METHANOL CASALE S.A.

METHANOL CASALE'S EXPERIENCE WITH A RUSSIAN METHANOL PROJECT

by

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DESIGN, SUPPLY, QUALITY CONTROL AND SUPERVISION

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ABSTRACT

During recent years Companies of CASALE GROUP (AMMONIA CASALE S.A., UREA CASALE S.A. and METHANOL CASALE S.A.) had the unique opportunity to make available to TOAZ their innovative know-how in various technological fields.

The case history described in this paper is an example of the peculiarity of CASALE GROUP approach in designing a new methanol plant and TOGLIATTIAZOT capability in the implementation of the project.
CASALE GROUP designed a new grass root methanol plant of 1350 MTD applying new technology as well as maximizing the use of equipment available at site as spare parts and manufacturing new equipment in Russia.
Three main features characterize the design of this methanol plant:

a) The redesign of an existing ammonia reformer to meet the requirements of the new methanol reformer by increasing the catalyst volume by 80%, the radiant section heat liberation by 28% and by modifying the convection section and utilizing modern refractory material.

b) The new horizontal methanol converter with its low cost (including installation), high vessel catalyst filling efficiency of 80%, low pressure drop, long term reliability, fast catalyst loading, internal steam generation and optimal temperature distribution with deviation below 1°C.

c) A compact plant layout with low capital and installation costs.

METHANOL CASALE supplied all the imported equipment and materials, performed the quality control of equipment available at site, as well as the equipment manufactured in Russia.
OAO TOGLIATTIAZOT carried out the civil and structural engineering for the whole plant based on METHANOL CASALE detail engineering and manufactured most of the equipment procured in Russia under the tight supervision and quality control of CASALE specialists and inspectors.

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TOGLIATTIAZOT erected and commissioned the new methanol plant under the supervision, quality control and training of METHANOL CASALE.

In spite of the Russian winter conditions the start-up in winter time was smooth and fast.

After several years of slow development and difficulties in C.I.S., this is the first chemical plant of relevant size to be erected in Russia, thanks to a combination of the world wide expertise of METHANOL CASALE and the focused implementation capability of TOGLIATTIAZOT with their long experience in the construction, commissioning and operation of large capacity ammonia, urea and methanol plants.

DESIGN, SUPPLY, QUALITY CONTROL AND SUPERVISION

1. INTRODUCTION

CASALE Companies (Ammonia, Urea, Methanol and Chemicals) have a wide experience in revamping ammonia, urea and methanol plants, having revamped more than 100 ammonia converters, over 50 urea plants and 16 methanol plants with different capacities in the world.

During the last years Companies of CASALE GROUP (AMMONIA CASALE S.A., UREA CASALE S.A. and METHANOL CASALE S.A.) had the unique opportunity to make available to TOGLIATTIAZOT their innovative know-how in various technological fields.

TOGLIATTIAZOT is one of the largest chemical complexes in the world, having seven ammonia trains with a total annual production capacity of 3.5 million ton, two urea trains with a total annual production capacity of 1.0 million ton and now a methanol plant with an annual production capacity of 0.45 million tons.
Gradual retrofitting of the ammonia trains was the initial approach and during the last decade chemical production upgrading and energy saving were the main achievements, corresponding to the anticipated targets of 10% productivity increase and energy saving of 0.5 million kcal/ton of ammonia, equal to a saving of 26 million cubic meter of natural gas per single production line per year.

Nevertheless ammonia production did not represent an isolated and specialized case. TOAZ confidence in CASALE plus the good mutual understanding between them, led the two companies making an audit of the complete factory.

Urea trains were included in this modernization program, applying a revamping scheme for a production increase of 15% and a drastic reduction of the contamination of aqueous emissions, stopping the pollution of surface waters.

On the basis of the positive results achieved in the ammonia and urea trains, and TOGLIATTIAZOT's determination to diversify their production to new products, the two companies conceived a new project for a methanol plant based on CASALE technology.

The case history described in this paper is an example of the peculiarity of CASALE GROUP approach to designing a new methanol plant and TOAZ capability in implementing the project.

2. NEW METHANOL PLANT IN TOGLIATTI

METHANOL CASALE was requested by TOAZ to study the possibility of transforming one of the 3 existing GIAP AM 76 ammonia plants into one methanol plant keeping the same production capacity.
Later TOAZ decided not to transform one of the existing ammonia plants but to build a new methanol plant, using as much as possible the equipment already in its warehouse, originally designed for the eighth ammonia plant.
A new methanol plant with a capacity of 1350 MTPD (1477 STPD) was designed by METHANOL CASALE taking into account TOAZ requirements not only to maximize the use of the equipment present at site, but also to maximize the manufacture of new equipment inside Russia.
Fig. 1 shows the flow sheet of the new methanol plant designed by CASALE indicating the main equipment reused, those manufactured in Russia and those imported.

The plant is divided into four main process steps:

- The **Feedstock Preparation** which includes:

  - the Hydrodesulphurization where sulphur compounds are processed from natural gas;
  - the Steam Reforming Section where the natural gas is processed to produce synthesis gas.

  CO_2 is added to natural gas to increase the quantity of carbon atoms available for conversion into methanol in the synthesis section.
  A considerable quantity of waste heat is available both from the process gas and the flue gas streams.

  This heat is recovered by rising high-pressure steam, preheating reactants and providing distillation reboil heat.

- The **Compression Section** where syngas is compressed, mixed with recirculating gas and sent to the synloop.

- The **Synthesis Section** where the methanol reaction takes place in the horizontal converter and, at the same time, steam is raised to be sent to the refining column second reboiler.

- The **Distillation Section** where the crude methanol produced in the synloop is refined in two stages: in the first stage the light ends are removed, while in the second stage the heavier ends and water are removed to give refined product methanol of grade AA quality.

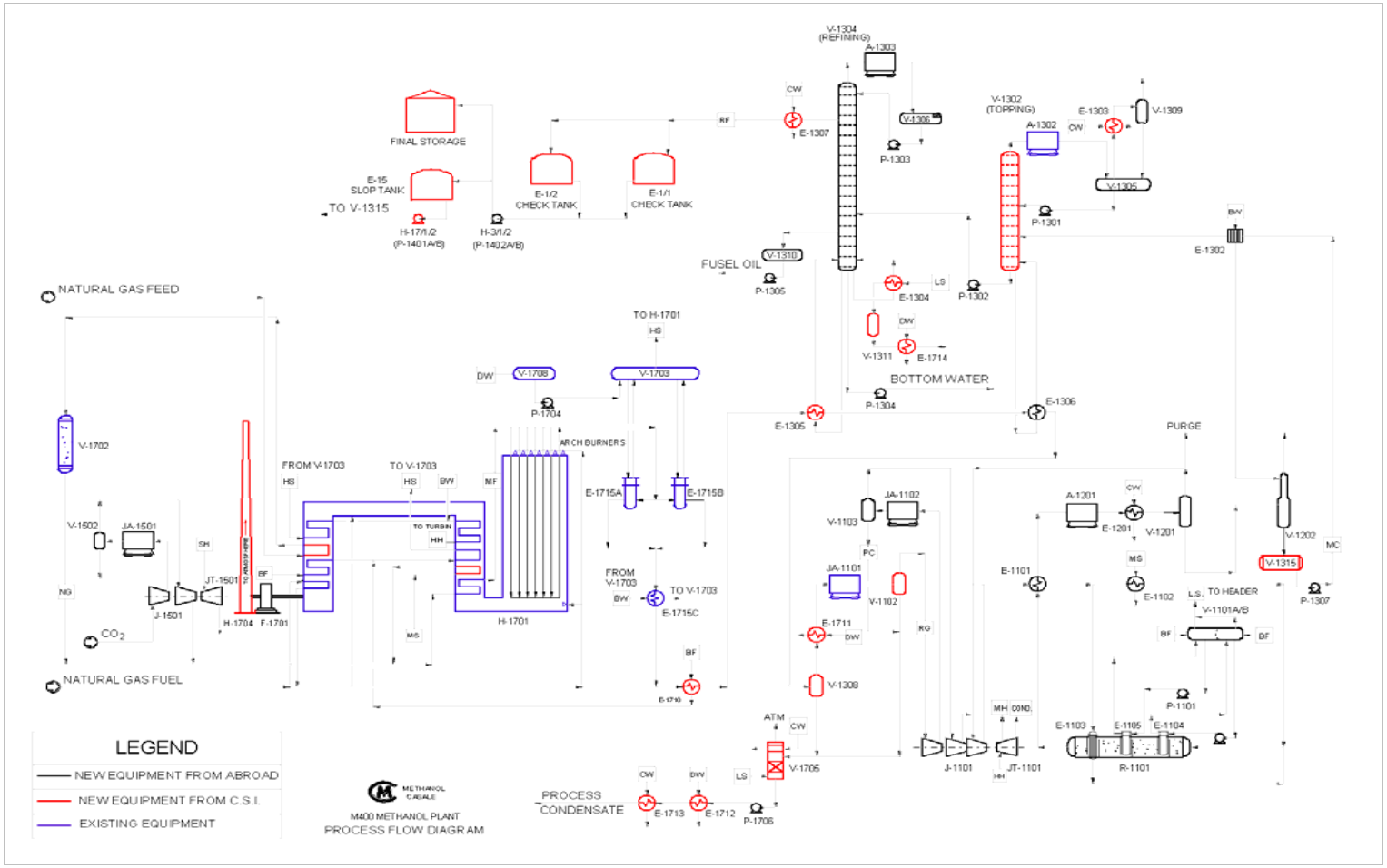

Fig. 1 - New Methanol Plant Process Flow Sheet

There are two main features of the new methanol plant:

a) The redesign of the existing ammonia reformer in order to meet the requirement of a new methanol reformer.

b) The new horizontal methanol converter with internal steam generation.

3. STEAM REFORMING

The process scheme of the GIAP ammonia reformer, which is very similar to a Kellogg design, is detailed in fig. 2 together with the convection section.

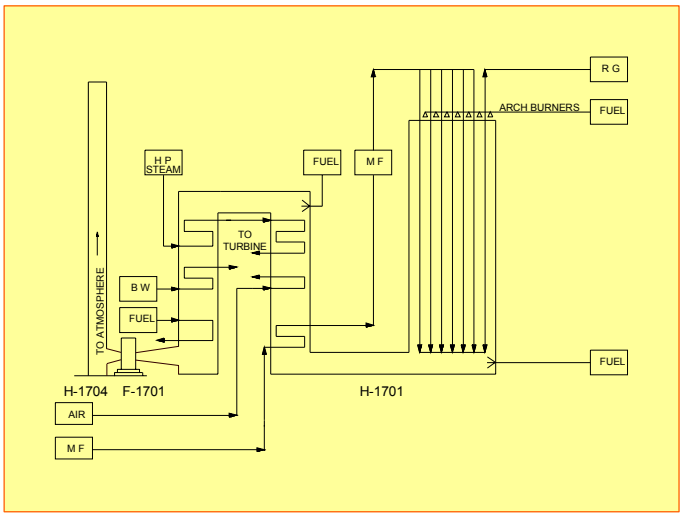

Fig. 2 – Existing Reformer Process Scheme

In order to reach the guaranteed 1350 MTD methanol, the new reformer configuration required the process design modifications as per fig. 3.

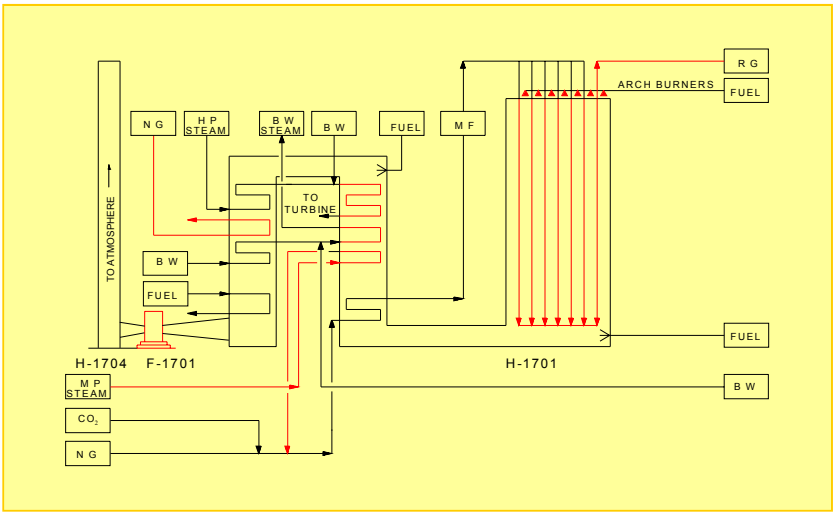

Fig. 3 – New Reformer Process Scheme

The main revamping features are the following:

- Increase of reforming catalyst quantity from 20.8 m^3 to 37.6 m^3 by changing catalyst tubes with larger diameter and smaller thickness (12 mm);
- Increase of radiant heat liberation from 170'000'000 kcal/h to 227'000'000 kcal/h by modification of arch burners;
- Addition of one BFW heater/boiler convection coil;
- Addition of one natural gas preheater convection coil;
- Utilization of existing air preheater convection coil to heat MP process steam;
- Addition of inline de-superheater between 1st and 2nd stage H.P. steam superheaters to control the temperature at H.P. turbine inlet.
- New flue gas fan driven by electric motor and steam turbine on a single train, with turbine speed automatically controlled.

4. NEW HORIZONTAL METHANOL CONVERTER

Due to the operating conditions in terms of pressure and temperature being milder than in an ammonia converter, the horizontal layout becomes an attractive solution for modern large capacity reactors.
The pressure vessel is a simple cylindrical shell laid down horizontally and contains all catalyst baskets and heat exchangers and boilers between the beds.

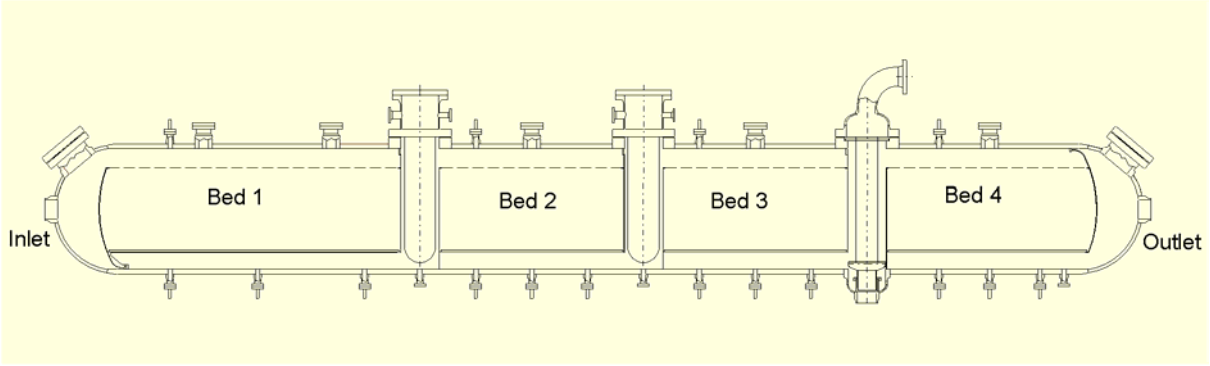

Fig. 4 - Horizontal Converter

The important features of the **CASALE HORIZONTAL CONVERTER** design are as follows:

- Possibility to recover the reaction heat raising steam up to 25 bar.
- Simple mechanical design: the catalyst baskets are just empty containers, without complicated internals like tubing, coils etc.
- All exchangers are completely removable from the pressure shell, for easy maintenance.
- Single vessel layout, for any capacity, up to 3000 MTD and more (3300 std).
- Low pressure drops thanks to the cross (rather than axial) flow pattern of the catalyst.
- Maximum utilization of the vessel's internal volume.
- The design allows filling more than 80% of the vessel volume with catalyst thus resulting in compact, low cost units.

Furthermore no external high temperature piping is necessary to connect the exchangers. Also the steam/BFW piping system is greatly simplified since the steam drums can be located very close to the reactor. Standard, well-proven shell and tube heat exchangers are used and a very simple foundation layout. The package of reactor and exchangers needs only two saddles for support.
The converter and related equipment, like boilers and steam drums, are all at ground level.

The above features of the Horizontal Methanol Converter have led to the realization of a reactor with the following advantages:

- **Low cost, including installation.**
- **Reduced energy consumption thanks to the low-pressure drop.**
- **Long-term reliability since very simple, design equipment is used.**
- **Very easy maintenance of the internals.**
- **Fast catalyst loading / unloading of the beds (this operation can be done simultaneously for each bed).**
- **Steam rising, which is used in the distillation reboiler.**
- **Optimal temperature profile at inlet and outlet of each bed with temperature spread below 1°C.**

Fig. 5 - Horizontal Converter during Transportation

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Fig. 6 – Methanol Synloop in Togliatti

The remaining equipment of the plant is based on conventional design but with the particularity of a compact layout in order to reduce manufacturing and erection costs.

Fig. 7 shows the simplified plant layout of the new methanol plant.

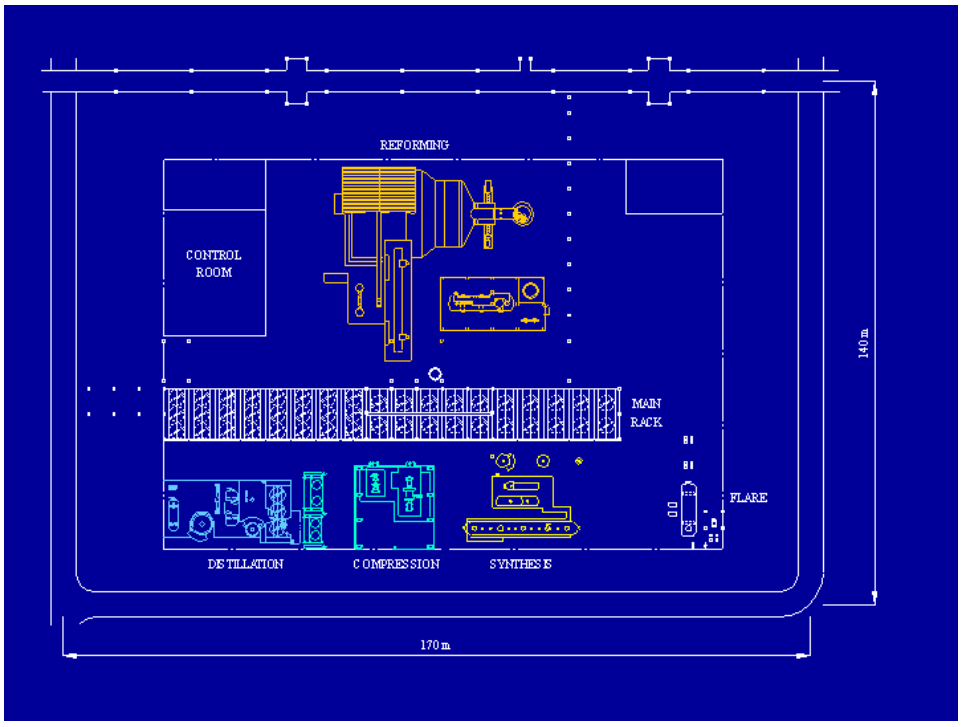

Fig. 7 – Simplified Plant Layout of New Methanol Plant

In this project, METHANOL CASALE scope of work mostly covered:

- Basic Engineering
- Detail Engineering including:
  - Mechanical engineering
  - Piping engineering
  - Instrument engineering
  - Electrical Engineering
- Supply of all imported equipment and materials
- Quality control of equipment available at site
- Quality control of equipment manufactured in Russia
- Site supervision and quality control during erection
- Training
- Site supervision during pre-commissioning, commissioning, start-up and plant operation optimization.

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5. CONCLUSION

This practical case has shown that, thanks to its world wide expertise in different processes and technologies, CASALE GROUP has been able to optimize the re-utilization of existing equipment for a different process, as well as the design of new equipment in order to build a complete new optimized grass root plant.

Fig. 10 - New Grass Root Methanol Plant in Togliatti

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