

Процессы электролиза и электрохимические производства

Традиционные производства

Ключевые характеристики

Важнейшие электродные материалы

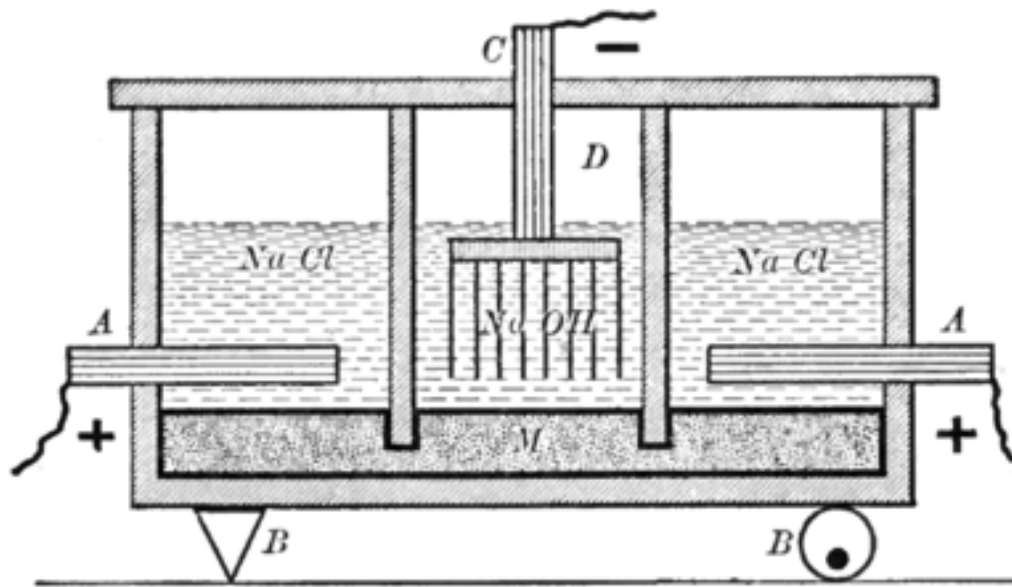
Хлорный электролиз

1851:
Чарльз Ватт
(1858 - 1899)



1886:
Гамильтон Юнг
Кастнер

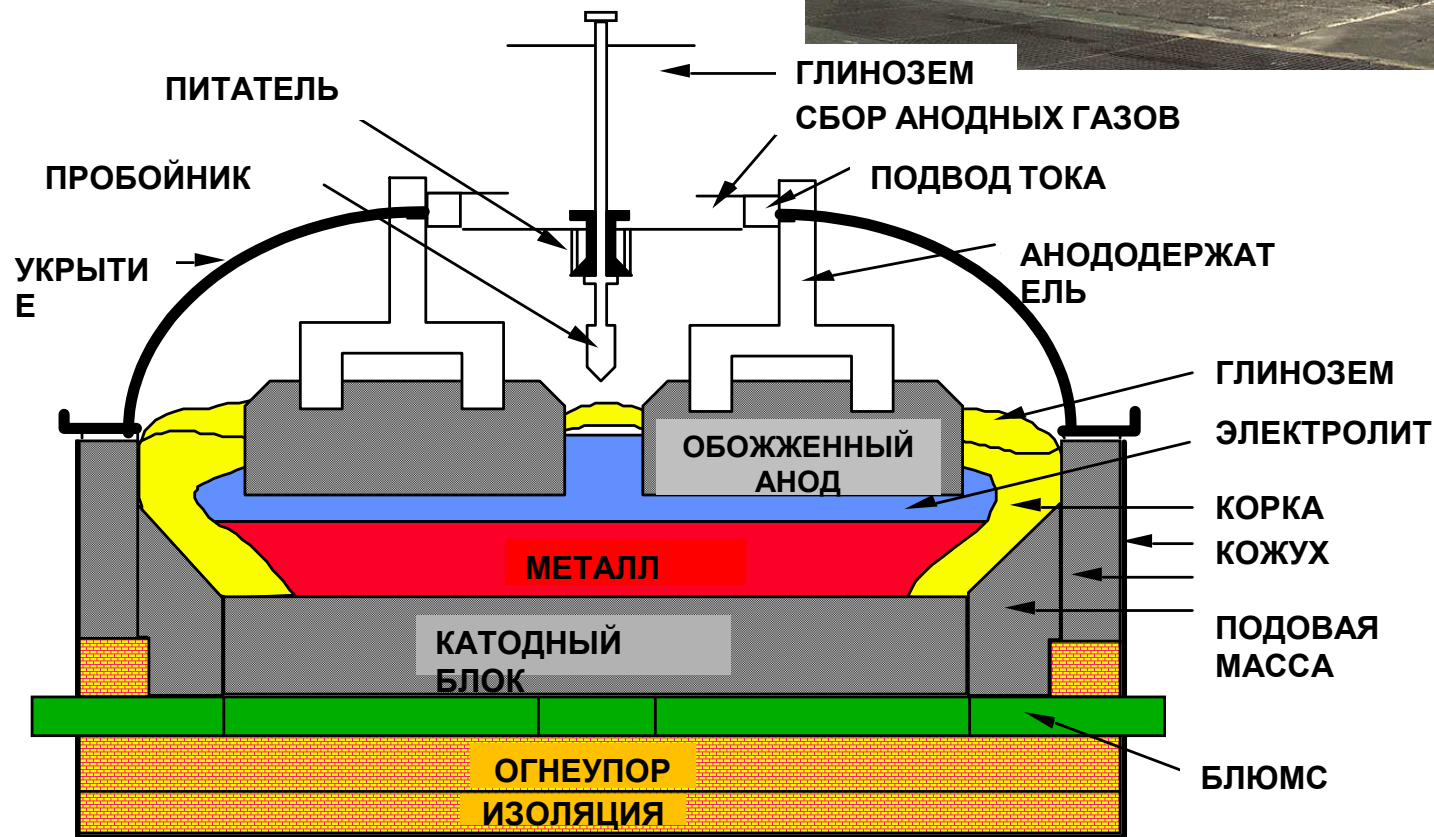
1895:
+ Карл Келлнер



И тут КАТАЛИЗАТОРЫ – например, ОРТА (окисно-рутений-титановый анод)

Получение алюминия

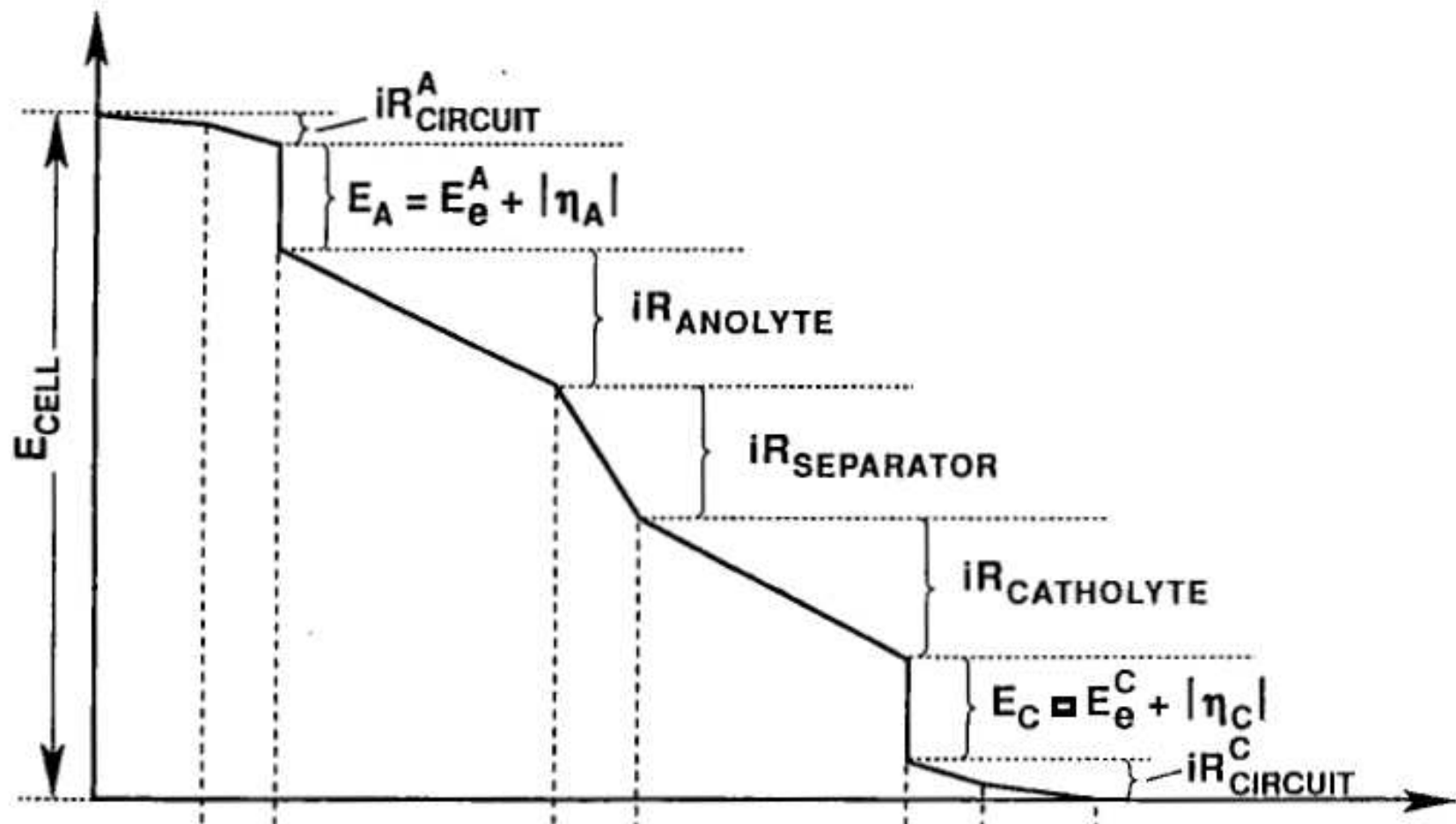
1886
Холл-Эру
(Эру-Холл)



Производительность (Capacity) моль/(м²·с)

Удельная производительность (Space time yield) моль/(м³·с)

Энергозатраты



ОРГАНИЧЕСКИЙ ЭЛЕКТРОСИНТЕЗ

- Reduction of carbon-carbon double bonds,
- Reduction of carbonyl groups,
- Reduction of nitrile or nitro groups,
- Reductive coupling,
- Reductive cleavage,
- Oxidation of hydrocarbons,
- Oxidation of functional groups,
- Oxidative coupling,
- Oxidative substitution,
- Electrochemical fluorination,
- Indirect oxidation or reduction.

Inorganic electrochemical processes.

Al, Na, Mg, Li	Molten salt electrowinning
Cu, Zn, Cu, Ni, Cr, Pb	Hydrometallurgy
Cd, Mn, Tl, Ga, In, Ag, Au	Electrowinning or refining
Chlorine/Caustic	Noble metal oxide anode, brine electrolyte
Chlorate	Noble metal oxide anode, brine electrolyte
Perchlorate	Pt/Ti, PbO ₂ anodes, chlorate electrolyte
Persulfate	Pt/Ti anode, conc. H ₂ SO ₄
Hypochlorite	DSA ^R , aqueous NaCl
Permanganate	Ni, monel anode, KMnO ₄ electrolyte
Fluorine	Carbon anode, KF/2HF eutectic
Manganese dioxide	C, Pb, Ti anodes, MnSO ₄
Water electrolysis (H ₂ , O ₂)	Ni on steel, KOH
Hydrogen peroxide	Carbon cathodes, NaOH
Ozone	Vitreous carbon anode, conc. aqu. HBF ₄
Bromate	C, Pt/Ti, PbO ₂ , aqu. NaBr
Chromic acid	Lead anode, Cr(III) in H ₂ SO ₄
Cuprous oxide	Copper, aqu. NaCl
Potassium stannate	Anodic dissolution
Chlorine dioxide	DSAR, carbon cathode, sodium chlorate and HCl

Cathodes:

(a) H₂ evolution

Steel, Ni, Ni- coatings, precious metal coating.

(b) O₂ reduction

Dispersed Pt on high area carbon.

(c) Other reactions

High H₂ overpotential metals, *e.g.*

Hg, Pb, Cd.

Other metals *e.g.* Ni, Cu, Ag, steels,

stainless steels, Hastelloy (Ni-Mo-Fe

or Ni-Mo-Cr), graphite, other carbons,

conducting ceramics, *e.g.* TiO_x

(Ti₄O₇, Ti₅O₉), Raney Ni, Pt/Pt,

Pd/C for electro-hydrogenation.

Anodes:

(a) O₂ evolution

IrO₂-coated Ti.

PbO₂ on Ti or carbon.

Pb in H₂SO₄.

Steel in a neutral and basic medium.

Ni and Spinel in basic medium.

RuO₂-based coatings on Ti(DSA).

Other oxides based on Co₃O₄ and PdO₂.

Pt, Pt/Ti, Ir/Ti, Pt-Ir/Ti and other substrates.

PbO₂ on Ti, Nb or C.

Fe or Pb in acid sulphate media.

Carbons.

Ni and spinels in basic media.

Conducting ceramics, e.g. TiO_x(Ti₄O₇,Ti₅O₉)

(b) Cl₂ evolution

(c) Other reactions