LICENSING AN EPC PROJECT – CASE STUDY ON A FULLY MODULARIZED SRU AND AGE PACKAGE FOR GAS FIELD IN EGYPT

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SUMMARY

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INTRODUCTION

- **CASE STUDY**

  Project recently awarded to KT **(May 2016)**

- **SCOPE OF WORK**

  Licensing, engineering and procurement of the SRU-TGTU-AGE serving the sour gas processing facilities of one of the major gas field lately discovered in the Mediterranean Sea.

- **PLANT CAPACITY**

  Realization of 4 SRU packages with a capacity of 26 t/d of sulphur production each.

- **EXPLORATION IN PROGRESS**

  Gas field has been discovered two years ago. Exploration is still on going thus design has been adjusted during the Project execution to accommodate the changes on sour gas composition.

DESIGN REQUIREMENTS

- Sulphur Recovery Efficiency
- SO_2 emissions at stack
- Sulphur quality
- Modularization of the Unit
- Tight schedule and start-up within 2017

BASIS OF DESIGN

Five possible design cases of amine acid gas foreseen

Case A - Sizing Case

- Highest flowrate, H_2S concentration being 15% vol., 0.8% vol. HC + BTEX, presence of COS and Mercaptans

Case B - Alternative Case

- Same composition and flowrate of as case A with the addiction of 1% of ethane

Case C - Very Lean Case

- H2S concentration being 4.3%vol, 0.9% vol. of HC + BTEX, presence of COS and Mercaptans

Case D - Lean Case

- Flowrate about 50% of case A, H2S concentration being 6.89%, 1.7% vol. HC + BTEX , highest presence of mercaptans and COS

Case E - Turndown Case

- Same composition of case D but the flowrate is 22.5% of case D

Additional Acid Gas from SWS

- A small stream from Sour water stripper gas shall also be treated in the unit with a fixed composition and flowrate.
- No ammonia is present in such gas

BASIS OF DESIGN

Exploration progress: additional verification cases have been studied

Verification 1

- Highest acid gas flowrate from AGR: 10% more than Case A
- Same composition as for Case A

Verification 2

- Highest contaminants concentration: higher impurities like COS and BTEX
- Flowrate similar to Case A

TECHNICAL CHALLENGES

Acid Gas quality

H2S as low as 4.3% vol. and BTEX

- H_2S Enrichment needed to ensure temperature for contaminants destruction in Thermal Reactor
- BTEX absorbed significantly by the amine and need to be destroyed in the Thermal Reactor because are poisonous for the Claus Catalyst

Presence of Mercaptans and COS

- Only slightly absorbed by the amine in the AGE section:
  - Increase of SO2 content at stack
  - small quantity absorbed shall be treated in the Thermal Reactor

TECHNICAL CHALLENGES

Impurities destruction in Claus Section

Mercaptans absorbed by the Amine and BTEX

Destruction need to be ensured in Thermal Reactor by:

- Ensuring proper temperature
- Ensuring proper residence time

Since the Acid Gas is so lean in H_2S, Thermal Reactor operates with Fuel Gas cofiring.

TECHNICAL CHALLENGES

Acid Gas flowrate rangeability

- **Wide rangeability** → 11%-100% on sour gas flowrate
- **Proper flow rate must be ensured** → Correct operation of all the equipment (column hydraulic, gas space velocity, etc.)
- **Temperature in Thermal Reactor** → Proper operating range:
  - Optimization of Acid Gas enrichment and co- firing TOGETHER is needed
  - Optimizing the two parameters separately is counterproductive

TECHNICAL CHALLENGES

Process performances

- **Overall Sulphur Recovery Efficiency** → +99.9% Guaranteed
- **SO2 emissions** → 150 mg/Nm^3 at 3% O_2 at dry basis
- → Hard to achieve with high CO2 and low H2S Acid Gas feedstock
  - Operation with regular MDEA not suitable and chilling unit is needed
  - Achievement penalized by the presence of COS and Mercaptans

TECHNICAL SOLUTIONS PROPOSED

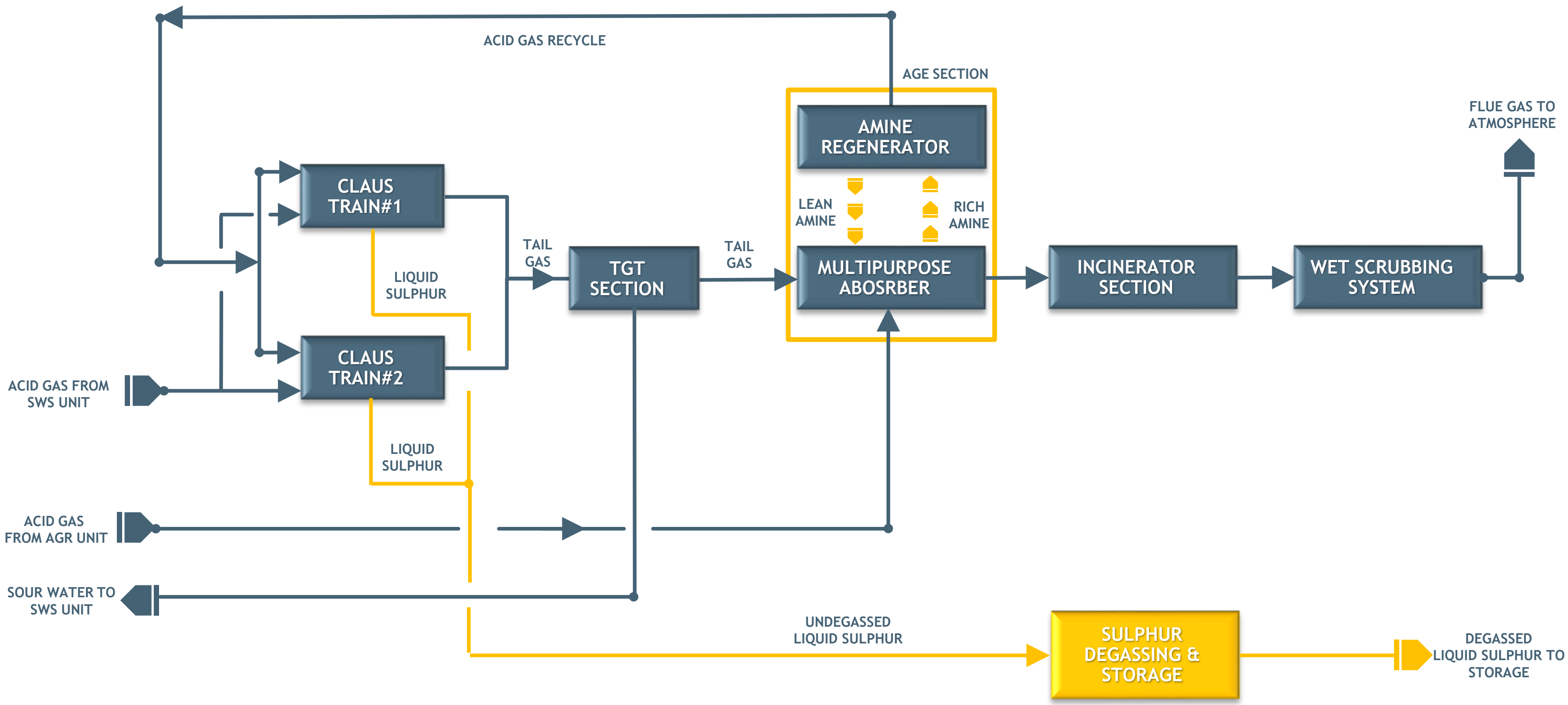
Unit Arrangement

Considering the feedstock to treat each SRU package is composed by the following sections:

- ❑ Acid Gas Enrichment – KT Multipurpose Absorber ™
- ❑ 2 x Claus trains
- ❑ Liquid Sulphur Degassing and Storage Section
- ❑ Tail Gas Treatment (TGT) Section
- ❑ Incinerator Section
- ❑ Wet scrubbing system

TECHNICAL SOLUTIONS PROPOSED

Unit Arrangement



Plant Block Flow Diagram

TECHNICAL SOLUTIONS PROPOSED

Multipurpose Absorber™

Multipurpose Absorber™ technology:

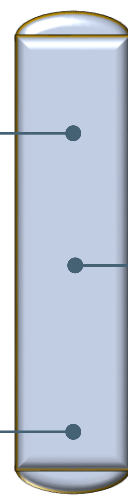
- ❑ Acid Gas Enrichment and Tail gas absorption in a combined column
- ❑ Super-enrichment
- ❑ Optimization of solvent circulation
- ❑ Use of semi-lean from TGT absorption section for AGE section

1

H2S SELECTIVE ABSORPTION
Using formulated amine solution and refrigeration package unit

2

TAIL GAS ABSORPTION
H2S recovery from tail gas coming from TGT section



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ACID GAS SUPER-ENRICHMENT
Partial recycle of acid gas from regenerator overhead

DESIGN OBJECTIVES

- ✓ Improve the acid gas concentration in H2S
- ✓ Stabilize the column hydraulic especially at turndown operation

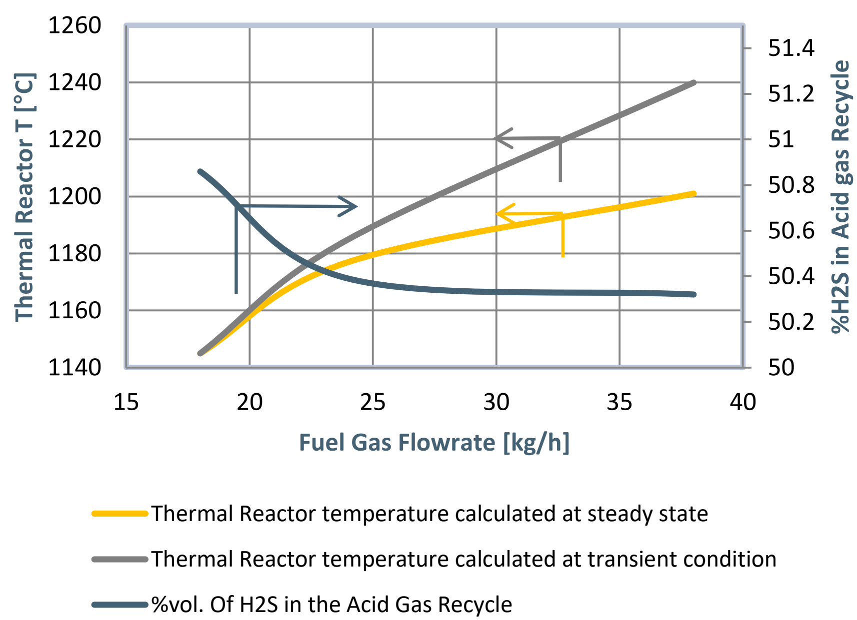
TECHNICAL SOLUTIONS PROPOSED

Co-firing

Despite the enrichment achieved in the TGT Multipurpose Absorber™, co-firing operation in the Thermal Reactor is required for impurities destruction.

However:

- ❑ Coke formation shall be avoided
- ❑ CO_2 production shall be minimized for H_2S enrichment
- ❑ Optimization of temperature in the Th. Reactor: fuel gas flowrate vs enrichment



TECHNICAL SOLUTIONS PROPOSED

Feed preheating

Combustion air and Acid Gas preheating required in order to:

- ❑ Minimize the fuel gas required for co-firing operation
- ❑ Maximize Th. Reactor temperature

In-line heater

In-line heater required for:

- ❑ Reducing gas production (H2 required for hydrogenation reactions)
- ❑ Re-heating of Tail gas

Hydrogenation Reactor temperature control

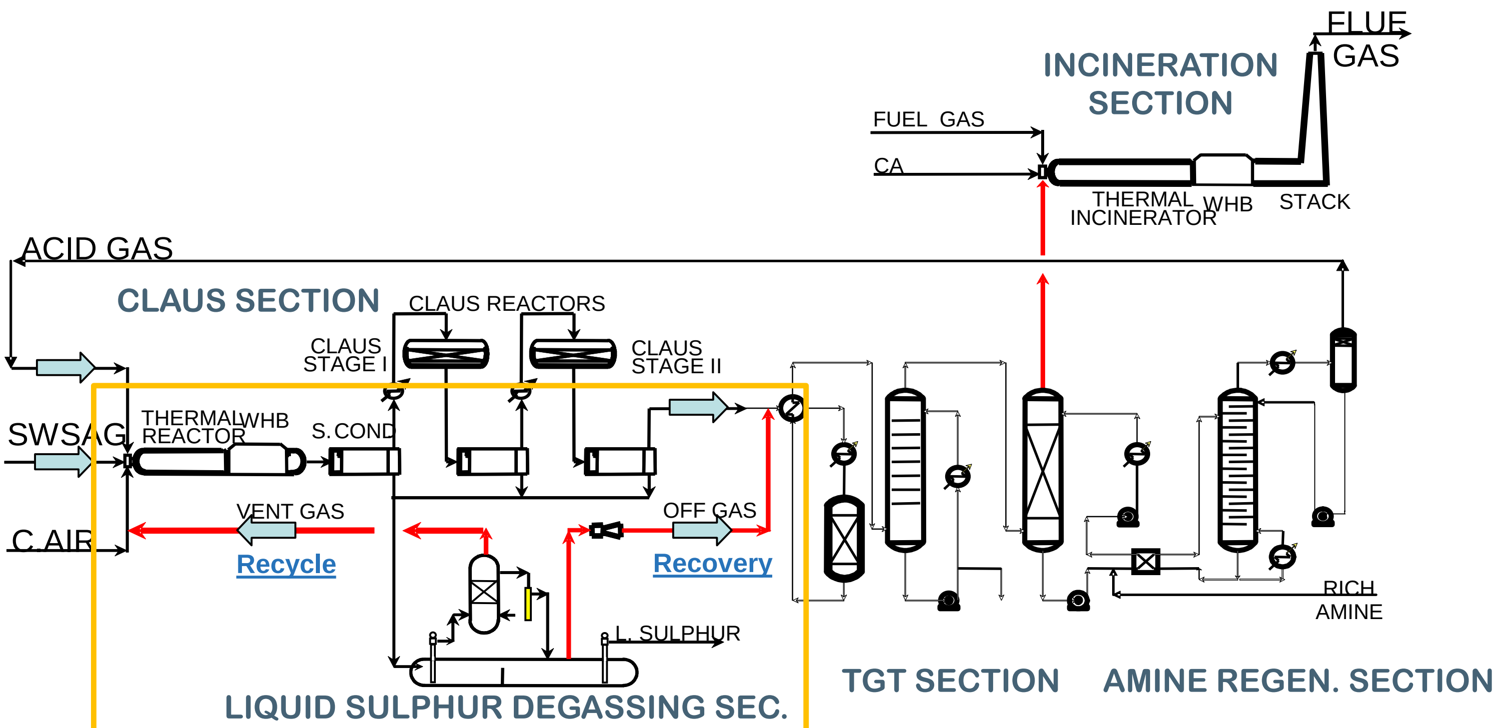
- ❑ TGT WHB has been foreseen for temperature adjustment (2 passes)

TECHNICAL SOLUTIONS PROPOSED

Degassing system recycle

In order to achieve SO2 emissions, it has been required to recycle the H2S from liquid sulphur back to the SRU.

- ❑ Degassing air has been recycled to the Th. Reactor
- ❑ Sweep gas has been recycled to TGT section



TECHNICAL SOLUTIONS PROPOSED

SO2 Scrubbing system

Higher Mercaptans and COS content for some cases has been discovered once the Project started. In these cases SO2 emissions cannot be guaranteed with the proposed scheme.

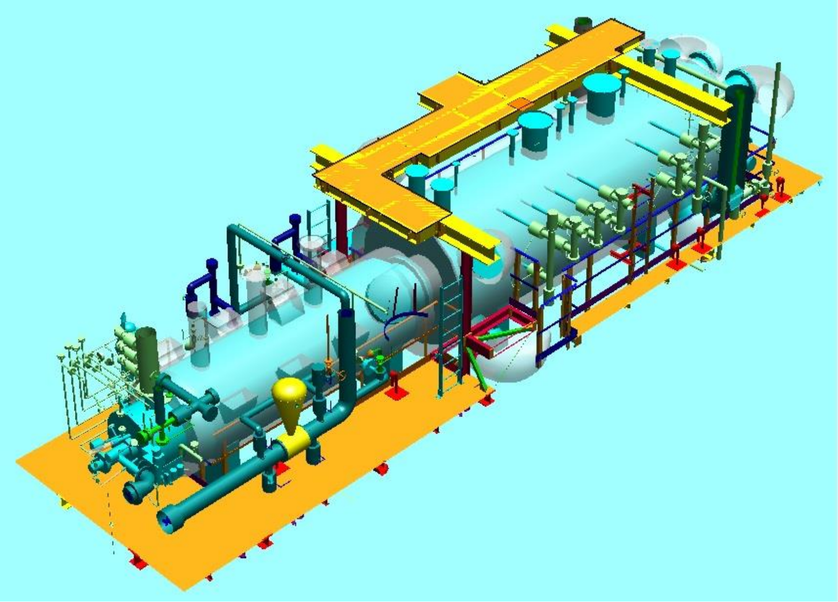
To meet the SO2 emissions also in case of high impurities content, technical solution has been identified in a flue gas washing to remove the SO2 to 150mg/Nm3:

- ❑ Wet process scrubbing
- ❑ Caustic solution used as chemical
- ❑ «Add-on» system: SO2 system will be installed with plant in operation after S/U

FULL MODULARIZATION OF THE PLANT

Project has been developed from the beginning fully modularized to match the tight schedule for the Start-up of the unit within 2017. Main advantages are:

- ❑ Minimization of construction activities
- ❑ Pre-commissioning and functional tests perfomed at yard
- ❑ Modules delivered according to construction schedule



3D Model snapshot of Claus Thermal Reactor

Picture of one module at yard

ORGANIZATIONAL INNOVATION

Project vertical workflow has been reviewed to comply with the challenges of schedule and S/U of the Unit:

- ❑ Process design and engineering activities in parallel
- ❑ Procurement of equipment and bulk material based on the modules construction schedule
- ❑ Problem solving to avoid delay in the delivery
- ❑ Overlap between construction, engineering and precommissioning activities

WORK IN SERIES
PASSING THE INFORMATION THROUGH A VERTICAL WORKFLOW

WORK IN PARALLEL
RUN TOWARDS A COMMON GOAL

Current progress of the construction work

CONCLUSION

The presented Case Study collects KT's experience on a recent awarded project realized from beginning to end in a very limited time **(12 months).**

All the shared technical and management challenges have been overcome thanks to:

- ❑ Licensor knowhow
- ❑ EPC Contractor expertise
- ❑ Two indentities working sinergically

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