Challenge for the Engineering Cup

IMPROVING THE OPERATIONAL READINESS OF AMMONIA PRODUCTION

Focus Area

Automation of technological processes; chemical production.

Objective

To propose a solution that reduces ammonia losses and increases plant profitability by shortening and improving the efficiency of start-up operations of ammonia synthesis columns through the use of purge gases from a neighboring ammonia unit, along with the development of the required pipeline tie-in scheme.

Company Overview

EuroChem is a global mineral and chemical company producing a wide range of nitrogen, phosphate, and compound fertilizers, as well as industrial chemical products. The company employs more than 13,500 people worldwide.

Context and Relevance

Ammonia production units in the Russian Federation have been in operation for 40–50 years. They are characterized by high equipment wear and low reliability.
Statistics show that unplanned shutdowns and start-ups significantly exceed planned maintenance-related operations.
Accelerating start-up procedures—given their frequency—allows enterprises to reduce ammonia losses during unplanned start-ups and increase profit from additional ammonia output during planned shutdown/start-up cycles.

Task for Participants

1. Analyze the number and duration of start-up periods

Analyze and determine the number of startup periods per year for a single production unit and for the enterprise as a whole. Estimate the duration of the startup phase (heating and bringing the ammonia synthesis column to operational mode) that can be reduced by using purge gas from a neighboring ammonia production unit.

2. Study the heating principle of synthesis columns

• Review the operating principle, purpose, and scheme from the *Technological Regulations for the Ammonia Production Unit, 1360 t/day, TEC Severodonetsk, A/O "Soyuzazot", 1979*.
• Evaluate the modifications required for the existing heating scheme, which currently uses a fired heater, when integrating a supply line for a gas stream (heat-transfer medium). The heat-transfer medium—purge gases—would be taken from an adjacent ammonia unit (ABC). Ammonia plants can potentially supply each other with purge gases to preheat synthesis

columns. Since no pipeline interconnection exists, it must be designed, with required capital investments for piping and automation of flow distribution.

The economic benefit is achieved because the synthesis column can be heated even when the preceding stages of the technological process have not yet been started up (or are only partially started).

3. Evaluate economic feasibility

Take into account:
• number of planned and unplanned shutdown/start-up events,
• start-ups following catalyst replacement or catalyst reduction,
• potential efficiency gains due to reduced start-up duration.

4. Assess project risks and limitations

Consider technical, operational, and organizational risks associated with implementing the proposed scheme.

Input Data

Technical Parameters

• Ammonia unit capacity: 1,750 t/day
• Number of ammonia units on site: three
• Assume each unit has one synthesis column
• Start-up acceleration per synthesis column: 6 hours

Economic indicators

• Marginal revenue from additional ammonia output: 25,000 rubles per ton
• Assume natural gas consumption is the same for standard and accelerated startup
• The economic effect should be calculated solely based on increased ammonia output

Constraints

No additional constraints specified

Expected Deliverables

Participants must present:

1. Analysis of the number and duration of start-up periods for ammonia synthesis columns, including an estimate of potential time savings.
2. Technological proposal describing the modified heating scheme using purge gases from a neighboring unit.
3. Capital cost assessment for constructing inter-unit pipeline connections and automation systems.

4. Economic impact calculation for various scenarios (planned/unplanned start-ups, catalyst replacement).
5. Evaluation of key risks and constraints associated with the implementation of the proposed solution.

Additional Materials

Available upon request.