Progress in HCH infrastructures in the Basque Country

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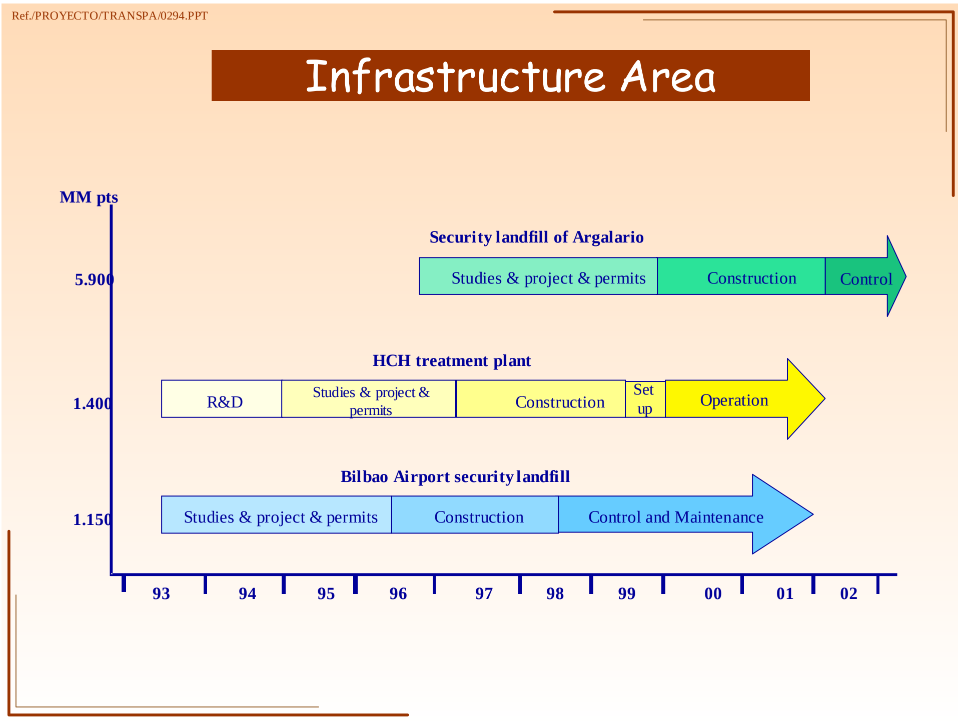
Background

At the 5th HCH Forum in June 1998, IHOBE, S.A. explained the basic lines of the strategy adopted by the Department of Land Use, Housing and the Environment to solve the problems caused by the uncontrolled dumping of HCH in the Basque Autonomous Community. Of the three key infrastructure elements envisaged under that strategy, the safety landfill for confining 110,000 m^3 of HCH-contaminated soil at Bilbao airport had already been successfully completed.

The HCH treatment plant was under construction, and the Argalario safety landfill for 300,000 m^3 of contaminated soil was in the bidding stage. Since then the HCH treatment plant has been built, tested and set up, and it has now been destroying pesticide since some months. Construction of the Argalario landfill is well under progress.

We shall now attempt to explain the progress made in these two projects and give preliminary results for the operation of the plant. We must remark that both projects are founded by the Cohesion Found of the European Union with 80% of the costs.

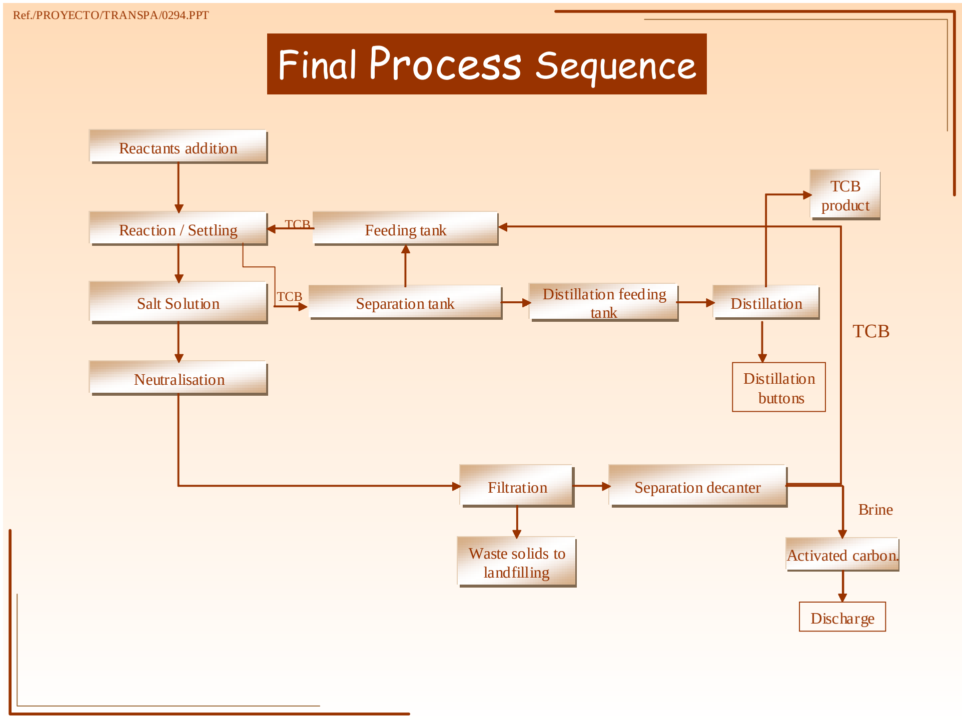


HCH plant

Setting up of the HCH plant began in June 1999 and was completed in December the same year. During those 6 months, trials were run on all the equipment and modifications were made at various stages of the process to ensure that the design capacity would be reached.

The plant came in operation in January 2000, and is expected to finish operation by December this year with the treatment of approximately 3,500 tonnes.

The sequence of the HCH treatment process is as follows:



Process stages

HCH Preparation

The HCH is stored in 1 cubic metre industrial big-bags. A fork-lift truck takes these bags to the separation and milling system, where an elevator feeds them into the processing area.

Product handling begins with the opening of the bags and a coarse sieving to separate any stones and other objects measuring more than 5 cm. The HCH is then broken up in a ball mill and finally put through a 5 mm sieve so that waste can be fed into the reaction system via a vertical conveyor.

The air in the area where the bags are opened is cleaned by bag and activated carbon filters. This enables the air in the workshop to be renewed according to the legal emission limits.

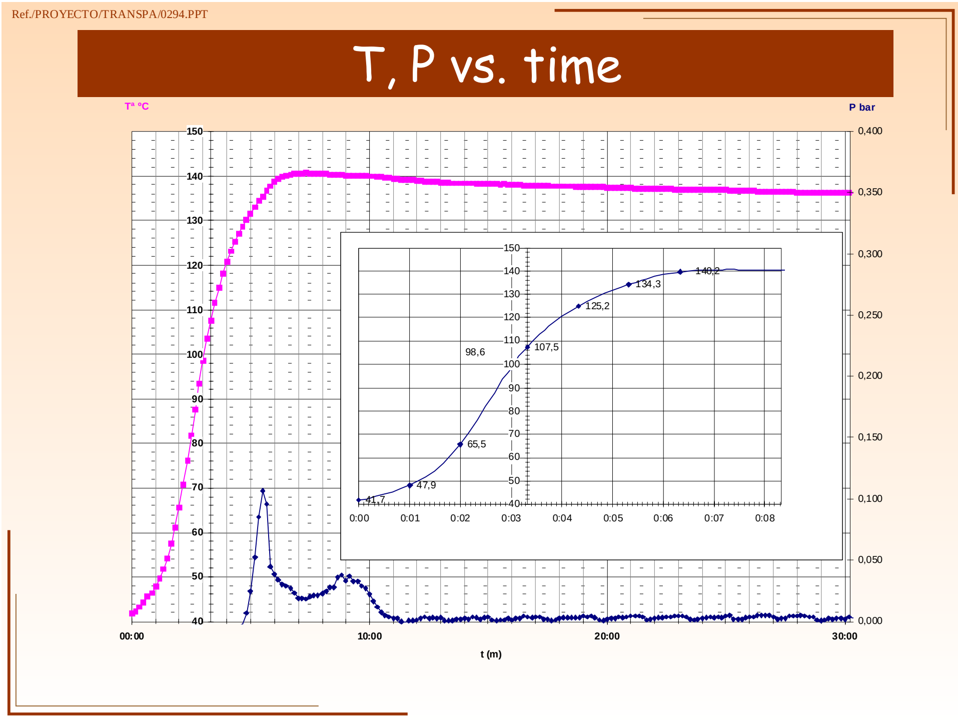
Reaction

The HCH is stored in a holding hopper, then taken on by a worm screw mechanism to a weighing hopper, where the 600 kg required for the reaction are weighed off.

The hopper discharges by gravity into a dispersal tank, where TCB is added to form a suspension. The resulting mixture is taken to one of the reactors where additional TCB is then fed into the reactor to make up the necessary amount of approximately 4,400 kg.

In turn, the caustic soda required for the reaction is discharged into the reactors. Approximately 260 kg of sodium hydroxide is added per reaction batch.

Finally the catalyst is added and the chemical reaction is set off.



After 30 seconds of reaction, TCB, sodium chloride and water are obtained:

$$C_6H_6Cl_6 + 3NaOH \xrightarrow{cat} C_6H_3Cl_3 + 3H_2O + 3ClNa$$

The two reactor units of the plant work alternately, so that while one is reacting the other is being loaded. With this overlap the design output can be achieved.

Separation

Once the reaction is over, the next stage is to separate the organic phase, i.e. TCB, from the non-organic phase, i.e. brine.

First of all TCB is removed from the side of the reactor and taken to the TCB circuit, so that the amount separated in each reaction goes into the distillation system and the rest is recirculated for successive reactions.

Water is then added to the contents of the reactor to form a brine solution. After neutralisation of the excess NaOH, this brine and the TCB remaining in the reactor are taken to a press filter, where any small gravel and clay accompanying the HCH are eliminated.

The liquid from the filter is pumped to a decanter, where the big difference in their densities is used to separate the brine from the TCB. This TCB is added to the TCB, which was removed from the side of the reactor.

The brine from the decanter is put through two successive activated charcoal filters, which retain any remaining TCB and HCH. Finally, the treated brine is stored in deposits, chemically characterised and checked for compliance with the relevant governmental licence requirements. If it complies, it is discharged into a tidal area of the river.

The TCB obtained in the reaction can be used in the chemical industry.

To facilitate the further use, the TCB is distilled at the plant to adjust its composition and separate it from the heavier compounds. It is then ready for shipment to the end user.

This facility is automatic, and is run from the control panel. The whole process is controlled and the main data are recorded at the same panel from which all the required equipment during the operation is activated.

Facilities and ancillary equipment

The plant has various ancillary facilities used to assist in the process, including the following:

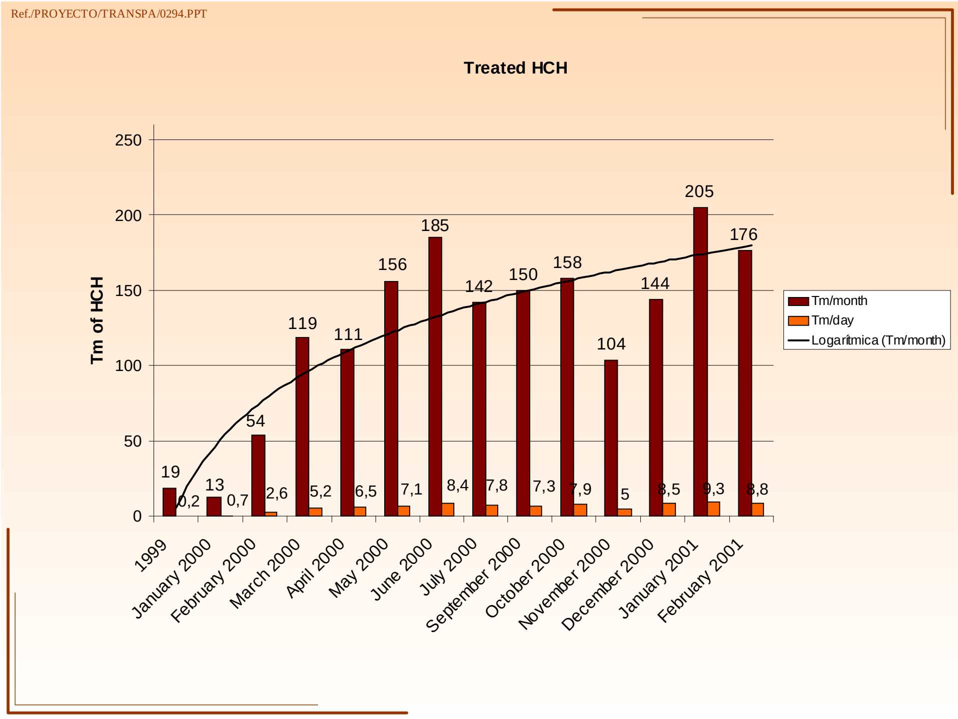
1. A transformer centre to provide electric power for the operation.
2. A water-cooling system with a cooling tower, which provides a continuous supply of cold water to the coolers of the reactors and to the column.
3. A nitrogen input system to inertise tanks & equipment with the presence of hot TCB.

4. Compressed air for instruments.
5. An uninterrupted power system to ensure that the plant can be brought to a stop safely. If the electricity supply cuts off, power is provided for 30 minutes so that reactions can be completed and the process is not interrupted.
6. A fire detection & prevention system.
7. Black/ white changing rooms for personnel and individual protective equipment for employees.
8. An activated charcoal treatment unit for the facility's air renewal system.
9. A laboratory where the process parameters and environmental factors are monitored.

Current plant output

HCH

HCH treatment progress at the facility is shown in the following Figure. As can be seen, over the last three months an average of over 8.5 tonnes per day has been treated.



This will enable that all the material, which is so far stored (proved to be around 3,500 tonnes in the end) will be treated by December 2001. To achieve this, it is estimated that an average of 180 tonnes per month should to be treated.

The TCB produced is now being used in the manufacture of dyes, colourings and agricultural chemicals.

Environmental monitoring

Environmental monitoring at the plant comprises regular monitoring of air emissions from the plant and of the grade of brine discharged.

Air

The facility has 2 stacks: one for renewing the air in the HCH preparation area and the other for the process itself.

During its first 10 months of activity, the concentrations of TCB and HCH were measured daily at each stack. A total of 400 readings were taken. Since then the measurements have been made twice a month and this will be carried out until operations are completed.

The limits set by the licensing authorities are 20 mg/Nm³ for TCB and HCH (ref. TA Luft Technical Instructions on Air). The performed analyses showed highly satisfactory levels, with an average of below 2 mg/Nm³, well below the permitted limit. This is shown in the following Table.

Ref./PROYECTO/TRANSPA/0294.PPT

Emissions Summary

	HCH Store Emissions				Process Plant Emissions				Number of samples
	HCH Concentration mg/Nm³		TCB Concentration mg/Nm³		HCH Concentration mg/Nm³		TCB Concentration mg/Nm³		
	Medium	Maximum	Medium	Maximum	Medium	Maximum	Medium	Maximum	
1999	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	2,5	5,1	6
July	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	4,5	8,9	42
August	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.		44
September	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.		42
October	N.D.	N.D.	N.D.	1,3	N.D.	N.D.	<1	5,0	38
November	N.D.	N.D.	N.D.	N.D2,3.	N.D.	N.D.	1,5	8,7	42
December	N.D.	N.D.	N.D.	1,1	N.D.	N.D.	N.D.	1,0	28
January 2000	N.D.	N.D.	N.D.	2,5	N.D.	N.D.	N.D.	2,4	40
February	N.D.	N.D.	<1	2,0	N.D.	N.D.	1	3,0	42
March	N.D.	N.D.	1,8	3,6	N.D.	N.D.	2	3,8	46
April	N.D.	N.D.	<1	1,9	N.D.	N.D.	1,2	2,0	16
May	N.D.	N.D.	N.D.	1,4	N.D.	N.D.	1,1	1,2	6
June	N.D.	N.D.	1,5	1,8	N.D.	N.D.	1,2	1,3	4
July	N.D.	N.D.	1,1	1,2	N.D.	N.D.	1,9	2,7	4
August	Plant stop for maintenance								
September	N.D.	N.D.	1,3	1,5	N.D.	N.D.	1,5	1,5	4
October	N.D.	N.D.	0,7	1,3	N.D.	N.D.	0,7	1,4	4
November	N.D.	N.D.	1,4	2,4	N.D.	N.D.	0,7	1,1	6
December	N.D.	N.D.	1,8	1,9	N.D.	N.D.	3,7	5,9	4
January 2001	N.D.	N.D.	0,7	1.4	N.D.	N.D.	1,7	2	4
February	N.D.	N.D.	1,2	2,4	N.D.	N.D.	1,2	2,3	4
									426

Emission limits for TCB = 20 mg/Nm³; HCH = 20 mg/Nm³

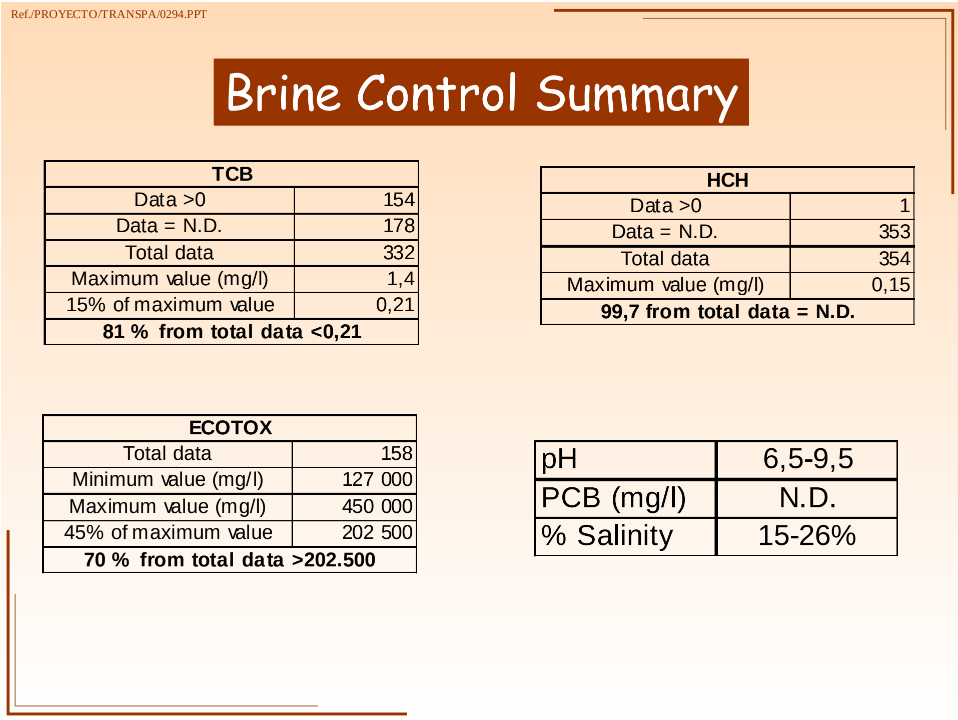
Brine

Exhaustive checks are run on the HCH and TCB concentrations, eco-toxicity, salinity and pH of every 25 m³ batch of the brine generated. The limits set by the authorities are as per the European Directive (90/415/EEC):

Ref./PROYECTO/TRANSPA/0294.PPT

European Directive (90/415/EEC)

Medium value	TCB	HCH
Monthly (g/ Tm)	10	5
Monthly (mg/l)	1	2
Daily (g/ Tm)	20	10
Daily (mg/l)	2	4



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Brine Control Summary

TCB	
Data >0	154
Data = N.D.	178
Total data	332
Maximum value (mg/l)	1,4
15% of maximum value	0,21
81 % from total data <0,21	

HCH	
Data >0	1
Data = N.D.	353
Total data	354
Maximum value (mg/l)	0,15
99,7 from total data = N.D.	

ECOTOX	
Total data	158
Minimum value (mg/l)	127 000
Maximum value (mg/l)	450 000
45% of maximum value	202 500
70 % from total data >202.500	

pH	6,5-9,5
PCB (mg/l)	N.D.
% Salinity	15-26%

Environmental monitoring during operations

Environmental monitoring during operations includes sampling and characterisation in the various media involved to check the changes due to the impact of the former lindane production plant and that of the present plant.

In September 2000, characterisation tests performed on water and soil revealed that HCH and TCB concentrations are comparable to those existing prior to the entry of the HCH plant into operation.

Although it was scheduled for October 2000, air quality sampling actually began on 28/02/01, because the laboratory had difficulties in finding locations for its equipment.

Equipment has now been set up in 2 places 500 m far from the plant (Arteagabeitia and Cruces), and daily samples will be taken for one month.

Up to March 9th, levels of HCH and TCB were not detectable (ND) at a detection limit of 1 ng/m^3 for HCH and 50 ng/m^3 for TCB.

Supplementary studies

IHOBE has commissioned two studies to obtain more details on the performance of the technology used.

The first was being undertaken by the Department of Chemical Engineering, Faculty of Science, University of the Basque Country, under the title "Developing strategies to achieve a conversion less dependent on load characteristics at the HCH treatment plant". This study seeks to make the reaction system more effective and reduce the variation between the different loads.

The study has made progress in collecting process information, assessing it and proposing additional experiments.

The preliminary conclusions are as follows:

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STRATEGIES TO ACHIEVE
A CONVERSION LESS DEPENDENT ON
CHARACTERISTICS OF THE FEED BACTCH
IN THE HCH TREATMENT PLANT.

ANTECEDENTS

The HCH destruction efficiency and process conditions in the HCH treatment plant in Baracaldo, presents high variability due to the presence of inert substances in the HCH batch composition.

This requires to develop an operating strategy that guarantees high HCH reaction efficiency regardless the batch composition.

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STRATEGIES TO ACHIEVE
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IN THE HCH TREATMENT PLANT.

OBJECTIVES

1. Analysis of historic data
   ...to analyse the sensitivity of conversion with process variables
   ...to search the way of indirect monitoring of conversion by process variables

2. Development of a method for indirect monitoring of conversion
   ...by selecting new process variables and designing experiment in the plant
   ...by collecting and analysis of experimental data in the plant

3. Development of operation strategies to reduce the effect of feed batch composition on the conversion
   ...by designing and training of potential strategies
   ...by comparing effectiveness of the potential

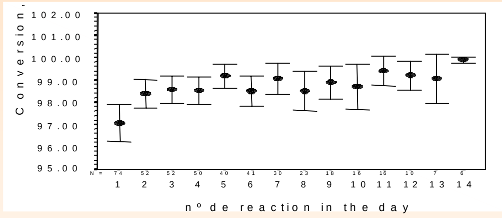
OBJECTIVE 1: Analysis of historic data

METHODOLOGY

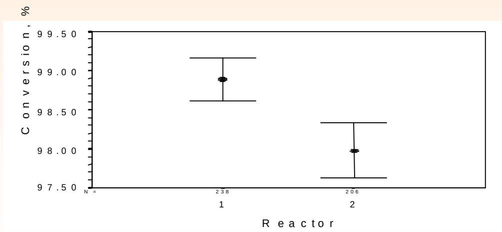
The searching of correlation between conversion and process variables has been made by statistical analysis of historic data.

RESULTS

- Conversion is lower in the first batches treated early in the day



- Reactor A and B operates differently for the same conditions, because of differences in the position of utilities (heating, reflux, cooling....)



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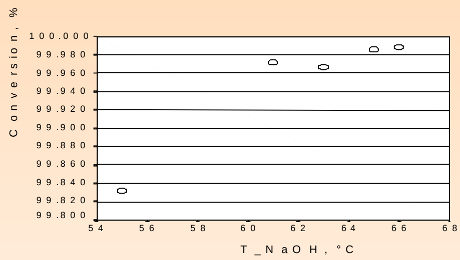
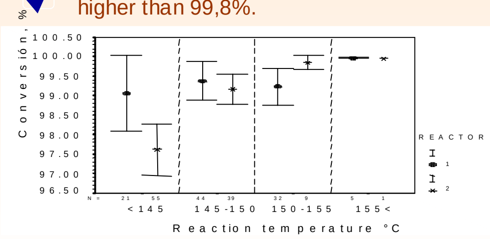
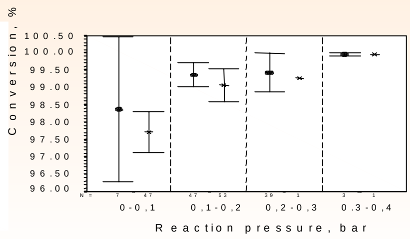
- Conversion is increased by increasing temperature at the beginning of reaction (before adding NaOH)



- When reaction temperature exceeds 155°C and 0,3 bar, conversion is higher than 99,8%.





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CONCLUSIONS

Three process variables are related with conversion:

(1) temperature before adding NaOH

(2) temperature reached during reaction

(3) pressure reached during reaction

only temperature before adding NaOH can be used for indirect monitoring of conversion.

- The second study is carried out by GAIKER, and involves a Life Cycle Analysis of the plant in comparison with other technologies (incineration, safety landfills).

Some very preliminary conclusions of the study are as follows.

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LIFE CYCLE ASSESSMENT

Simplified LCA of different options for the treatment of HCH

Main objectives of this simplified LCA:

-Evaluate the different alternatives for the treatment of HCH waste

-Identify key points of the existing alternative treatments

-Establish the basis for the later exhaustive LCA: need for further data, key impacts...

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IMPACTS CONSIDERED

- Raw material consumption
- Energy
- Hazardous wastes
- Emission of carcinogenic substances
- Respiratory effects caused by organic substances
- Respiratory effects caused by inorganic substances
- Emission of ecotoxic substances

CHARACTERISED RESULTS ACCORDING TO THE METHODOLOGY ECOINDICATOR 99:

- Agregates the emissions of substances during the Life Cycle of a product/process according to their contribution of each impact.
- These results do not provide comparison among different impacts.

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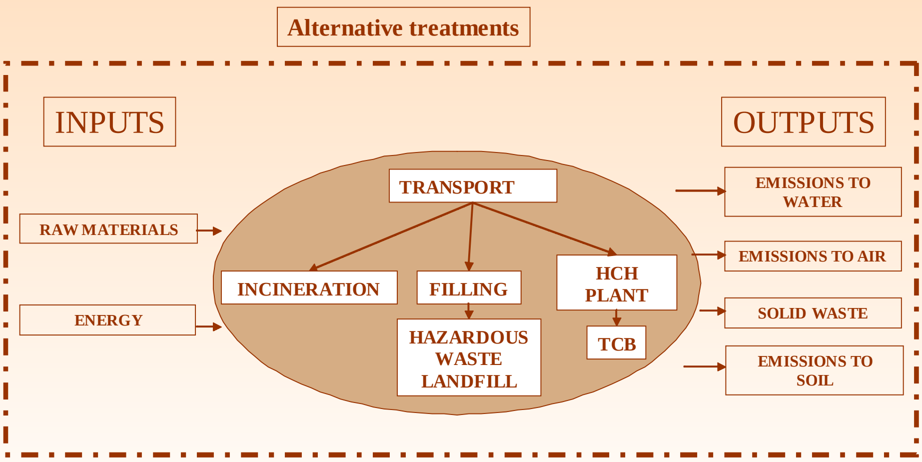
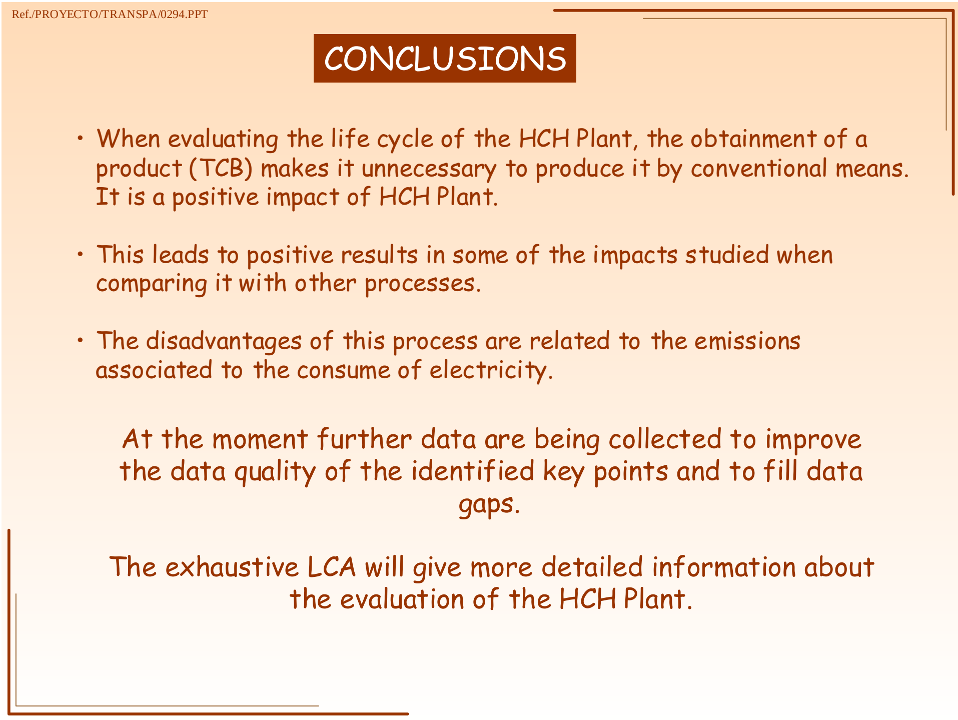
Functional unit: Waste treatment of 5000 tonnes of HCH



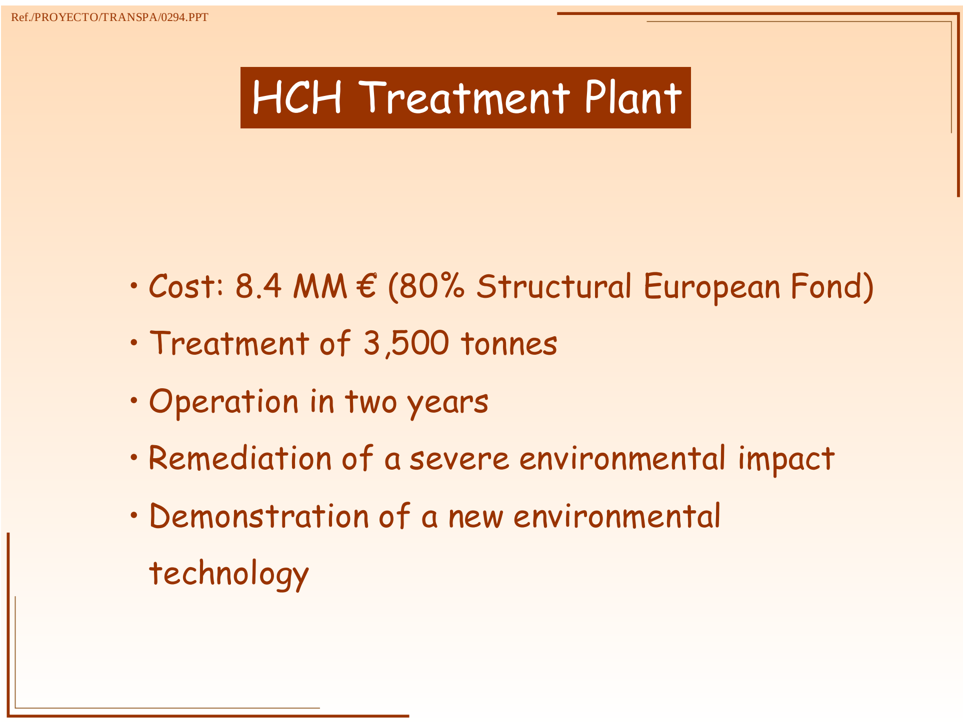


It is expected that this study will be completed in May 2001.

Budget

The budget for the project, including the erection of the plant and two years' operation, amounted up to 8.4 million Euros. 80% of that amount is subsidised by the European Cohesion Fund.

A breakdown of the operating costs of the plant under the relevant subheadings gives the following distribution:



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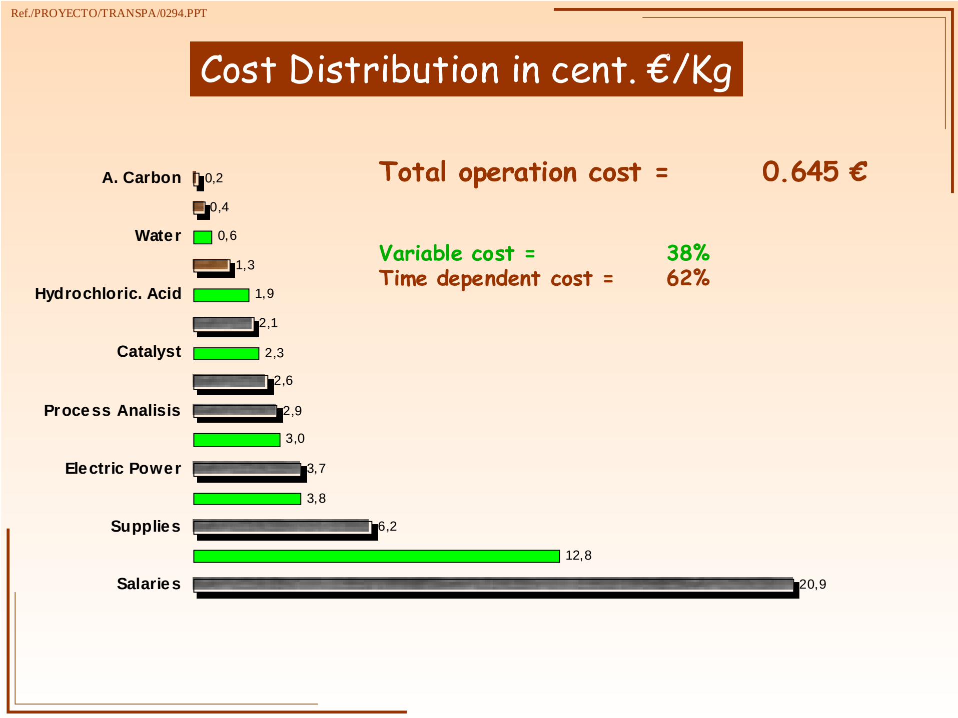

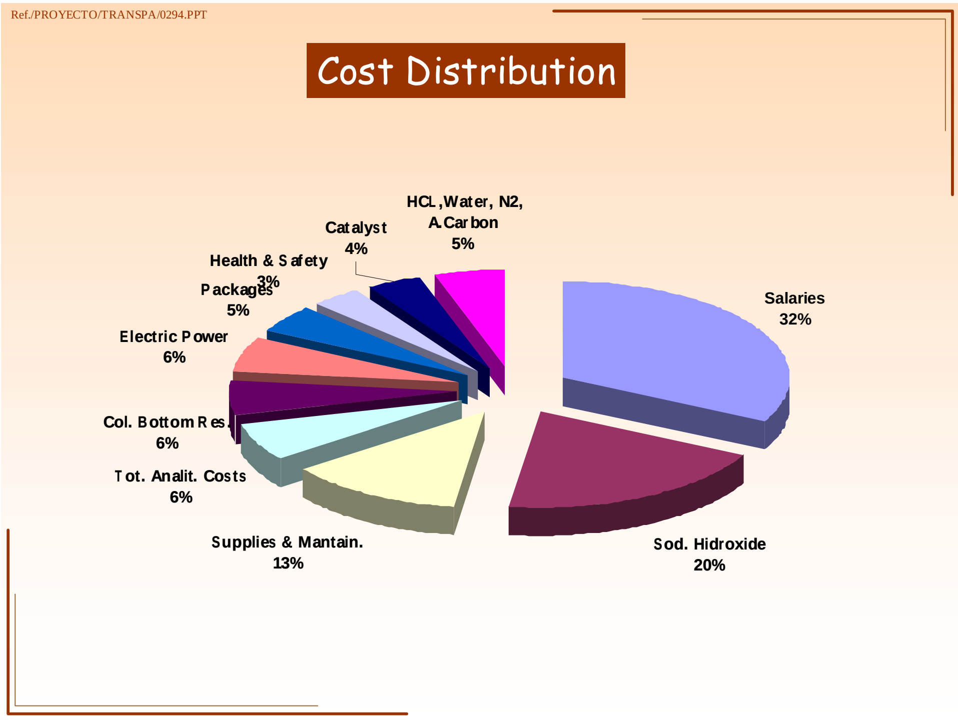

The future

The plant's activity will come to an end in December 2001 once all the pure HCH at the site has been treated.

The plant will then be dismantled, the process buildings will be demolished and the soil, rubble and solid waste from the plant will be confined in the security landfill, which IHOBE is building in the vicinity for HCH-contamanated soil.

Argalario Safety landfill

The following Table shows the major figures for the Argalario safety landfill project.

Ref./PROYECTO/TRANSPA/0294.PPT

Argalario Safety Cell
"Big Figures"

Cost	**4,200 MM pts (25,242,500 €)** Environmental Control: 244 MM pts Health & Safety: 144 MM Quality Control: 28 MM Geotextiles Control: 44 MM Direction of Works: 87 MM Communication and Publications: 38 MM
Time	33 months since Oct. 99
Total Volume	300,000 m^3

Ref./PROYECTO/TRANSPA/0294.PPT

Argalario Safety Cell
"Big Figures"

Domestic waste Landfill	650,000 m^3
Sites to remediate	10 (4 in Barakaldo)
Municipalities (7)	Barakaldo, Sestao, Portugalete, Abanto, Galdames, Ortuella, Erandio
Contaminated soil origin	85% Barakaldo - 15% other
Level of remediation	10 ppm HCH
Different legislation	50
Cell surface	20,000 m^3
Leachate treatment capacity	20 m^3/h
River Burtzako flow capacity	20 m^3/sg
Support barrier for the landfill	70 ml y 1 m diameter
Landfill	1v : 3h
Landfill surface	37,000 m^2
Landfill excavation	81,000 m^3
Cell excavation	11,000 m^3
Cell filling material	88,000 m^3
Road construction	4,000 ml
Surface of support activities	19,000 m^2
Grass seeding area	85,000 m^2
Tree plantation	2,500 ud.

It is expected that the work will be completed in the second quarter of 2002.

By the time when this infrastructure element is completed, 9 years will have elapsed since the completion of the inventory of the contaminated sites, and almost 50 million euros will have been spent to eliminate the problems caused by HCH pesticide waste in the Basque Country.