BAUXITE RESIDUE VALORISATION AND BEST PRACTICES CONFERENCE

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JSC “CENTER OF EARTH SCIENCE, METALLURGY AND ORE BENEFICATION”

WASTELESS PROCESSING OF RED MUD BY HYDROGARNET TECHNOLOGY

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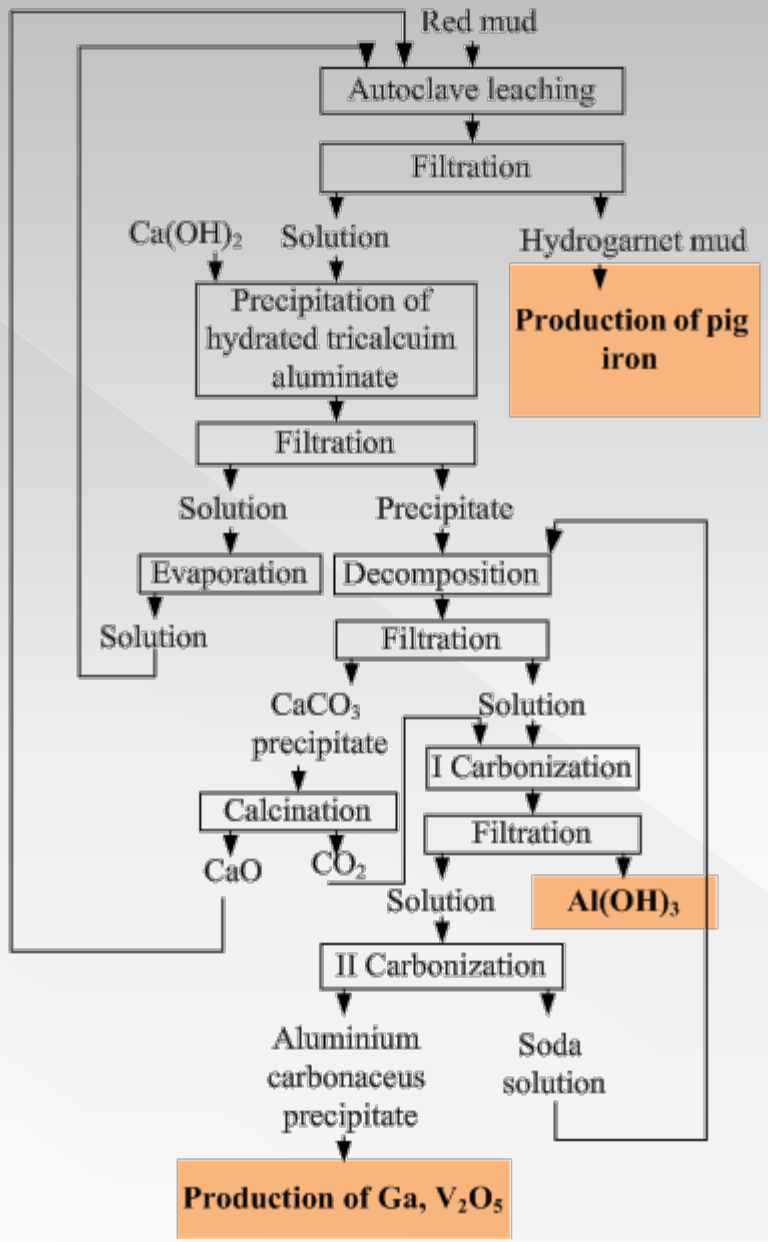
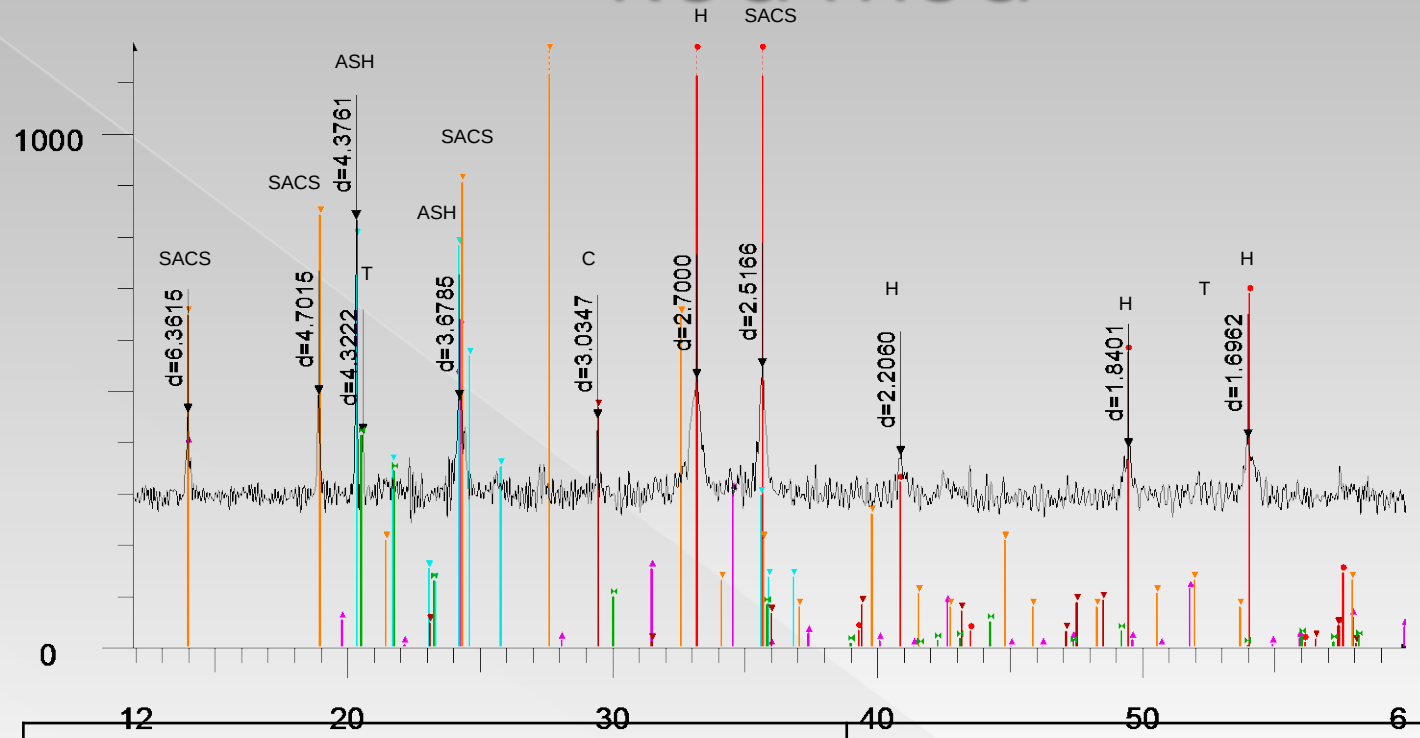


Technological scheme of hydrogarnet process for red mud

Red mud

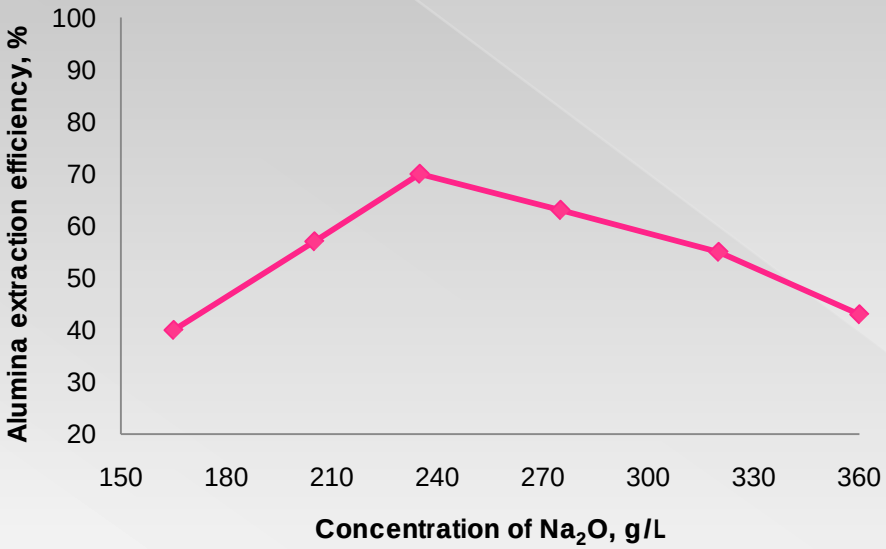


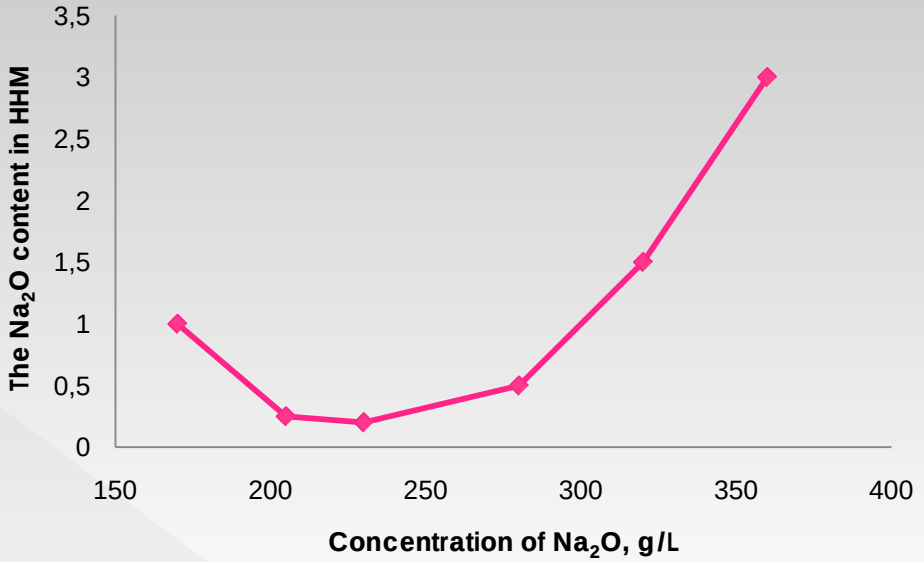
Compound Name	Formula
Hematite	Fe_2O_3
Aluminum Silicate Hydrate	$Al_2Si_{70}O_{143}\cdot H_2O$
Sodium Aluminum Carbonate Silicate	$3NaAlSiO_4\cdot Na_2CO_3$
Calcite	$CaCO_3$
Tridymite (syn)	SiO_2

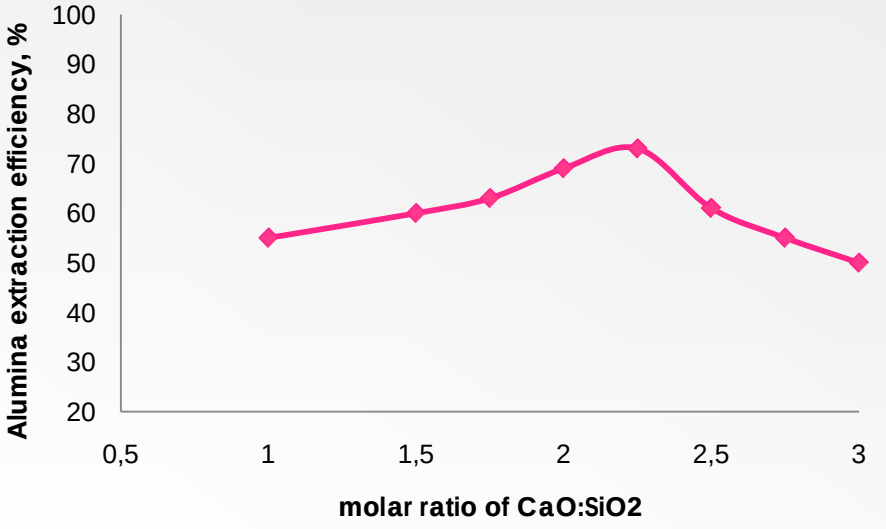
Component	NaO	Al_2O_3	SiO_2	Fe_2O_3	TiO_2	CaO
%	9,95	39,53	6,18	23,12	4,37	1,1

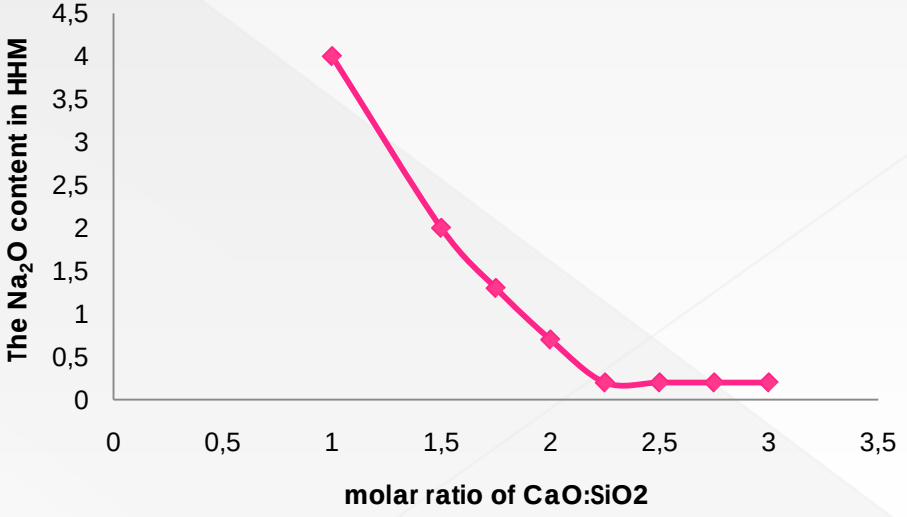
Autoclave leaching

The optimum conditions for leaching were found to be: 240°C, 90 minutes, liquid to solid molar ratio of 4, $CaO:SiO_2$ molar ratio of 2,25, α_k=30.

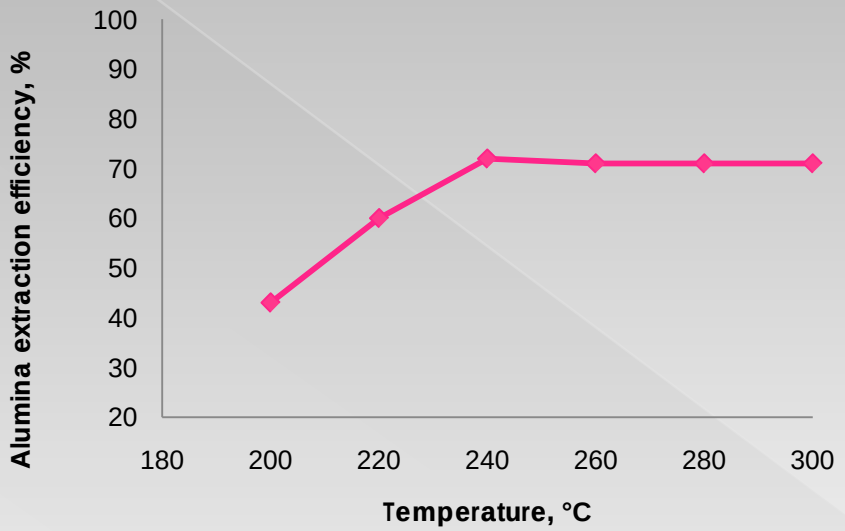


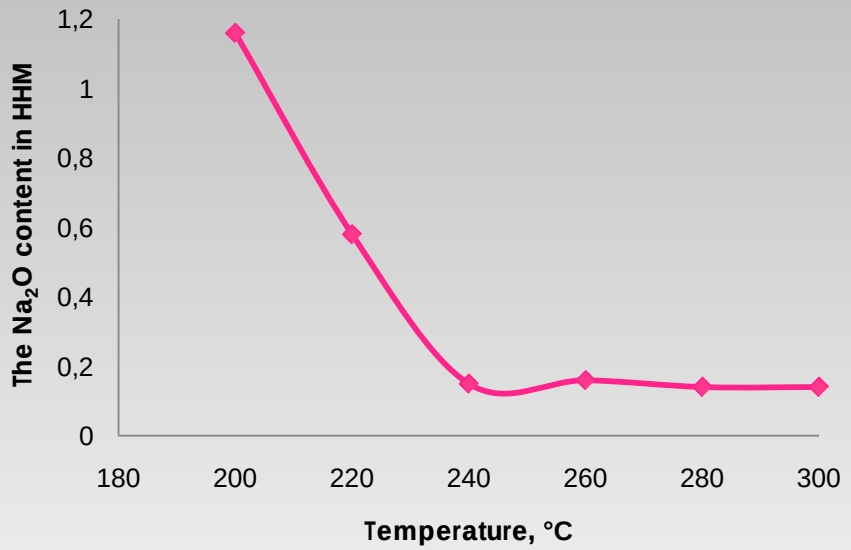


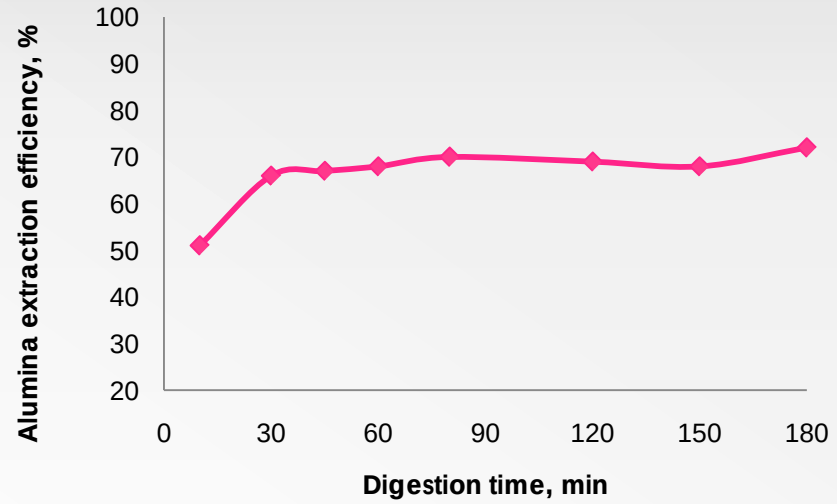


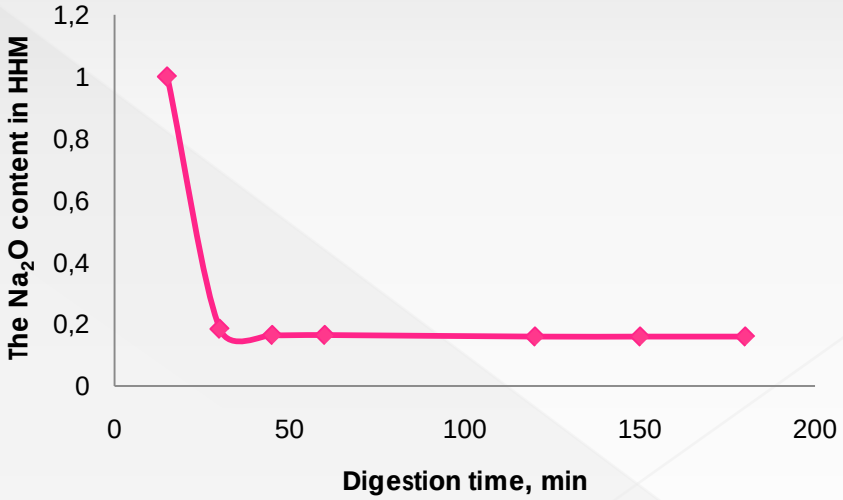


Autoclave leaching





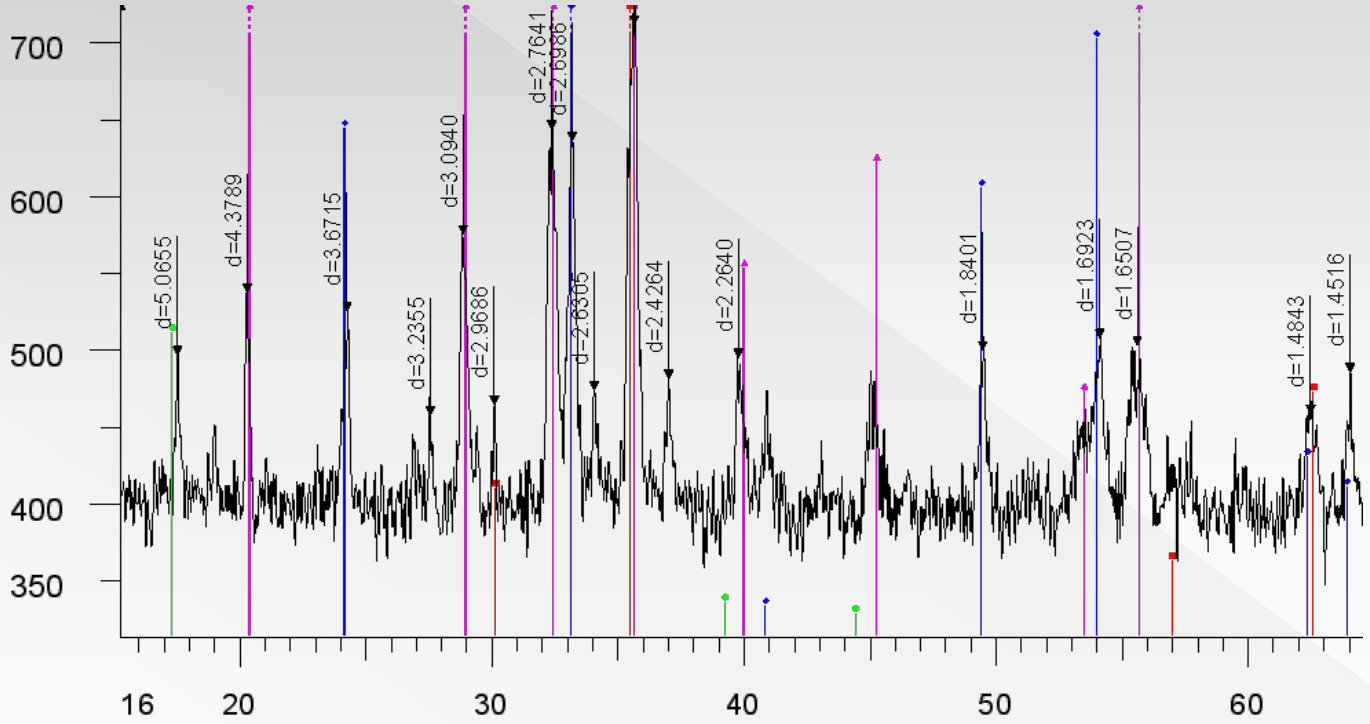




Autoclave leaching

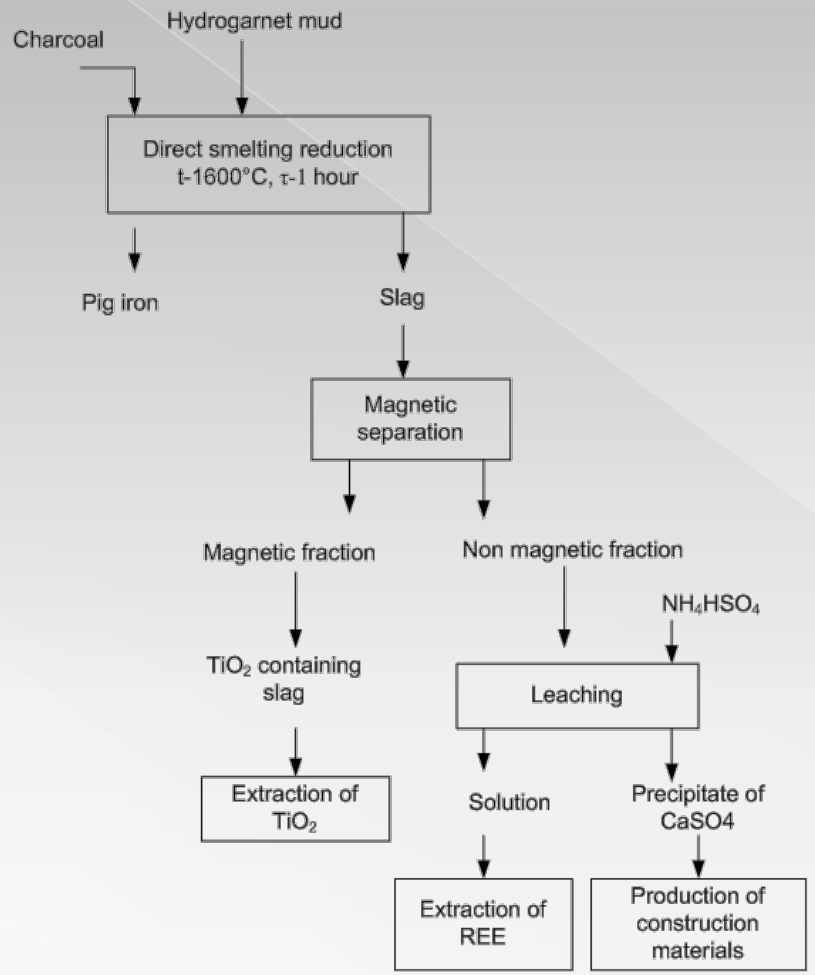
g/L	Al_2O_3	SiO_2	Na_2O	SO_3	α_k
Middle modulus solution	24.24	0.05	172.94	3,52	11.22

%	Al_2O_3	SiO_2	TiO_2	CaO	Fe_2O_3	Na_2O
Hydrogarnet mud	4.04	11.85	7,03	23,82	41.95	0.32



Compound Name	Formula
Hematite	Fe2O3
Andradite (hydrated)	Ca3(Fe0.87Al0.13)2(SiO4)1.65(OH)5.4
Katoite, syn	Ca3Al2(O4H4)3
Magnetite, syn	Fe3O4

Direct smelting reduction



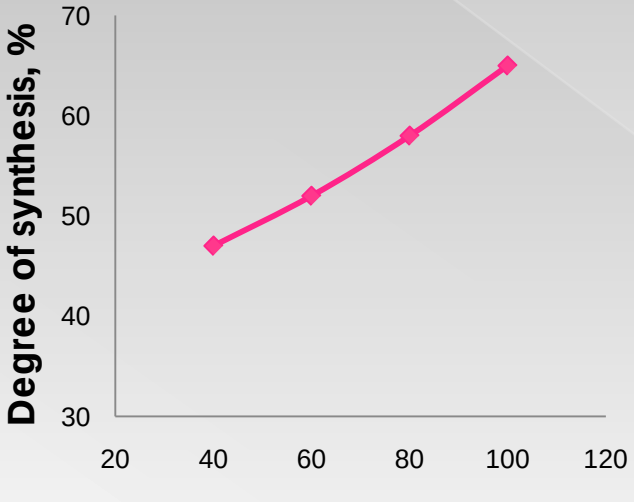
Component, %	Pig iron	Slag	
		Magnetic faction	Non-magnetic faction
Fe	94.7	37,56	0,22
Si	3,2	6,79	9,47
Ti	1,8	14,1	1,07
Al	0.52	4,36	12,43
P	0.001		
C	2,3		
Cr	0.38		
Mn	0.101		
Ni	0.043		
Cu	0.052		
Ca		11,52	35,94

Component, ppm	Ga	Sc	Y	La	Ce	Nd	Sm	Eu	Gd	Er	Lu	ΣREE
Magnetic faction	57	64,5	6,5	51	-	23	-	-	25,4	9	7	186,4
Non-magnetic faction	17	167,0	57	144	33,6	80	2	3	33	6,5	1	527,1

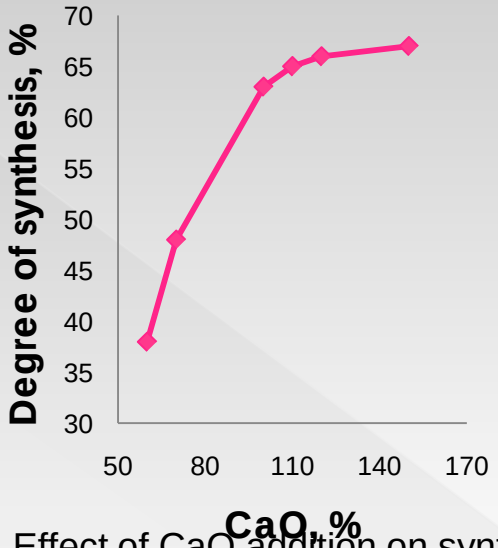
Precipitation of tricalcium hydroaluminate

The optimum conditions for synthesis of tricalcium hydroaluminate were found to be: 100°C and 2 hours.

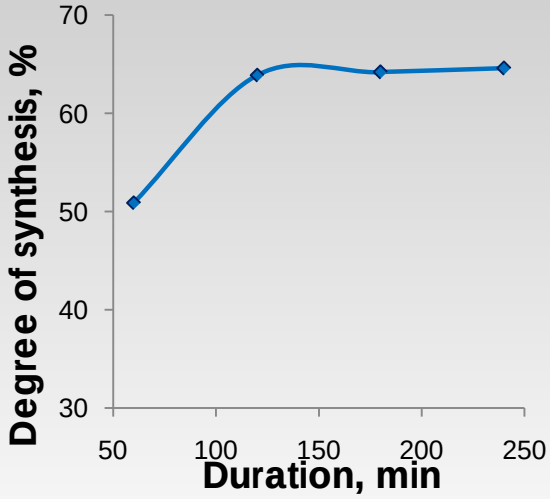
$$Na_2O \cdot AI_2O_3 + 3\ Ca(OH)_2 = 3CaO \cdot AI_2O_3 \cdot 6H_2O + 2NaOH$$



Effect of leaching temperature on synthesis of TCHA



Effect of CaO addition on synthesis of TCHA (from 100% in an amount stoichiometrically required CaO)

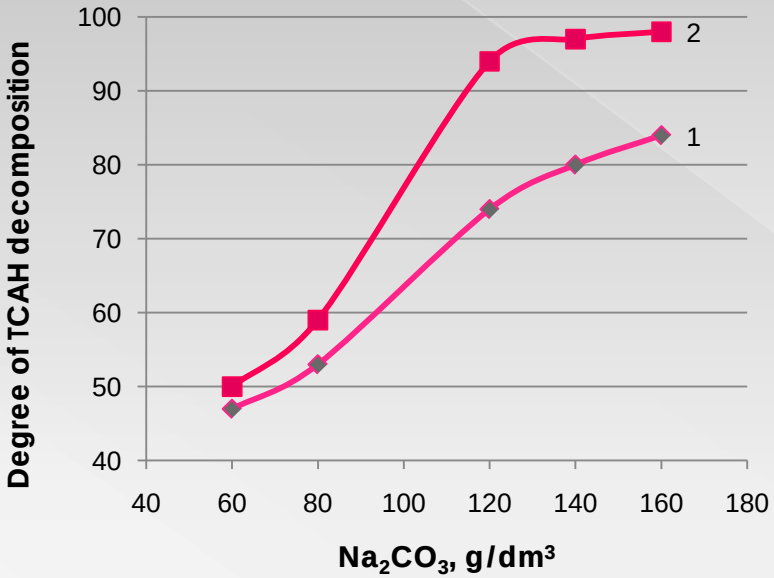


Effect of leaching duration on synthesis of TCHA

Compound Name	Formula	%
Calcium Aluminium Hydrogen Oxide	$Ca_3Al_2(O_4H_4)_3$	91,5
Portlandite, syn	$Ca(OH)_2$	4
Calcite, syn	$CaCO_3$	4
Paraalumohydrocalcite	$CaAl_2(CO_3)_2(OH)_4 \cdot 6H_2O$	0,5

Decomposition

Tricalcium hydroaluminate **decomposition** was carried out with 3 types of solution:
- alkali solution Na_2O 240 g/L
- sodium-alkali solution Na_2O 120 g/L and Na_2CO_3 20 g/L
- soda solution Na_2CO_3 60-160 g/L

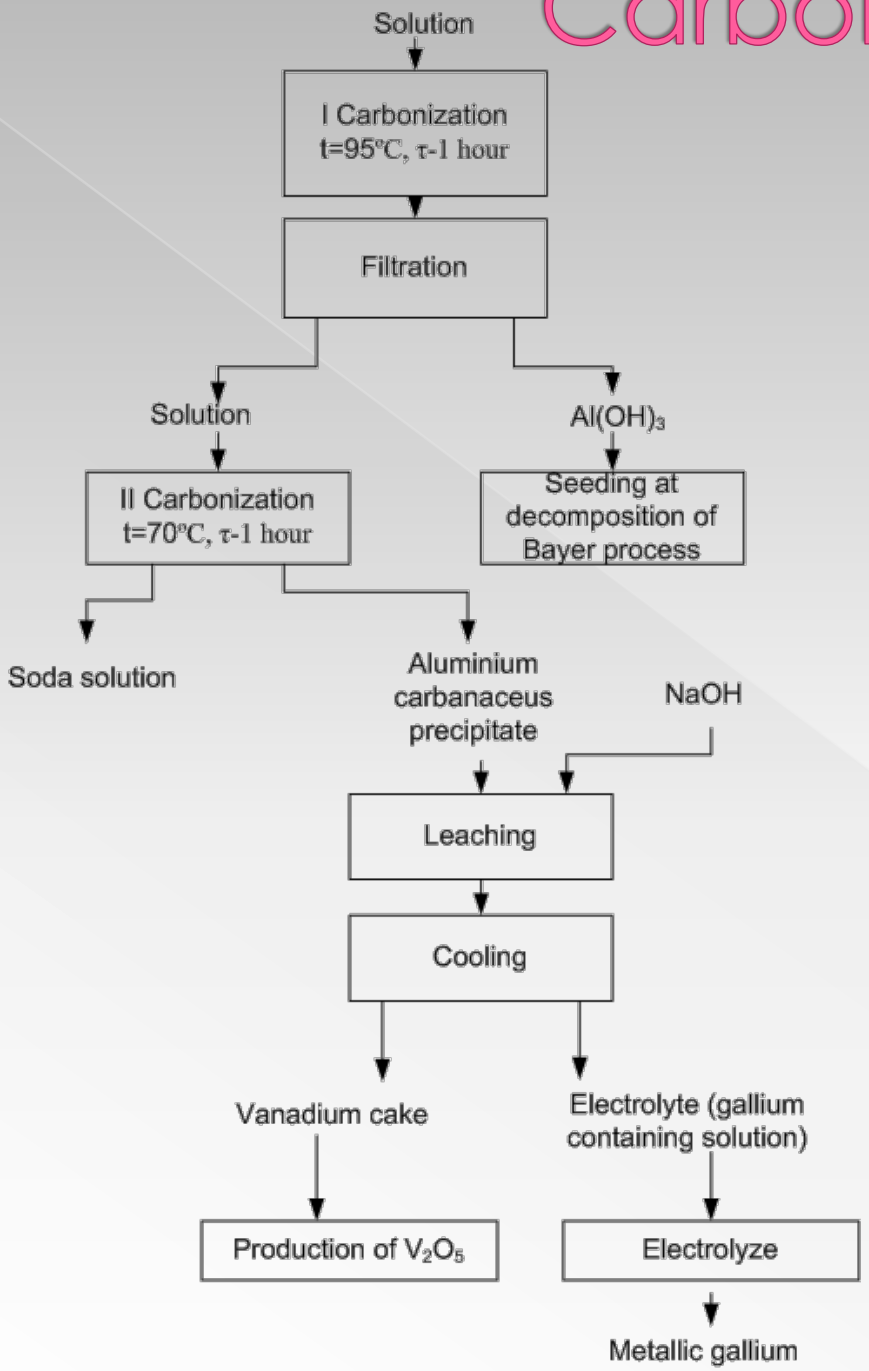


Effect of TCAH decomposition on soda solution concentration on different temperatures
1 – 100 °C,
2 - 180 °C

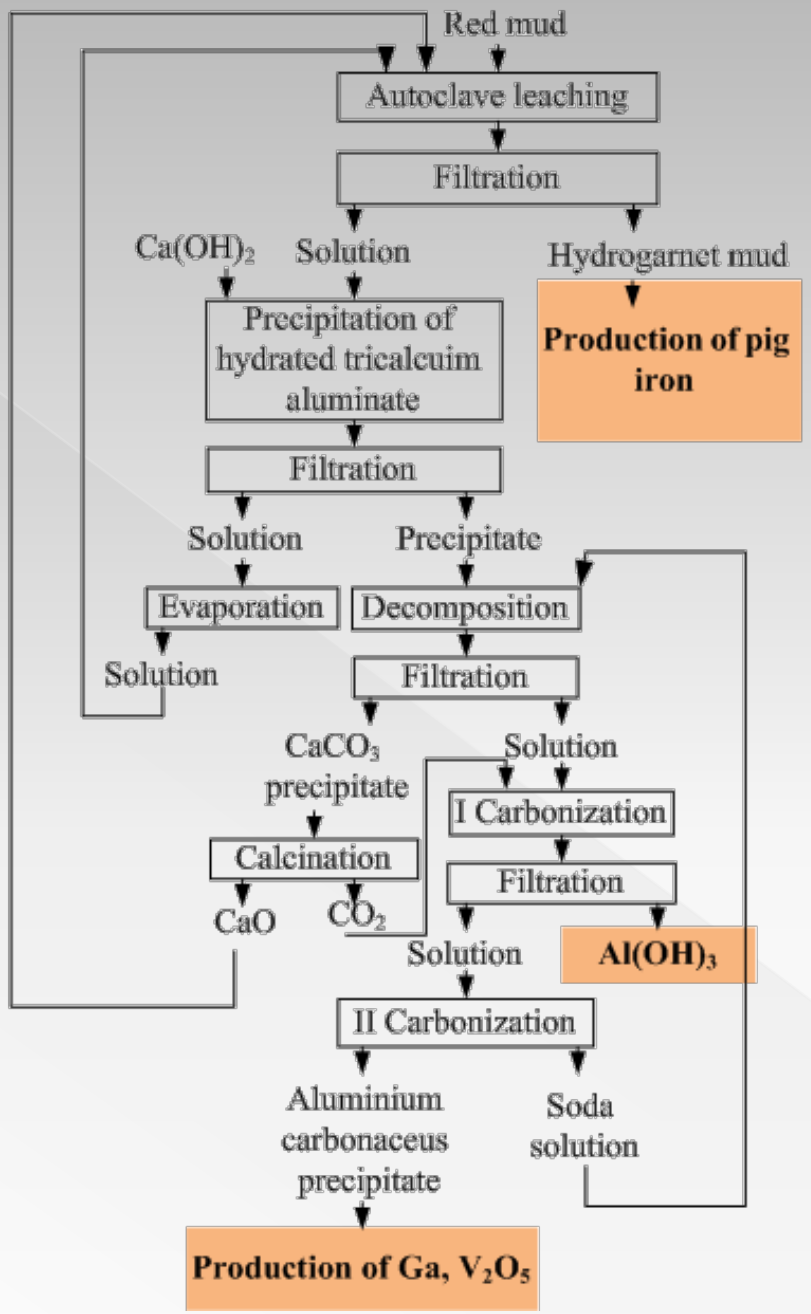
Compound name	Formula	S-Q, %
Calcyte	$Ca(CO_3)$	88,3
Unnamed_Hydrogarnet	$(CaO)_3(Al_2O_3)_{1,75}(H_2O)_{3,75}$	6
Sodium Carbonate Oxide	Na_2CO_3	5,7

The optimum conditions of decomposition were found to be: C_{Na2CO3} -140g/L , t-180°C, τ-2 h, L:S = 4

Carbonization



Comp.	%
Na_2O	24,8
Al_2O_3	29,5
CO_2	31,5
Ga	0,52
V_2O_5	0,92



Technological scheme of hydrogarnet process for red mud

Conclusion

As a result of processing of red mud by hydrogarnet technology 98,0 of alkali regenerated.

Hydrogarnet mud – silicaferrous concentrate with high consumer properties. 64,9% of Al_2O_3 extracted from hydrogarnet mud.

The optimum conditions for leaching were found to be: 240°C, 90 minutes, liquid to solid ratio of 4, $CaO:SiO_2$ molar ratio of 2,25, α_k=30.

The optimum conditions for synthesis of tricalcium hydroaluminate were found to be: 100°C and 3-4 hours.

The optimum conditions for decomposition of tricalcium hydroaluminate were found to be: Na_2CO_3 concentration 140-160 g/l, 180°C and 2 hours. Extraction of Al_2O_3 95-98,3%.

Direct smelting reduction of hydrogarnet mud to obtain pig iron and slag was studied. Extraction of iron into pig iron was 88%.

Thank you for your attention