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"SOME ASPECTS OF CATIONIC SILICA FLOTATION OF BRAZILIAN ITABIRITES"

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CMR

1.0 INTRODUCTION

Ashland Chemical Company is both manufacturer and distributor of a broad line of chemical products. Research, quality control and a high degree of specialization in areas of primary service provide a base for pioneering as well as supplying large quantities of chemicals to all kinds of manufacturers.

One specific area of primary interest to us is the development and application of the finest cationic silica collectors possible and is due primarily to the increasing necessity of recovering minerals from lower grade but more widely distributed ores. Historically, we have worked in conjunction with mining companies to develop and optimize the chemical parameters necessary for effective beneficiation. Early applications were primarily that of adding amine flotation and possibly a regrind mill at the end of a magnetic concentration process. This increased concentrate iron content with lower silica, which resulted in lower freight costs per iron unit and more efficient blast furnace operation with less slag production. This technology is now used at the following: Pilot Knob Pellet Co., Empire Mining Co., Sherman Mining Co., Lamco, Adams Mine, National Steel and Griffith Mines. Then in late 1973, Iron Ore Company of Canada opened the first iron ore processing facility to use only amine flotation for beneficiation. The plant uses Arosurf MG-83 and is designed to produce 4 MM long tons/yr. of concentrate from a hematite feed containing 55% iron. In mid-1974, Cleveland Cliff's new Tilden Plant in Michigan, U.S.A., went on stream. This is the first plant to treat a fine grained earthy hematite ore via selective flocculation and cationic flotation. The plant is designed for 4 MM L.T./yr. of concentrate and uses Arosurf MG-98A-3 as the silica collector. Today, new concentrators that will utilize flotation are being built or planned in Africa, North America and Brazil. We have had the opportunity to test many of these ores in our lab and would like to share our information, particularly that pertaining to itabirites with you.

2.0 ITABIRITE FLOTATION

The flotation of silica from Brazilian itabiritic low grade ore is an efficient and flexible process. Efficient in that it is relatively uncomplex to upgrade ore 15-20 percentage points and flexible in that mill operator can adjust final concentrate grade to compensate for fluctuations in ore feed composition. Acceptable iron concentrate grade and recovery are easily achieved via a variety of beneficiating schemes. This ease of upgrading is due primarily to the noticeable absence of troublesome middling particles in the feed. Liberation of iron and silica at about 10-20 mesh (1.70 mm—850μm) results in a good clean separation using only a few flotation stages. High grade concentrates are realized with only one bank of rougher flotation cells in many cases, however,

for superconcentrates cleaner cells may be added. Closed circuit iron recoveries of 90% and better are possible when two stage scavenger flotation is employed; or as much of the silica is in the coarser particle size fraction, +200 mesh (75μm), fine screening and recirculation of the screen undersize from a single stage scavenger froth may suffice.

3.0 EVALUATING ITABIRITES FOR CONCENTRATABILITY

Much of our experience at Ashland relates to lab testing amines and processes on itabirites for possible plant application. In developing methods for upgrading these itabirites via flotation invariably the areas of critical importance that must be defined are:

1) The effects of particle size and distribution on flotation grade and recovery.
2) The effects of slimes on flotation response.
3) The effects of hematite depressants on flotation response.
4) The effects of collectors, frother and pH on flotation efficiency.

3.1 THE EFFECTS OF PARTICLE SIZE AND DISTRIBUTION ON FLOTATION GRADE AND RECOVERY

The grinding characteristics of the ore to be tested must be ascertained. This can be achieved by grinding presplit ore charges for varying times such as 8, 12, 16 and 20 minutes each, all other conditions such as ball charge, % solids, RPM of mill, and chemical additives being held constant. These ground charges may then be further tested using a preliminary flotation procedure. Results when plotted on a graph should indicate optimum flotation grind times necessary to achieve desired metallurgy. Generally, too coarse a grind results in a decrease in concentrate grade whereas extremely fine grinding leads to excessive fine hematite losses in the tailings.

3.2 THE EFFECTS OF SLIMES ON FLOTATION RESPONSE

With itabirites, excessive slimes are detrimental to flotation for the following reasons: They inhibit coarse silica flotation by coating the particles thus preventing complete amine adsorption, they consume large amounts of collector due to their tremendously high surface area, their presence cause extensive flotation times and voluminous froths. The easiest way to minimize these adverse effects is to incorporate a desliming step. This can be accomplished by conditioning the ground slurry with a small amount, usually 100-250 g/t of a dispersant such as sodium silicate followed by a settling period and subsequent siphoning of the supernatant slimes. This cycle of agitation, sedimentation, and siphoning may be repeated as many times as necessary until the desired weight rejection is obtained. Most itabirites we have processed required less than two stages of deslime to remove 3-10% weight percent. Total iron loss is usually less than five percent.

3.3 THE EFFECTS OF HEMATITE DEPRESSANTS ON FLOTATION RESPONSE

Depressants are used where minerals to be separated have similar flotation characteristics — for example quartz and hematite. Without the addition of a hematite depressant, amine collectors will adsorb on both minerals resulting in poor selectivity. It is important that depressants be thoroughly evaluated as to both starch type and method of dispersion preparation in order to achieve the best performance. For our testing on itabirites we use pearl starch of Brazilian origin prepared by adding six parts starch as a cold water slurry to boiling water containing one part NaOH. Too little starch results in fine hematite flotation during later stages of flotation with significantly higher iron unit losses in the tailings.

3.4 THE EFFECTS OF COLLECTORS, FROTHERS AND pH ON FLOTATION EFFICIENCY

Effective mineral separation via froth flotation with itabirites requires the use of chemical additives. They are:

1) The collector or flotation reagent which imparts the hydrophobicity to the silica.
2) The frother which lowers the aqueous surface tension to produce a semistable foam at the air-water interface.
3) The pH regulator, in this case NaOH, which is used to enhance the selective adsorption of the collector to a specific mineral surface.

Good collectors, such as Arosurf MG-98A or MG-83, should be liquid, easily dispersible, highly active, selective and readily available. The easiest method of evaluating collectors is to test them side by side under standard conditions carefully noting difference in grade achieved, use levels and recovery. The appearance of large, sparsely mineralized bubbles usually indicate amine starvation. Inversely a highly meticular froth indicates that fine hematite is being floated due to over reagentization. Typically 75-125 g/t amine is sufficient to upgrade itabirites. Frother requirements are usually one-fourth that of the amine. Frother types and ratios may be determined by simple substitution.

The desired pH for economical flotation can also be determined by experimentation. The data from three or four lab tests run at different pH's should yield an acceptable determination of the optimum.

4.0 DATA FROM TESTS

The following selected data from tests using two distinct types of itabirites, ores A+B, illustrate the metallurgy that can be achieved as the process is optimized.

ORE A

Grind		Deslime			Starch Conditioning		Rougher Flotation		
Time	Sodium Silicate	No. of Stages	Settling Period	pH	Pearl Starch	NaOH	Arosurf MG-98A	MIBC	pH
12	250 g/t	1	2.5'	7.8	375 g/t	85 g/t	100 g/t	25 g/t	8.7

Product	Wt. %	Assay % Fe	% Fe Dist.	Cum. % Fe Dist.
Conc	51.53	68.56	70.36	70.36
Scav 1 UF	13.87	62.46	17.23	87.59
Scav 2 UF	6.59	43.07	5.66	93.25
Froth	24.64	8.48	4.16	97.41
Slimes	3.37	38.50	2.59	100.00
	100.00	50.21	100.00	

ORE B

Grind		Deslime			Starch Conditioning		Rougher Flotation		
Time	Sodium Silicate	No. of Stages	Settling Period	pH	Pearl Starch	NaOH	Arosurf MG-83	MIBC	pH
10	250 g/t	1	3.0'	7.5	500 g/t	250 g/t	125 g/t	25 g/t	7.95

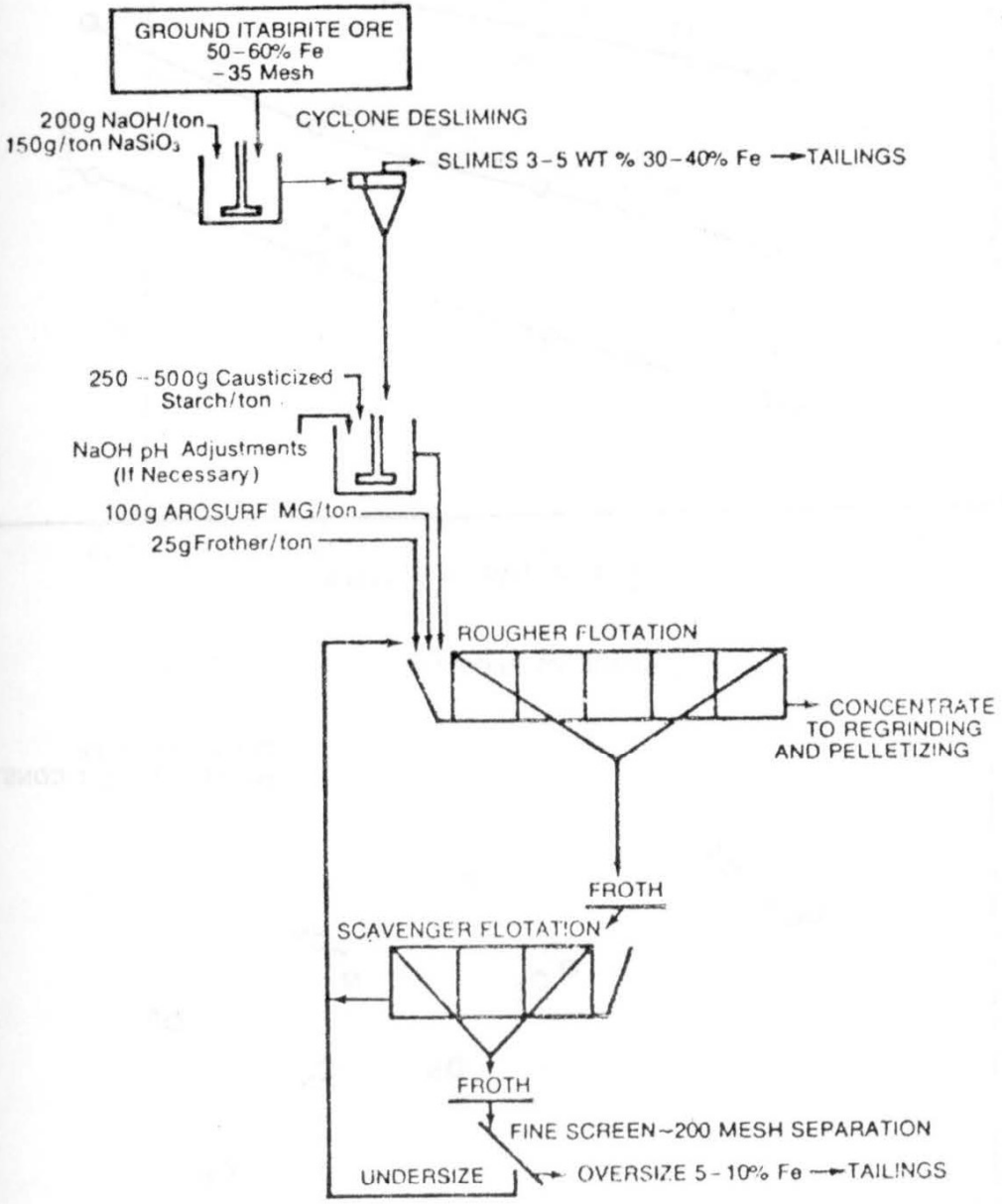
Product	Wt. %	Assay % Fe	% Fe Dist.	Cum. % Fe Dist.
Conc	59.82	66.15	76.94	76.94
Scav 1 UF	10.11	60.01	11.80	88.74
Scav 2 UF	2.84	54.94	3.03	91.77
Froth	22.98	8.83	3.95	95.72
Slimes	4.24	51.84	4.28	100.00
	100.00	51.43	100.00	

Locked cycle tests were run on ore Type A. The purpose was to measure the effects of recycled scavenger underflows on concentrate grade and recovery. Equilibrium was achieved during cycles 5 through 8. Average concentrate grade was 68.63% Fe. No attempt was made to compensate for increased amine concentration from recycled products, therefore, recovery was unrepresentatively low (88.09%).

METALLURGICAL BALANCE ON CYCLES 5 THROUGH 8

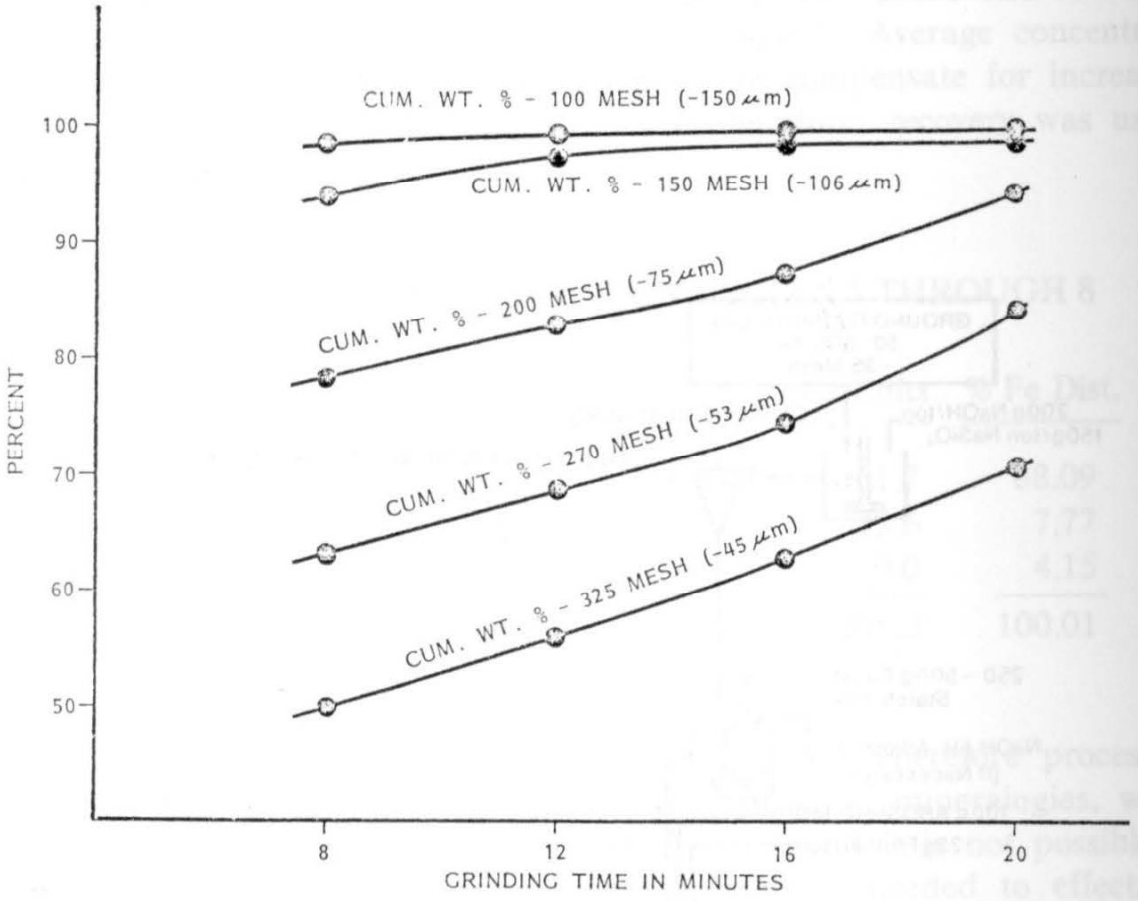
Product	Wt. (GMS)	% Fe	Fe Units	% Fe Dist.
Conc	1547.0	68.63	1061.7	88.09
Froth	707.2	13.24	93.6	7.77
Slimes	126.9	39.40	50.0	4.15
Calculated Head Assay	2381.1	50.62	1205.3	100.01

No two ores respond to flotation exactly the same. Therefore processing alterations and modifications to accommodate different mineralogies, water chemistry, etc., are quite common. With this in mind it is not possible to predict the exact chemical and physical parameters needed to effectively upgrade any individual ore without testing. However, experience has shown us that the basic criteria for evaluating itabirites for concentratability frequently encompass those mentioned in this paper, and we thank you for allowing us to present them.

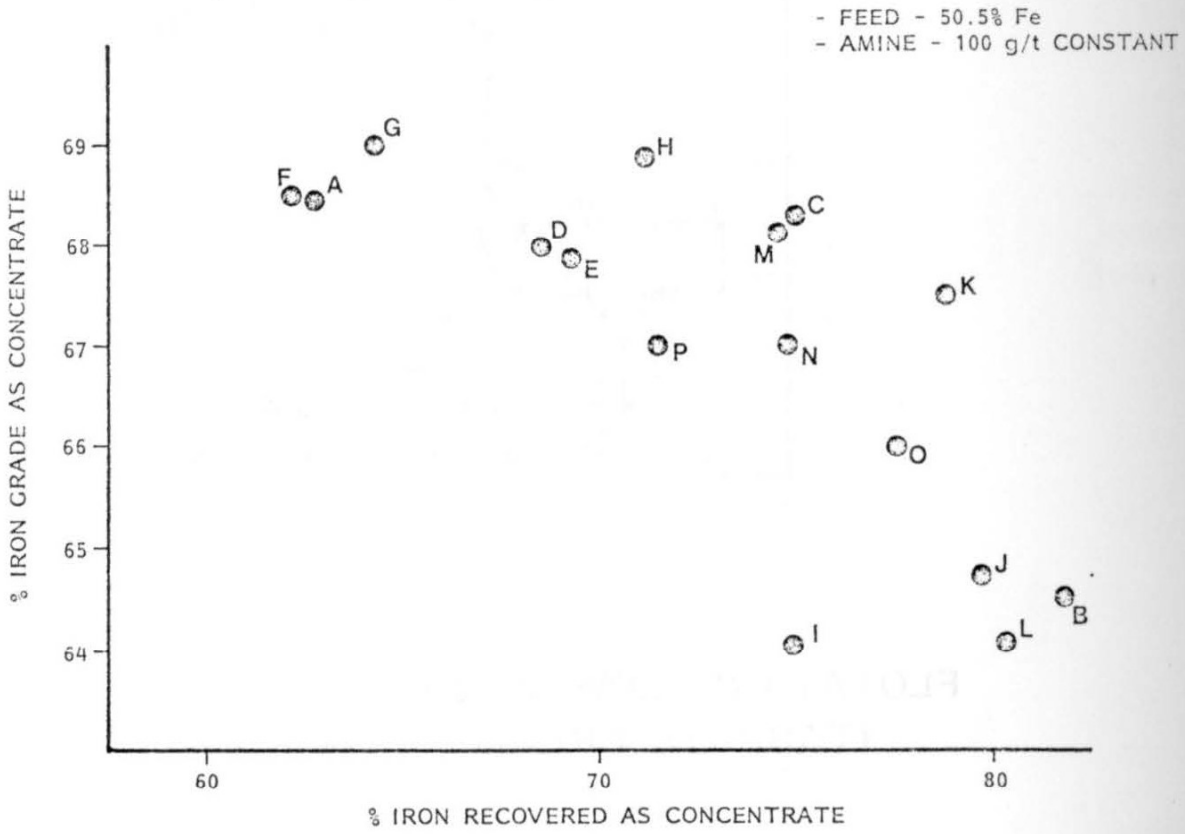


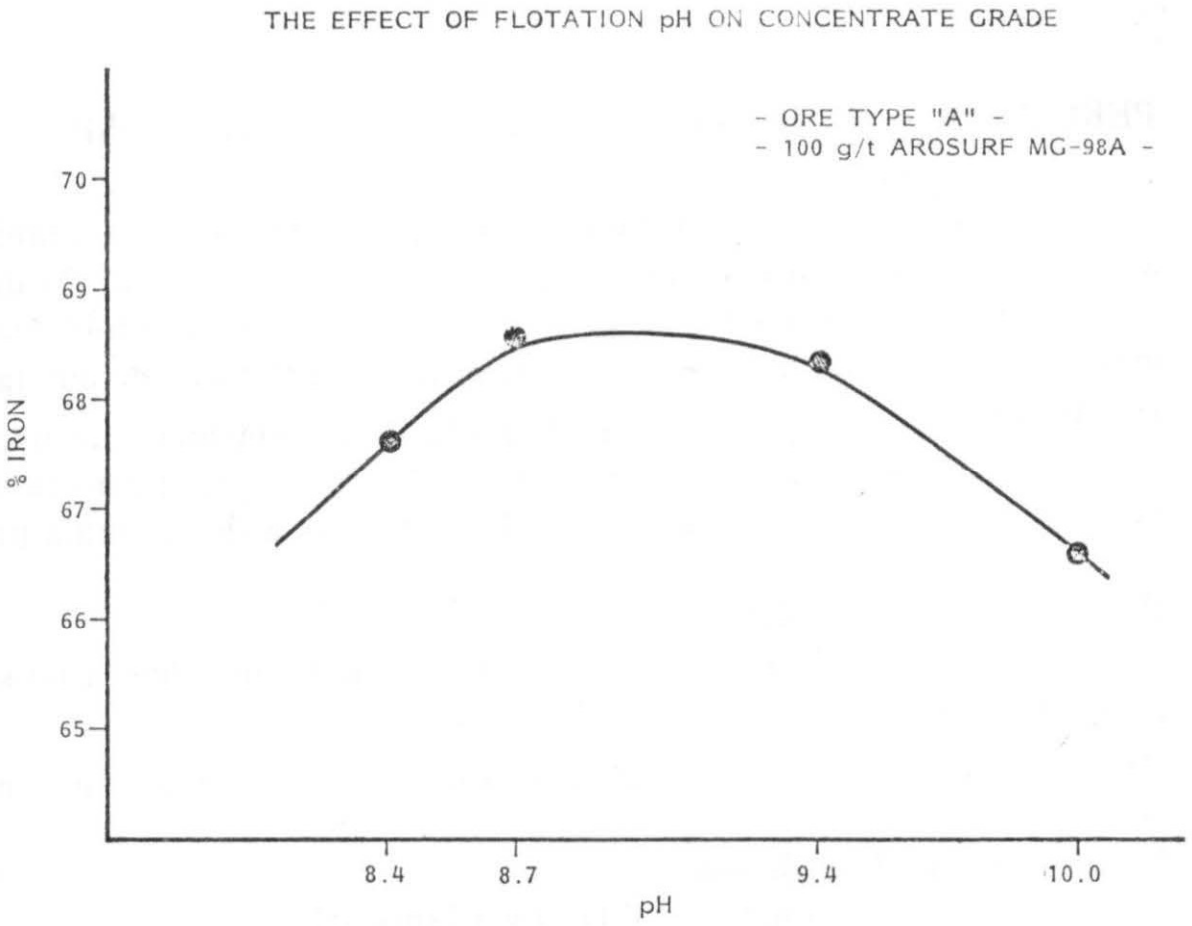
FLOTATION FLOW SHEET
ITABIRITE ORE

SIZE DISTRIBUTION VS GRINDING TIME IN LAB BALL MILL



GRADE VS RECOVERY




THE EFFECT OF FLOTATION pH ON CONCENTRATE GRADE
- ORE TYPE "A" -
- 100 g/t AROSURF MG-98A -
% IRON
70
69
68
67
66
65
8.4
8.7
9.4
10.0
pH

DEBATES

PERGUNTA — Sr. José Geraldo — Escola Politécnica — USP.

Eu gostaria de saber o seguinte:

No uso da Etamina, já houve algum problema quanto à estabilidade do acetato de amina com a temperatura e o tempo de estocagem. Porque eu tive referências há pouco tempo de que a C. S. estava com um problema de espumação demais na flotação, que acho seja devido à flotação de aminas ácidas.

RESPOSTA — Em primeiro lugar, gostaria de informar que não estamos usando tiaminas e sim tiaminas primárias. Até 50° de temperatura não houve nenhum problema. Não estamos usando a etamina e sim a amina primária.

Pergunta do Sr. Coordenador:

A Ashland está tomando, ou já tomou alguma providência no sentido de produzir a Amina, no Brasil, a MEB e MIBC?

RESPOSTA — Estamos planejando fabricar este produto aqui, no Brasil.

Pergunta do Sr. Coordenador:

E que tipo de amina a Ashland vai fabricar?

RESPOSTA — Será o tipo MG-98A, é um tipo para distribuição. Os catálogos trazem a estrutura química deste tipo de aminas que vamos fabricar no Brasil (os catálogos serão distribuídos). Na maior parte são heterominas. Está tudo explicado no catálogo e não são derivadas de coco.

Pergunta do Sr. Coordenador:

Quanto à matéria prima, os Srs. vão fabricar, no Brasil, o amoníaco, ou vão depender de importação?

RESPOSTA — Alguma coisa vai depender de importação. Provavelmente, no início deverá ser importada, mas será uma pequena parte apenas. A maior parte das matérias-primas serão de origem nacional, inclusive o amoníaco.

O COORDENADOR — Gostaria de saber se alguém deseja fazer mais alguma pergunta sobre esse tipo de processo de concentração do Itabirito.

(Pausa).

Agradecendo mais uma vez a presença de todos aproveito a oportunidade para convidá-los a assistirem a mais uma conferência logo após o intervalo. Está encerrada a sessão