	2	8
Investment cost	5	Moderate	2	10	Moderate	3	15	Low	3	15	Moderate	1	5
Estimated metal yield	5	>92%	3	15	>94%	3	15	75-85%	1	5	<90%	1	5
Suitability of Turkish UBC	3	Yes	3	9	Yes	3	9	Moderate	2	6	No	1	3
Total ranks				229			216			159			185

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GÜNCEL ALÜMİNYUM ÜRETİM YÖNTEMLERİ

Birincil ve ikincil alüminyum üretim karşılaştırılması

Parameter	Birim	Birincil	İkincil
Harcanan enerji	GJ/t Al üretilen	174–186	10–20
Atmosfer emisyonu	kg/t Al üretilen	204	12
Katı atık	kg/t Al üretilen	2100–3650	400
Su tüketimi	kg/t Al üretilen	57	1.6
Yatırım	-	Yüksek	Düşük
Emisyon	-	Yüksek seviyede	Düşük seviyede

Alüminyum değer zinciri

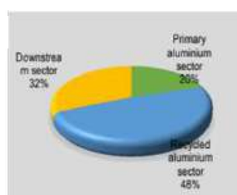
https://www.statista.com/statistics/264624/global-production-of-aluminum-by-country/

https://www.metalurji.org.tr/dergi/dergi161/d161_1729

Secondary Aluminium Industry: Dross Valorisation

Dross production and recovery numbers (000 tonnes)

Materials / Year	2016	2017
Dross generation	2,940	3,005
Dross recovered	1,420	1,450
Aluminium recovered	450	464

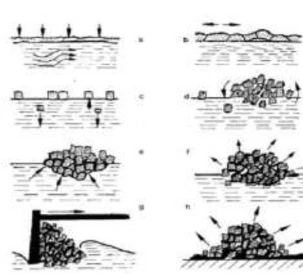


World dross generation by generating sector

Keeping pace with aluminium usage the dross generation across the aluminium value chain is expected to grow at around 4 to 5% per annum in the coming years.

Benefits of Dross Recovery

- 1-2% of total Green House Gas emissions.
- 1 ton alumina → 2 tonnes of red mud → 3 tonnes of bauxite
- Recycling 1 kg of aluminium can save about 4 kg of bauxite, 2 kg of chemicals, and 7.5 kWh of electricity.
- Near 50% of the 3 million tonnes of dross still finds its way to land fill
- Landfilling cost : $38 million.



a) and b) Surface oxidation

c) Cracking, Sinking & Floating of Al_2O_3

d) Conglomeration of Al_2O_3

e) Metallic Al capture

f) Further oxidation

g) And h) Skimming

Al Circle (n.d.) Aluminium Dross Processing: A Global Review Retrieved from www.alcircle.com

Secondary Aluminium Industry: Dross Valorisation

Wastes of secondary production

- White dross → Metallic aluminium content: 20-80%
- Black dross → Metallic aluminium content: 5-25%
- Salt cake → Metallic aluminium content: up to 8%

M. E. Schlesinger, Aluminium Recycling, Boca Raton: CRC Press, Taylor & Francis Group, 2014.

Secondary Aluminium Industry: Dross Valorisation

Products from aluminium dross:

- Al ingot
- Al_2O_3
- Fused Al_2O_3
- Fused brown Al_2O_3
- $MgAl_2O_4$
- $CaAl_2O_4$
- H_2
- Flux
- Al powder

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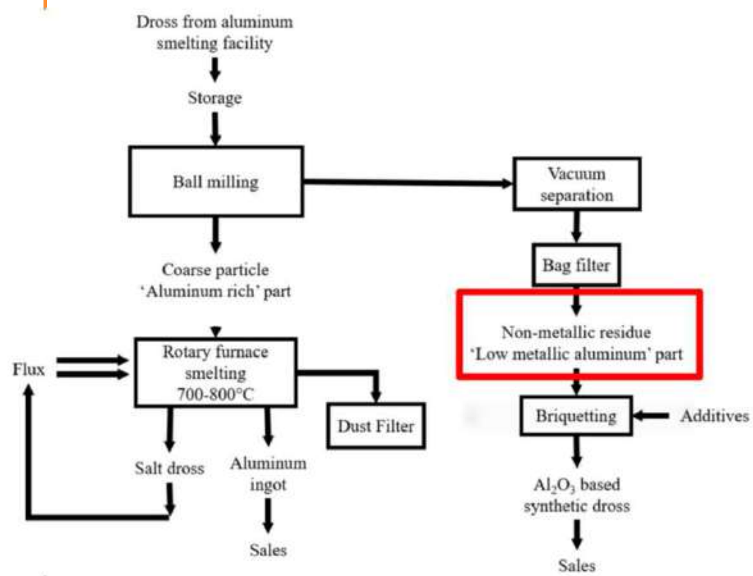
White Dross Processing Flowchart



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https://doi.org/10.1007/s42461-020-00344-0

Investigation of Alumina-Based Ceramic Production from Aluminum Black Dross

Umay Cinarli[1] · Ahmet Turan[2]

Received: 3 July 2020 / Accepted: 20 October 2020 / Published online: 26 October 2020

Abstract

High-energy consumption in primary aluminum production (from bauxite ores) makes secondary aluminum production (from metallic raw materials such as scrap and dross) very critical. Aluminum dross, as a waste, arises in pyrometallurgical processes, and it is the mixture of metallic Al, Al_2O_3, other metal oxides, metal halides, and some other compounds like AlN. Aluminum dross has two subgroups (white and black) with respect to its metallic aluminum content. White dross is a secondary aluminum resource because of its high metallic aluminum content, whereas black dross, having low metallic aluminum content, is generally disposed in dumping areas. In the present study, it was aimed to develop a simple technique to valorize aluminum black dross in the form of alumina-based ceramic materials through pyrometallurgical (calcination) and hydrometallurgical (leaching) operations. Moreover, thermochemical simulations were conducted by using HSC Chemistry 6.12 software to simulate calcination conditions. After leaching experiments, an alumina-based ceramic containing approximately 36.8% Al_2O_3, 61.4% $MgAl_2O_4$ with 1.8% Na_2FeO_4, which might be available to use as a spinel refractory in steel smelting furnaces, was obtained in the experiment carried out in a solution containing 10 mL H_2SO_4 and 40 mL distilled water (3.5 M). Moreover, the sinterability of the alumina-based ceramic was investigated at the temperatures from 1350 to 1550 °C. In the sample which was sintered at 1550 °C, a density value of 3.15 g cm^{-3} and a hardness value of 69.58 HV were measured.

Journal of Sustainable Metallurgy (2022) 8:851–862
https://doi.org/10.1007/s40831-022-00532-w

RESEARCH ARTICLE

Fused Calcium Aluminate Production from Aluminum White Dross Residue

Buse Tuğçe Polat[1] · İlayda Elif Öner[1] · Selçuk Kan[1] · Kağan Benzeşik[1] · Onuralp Yücel[1]

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Abstract

Despite the numerous advantages of using and recycling aluminum, inevitable by-products in the form of non-metallic residues (NMR) of aluminum white dross (AWD) can be environmentally harmful. The aim of this study was to find a solution regarding aluminum treatment via pyrometallurgical methods and, ultimately, to obtain calcium aluminate (CA) flux for the iron and steel industries. The optimum parameters, such as temperature, duration, and particle size of the limestone, for CA production from the NMR of AWD were investigated. Calcination experiments were divided into two categories. The aim of the first set of experiments was to increase alumina (Al_2O_3) purity and remove nitrogen (N) in the rotary furnace. N content was reduced to 0.25 wt% at 1150 °C and 2 h duration, while Al_2O_3 purity reached 94.67 wt% as the optimum results for the calcination experiments. The obtained results were also compatible with thermodynamic simulations. In the second set of experiments, NMR of AWD was synthesized via the addition of limestone to obtain CA. It was observed that the crushed limestone favors the forming of CA phases. Last, in order to determine the optimum fusing condition, the fusion process was applied 1350, 1450, and 1550 °C to mixture of limestone and NMR. It was observed that the material completely melted at 1550 °C and phases containing CA were formed. The produced samples were characterized by X-ray diffraction (XRD), atomic absorption spectroscopy (AAS), and N analyzer.

What is the next stage?

Secondary Aluminium Industry
[Recycle-Friendly Alloys]

Designing Aluminum Alloys for a Recycle-Friendly World

By Subodh K. Das, Secat, Inc.

- Reducing the number of alloy grades,
- Easily separateable devices,
- Removable coatings on the surface,
- Wider range of element concentrations in alloy grades.

The Change of the World; The Change of Engineering

Industrial Revolution 1800s

Climate Revolution 2000s

Explorer engineering | **Engineering in 20th century** | **Sustainable Engineering**

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SÜRDÜRÜLEBİLİRLİĞE ENGEL OLAN GÜNCEL DURUMLAR

"SÜRDÜRÜLEMEZLİK HALİ"

"incredible raw materials that go into the Tesla Model S that help to make all of these things possible.."

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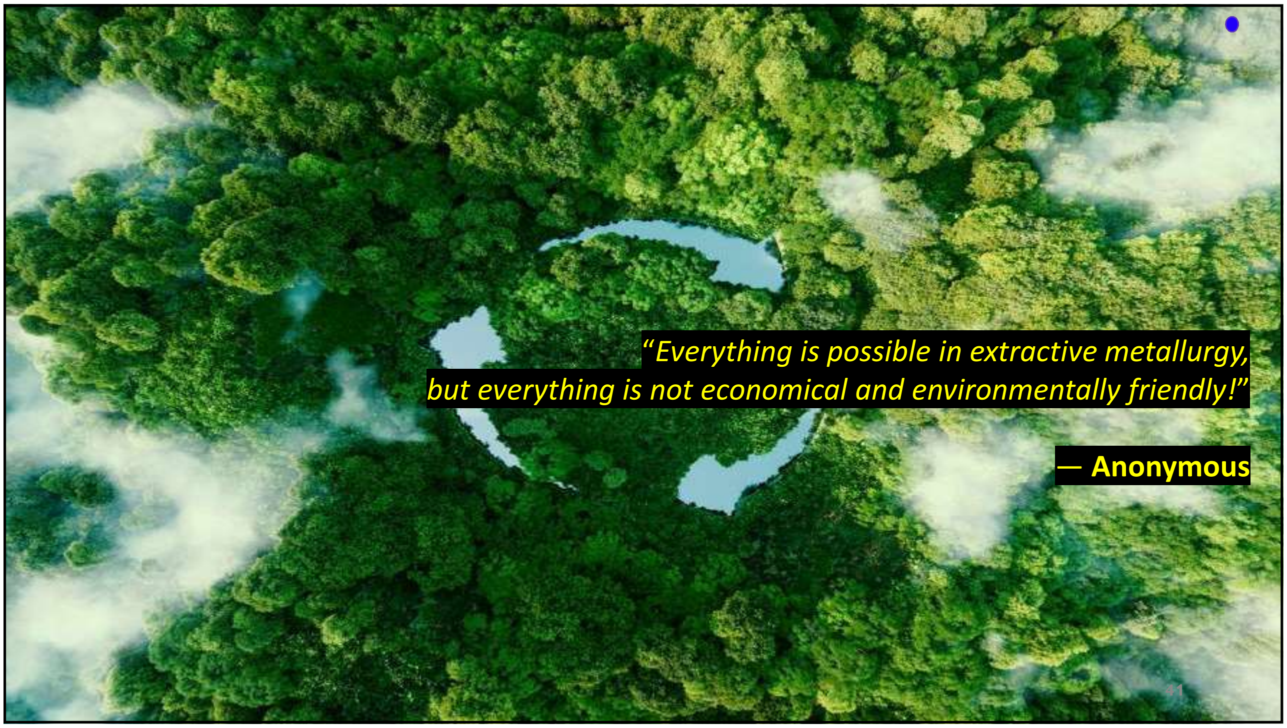

Katılımınız için teşekkürler

TALSAD 50 YIL

YouTube

Alüminyum ve çevre 1-2-3

Alüminyumu yakından tanımak

Alüminyum ile yolculuk

Investigation of Alumina-Based Ceramic Production from Aluminum Black Dross

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