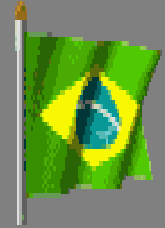


9th IWA Spec. Conference
Large Wastewater Treatment Plants
Prague, Czech Republic, 2003



**COST – EFFECTIVE SOLUTIONS FOR SEWAGE
TREATMENT IN DEVELOPING COUNTRIES**

THE CASE OF BRAZIL

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UNIVERSIDADE FEDERAL DO RIO DE JANEIRO

BRAZIL

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Introduction

- Less than 55% of the urban population of Brazil has public sewers, and less than 20% of the wastewater is treated.
- The challenge: which are the most efficient and cost-effective levels of treatment? Which processes provide sustainability in a developing country such as Brazil?

Introduction

Special attention has been given to the so called low-cost treatment :

- **Chemical Enhanced Primary Treatment (CEPT);**
- **Upflow Anaerobic Sludge Blanket Reactors (UASB);**
- **Chemical Sludge Stabilization (CSS).**

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The CEPT Experience

A + 100 years old process

It was used in USA, until 1930s; it fell into disfavor due to:

- **The required high application of metal salts;**
- **Consequent high chemical sludge generation;**
- **Advent of the activated sludge process.**

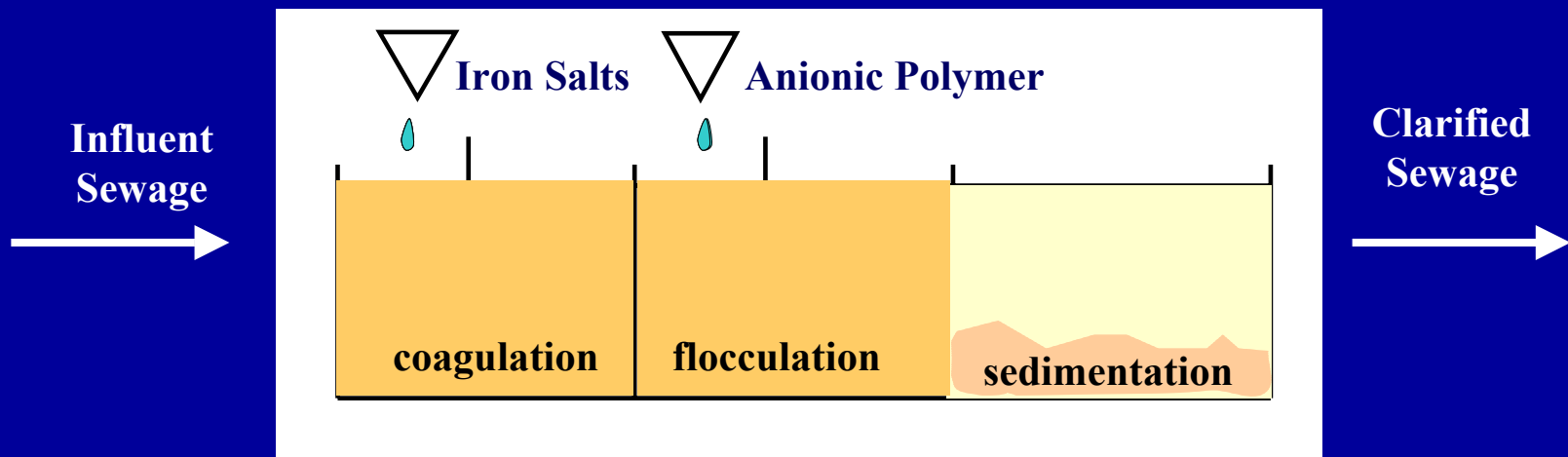
Nowadays, the CEPT process found its place again :

- **Recent offer of less costly chemicals;**
- **Low dose chemical coagulation, new polymers.**

The CEPT Experience

Process Description

CEPT is a wastewater treatment technology based on suspended solids removal by physical-chemical processes of coagulation, flocculation and sedimentation.



- **BOD removal up to 50%; TSS removal up to 80%;**
- **Great economy in investment costs.**

The CEPT Experience

Results obtained in Brazil



The difference between such results, may be explained by both plants being operated well under design flow and having part of the flow diverted from two different polluted rivers

Month (*)	BOD removal (%)		TSS removal (%)	
	Pavuna STP	Sarapuí STP	Pavuna STP	Sarapuí STP
June	63,3	-	78,5	67,1
July	69,9	42,7	62,9	65,0
Aug.	60,8	39,0	65,4	82,1
Sept.	69,6	42,1	70,4	85,1
Oct.	59,7	41,1	55,3	75,1
Nov.	63,2	43,0	52,6	65,1
Dec.	59,0	-	67,7	65,0

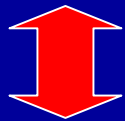
Start-up and Initial Operation

The CEPT Experience

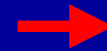
Sludge Increase

- Sludge generation is increased in the CEPT concept;
- Increase costs in sludge conditioning, stabilization and drying.

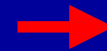
**Conventional activated sludge
preceded by CEPT process
(30mg/l FeCL₃ dose)**



**Conventional activated sludge
preceded by conventional primary
clarifiers**



**Goiânia STP
(increase of 32%)**



**Hyperion, Los Angeles
(increase of 24%)**

The CEPT Experience

Chemical Sludge

In Brazil, the higher costs due to sludge augmentation have been counterbalanced by choosing Chemical Sludge Stabilization (CSS) instead of the classic anaerobic digestion: Pavuna, Sarapuí, Goiânia, Virgem Santa, Guapimirim, Lavapés STP.

The case of Goiânia STP:

Sludge Treatment	Initial Stage: Primary Treatment CEPT	Final Stage: Secondary Treatment CEPT + Activated Sludge
Anaerobic Digestion	R\$ 18 x 10 ⁶	R\$ 63 x 10 ⁶
Chemical Stabilization	R\$ 10 x 10 ⁶	R\$ 47 x 10 ⁶
Economy	44%	25%

(*) Database: year 1999

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The UASB Experience

The main characteristics

**High sludge age
(usually over 30 days)**



**Smaller amount of excess sludge
produced**

**Low hydraulic
detention time**



Lower construction costs

The UASB Experience

The main characteristics

- Compact system, using a small surface area;
- Practically no equipment in the anaerobic vessel, with low construction and operational costs;
- Very low energy consumption;
- Low excess sludge produced;
- The excess sludge has a good concentration, with good drying characteristics.

The UASB Experience

The main disadvantages

- High potential for H₂S generation; bad odors?
- Low capacity of receiving toxic loads;
- Low start-up; inoculation needed;
- Effluent: below legal standards;
- Limited efficiency: 45-70% COD; 55-75% BOD;
- < 1log FC; 0% N, P.

The UASB Experience

UASBs in Brazil

- **Onças STP, Belo Horizonte, MG: 3,0 m³/s (design phase)**
 - **Atuba Sul STP, Curitiba, PR: 1,5 m³/s (operational)**
 - **Sta. Quitéria STP, Curitiba, PR: 0,6 m³/s (operational)**
 - **Piracicamirim STP, São Paulo, SP: 0,4 m³/s (operational)**
- **BOD Efficiency: between 55 and 75%**
 - **COD Efficiency: between 50 and 70%**

The UASB Experience

Legislation

- UASB effluent always above 60 mgBOD/l, up to 120;
- Above legal limits;
- 30 to 60 mg/l are required according to different State legislation.

**Research Program on feasible
technologies for UASB post-treatment**

The UASB Experience

UASB + Post-treatment: Research Program

Process	Description	Average Design
Trickling Filter	Gravel media	0,75 BOD/m ³ d
Aerated Submersed Filter	Gravel media	0,85 BOD/m ³ d
	PVC modules or plastic media	1,6 BOD/m ³ d
Dissolved Air Flotation	With FeCl ₃ coagulation and flocculation	40 mg/l
		20 minutes
		30 - 60 - 90 s ⁻¹ G
Aerated Ponds	Machanical aerators	2 days detention time
	Sedimentation ponds	1 day detention time
Activated Sludge	Plug flow aerated tanks	4 days sludge age

(*) for temperatures betw een 20 and 26 °C

The UASB Experience

UASB Design Criteria

Criteria	Value for average flow
Hydraulic volumetric load	< 4,0 m ³ /m ² .d
Hydraulic detention time	6,0 - 9,0 h
Upflow velocity	0,5 - 0,7 m/h
Overflow rate in the clarifier zone	14,4 - 19,2 m ³ /m ² .d
Hydraulic detention time in the clarifier zone	1,5 - 2,0 h
Solids generation	0,1 - 0,2 Kg TSS/Kg influent COD
Excess sludge concentration	2,0 - 5,0 %
Sludge specific weight	1020 - 1040 Kg TSS/m ³

(*) for temperatures between 20 and 26 °C

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CEPT as a Pre-Treatment Process

When applying any chemical process, one must be aware of the many disadvantages that chemical products have:

- Acquisition
- Storage
- Handling
- Safety
- Costs

Discussion

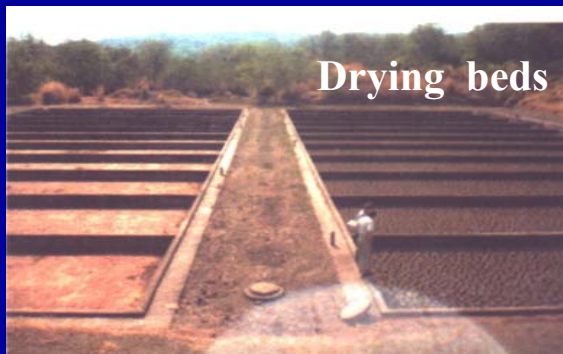
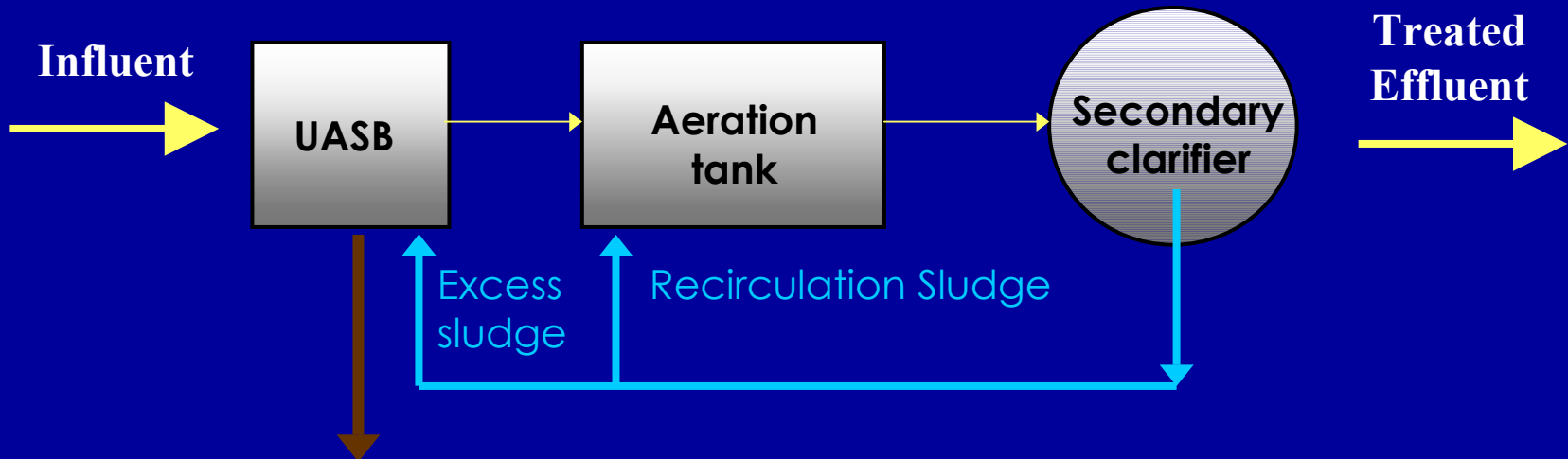
CEPT as a Pre-Treatment Process and its Costs

The case of Goiânia STP:

Treatment Pattern	Initial Stage (R\$ x 10 ⁶)	Final Stage (R\$ x 10 ⁶)	Final Stage (R\$ x 10 ⁶)
1. Conventional Primary + Activated Sludge + Anaerobic Digestion	17,1	56,8	60,7
2. CEPT + Activated Sludge + Anaerobic Digestion	18,7	45,6	55,8
3. CEPT + Activated Sludge + CSS	10,5	37,5	55,6
4. CEPT + Anaerobic Digestion (IS) and Conventional Primary + Activated Sludge + Anaerobic Digestion (FS)	18,9	51,6	63,4

Discussion

UASB reactors as Pre-Treatment units



Discussion

UASB reactors as Pre-Treatment units

- **Double the BOD or COD removal rates (as compared to conventional primary units);**
- **Lower volume of sludge produced;**
- **Construction and operation costs are lower;**
- **The plant may be constructed in stages: first the UASB, later the pos-treatment;**
- **Costs of secondary treatment units are reduced by about half;**

Discussion

UASB reactors as Pre-Treatment units

- In the activated sludge process following an UASB reactor, the energy is cut to 45 to 55% of the conventional system without nitrification, and up to 65 to 75% with nitrification;
- The cost of UASB + aerobic treatment < 80% of the cost of a conventional secondary treatment;
- Sludge production is lower and the excess can be returned to the UASB reactor;
- The final excess sludge is well digested and has good drying properties.

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Conclusion

CEPT or UASB = GREAT BENEFITS

- **They reduce the size, the investment and the operational cost of secondary treatment;**
- **They can be implemented in steps of treatment and are competitive to other technologies;**
- **They prove to be feasible for developing countries, where construction costs are always a limiting factor for sewage treatment expansion.**



PRAGUE STP



Thank you !

Dikuji !

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CENTRO EXPERIMENTAL DE TRATAMENTO DE ESGOTOS
ESCOLA POLITÉCNICA