Tecbio

Our Business is Biodiesel

Technical Aspects of Biodiesel Production

Workshop INMETRO
Measurement and Standards for Biofuels: Enabling a Transition from Petroleum as a Vehicular Energy Source

Rio de Janeiro, September 14th, 2006

Expedito José de Sá Parente, Jr.
Technical Director

Tecbio

Our Business is Biodiesel

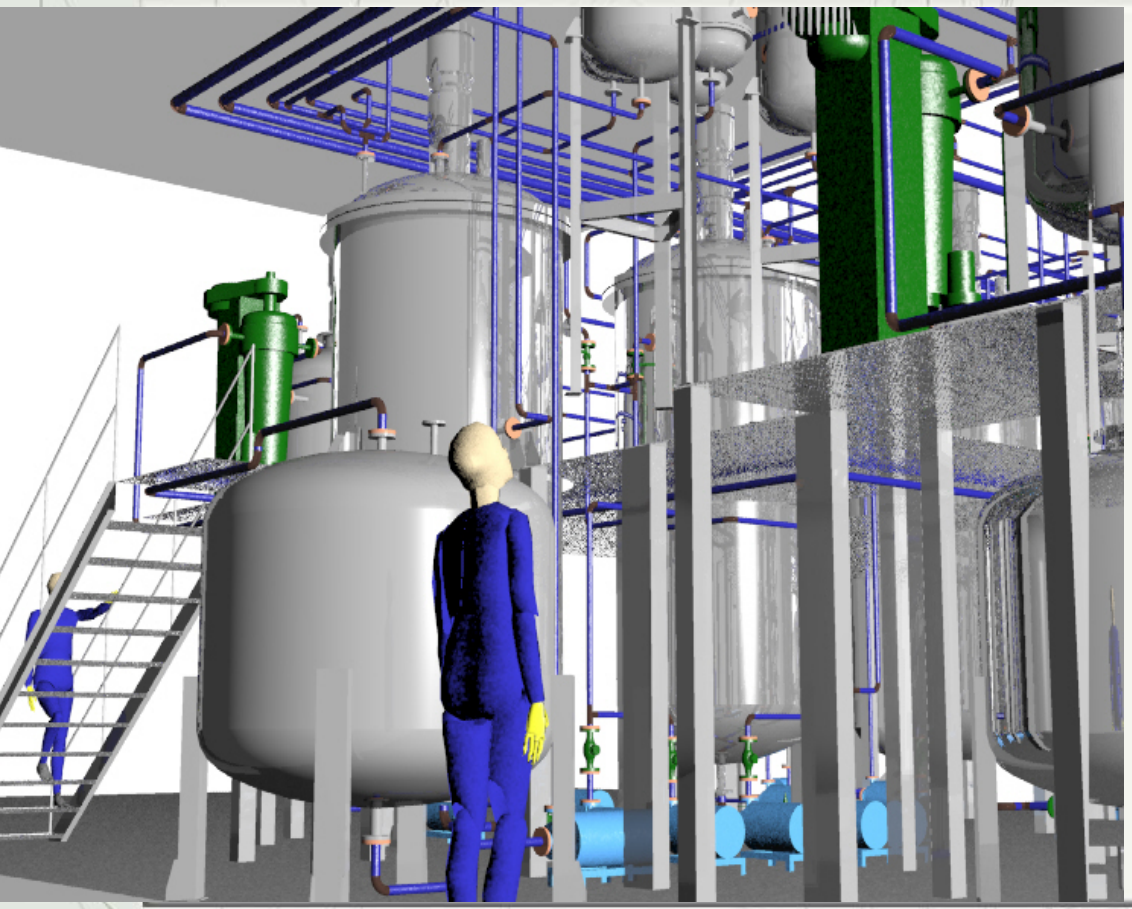
What is Biodiesel?

Definition

It is a renewable fuel, composed by fatty acid methyl (or ethyl) esters, produced by a transesterification reaction between vegetable oil or animal fats and methanol (or ethanol).

Tecbio

Our Business is Biodiesel



Industrial Production of Biodiesel

Tecbio Our Business is Biodiesel

Sources of Raw Materials

What is Plural Biodiesel ?

- Biodiesel production from any kind of vegetable oil, animal fat or lipidic residues.
- Use of methanol or ethanol as transesterifying agent.
- Biodiesel production in a small, medium e large scale, regarding the regional motivations.

Tecbio Our Business is Biodiesel

Productivity of Vegetable Oils

Nature	Yield (kg/ha.year)	Oil Content (%)	Productivity (kg seed./ha.year)
Soya	560	20	2.800
“Nabo forrageiro”	240	30	800
Castor Bean	470	47	1.000
Sunflower–Intra-harvest	572	44	1.300
Sunflower – summer	792	44	1.800
Cotton seed	361	19	1.900
Rapeseed	713	38	1.876
Peanut–dry region	563	45	1.251
Peanut–wet region	788	45	1.751

source: Embrapa

Tecbio Our Business is Biodiesel

What is the Technical Difference among Raw Materials?

- Yield per hectare
- Cost & Price
- Employability
- Nature of Impurities
- Composition of Fatty Acids
  - Number of Carbons
  - Number of Double Bonds
  - Presence of Chemical Groups

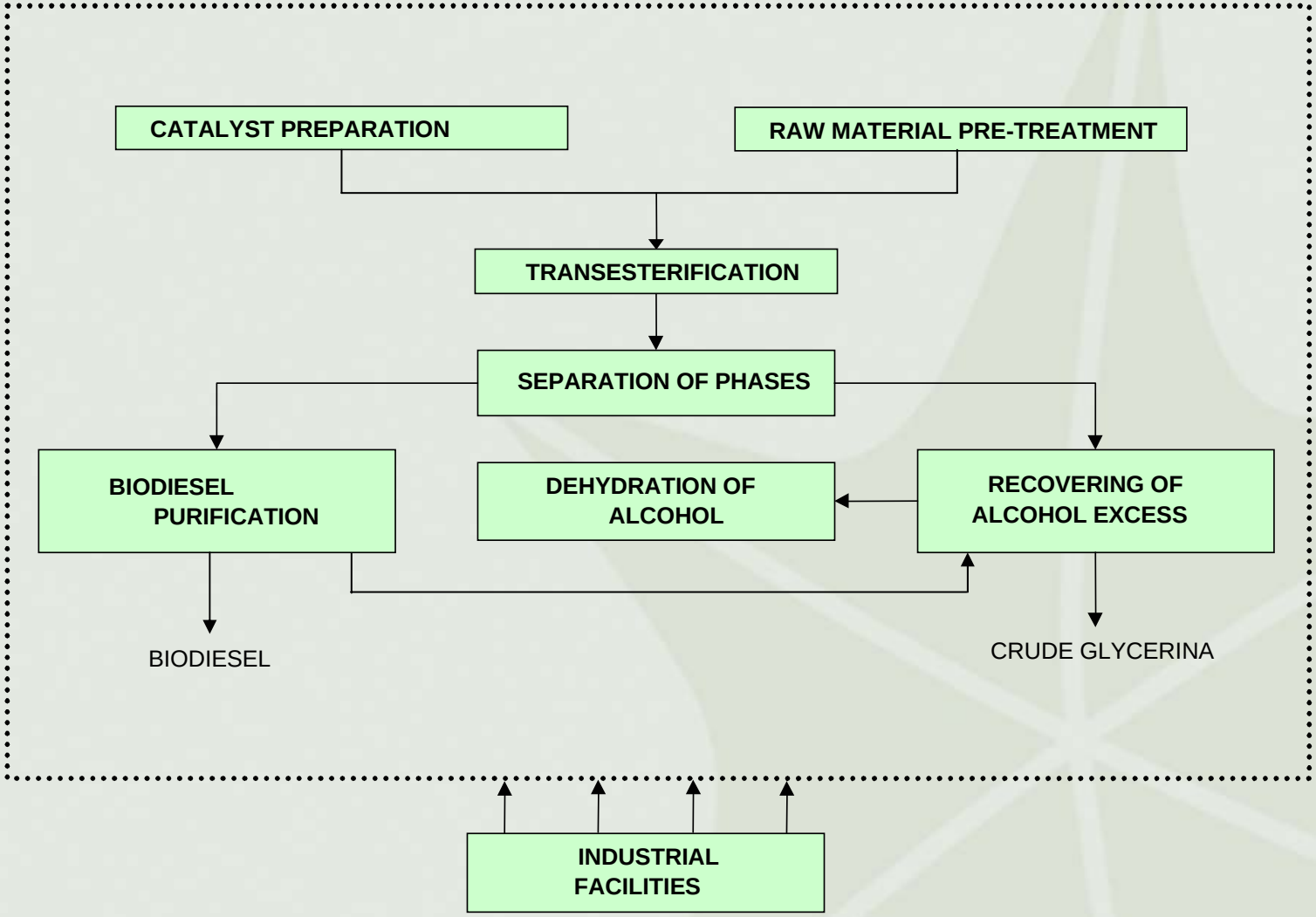
Nome	Nº C	Nº Duplas
Caprílico	08	0
Cáprico	10	0
Láurico	12	0
Mirístico	14	0
Palmítico	16	0
Esteárico	18	0
Araquídico	20	0
Oléico	18	1
Linoléico	18	2
Linolênico	18	3
Ricinoléico	18	1 + OH

Biodiesel in Brazil

- **December 2004 – ANP 42/04 – Biodiesel specification and authorization of its use.**
- **Federal Laws developing production and use of biodiesel.**
  - taxes incentives associated with fomentation of family agriculture.
  - starting in 2006: addition to diesel oil of all biodiesel available from family agriculture is mandatory.
  - addition in diesel oil of 2% of biodiesel in 2008 and 5% in 2013 is mandatory.
    - Demand of 800.000 tons. in 2008 e 2.500.000 tons. in 2013.
- **Installed Capacity:**
  - 2005: ~ 50.000 tons/year
  - 2006: ~ 600.000 tons/year

Tecbio Our Business is Biodiesel

Block Diagram of Industrial Process



Tecbio Our Business is Biodiesel

What is the Difference Among Biodiesel Production Technologies ?

- Required Quality of Raw Materials
- Mass and Energy Balance
- Quantity and Quality of By-Products.
- Quantity and Quality of Residues.
- Operational Aspects of the Process:
  - Process Control
  - Maintenance
  - Dynamic and Stability of the Process
  - Flexibility
- Investments vs. Scope
- Guarantees

Tecbio

Our Business is Biodiesel

Comparative Evaluation among International Specifications

ANP 42/2004 – ASTM D6751 – EN 14214

		ANP 42/2004					EN 14214	ASTM D6751
PROPERTIES	Type	METHOD			UNT	LIMIT	LIMIT	LIMIT
		ABNT NBR	ASTM D	EN/ISO				
Aspect	P	-	-	-	-	LII	NE	NE
Density @ 20ºC	N	7148, 14065	1298, 4052		kg/m3	Anotar (1)	NE	NE
Kinematical Viscosity @ 40°C,	N	10441	445	EN ISO 3104	mm2/s	Anotar (1)	3,5 - 5,0	1,9 - 6,0
Water, max. (2)	P	-	2709	-	% v/v	0,05	500 mg/kg	500 mg/kg
Total Contamination (3)	P	-	-	EN 12662	mg/kg	Anotar	24	NE
Flash Point, min.	P	14598	93	EN ISO3679	°C	100	120	130
Ester Content (3)	P	-	-	EN 14103	% w/w	Anotar	96,5	NE
Distillation; 90% vol. recovered, max.	N	-	1160	-	°C	360	NE	360
Carbon Residue of 100% distillated, max.	P	-	4530, 189	EN ISO 10370,	% w/w	0,1	NE	0,05
Ashes, max.	P	9842	874	ISO 3987	% w/w	0,02	0,02	0,02
Total Sulfur (3)	P	-	4294, 5453	EN ISO 14596	% w/w	Anotar	10 mg/kg	15 mg/kg
Na + K, máx	P	-	-	EN 14108, EN 14109	mg/kg	10	5	NE
Ca + Mg (3)	P	-	-	EN 14538	mg/kg	Anotar	5	NE
Phosphorus (3)	P	-	4951	EN 14107	mg/kg	Anotar	10	10

		PORTARIA ANP 42/2004					EN 14214	ASTM D6751
CARACTERÍSTICA	Tipo	MÉTODO			UND	LIMITE	LIMITE	LIMITE
		ABNT NBR	ASTM D	EN/ISO				
Corrosividade ao cobre, 3h a 50 °C, máx.	P	14359	130	EN ISO 2160	-	1	1	3
Número de Cetano (3)	N	-	613	EN ISO 5165	-	Anotar	51	47
Ponto de entupimento de filtro a frio, máx. (1)	N	14747	6371	-	°C	-7		NE
Índice de acidez, máx.	**P**	**14448**	**664**	**EN 14104 (4)**	**mg KOH/g**	**0,8**	**0,5**	**0,8**
Glicerina livre, máx.	**P**	**-**	**6584 (4)**	**EN 14105 (4) EN**	**% massa**	**0,02**	**0,02**	**0,02**
Glicerina total, máx.	**P**	**-**	**6584 (4)**	**EN 14105 (4)**	**% massa**	**0,38**	**0,25**	**0,24**
Monoglicerídeos (3) .	**P**	**-**	**6584 (4)**	**EN 14105 (4)**	**% massa**	**Anotar**	**0,8**	**NE**
Diglicerídeos (3)	**P**	**-**	**6584 (4)**	**EN 14105 (4)**	**% massa**	**Anotar**	**0,2**	**NE**
Triglicerídeos (3)	**P**	**-**	**6584 (4)**	**EN 14105 (4)**	**% massa**	**Anotar**	**0,2**	**NE**
Metanol ou Etanol, máx.	**P**	**-**	**-**	**EN 14110 (4)**	**% massa**	**0,5**	**0,2**	**NE**
Índice de Iodo (3)	**N**	**-**	**-**	**EN 14111 (4)**		**Anotar**	**120**	**NE**
Estabilidade à oxidação a 110°C, mín	**N**	**-**	**-**	**EN 14112 (4)**	**h**	**6**	**6**	**NE**
Éster metílico de ácido linoléico, máx.	N				% massa	NE	12	NE
Éster metílico de ácido polinsaturado (>= 4	N				% massa	NE	1	NE
Massa específica a 15ºC	N				kg/m3	NE	860 - 900	NE
Resíduo de carbono dos 10% finais da destilação, máx.	P					NE	0,3	NE

Notes

- NE – Absent on the specification.
- (1) – The mixture biodiesel/diesel oil must reach the diesel oil specification (ANP 310).
- (2) – The method EN ISO12937 can be used to analyze water, since the analysis and the register of the value using the method ASTM D 2709 be applied too.
- (3) – Properties to be analyzed every three months.
- (4) – The referred methods demand validation for some specie of raw material and for ethyl esters.
- N – Property related to the NATURE of raw material.
- P – Property related to quality of the PROCESS.

Tecbio

Our Business is Biodiesel

Properties related to the performance of the PROCESS

CARACTERÍSTICA	PORTARIA ANP 42/2004				
	MÉTODO			UND	LIMITE
	ABNT NBR	ASTM D	EN/ISO		
Aspecto	-	-	-	-	LII
Água e sedimentos, máx. (2)	-	2709	-	% volume	0,05
Contaminação Total (3)	-	-	EN 12662	mg/kg	Anotar
Ponto de fulgor, mín.	14598	93	EN ISO3679	°C	100
Teor de éster (3)	-	-	EN 14103	% massa	Anotar
Resíduo de carbono dos 100% destilados, máx.	-	4530, 189	EN ISO 10370,	% massa	0,1
Cinzas sulfatadas, máx.	9842	874	ISO 3987	% massa	0,02
Enxofre total (3)	-	4294, 5453	EN ISO 14596	% massa	Anotar
Sódio + Potássio, máx	-	-	EN 14108, EN 14109	mg/kg	10
Cálcio + Magnésio (3)	-	-	EN 14538	mg/kg	Anotar
Fósforo (3)	-	4951	EN 14107	mg/kg	Anotar
Corrosividade ao cobre, 3h a 50 °C, máx.	14359	130	EN ISO 2160	-	1
Índice de acidez, máx.	**14448**	**664**	**EN 14104 (4)**	**mg KOH/g**	**0,8**
Glicerina livre, máx.	**-**	**6584 (4)**	**EN 14105 (4) EN**	**% massa**	**0,02**
Glicerina total, máx.	**-**	**6584 (4)**	**EN 14105 (4)**	**% massa**	**0,38**
Monoglicerídeos (3) .	**-**	**6584 (4)**	**EN 14105 (4)**	**% massa**	**Anotar**
Diglicerídeos (3)	**-**	**6584 (4)**	**EN 14105 (4)**	**% massa**	**Anotar**
Triglicerídeos (3)	**-**	**6584 (4)**	**EN 14105 (4)**	**% massa**	**Anotar**
Metanol ou Etanol, máx.	**-**	**-**	**EN 14110 (4)**	**% massa**	**0,5**

Tecbio

Our Business is Biodiesel

Properties related to the

NATURE of raw material

	PORTARIA ANP 42/2004				
CARACTERÍSTICA	MÉTODO			UND	LIMITE
	ABNT NBR	ASTM D	EN/ISO		
Massa específica a 20ºC	7148, 14065	1298, 4052		kg/m3	Anotar (1)
Viscosidade Cinemática a 40°C,	10441	445	EN ISO 3104	mm2/s	Anotar (1)
Destilação; 90% vol. recuperados, máx.	-	1160	-	°C	360
Número de Cetano (3)	-	613	EN ISO 5165	-	Anotar
Ponto de entupimento de filtro a frio, máx. (1)	14747	6371	-	°C	-7
Índice de Iodo (3)	**-**	**-**	**EN 14111 (4)**		**Anotar**
Estabilidade à oxidação a 110°C, mín	**-**	**-**	**EN 14112 (4)**	**h**	**6**

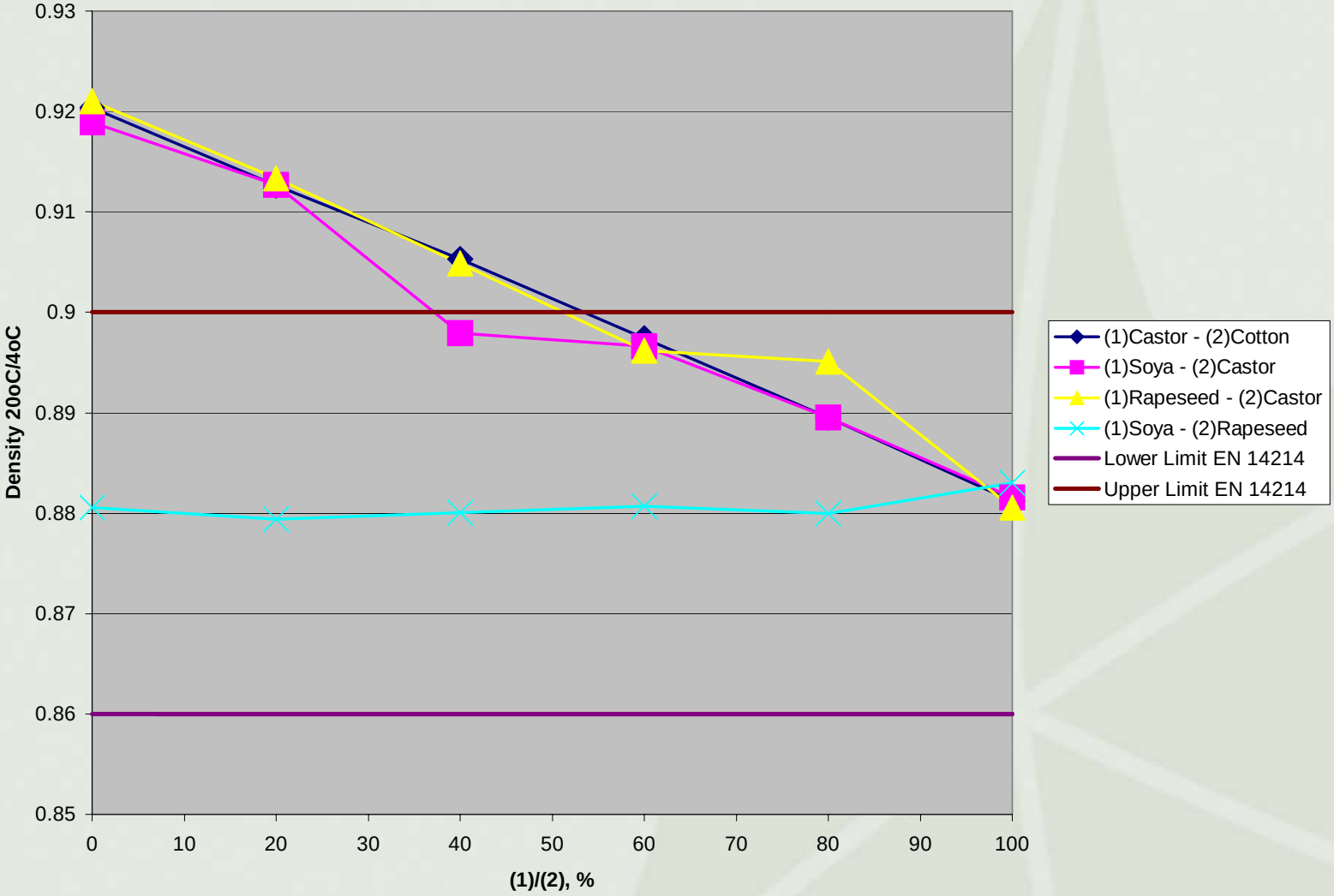
Conclusions

- Flexibility for a Multi-Feedstock Biodiesel Production
- Establishment of Limits "*Anotar*" (Just Note) for the properties that its analytical METHOD or even its LIMIT is still un-defined due to the diversified raw material nature.
- Control that the blend biodiesel/diesel oil (BX) must reach totally the specification of diesel oil (ANP 310).

- METHOD: Incentive for development of analytical methods for multi-feedstock purpose.
- LIMIT: Necessity of blend of among biodiesel from different raw material to reach American and European specifications.

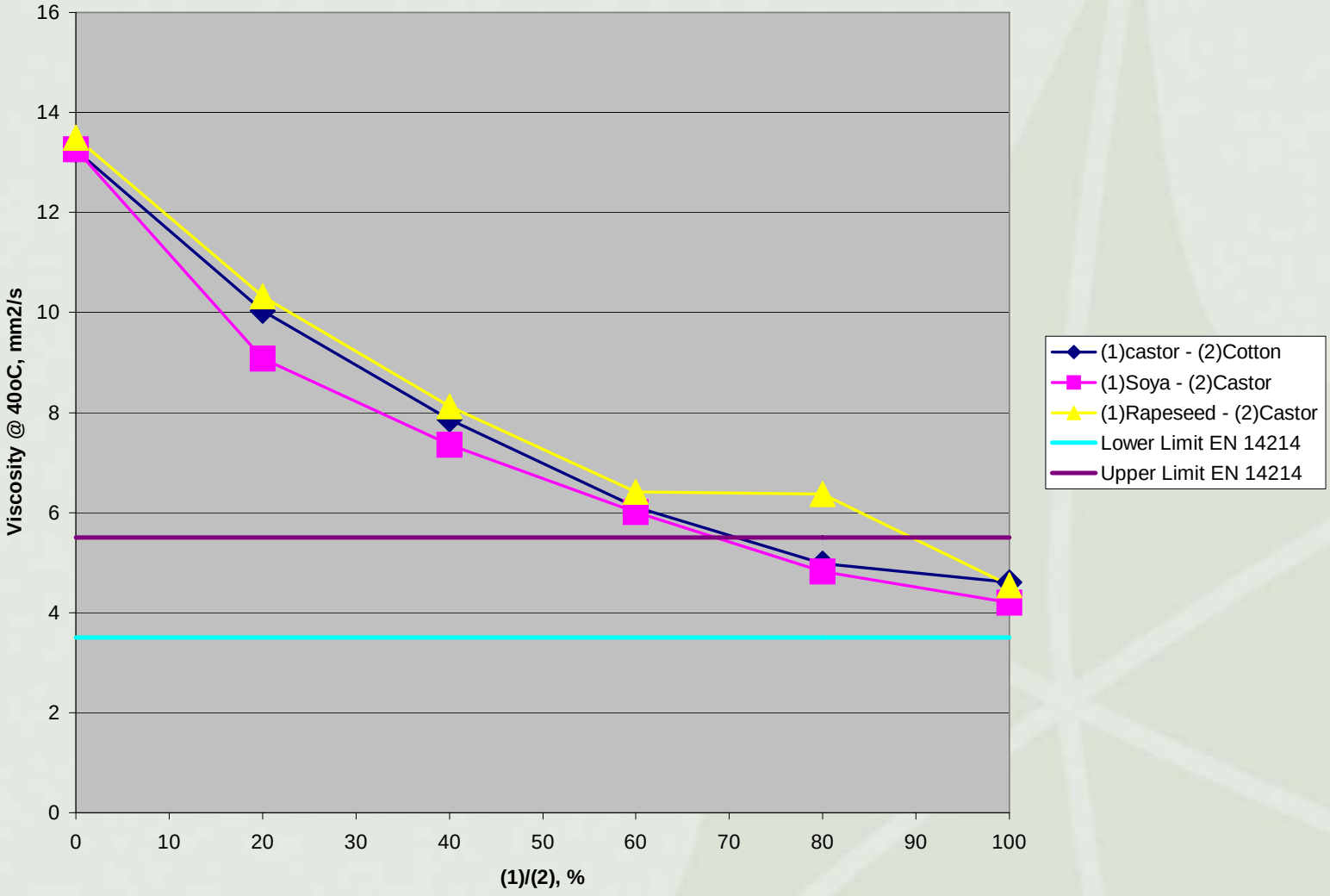
Tecbio Our Business is Biodiesel

Biodiesel Blends - Density

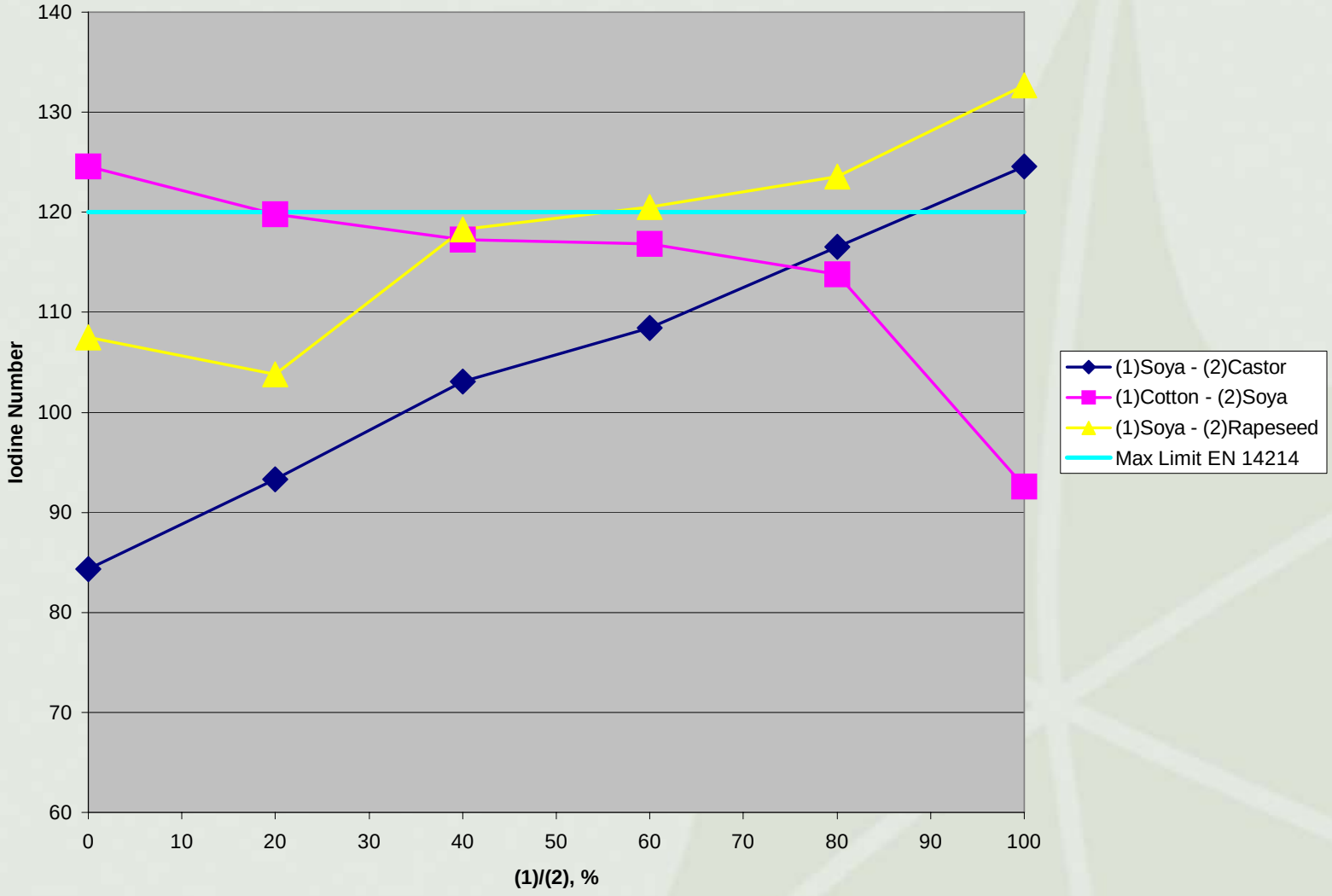


Tecbio Our Business is Biodiesel

Biodiesel Blends - Viscosity



Biodiesel Blends – Iodine Number



Challengers for the biodiesel production and trading

- Raw material providing.
- High cost of opportunity of vegetable oil valorized by the chemical market.

POTENTIAL MARKET: m3 / year		ALLOWED PRICES: US$ / ton
$< 1 \times 10^5$	FÁR-MACOS	> 2.000
$< 8 \times 10^6$	PRODUTOS QUÍMICOS	> 1.000
$< 1 \times 10^7$	PRODUTOS ALIMENTÍCIOS	> 600
$> 5 \times 10^8$	BIOCOMBUSTÍVEIS	< 600

Challengers for the biodiesel production and trading

- Increase yields on the oil-seeds production.
- Valorization of by-products, specially glycerin.
- A real multi-feedstock biodiesel production, regarding all the aspects, not only the technical ones.
- Establish of quality standards of different raw materials.
- Development of analytical methods for the quality control of the process and the products.
- An uniform international specification.

tecbio

Our Business is Biodiesel

Internal view of industrial-pilot plant in the campus of Federal University of Piauí (Brazil).

Projeto patrocinado pela ELETROBRAS e CEPISA

tecbio

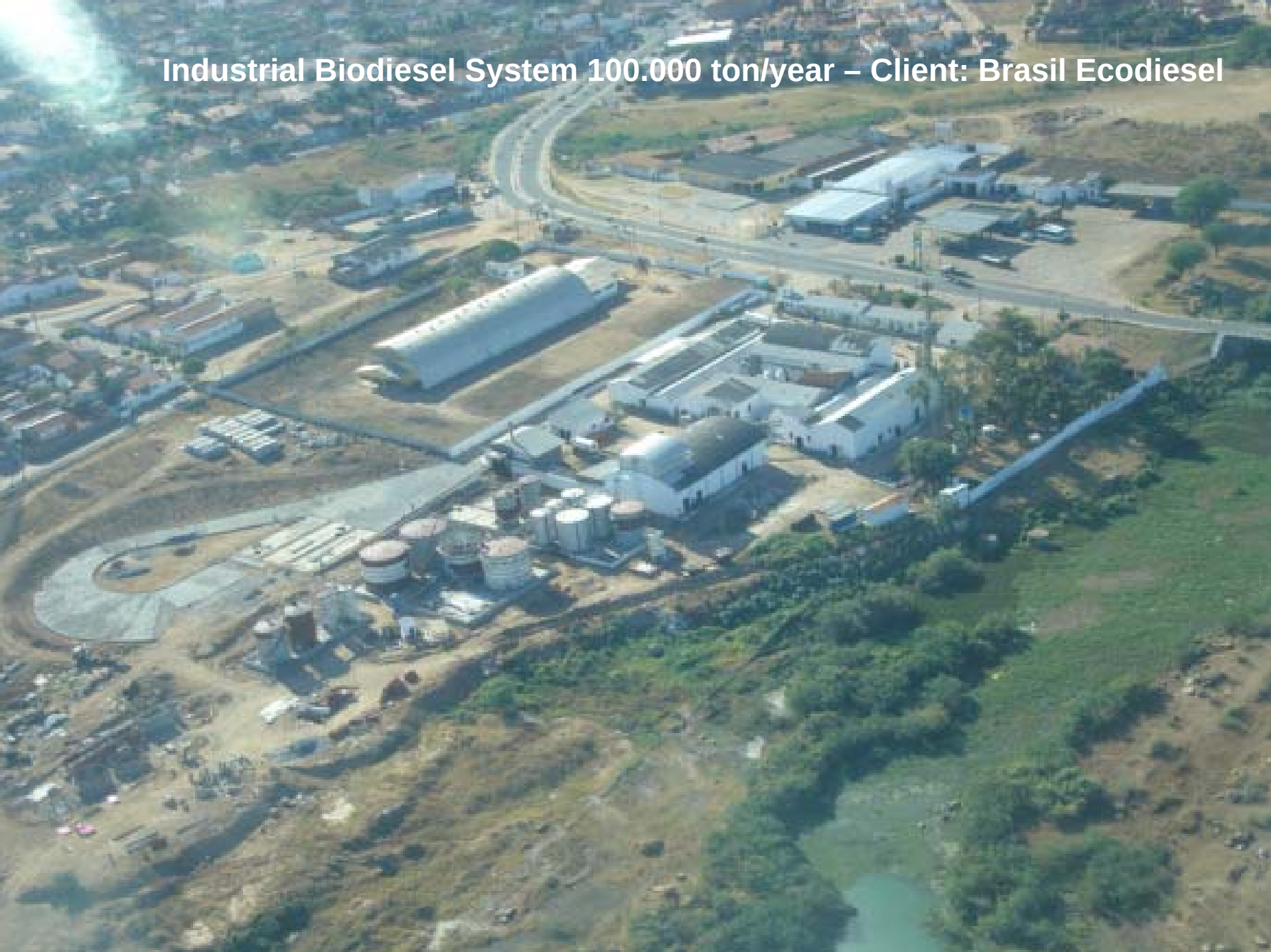
External view of the industrial-pilot plant in the campus of Federal University of Piauí (Brazil), showing the storage tanks and the process building.

Projeto patrocinado pela ELETROBRAS e CEPISA

Industrial Biodiesel System 40.000 ton/year – Client: Brasil Ecodiesel

Industrial Biodiesel System - 40.000 ton/year - Client: Brasil Ecodiesel

Industrial Biodiesel System 40.000 ton/year – Client: Brasil Ecodiesel


Industrial Biodiesel System 100.000 ton/year – Client: Brasil Ecodiesel

Tecbio Our Business is Biodiesel

Thank you very much !

Expedito José de Sá Parente Júnior

Technical Director

TECBIO – Tecnologias Bioenergéticas Ltda.

Fax\Phone:

(+55) (85) 32 87 17 91

(+55) (85) 32 87 67 28

(+55) (85) 32 87 13 77

expeditojr@tecbio.com.br

www.tecbio.com.br