
BAUXITE RESIDUE
VALORISATION AND
BEST PRACTICES
CONFERENCE
Leuven
5-7 October 2015

Opportunities within the Alumina Refineries to Make Bauxite Residue Easy to Downstream Use

György (George) Bánvölgyi
Senior Process Consultant

Why is most BR difficult to use?

Because

•*Soda content being between the extremes of 0.7% and 12.3% Na_2O,* ***average is 5.5%*** *(48 BRs from refineries). The soda content is in the form of*

- *chemically combined soda*
- *soluble soda*

•*Physical appearance (consistency) of most residues*

Sources of chemically combined soda

Reactions of clay minerals ($Al_2O_3.2SiO_2.2H_2O$) and quartz content (SiO_2) of bauxite, such as:

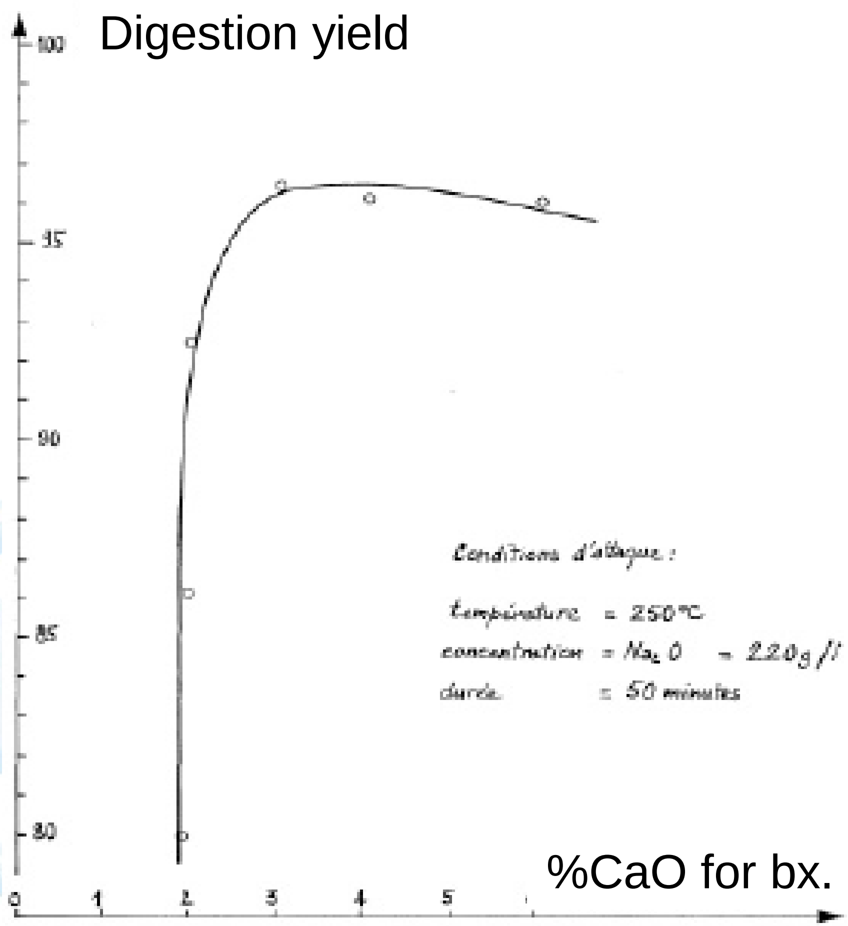
- During the low temperature digestion (140-150^oC) **kaolinite** reacts with NaOH and sodalite type desilication product (DSP) is formed $3(Na_2O.Al_2O_3.2SiO_2.(1\text{-}2)H_2O).Na_2X$, where $X=CO_3^{2-}$, $2AlO_2^-$, $2OH^-$, $2Cl^-$, SO_4^{2-}
- In the course of high temperature digestion (240-280^oC) both **clay minerals and quartz** react with NaOH and dissolved alumina and a mix of sodalite and cancrinite DSP is formed. At higher temperature cancrinite is preferred.

Options to reduce chemically combined soda

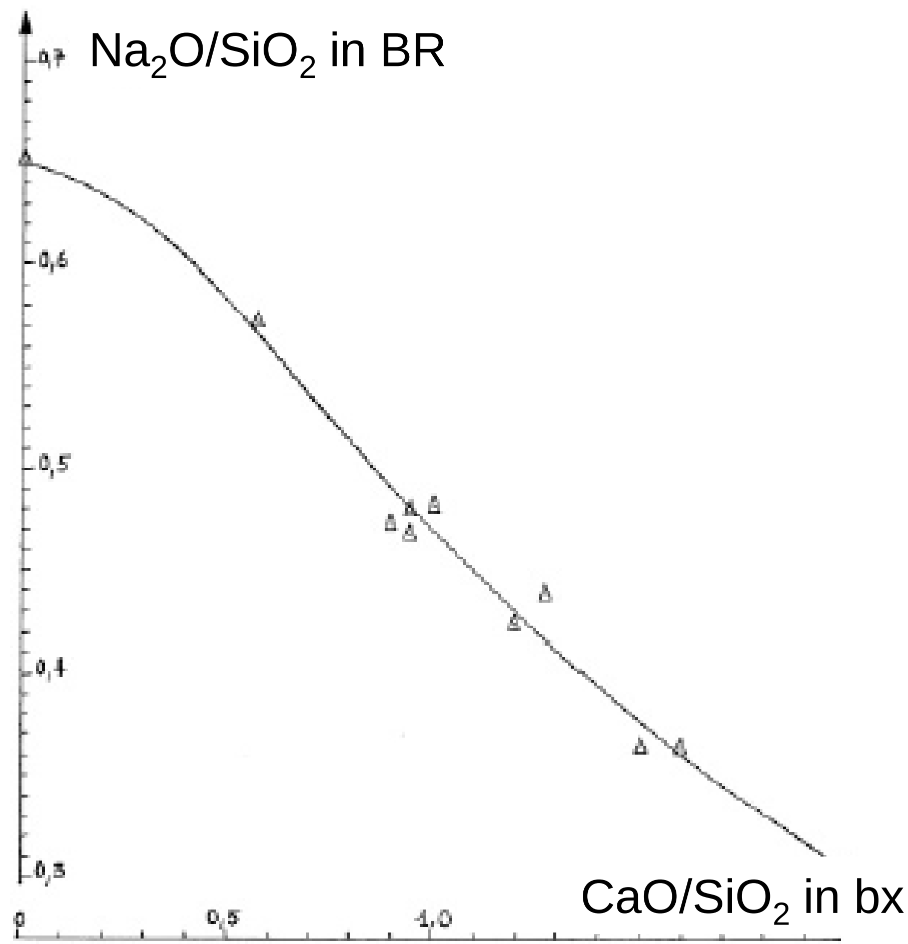
- *Lime addition to the digestion*
- *Hydrothermal treatment of BR in presence of lime*
- *Pyrometallurgical processing of BR*
- *Improved Low Temperature Digestion (ILTD) and related processes*

Lime addition to the digestion

Digestion yield and combined soda content in case of a diasporic bauxite at 250ºC



Digestion yield vs. lime addition

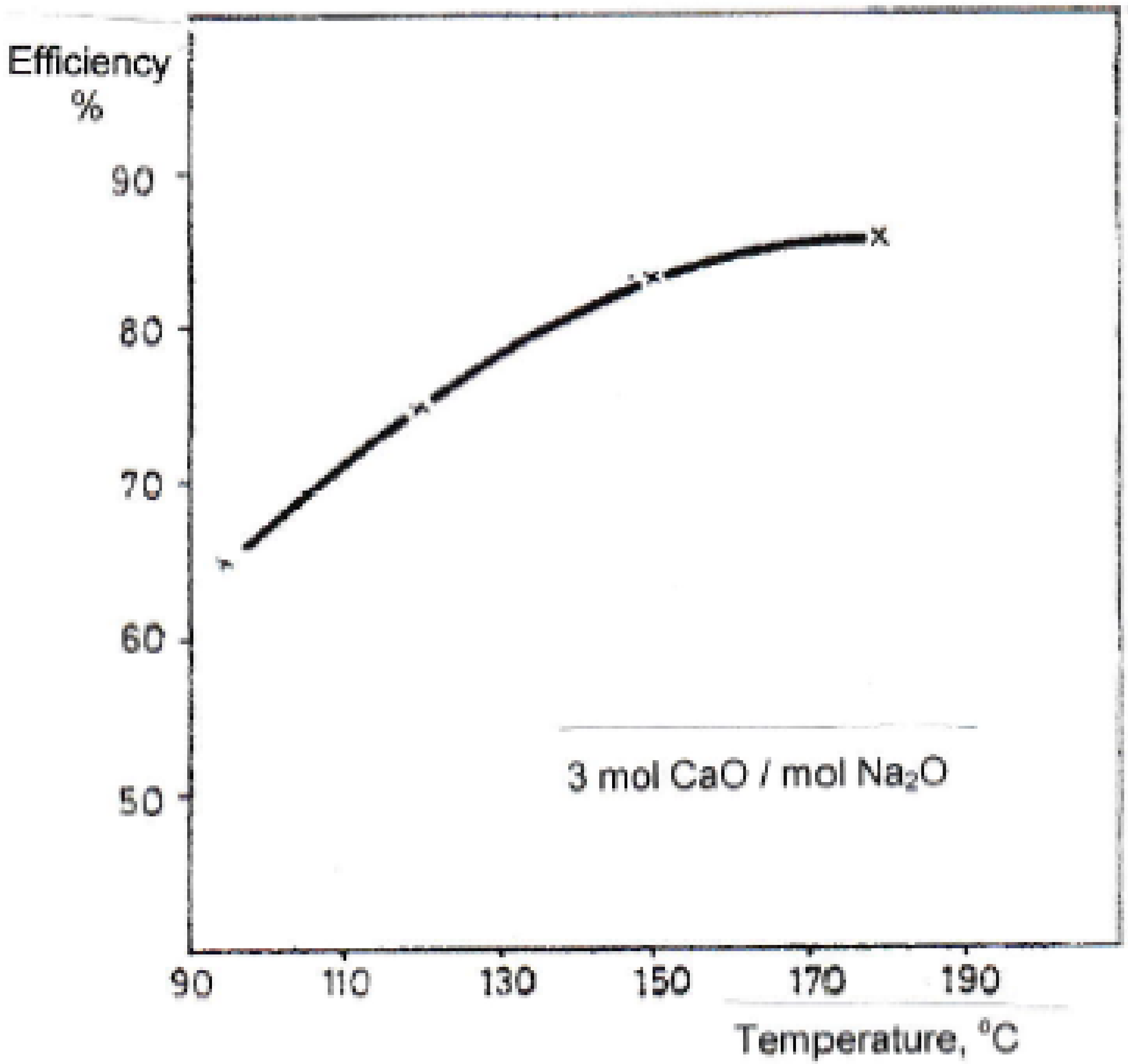


Soda content in BR vs lime addition

Hydrothermal treatment of BR in presence of lime

- **Causticization**: conventionally at about 90-100^oC
  - Product: $3CaO.Al_2O_3.kSiO_2.(6-2k)H_2O$, k~1.5
- **Hydrothermal treatment**: at high temperatures, over 260^oC, very low A/C ratio < 0.2
  - Soda recovery about 90%
  - Al_2O_3 recovery possibly up to 70%
  - Hydrogarnet product: $3CaO.Fe_2O_3.2SiO_2$

Soda recovery from BR at 3 mol CaO/mol Na_2O (lab tests)



Pyrometallurgical processing of BR

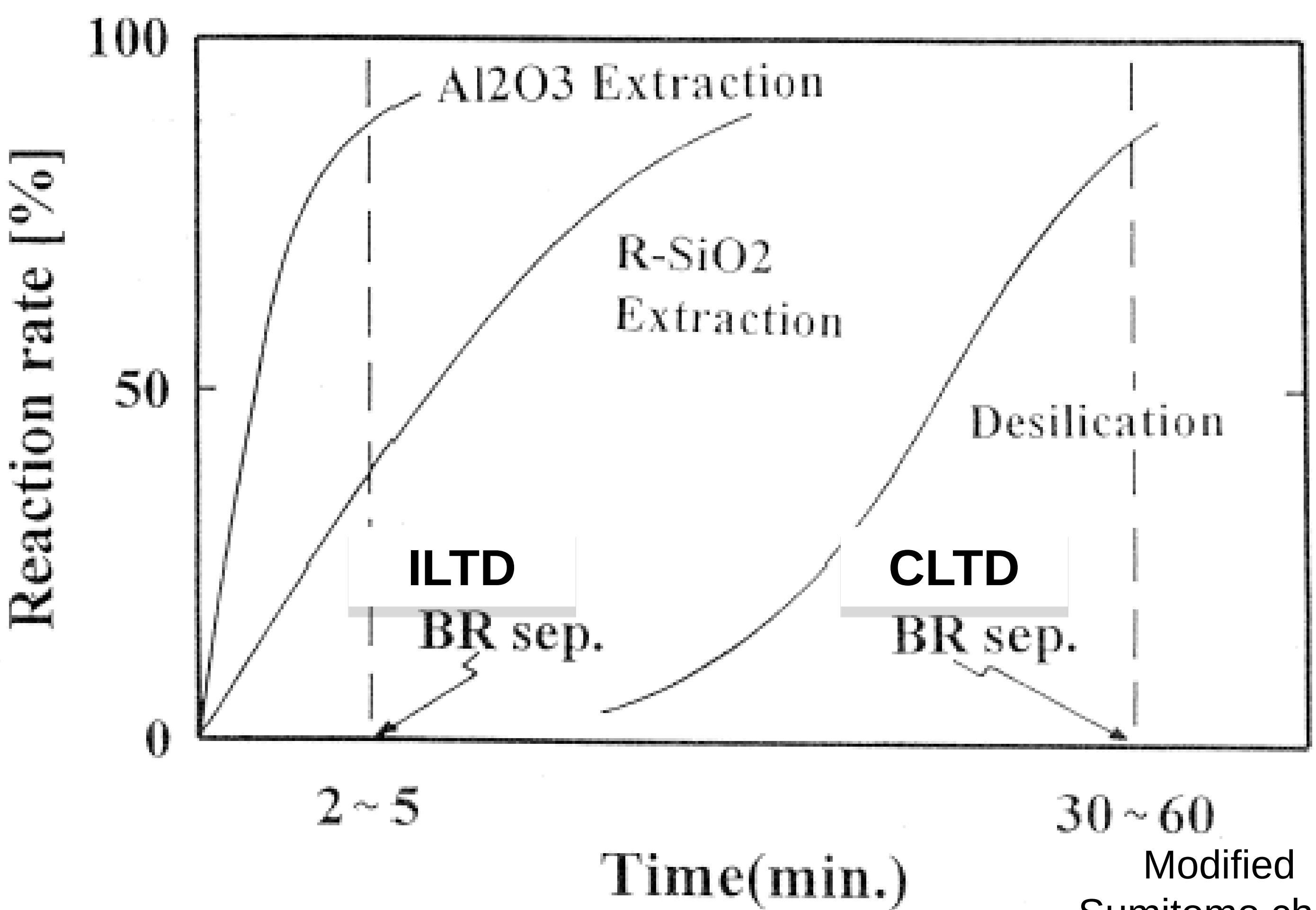
Origin of bauxite	Weipa	Trombetas	South Manchester	Darling Range	Iszka	Parnasse	Arkansas	Pavlodar
	Australia	Brazil	Jamaica	Australia	Hungary	Greece	USA	Kazakhstan
Digestion temperature	240°C	143°C	245°C	143°C	240°C	260°C	serial combined	serial combined
	red mud	red mud	red mud	red mud	red mud	red mud	brown mud	brown mud
Components, %								
Al_2O_3	17.2	13.0	10.7	14.9	14.4	13.0	5.5	3.7
SiO_2	15.0	12.9	3.0	42.6	12.5	12.0	23.1	21.6
Fe_2O_3	36.0	52.1	61.9	28.0	38.0	41.0	10.1	21.3
TiO_2	12.0	4.2	8.1	2.0	5.5	6.2	3.6	n.a.
Na_2O	9.0	9.0	2.3	1.2	7.5	7.5	3.6	1.2
CaO	-	1.4	2.8	2.4	7.6	10.9	47.2	43.4
Others	3.5	1.0	2.8	2.4	4.9	2.3	2.5	8.8
LOI	7.3	6.4	8.4	6.5	9.6	7.1	4.4	n.a.

Improved Low Temperature Digestion (ILTD) Process

Principal features:

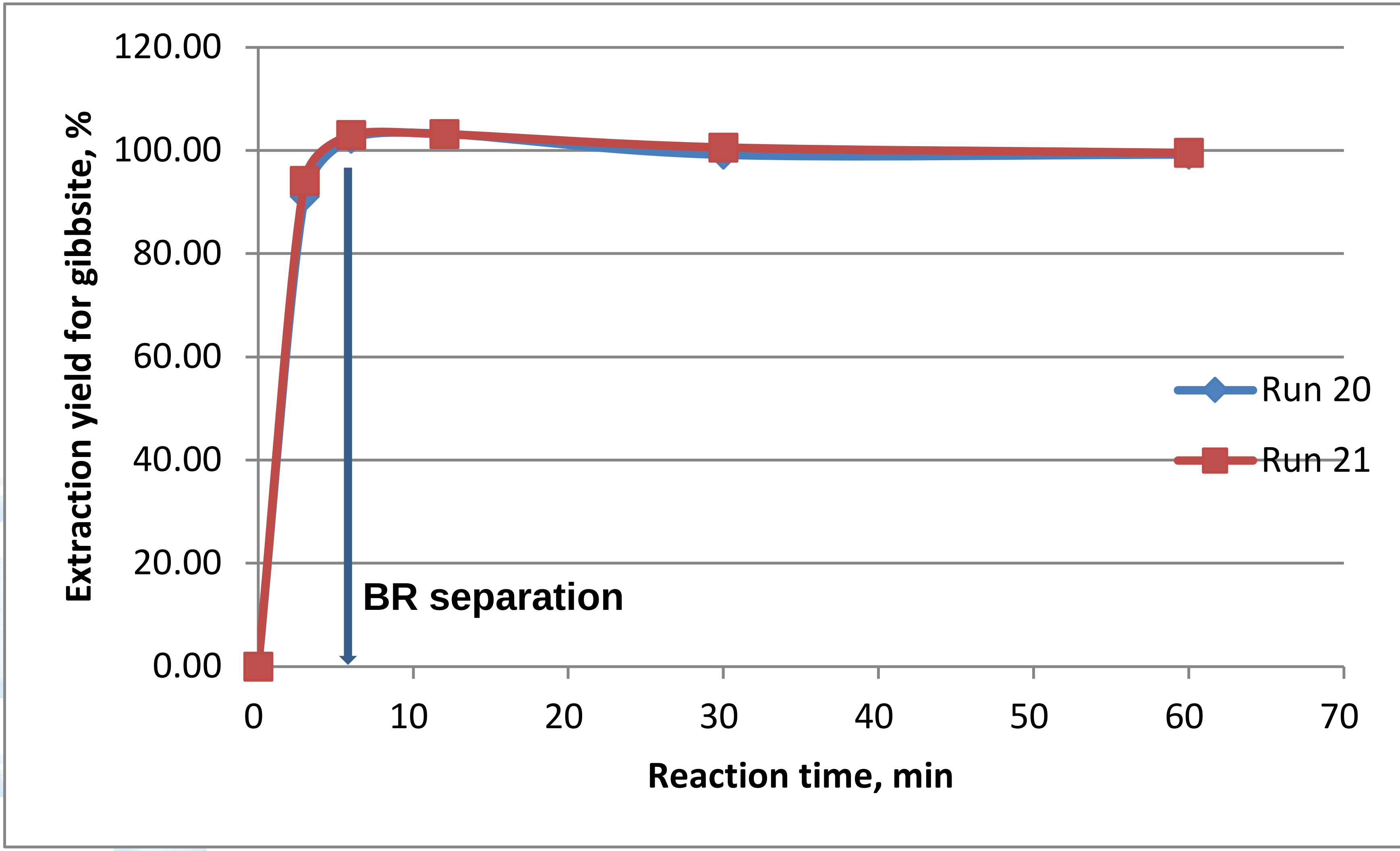
- ✓ no predesilication is needed
- ✓ high A/C ratio, short digestion time
- ✓ separation of the low soda bauxite residue just after the digestion preferably with Hi-Bar Filtration
- ✓ seeded pressure crystallization of the Desilication Product (DSP) out of the liquid phase.
- ✓ Material and energy costs: about 15% savings

ILTD vs. CLTD basics

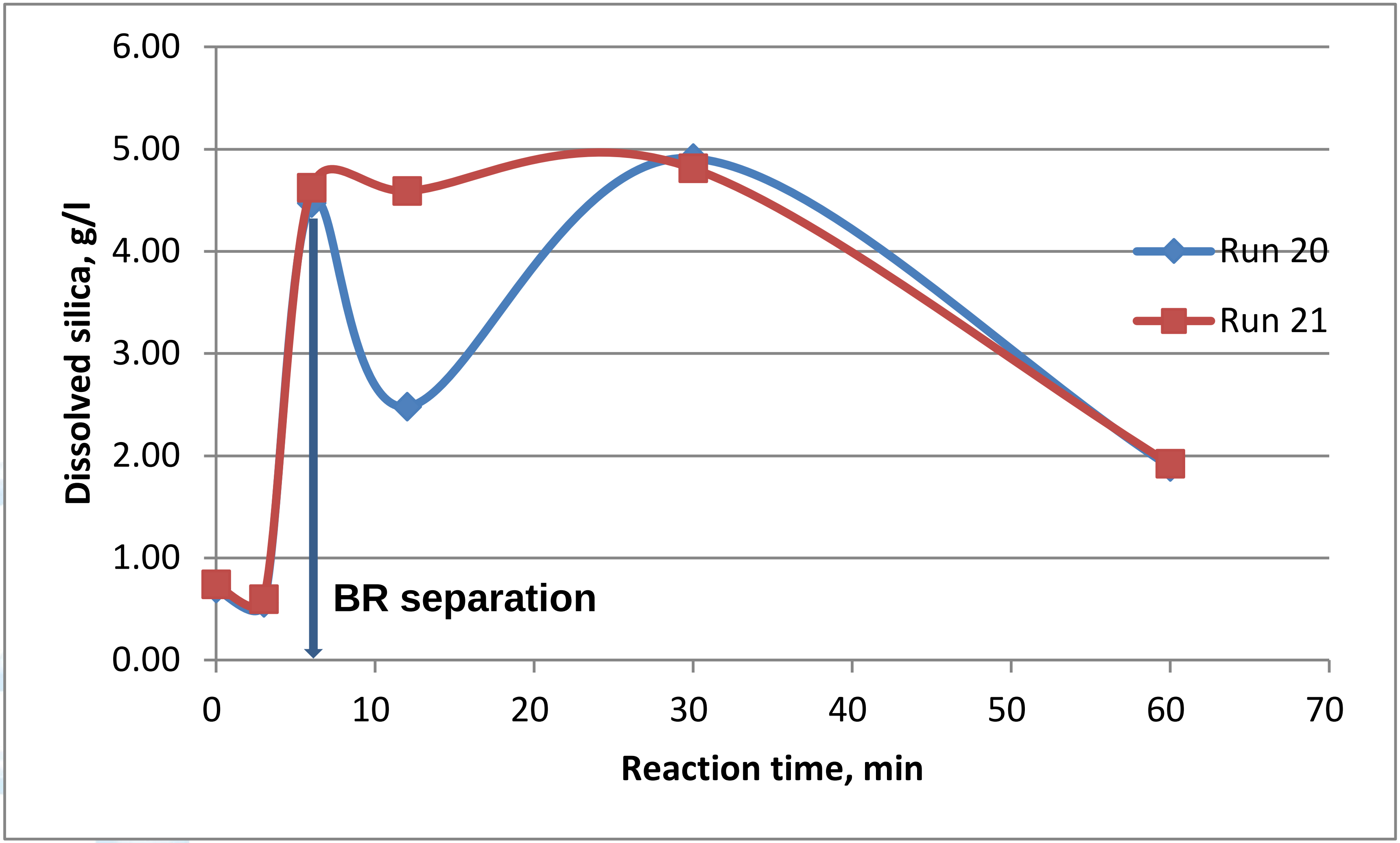


Modified
Sumitomo chart

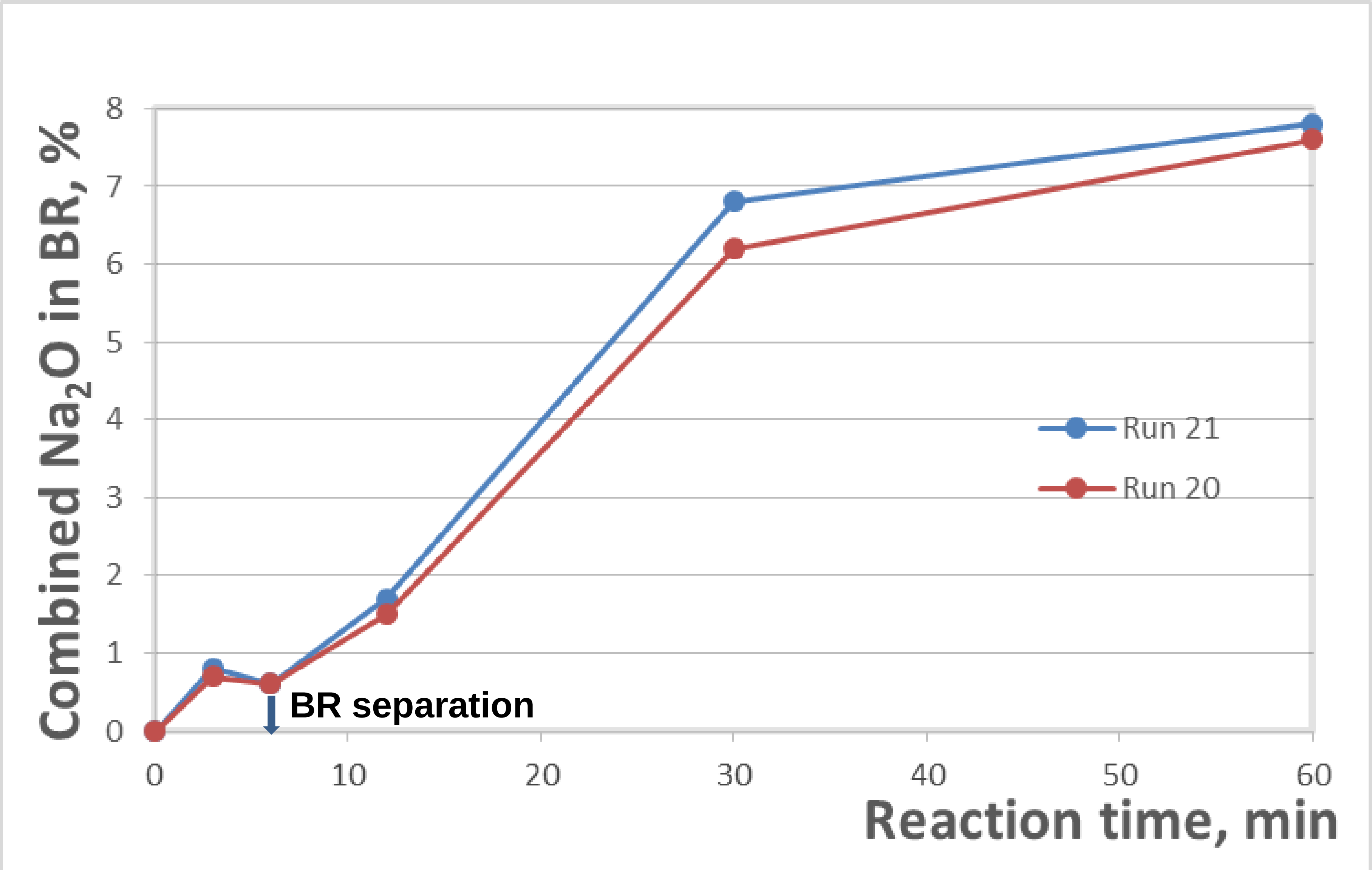
Extraction yield for gibbsite at 150ºC



Dissolved silica at 150°C



Combined Na_2O in BR at 150ºC



Composition of low soda bauxite residue of ILTD Process

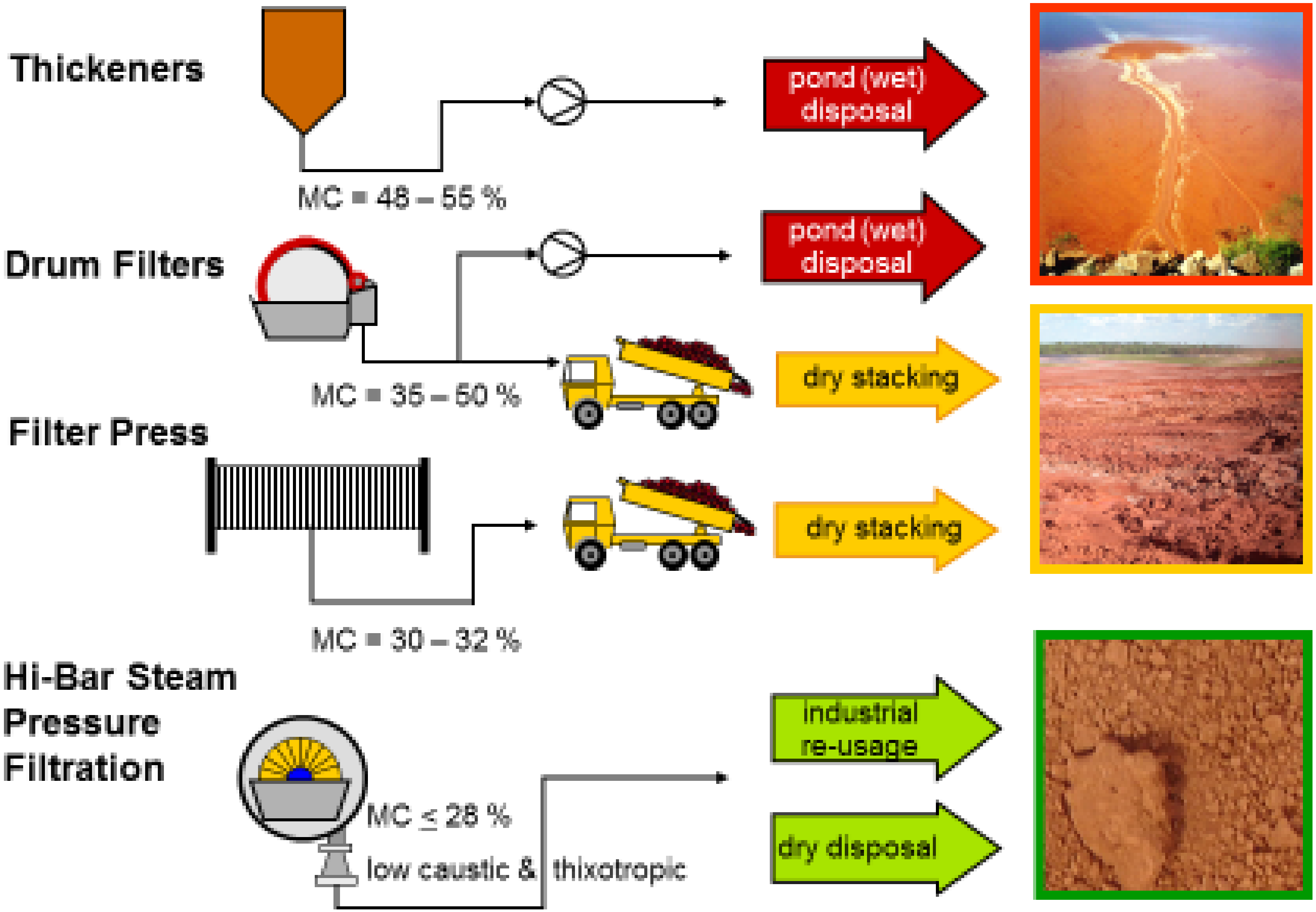
- Al_2O_3: 9.2%,
- SiO_2: 5.8%
- Fe_2O_3: 70.4%
- TiO_2: 4.1%
- $Na_2O_{combined}$: 0.6%
- Na_2O/SiO_2: 0.1

Average BR composition of two parallel tests at 150^{o}C, 6 min batch reaction time

Washing/dewatering means of BR

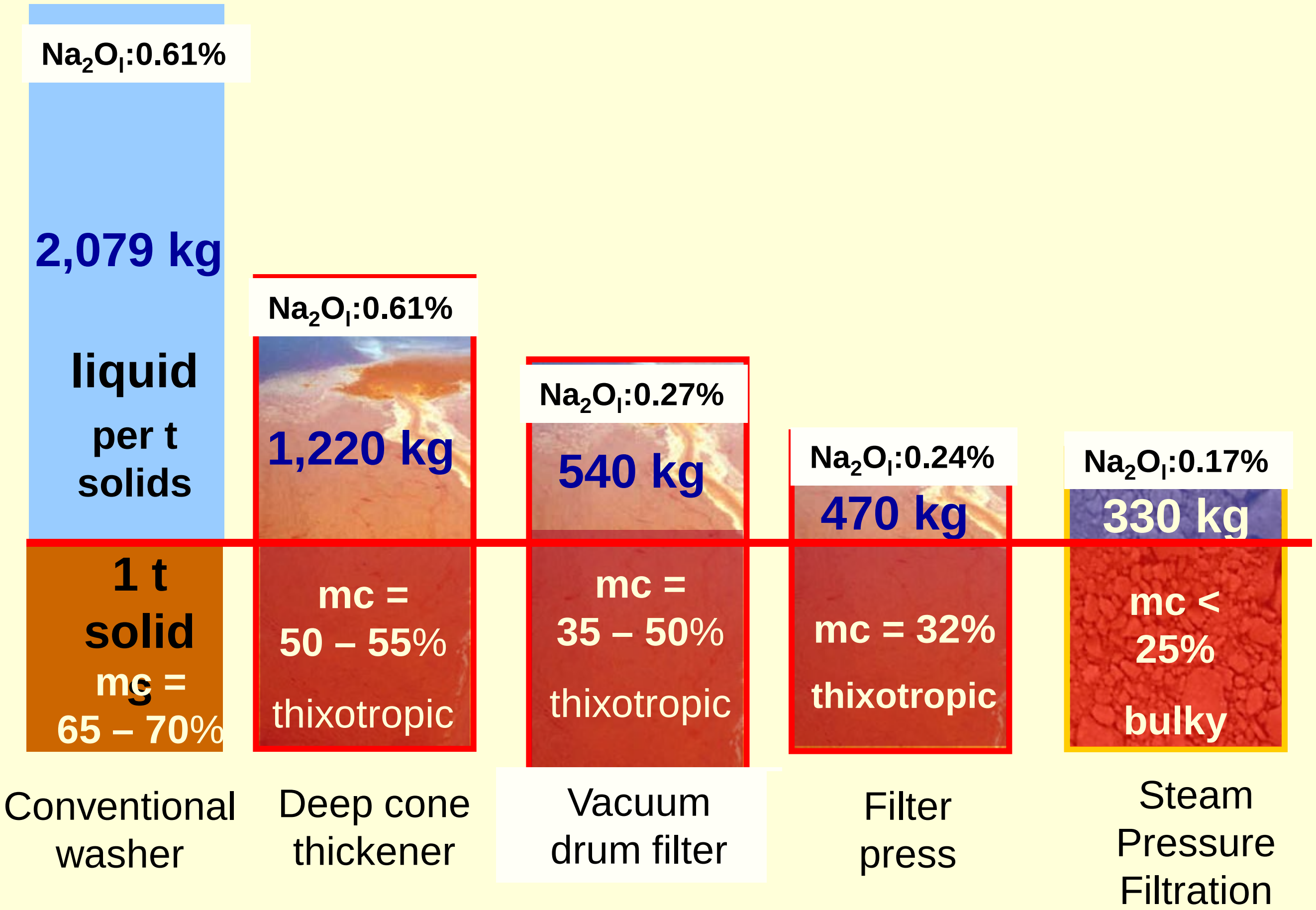
- Conventional washer
- Deep cone thickener
- Vacuum drum filter
- Leaf filter press
- Hi-Bar Steam Pressure filtration

Dewatering and Disposal Methods for Red Mud



BOKELA

Moisture contents, soluble soda contents at different means of de-watering



Physical appearance, soluble soda content of BR

	Conventional washer	Deep cone thickener	Vacuum drum filter	Filter press	Steam pressure (HiBar) filter
Solids material, t	1	1	1	1	1
U/F solids, %	30-35	45-50			
moisture content%	65-70	50-55	35-50	32	25
liquid phase	2,079				
liquid phase remaining with BR at disposal, kg	1,220	1,220	540	470	330
BR easy to handle	-	-	-	+	+
$Na_2O_{soluble}$, %	0.61	0.61	0.27	0.24	0.17

Recommended soda content for the further use of BR

- Should be determined on case by case
- **In general: < 3% Na_2O**

Thank you for your attention!