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New approaches in LNG Quality & Energy determination during LNG carrier unloading

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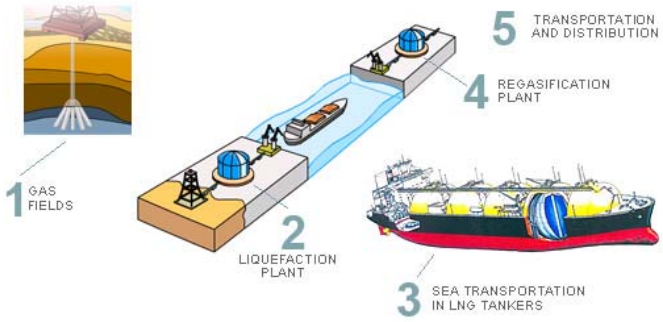
NATURAL GAS CHAIN



Knowledge LNG Quality variation origin/destination &
Knowledge Energy unloaded at any Receiving Terminal.

LNG Quality Prediction During Ship Transportation

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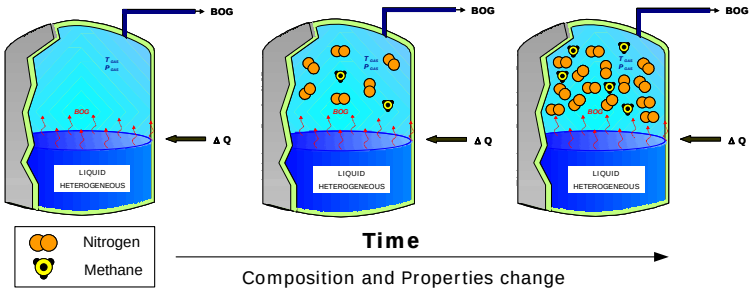
THE WORLD-WIDE LNG INDUSTRY

Liquefied Natural Gas (LNG) is an energy source with a worldwide steady growth. This increment of LNG demand has induced a fast augmentation of LNG transport by sea.

LNG AGEING



Composition and relevant properties of the LNG are slightly different between the origin port and the destination port .

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GERG Project
"Calculation MOdel(s) of LNG Ageing during Ship transportation (MOLAS)"

European gas companies leaded by Enagas have carried out the GERG Project to develop a software application for predicting changes in LNG composition during ship transportation from loading port to unloading port.

MOLAS Application can anticipate LNG composition and properties like High Heating Value, Wobbe Index and Liquid Density.

MOLAS APPLICATION

- A Physical Model based on mass balances and equilibrium state between liquid and vapour phases.

- A Statistical Model based on artificial neural networks and historical data about LNG trading by ship.

- A database is provided to get information about ships, countries, routes, trips, ports, exporters, etc. The aim of this database is to collect the most widely used data regarding LNG business.

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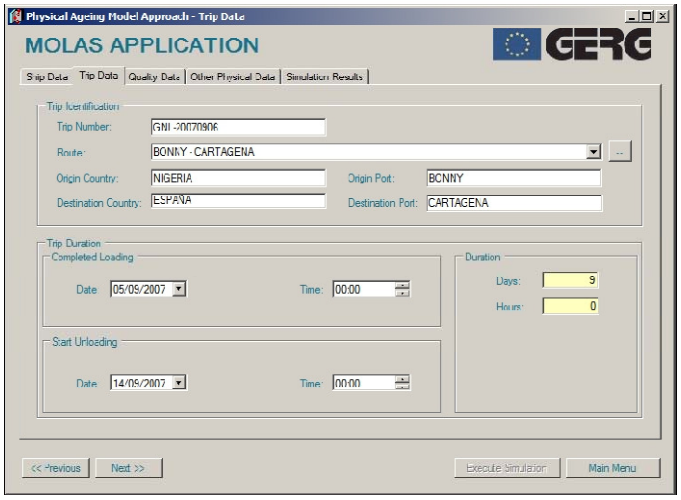
SOFTWARE DESCRIPTION

- The User can select between four languages: English, French, German and Spanish.

- Both models show the same input and output screens

Input Data*: Ship, Trip, Quality and Physical data at origin
Output Data*: Quality, Physical data and properties at destination



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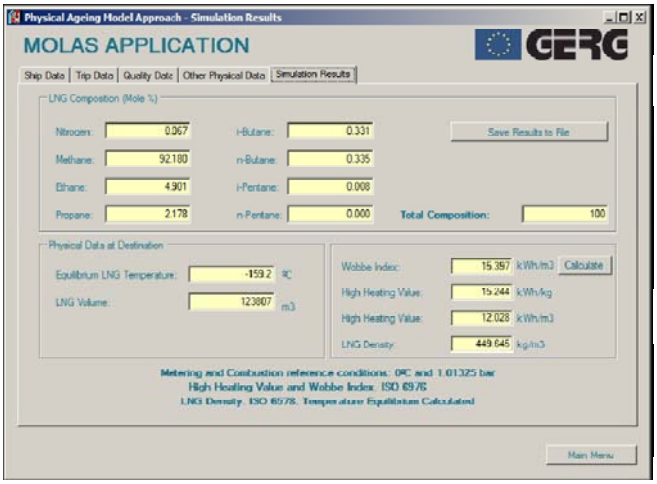

GENERATION iModel

Before running Statistical Model an iModel must be created based on artificial intelligence. The construction of the model uses available historical data which are stored in a specific database developed to handle the main information about LNG trading by ship. User can select the trips to generate the model.

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MODELS VALIDATION

The accuracy of both models has been tested by analysing the differences between their results and experimental values of selected variables measured from 153 LNG cargos in Enagas Regasification Plants.

Limits generally admitted in gas industry:

Variable	Limit
C1	0.5 %
HHV	0.25 %
WI	0.25 %
LD	0.27 %

CONCLUSIONS

- Errors found from both options have demonstrated that lay within tolerances admitted in the gas industry.

- In general, it is observed a better performance of Statistical Model.

- In any case, the physical model is always a valid option if the i – model can not be applied due to the lack of adecuate historical data.

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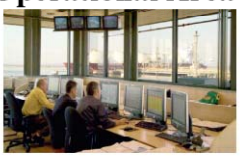
APPLICATIONS

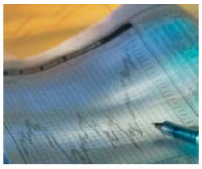
Operational Area



Quality Area

Administration Area

Economical Area



Accurate determination of LNG quality unloaded at Receiving Terminals: An Innovative Approach

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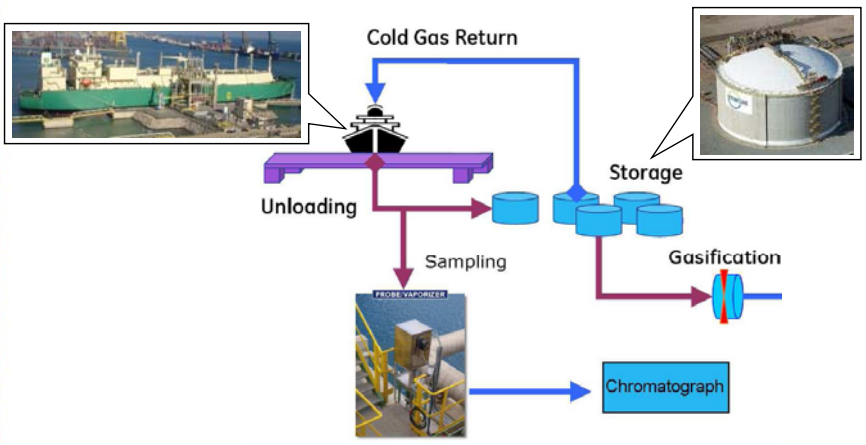
UNLOADING AT RECEIVING TERMINAL



Energy = V (m^3) × D (kg/m3) × CV (kWh/kg)

Level (Ship)	Temperature (Ship) **Composition** (Resgasification Plant)	**Composition** (Resgasification Plant)

Ship
140.000 m3
970 GWh

20 MM €

Error

1% = 9,7 GWh

200 M €

1GWh = 21.927 Euros (2008) **MM: Millions M: Thousands**

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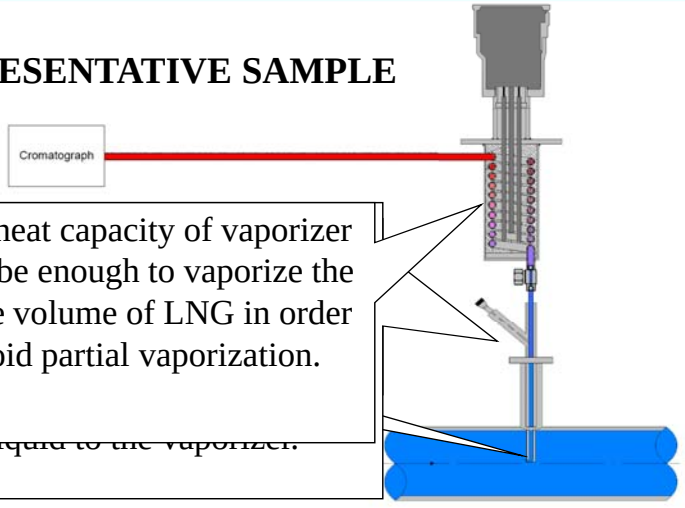
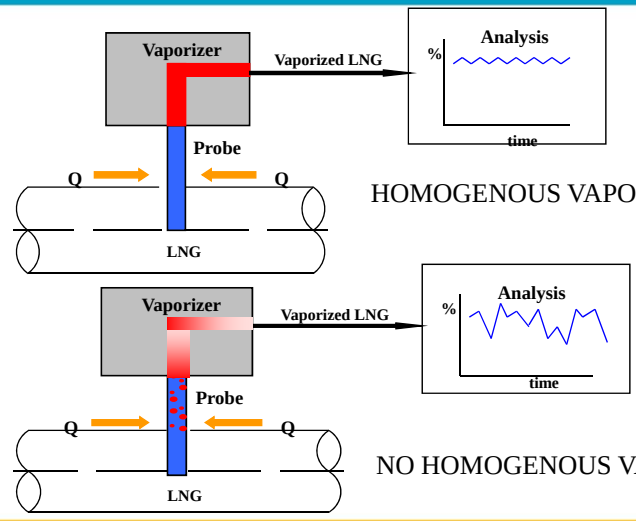
REPRESENTATIVE SAMPLE



The heat capacity of vaporizer must be enough to vaporize the whole volume of LNG in order to avoid partial vaporization.

in as liquid to the vaporizer.



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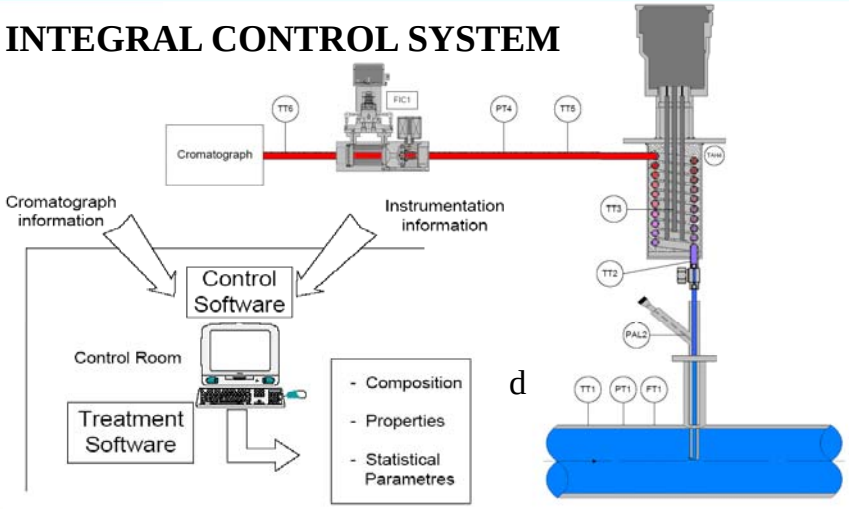
INTEGRAL CONTROL SYSTEM



TREATMENT AND PROCESSING SOFTWARE

Raw Data

↓

Elimination:
Thermodynamic Filters
Stable period selection

Valid Data

↓

Elimination:
Statistical criteria

Accepted Data

↓

MEAN COMPOSITION

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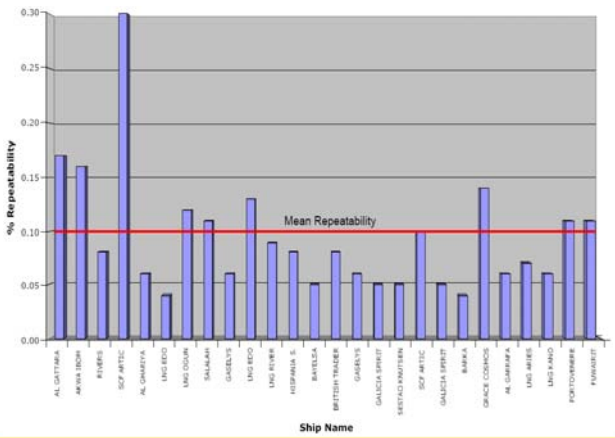
RESULTS



The smaller repeatability the more grouped are the analysis and the more reliable is the measurement.

CONCLUSIONS

- The Integral System proposed, based on an instrumentation, a control and data treatment software is suitable to guarantee a full representativity of transferred LNG.
- The obtained result is reliable, robust and supported for physical and statistical parameters.
- This system allow to have easily information about all the most influent parameter in the unloading process, and help to solve disputes.

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THANK FOR YOUR ATTENTION