**TITTLE:** IMPROVING REFINERY MARGIN BY INCREASING CONVERSION. BOTTOM OF THE BARREL TECHNOLOGIES.

**AUTHOR: ALBA SOLER ESTRELLA**

**FORUM:** BLOCK 2. F07 - Competitive refining technologies.

**KEY WORDS:** Bottom of the barrel, increase conversion, improve refinery margin

**ABSTRACT:**

New European Directive 2012/33/CE, published in 2012 and transposed to Spanish Law in 2015 (RD290/2015), obligates to reduce sulfur content in Marine Bunker Fuel to 0.1% wt in ECA areas and 0.5% wt worldwide. Besides, a falling demand for fuel is expected.

Both challenges can be converted into an opportunity: increasing conversion, competitiveness and economics of Spanish refineries.

This paper is focused on a project for one of these refineries, with a Hydroskimming conversion scheme, with elevated high sulfur fuel exportation (> 1,000 kt/year).

An analysis of the state of the art bottom of the barrel technologies has been developed. The most mature and cheaper technology with the target of increasing distillates yields and decreasing fuel production is a Delayed Coker.

A study to determine the technical scope (new units and modifications of the existing ones, plot plan requirements, coke management), allow us to determine the final investment and profitability of the project.

The results of implementing the new project in the refinery are:

- A crude basket change into a heavier, sour and cheaper one
- An increase in refinery conversion
- An increase in medium distillates production
- A decrease in fuel production, solving the problem of bunker new regulation

# IMPROVING REFINERY MARGINBY INCREASING CONVERSION. BOTTOM OF THE BARREL TECHNOLOGIES.

## 1. MARKET OVERWIEW

NewEuropean Directive 2012/33/CE, published in 2012and transposed to Spanish Law in 2015 (RD290/2015),obligates to reduce sulfur content in marine bunker fuel. New limits are:

- Year 2015: Sulfur content reduction from 1%wt to 0.1% wt in ECA areas (Emission Control Area: Baltic and North Sea,in Europe).
- Year 2020: Sulfur content reduction from 3.5%wt to 0.5% wt worldwide (potential delayed implementation to 2025).

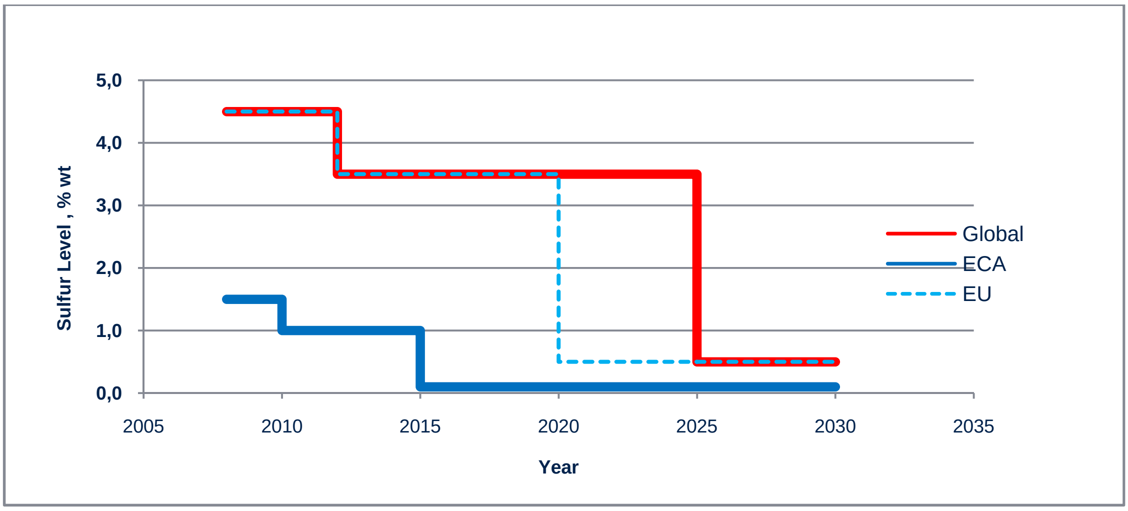



**Figure 1. Declining Marine Bunker Sulfur**

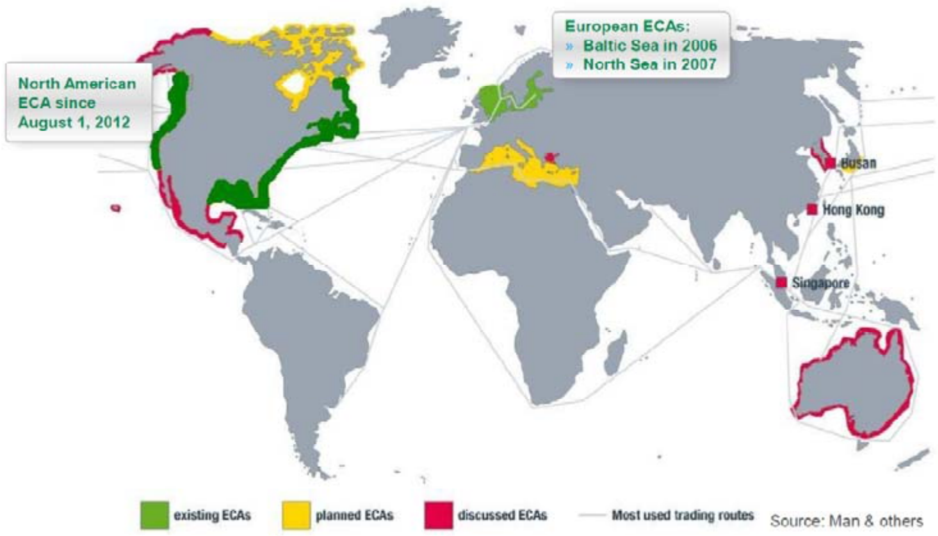



**Figure 2. ECA areas**

There are different technologies to comply with this regulation, such as:

| | Advantages | Disadvantages |
|---|---|---|
| Change Marine Fuels to Liquefied Natural Gas | Liquefied Natural Gas is cheaper | Bunker Motor is more expensive, and limited to short routes, and ports with infrastructures |
| Scrubber installation in Bunkers to control emissions | No requirement offuel change | No profitable for small shipment and with less than 30% time sailing in ECA area |
| Hydrotreatment of Bunker Fuels | Appropriateforallship ment | High investment in refineries |

**Figure 3. Technology alternatives to comply with Bunker Fuel Regulation**

The most probable future scenario seems to be a combination of these three options. This will define the high sulfur fuel (3,5% wt) demand for the coming years.

In any case, a falling demand for fuel is expected, so this challenge can be converted into an opportunity to increase refineries conversion, and consequently, competitiveness and economics of the Spanish refining system.

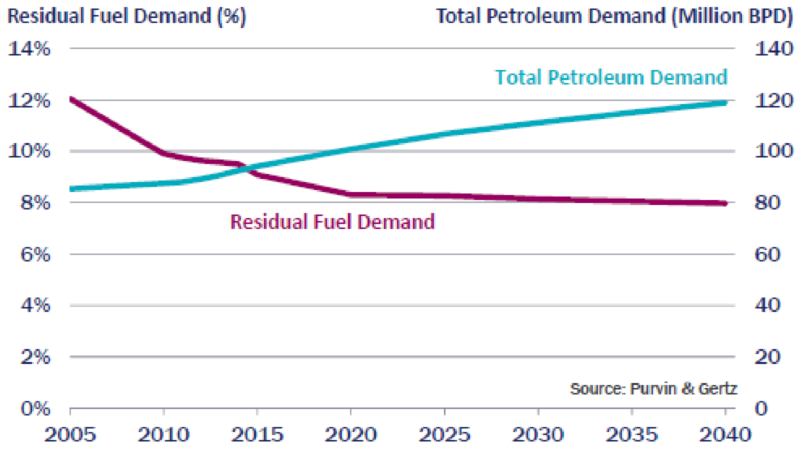



**Figure 4. Falling Demand for Residual Fuel**

This study is focused in one of the Spanish refinery, with a Hydroskimming conversion scheme,including a Visbreaker Unit, with elevated high sulfur fuel exportation (> 1,000 kt/year).

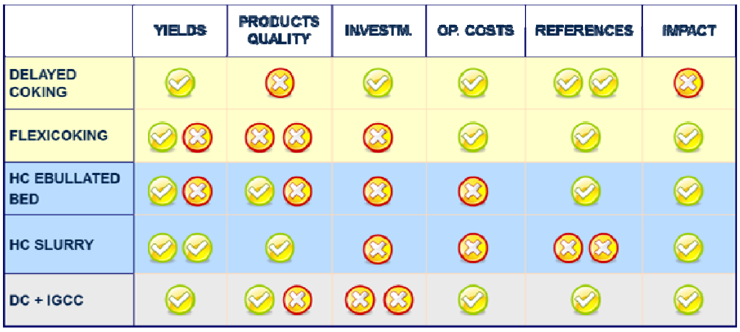
## 2. START OF THE ART TECHNOLOGIES SELECTION

An analysis of the state of art ofbottom of barrel technologies has been developed to conclude which is the most competitive and profitable technology, with the target of increasing distillates yield and decreasing fuel production.

| | Advantages | Disadvantages |
|---|---|---|
| **Delayed Coker** | Mature technology<br>Large number of references worldwide<br>Moderate Investment (See Appendix II)<br>Lower $CO_2$ emissions | Low products quality.<br>Post-treatment required<br>Coke management and commercialization |
| **Flexicoker** | No coke management and commercialization | High low calorific power yield, with difficulties to fit in refinery burners<br>High investment (See Appendix II) |
| **Hydrocracker (Ebullated Bed)** | No coke management<br>High products quality | Less conversion than Slurry Hydrocracker<br>High consumption costs<br>Unconverted residue destination |

| | | |
|---|---|---|
| | | High investment (See Appendix II) |
| **Hydrocracker (Slurry)** | High conversion (95%wt) (See Appendix I)<br>No coke management<br>High Distillates Yield (See Appendix I)<br>High products quality | Few commercial references<br>High investment (See Appendix II) |
| **Delayed Coker + IGCC** | Hydrogen, electric energy and vapor production with low cost raw material (coke) | Very high investment (See Appendix II) |

**Figure 5. Bottom of the Barrel technologies comparison**



| | YIELDS | PRODUCTS QUALITY | INVESTM. | OP. COSTS | REFERENCES | IMPACT |
|---|---|---|---|---|---|---|
| DELAYED COKING | ✓ | ✗ | ✓ | ✓ | ✓✓ | ✗ |
| FLEXICOKING | ✓✗ | ✗✗ | ✗ | ✓ | ✓ | ✓ |
| HC EBULLATED BED | ✓✗ | ✓✗ | ✗ | ✗ | ✓ | ✓ |
| HC SLURRY | ✓✓ | ✓ | ✗ | ✗ | ✗✗ | ✓ |
| DC + IGCC | ✓ | ✓✗ | ✗✗ | ✓ | ✓ | ✓ |

**Figure 6. Qualitative comparative of bottom of the barrel technologies**

Nowadays, our refining system is focused on low investment projects with high profitability. Besides, a mature technology with a large number of references, both in Europe and worldwide, is a priority in our business to minimize risk.

So, a Delayed Coker Technology is the best solution according to this criterion.

## 3. PROJECT SCOPE

To implement a new Delayed Coquer unit, it is required to implementadditional new units or revamping the existing ones, to accommodate the new coker products.

Ascheme and plot plan with the whole project scope, including the new and modified units, is shown below.

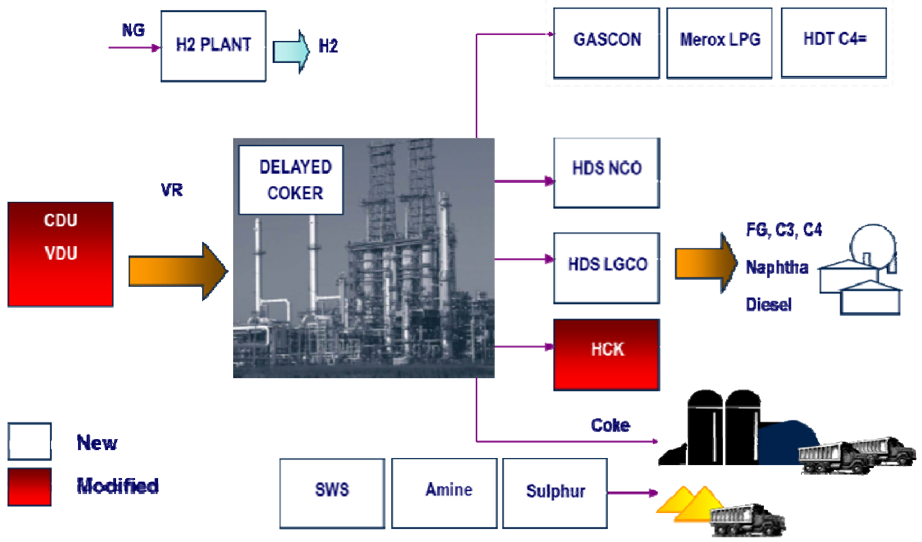



**Figure 7. Project Scope**

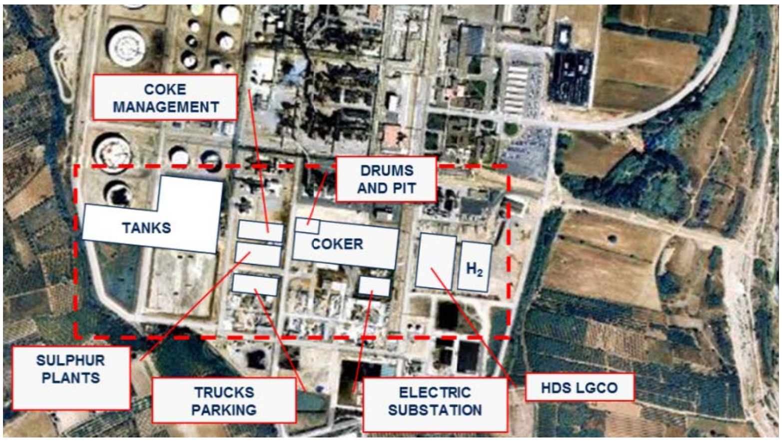



**Figure 8. Plot plan requirements**

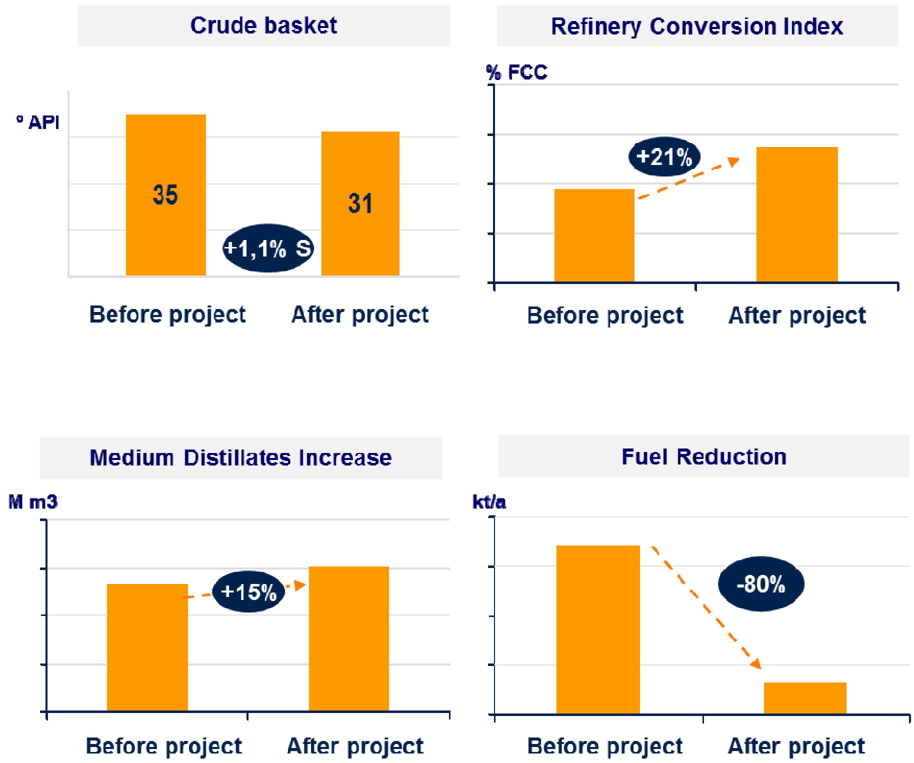
The coke management and commercialization is affordable but requires the construction of a new highway from the refinery to the port, in the occidental limit of the refinery and close to the project area. This will minimize the impact in traffic and close villages.

Total investment is estimated in 1000 M€ (+-50% error margin).

## 4. RESULTS

The results of implementing the new project in the refinery are:

- A crude basket change into a heavier, sour and cheaper one
- An increase in refinery conversion
- An increase in Medium Distillates production
- A decrease in fuel production




A profitable project in different scenarios is achieved, improving refinery margin and competitiveness, finding a solution to bunker new regulation.

## APPENDIX

### APPENDIX I

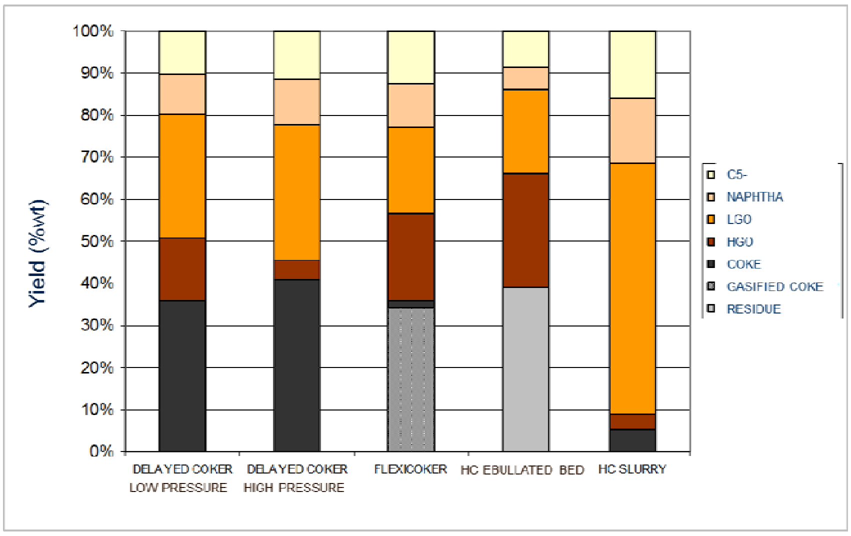



**Figure 9. Comparative yields of bottom of the barrel technologies**

## APPENDIX II

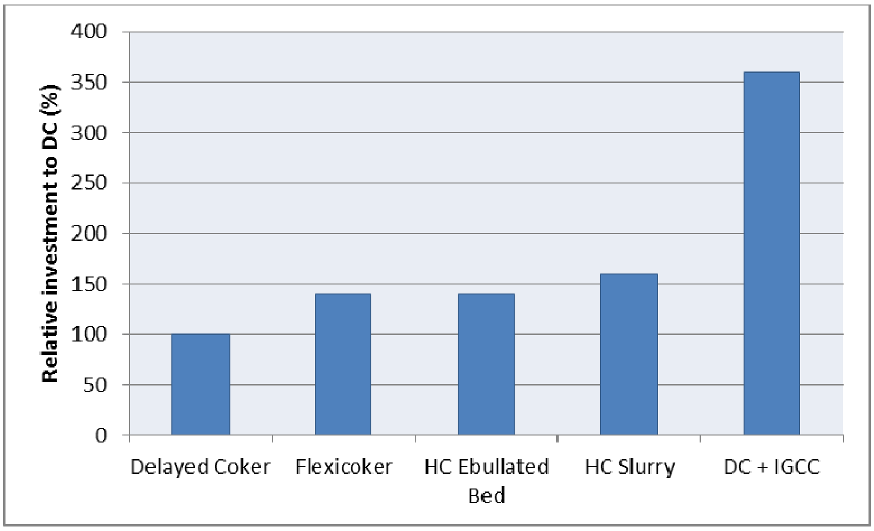



**Figure 10. Comparative investment of bottom of the barrel technologies**