Terms of Reference for:

Study for SRU troubleshooting

# BACKGROUND / INTRODUCTION

ORLEN Unipetrol is operating with two (2) Sulphur Recovery Units (SRU); Claus III and Claus IV. Both Claus trains are two-stage Claus units followed by a common Sulfreen unit and common tail gas incinerator with waste gas heat recovery.

Claus III is a 50 t/d two-stage Modified-Claus unit. The thermal stage consists of a combustion chamber with a front-side split configuration to allow processing SWS off gas. Claus III has a so called hot gas bypass configuration for reheating the first catalytic stage. Reheating of the second catalytic stage is achieved by a gas-gas heat exchanger. Claus III is suitable for low level oxygen enrichment.

Claus IV is a two-stage Modified-Claus unit with original design capacity of 107 t/d. Claus IV also used a hot gas bypass as reheat method for the first catalytic stage and a gas-gas heat exchanger for the second catalytic stage. Claus IV was modified previously to accommodate low level oxygen enrichment resulting in a processing capacity of 120 t/d.

The tail gases from both Claus units are routed to the common Sulfreen unit. The Sulfreen unit has two convertors. The regenerator heater for the Sulfreen catalyst beds is a gas/gas exchanger. Located downstream is the thermal incinerator waste heat boiler. The thermal incinerator is a forced draft incinerator with various stages of heat recovery downstream.

Typically Claus III processes feeds coming from Sour Water Stripper Unit (ammonia gas) and Amine Acid Gas (pure gas from Hydrocracker Unit), where Claus IV process Amine Acid Gas (H2S from POx and Amine regenerating unit 5510). Occasionally some upstream units are not operational, reducing the feeds send to both Claus units. In this operating case, there is not enough feed available to keep both Claus trains operational, and therefore Claus IV would be shut down, with all the remaining feeds directed to the operational Claus III.

ORLEN Unipetrol has experienced in this operating case a decrease in the sulphur recovery efficiency. The minimum sulphur recovery efficiency is set at 98.5%, but on average the recovery efficiency in this operation case is down to 98.05%.

ORLEN Unipetrol aims to request relevant and credible partner to provide assistance in evaluating a possible root cause for the decreased recovery efficiency, and provide a possible path forward for increasing the recovery efficiency and optimize the operating conditions.

ORLEN Unipetrol is possibly looking at another topic for the Sulphur Recovery Units; it would be of interest to evaluate what possible changes would be needed for Claus IV, in order to allow the unit to process Sour Water Stripper Gas in addition to the Amine Acid Gas feeds. Currently when Claus IV unit is operational, it processes Amine Acid Gas only. The current process conditions within the main reaction unit would cause the temperatures not to be high enough, in order to properly process Ammonia containing Sour Water Stripper Gas. ORLEN Unipetrol would like to know what possible modifications would be needed to the main reaction unit, to increase the temperature, to safely allow the unit to process existing and foreseen Sour Water Stripper Gases.

Ultimately Orlen Unipetrol is expecting in near future processing of sour gas from newly designed soot water striper in quantity of 100 kg/h. The sour gas contain also cyanides in significant concentration (see table below). The study should advice (modification of operating conditions, equipment modification) on processing of such at either Claus III or Claus IV Unit .

Obsah obrázku text, snímek obrazovky, Písmo, číslo

Obsah generovaný pomocí AI může být nesprávný.

**composition of soot water stripper gas**

# METHODOLOGY OF THE TROUBLESHOOTING STUDY

The study shall respect the following activities carried out by supplier.

1. Provision of testing protocol and test run conditions ahead of test run realization.
2. Provision of the request for specific equipment data sheet.
3. On site analytics of sour gases.
4. Matching analytical data with process data.
5. Data analysis and process modeling.
6. Root cause analysis.
7. Recommendation for Claus III, Sulfreen and Tail Gas Incinerator → Claus III sole operation including sour gas from new Soot Water Striper .
8. Recommendation for Claus IV revamp → Claus IV sole operation including all foreseen sour gases.
9. Capex estimate +/- 30% of the screened ideas.

# SCOPE / GENERAL LIST OF ACTIVITIES

This section includes a full explanation of the work to be completed on-site, the samples, schedule, and the deliverables.

For this project, that target is to review the recovery efficiency of the Claus III unit, while it is processing selection of Amine Acid Gas and **existing** Sour Water Stripper Gases, with Claus IV shut down / standby mode. This would be done by completing sampling and analysis activities on gas samples from the Claus unit. With this information, combined with DCS information, the supplier engineer would be able to provide recommendations to ORLEN Unipetrol and make changes to the operating conditions, with general goal to optimize the recovery efficiency.

This results in an approach to start with a baseline test completed on the first test day. The following two test days would be utilized to test the impact of the operational changes and review possibility to meet the recovery efficiency of 98.5%.

Optionally there is the possibility to extend the testing program, to test the Claus IV unit, while this is processing Amine Acid Gas. This would require an operational switch from the Claus III unit to the Claus IV unit, after which the supplier can sample and analyse samples from this unit. This would provide a baseline test for further engineering work to evaluate the possibility for Claus IV unit to process existing and new Sour Water Stripper Gases.

The supplier crew members will travel to ORLEN Unipetrol’s facility with their equipment shipped separately. The initial day on-site is used for equipment set-up, equipment calibration, safety inductions, site inspection, and engineering discussions. The field test will require three (3) additional days at the facility.

Extra days may be requested on-site at any time by ORLEN Unipetrol, to allow for delays or new operating conditions. The cost for all extra work has to be specified separately. The deliverables will be presented in a Basic Performance Report, including findings and recommendations for optimization of the Claus plant.

The sample list contained in this proposal is customized to ORLEN Unipetrol specific needs. However, the supplier crew will take as many samples as needed, time permitting, without additional cost to solve the problem.

This Scope is based on reasonable access to the process equipment. It assumes daytime testing ONLY

Scope of modifications and installation recommended by Supplier to be based on process and analytical data gathered during test run operation. The ultimate flow rates for the CLAUS IV revamp case to be provided by ORLEN Unipetrol after tender.

**Sample Analysis Program**

On-site field test work will include the collection of the following plant operational and performance data:

1. Process stream flow rates, unit temperatures, and analyser readings (from plant DCS);
2. Process unit pressures (supplier survey);
3. Feed gas and interstage gas compositions (available sampling points summarized in the attached documents).

For all streams designated the following components will be measured by supplier:

**Sulphur Components**

H2S, SO2, COS, CS2

**Hydrocarbon Components**

CH4, C2H6, C3H8, C4H10, C5H12, C6+, BTX

**Air/Inert Gas Components**

H2, Ar, O2, N2, CO, CO2

The normal analytical range for the sulphur components is 10 ppm to 100 percent. The normal analytical range for H2 is 0.1 to 100 percent. The normal analytical range for oxygen is 0.1 to 100 percent. The normal analytical range for all other components is 50 ppm to 100 percent.

**NH3 Analyses**

For all streams to be analysed for NH3 specific suppliers methods will be used:

High Concentration Ammonia

5 percent to 100 percent for Sour Water Stripper gases

Low Concentration Ammonia

1 ppm in solution to 5 percent for acid gas and SRU gas streams

Trace Sulphur Analyses

For all streams the analytical range will be extended to 1 ppm for H2S, COS, CS2 and 5 ppm for SO2.

**Other Analyses**

The following species can also be determined with four (4) weeks advance notice before the testing. Additional costs will apply to:

SO3 - for incinerator stack

NOX

# DELIVERABLES

# The main parts of the study shall include:

**Detailed Analytical Report**

This report includes stream compositions, including specialized trace analysis as required. It is composed of raw data that has been evaluated by the field technologist and reviewed by laboratory specialists for quality control. Report delivery will follow within no later than 2 to 4 weeks upon completion of the test work.

**Detailed performance report**

This report is a comprehensive engineering study based on the process data gathered during the on-site field test of ORLEN Unipetrol. Supplier engineers will use the Detailed Analytical Results combined with process data gathered during supplier on-site testing to build a simulation of the Sulphur Recovery Unit (SRU). The simulation will be used to determine the current plant performance (interstage and overall), the factors that are currently limiting the plant performance, and the performance capability if those limitations are removed. Recommendations will be made on the steps required to eliminate the problems to achieve optimum performance. Supplier detailed performance report will provide the following calculations and results:

**Overall Plant**

* heat and material balances;
* interstage conversion and recovery efficiencies and a comparison with predicted thermodynamic efficiencies;
* overall facility sulphur recovery efficiencies;
* tabulation of all items which are leading to lost recovery efficiency;
* a set of baseline data for future reference.

**Reaction Furnace**

* acid gas feed stream analyses (including hydrocarbon and other contaminants) to determine if adequate separation is occurring in the upstream processing units and to determine if all feed contaminants are being destroyed in the reaction furnace before reaching the catalyst;
* calculated reaction furnace temperatures based on the analytical results and a comparison with measured values;
* NH3 destruction efficiency;
* COS and CS2 formation rates in the reaction furnace.

**Catalytic Converters**

* catalyst activity in each Claus converter and recommendations on required catalyst rejuvenation or replacement;
* catalyst bed operating temperatures, sulphur dewpoint temperatures and sulphur dewpoint margins at current load conditions;
* COS and CS hydrolysis rates at each Claus converter and their effect on the overall plant efficiency.

**Reheaters**

* heat balance.

**Condensers**

* sulphur production and evaluation of liquid sulphur entrainment.

**Analyzers and Metering**

* accuracy of the plant tail gas analyser;
* accuracy of the plant acid gas, fuel gas and air metering systems;
* evaluation of the reaction furnace air flow control and reaction stoichiometry.

**Incinerator**

* emissions rates of various pollutants (SO2, CO2);
* combustion efficiency (hydrocarbon, CO and H2 breakthrough);
* review of analyzer accuracy.

**Key deliverables for any new installation(s) and/or modification(s) at Claus IV:**

* Requirements and critical points for design, construction and startup including alternatives;
* Conceptual design including capacities of the equipment (ISBL);
* Utilities consumption;
* Localization of the new unit, square area needed for construction and plot plan;
* Requirements within OSBL;
* Assessment of technical feasibility of proposed process changes as outlined above;
* Specification and rating of new unit equipment;
* Provide +/- 30% CAPEX estimate for each opportunity / process change;
* Estimate on operational costs;
* Risk analysis, alternatives if any;
* Impact on HSE (personal health and safety, environment);
* Simulation models in ASPEN or Petrosim 4.1 or PRO/II version 8.2 or higher;
* Ongoing consultation with client during the course of the FS development;
* All the calculations have to be performed for max. unit throughput,
* Other open points for more thorough review and clarification.

# TIMING

The detailed performance report including CAPEX recommendation for Claus IV will be delivered approximately 8 – 10 weeks upon completion of the test work.

Final completion / handover of the study in **June 2026**

# PRICING

The pricing to be defined separately as follows:

Part A - Claus III efficiency improvement and soot water stripper gas processing;

Part B – Claus IV revamp enabling solo operation including soot water stripper gas processing;

Part C – On site SRU training for process engineers and technologists (process description, technology parts and functionalities, process variables, start-up / shutd-down, troubleshooting as minimum);