METHANOL CASALE AND FOSTER WHEELER: JOINING FORCES FOR THE METHANOL MARKET

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presented at
NITROGEN 2006
Vienna, Austria
12-15 March 2006

FOSTER WHEELER

CasaleGroup

TITLE

METHANOL CASALE AND FOSTER WHEELER: JOINING FORCES FOR THE METHANOL MARKET

ABSTRACT

FOSTER WHEELER AND METHANOL CASALE HAVE JOINED THEIR FORCES TO MARKET METHANOL PLANTS USING A COMBINATION OF THEIR AVANT-GARDE TECHNOLOGIES.

FOSTER WHEELER AND METHANOL CASALE HAVE FORMED THIS ALLIANCE TO DESIGN AND BUILD INNOVATIVE METHANOL PLANTS, BASED ON THE MOST ADVANCED TECHNOLOGY, USING THE WELL-KNOWN FOSTER WHEELER / BANQUY SYNGAS PREPARATION PROCESS SCHEME AND THE UNIQUE METHANOL CASALE SYNTHESIS REACTOR DESIGN FOR REACTION LOOPS.

BOTH COMPANIES WILL SUPPLY KEY EQUIPMENT; METHANOL CASALE WILL PROVIDE THE PREREFORMER, THE AUTOTHERMAL REFORMER AND THE SYNTHESIS CONVERTER AND FOSTER WHEELER WILL FURNISH THE STEAM REFORMER.

A SINGLE TRAIN METHANOL PLANT OF 7000 MT/D WILL BE CONSTRUCTED BASED ON THIS NOVEL PROCESS SCHEME AND THE PROPOSED EQUIPMENT DESIGN CONCEPT. THIS METHANOL PLANT WILL HAVE THE HIGHEST CAPACITY, THE HIGHEST EFFICIENCY AND THE LOWEST CAPITAL COST.

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1. INTRODUCTION

Methanol Casale and Foster Wheeler are very well-known and reputable names in their own field of activity. Both active for almost a century, they have substantially contributed throughout the years to make the history of the petrochemical industry.

The relationship between Methanol Casale and Foster Wheeler has been traditionally good: Foster Wheeler has been a Licensee of Casale in the field of ammonia plants for decades.

Based on this rich background, recently the two companies established a preferential Alliance to design and erect methanol plants.

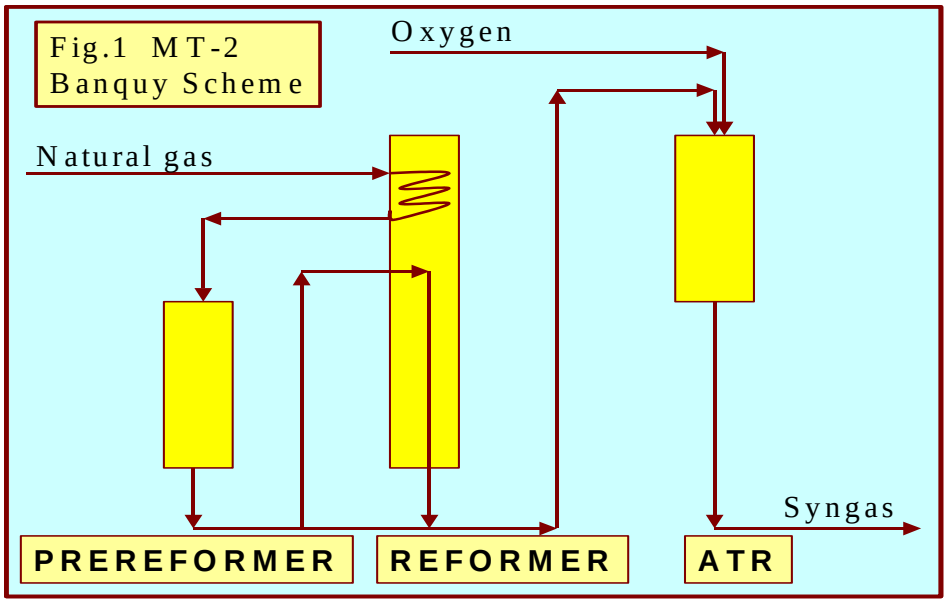
2. THE ALLIANCE

The Alliance takes advantage of the complementary capabilities of the two companies.
The strategy of Methanol Casale is aimed at developing and licensing technologies such as high efficiency reactors, while Foster Wheeler mostly focuses on activities related to large projects such as engineering, procurement and construction.
Furthermore, Foster Wheeler has a tradition of innovative technologies, such as its proprietary well-known Banquy scheme, also called combined reforming, for the production of large amounts of synthesis gas, as well as its primary reforming design.
Both companies have a worldwide experience and can operate in any environment and furnish a wide range of various services and products: from revamping of a synthesis converter to supply of a large methanol plant on EPC basis.
In the aliiance agreement, the scope of work will be split :
Methanol Casale will provide the license, the basic engineering and the proprietary equipment, i.e. the pre-reformer, the ATR and the synthesis converter.
Foster Wheeler will supply the steam reformer and provide management, engineering, procurement, construction, start-up and operation activities.

3. THE TECHNOLOGIES

The Alliance between Casale and Foster Wheeler merges the best methanol-production technologies on the market today.
The plant scheme proposed is based on the production of synthesis gas from natural gas with combined reforming, as shown in fig.1. This consists in the combination of primary reforming and authothermal reforming with oxygen of the natural gas feedstock. Adopted under

Foster Wheeler's license in several methanol plants worldwide, it is a well-known and proven scheme.
Methanol Casale's prereformer, ATR and plate-cooled converter designs characterize the syngas production and the synthesis even more, while the distillation is carried out by the usual three-column system.



3.1 Methanol Casale Technologies

3.1.1. Pre-reformer

In large-size methanol plants pre-reforming allows reducing the size of the downstream reforming section, stabilizing the composition of the feed gas and sinking the consumption of oxygen.

A few years ago Casale successfully introduced an innovative design for this reactor. The new design is based on its well-known axial-radial flow pattern for catalyst beds. It is characterized (see fig. 2,) by the fact that most of the gas flows radially through the catalyst, while the catalyst bed top is open. Therefore, the remainder gas flows to the bed top in an axial-radial direction. As a result, compared to the traditional pure radial beds - closed at the top - the catalyst bed is mechanically simpler, replacing the catalyst is easier and the catalyst itself has a higher utilization efficiency.

This catalyst bed design was first introduced for ammonia synthesis converters and it has since been used also for other reactions such as methanol synthesis, high and low temperature shifts, and pre-reforming itself.

At the present time, three Casale axial-radial pre-reformers are in service in ammonia plants, the oldest in 2001. Two more units are under construction for methanol plants.

The axial-radial pre-reformer is a very simple reactor: it is made up of a slim pressure vessel and a catalyst bed made by two annular vertical perforated walls and thermo-wells. The pressure vessel can be refractory-lined or operating at full temperature: both designs have been adopted - according to the peculiar conditions of each project - and are already successfully on-stream.

Compared to the old axial design, use of axial-radial pre-reformer has several advantages, i.e.:

- Low pressure drop thanks to the axial-radial design;
- Slimmer and cheaper pressure vessel, as the catalyst bed is axial-radial, therefore extended in height rather then in width;
- Smaller catalyst volume, as with the low pressure drop axial-radial bed it is possible to use small size catalyst - more active than the standard one;
- Longer catalyst life, again thanks to the use of small-size catalyst.

3.1.2. Autothermal Reformer

The Autothermal Reformer designed by Casale is characterized by the system used to mix oxygen and gas. This system is already in service in two methanol plants and in one ammonia plant, the oldest one since 2001, and has achieved all the goals that were set during design, i.e.:

- A long durability, the oldest one is in service since four years and, when recently inspected, it showed no sign of deterioration, see fig. 3;
- A good process performance, achieving the expected conversion of methane to syngas;
- Total absence of soot formation, as evidenced by the analysis and inspections on ATR catalyst and downstream equipment;
- Wide flexibility, it has been successfully operated at temperature conditions, composition and flow rates far from the design ones.

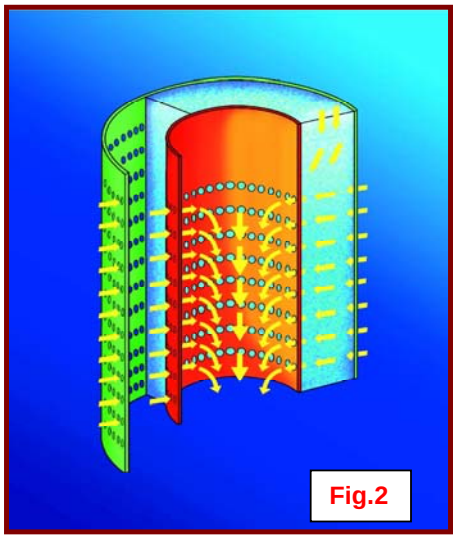


Fig.2

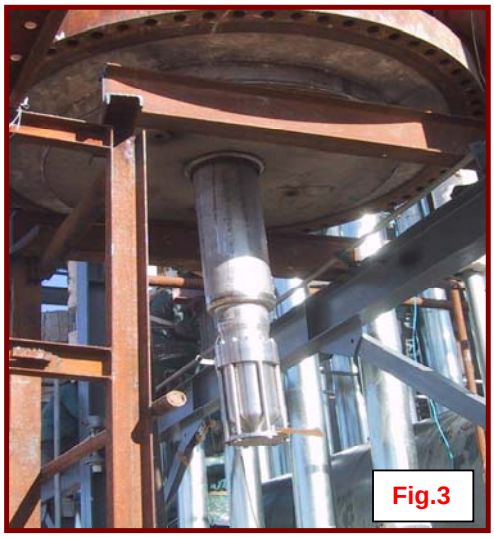


Fig.3

3.1.3. Synthesis converter

Methanol Casale synthesis converters are already well-known in the industry, as they are operating in nearly twenty different plants. Most of these converters were actually third-party designs that have been revamped, introducing new Methanol Casale internals in the existing pressure vessels, to improve their performances.
This revamping activity has demonstrated the superiority of Methanol Casale converters, and in fact, the same internals design has also been used in new plants from the beginning.
Most of these converters were known as “ARC converters” and were designed according a multiple adiabatic beds layout with intermediate cooling by quenching.
More recently Methanol Casale has developed and successfully introduced a completely new concept, which is a pseudo isothermal converter in which the heat transfer surfaces are plates instead of tubes, see fig 4, and the catalyst is outside the cooling plates.
There are several advantages deriving from this new design, as it is more efficient and makes it possible to build converters, which have a much higher capacity in a single vessel. Thanks to these advantages a decrease in the size and number of the loop equipment and pipes can be achieved as well as a reduction in energy consumption.

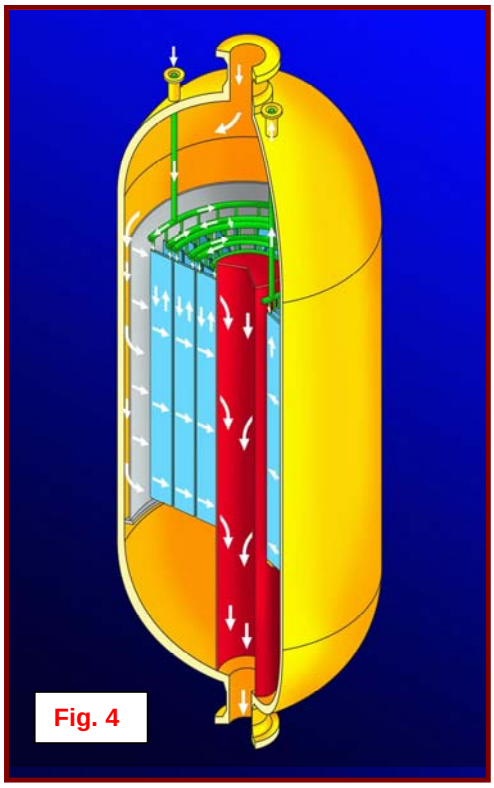


Fig. 4

The main reasons for the high performances and capacities achievable are that the cooling plates do not need a tube sheet. Therefore, a constraint in the converter size is eliminated. Moreover the converter can be designed with an axial-radial flow.
The converter is then a pressure vessel containing one or one with more axial-radial catalyst beds.

The cooling plates are immersed in the catalyst bed and the cooling fluid flowing inside the plates can be the fresh converter feed gas, water or other heat transfer fluid. A combination of different fluid is also possible.

These facts enable the design of converters with much higher capacities, as they do not have constraints of pressure drop, heat removal configuration or maximum tubesheet diameter and thickness.

Furthermore with this design it is possible to control the temperature profile in the catalyst mass by removing the reaction heat in such a way to operate the catalyst according to the highest reaction rate temperature profile, and this fact makes the converter more efficient.

3.2 Foster Wheeler technologies

3.2.1 Combined reforming

Foster Wheeler has filed a patent both in Europe and USA concerning a process for the production of synthesis gas; the process is called MT-2 and has been invented by a Foster Wheeler employee – David Banquy.

The process starts from a hydrocarbon feedstock aiming to produce a synthesis gas suitable either for methanol synthesis or for other applications requiring low H2/CO ratio.

In this process, the feedstock, supposed to be desulphurized, is divided into two fractions; a first fraction undergoes a primary steam reforming at high pressure and moderate temperature; the gas effluent from said primary steam reforming, as well as the second fraction of the feedstock, are combined and subsequently undergo a secondary reforming section by reaction with an oxygen containing gas in a reactor operating under essentially adiabatic conditions.

The synthesis gas, obtained as effluent from said secondary reforming, has a composition adjustable at will in a wide range, and therefore can be made as close as necessary to the stoichiometric composition required for methanol synthesis. The synthesis gas is available at high pressure, and can therefore feed directly, without compression, the synthesis loops downstream.

The process is particularly suitable for methanol production on a very large scale.

3.2.2. Primary reformer

A direct-fired steam hydrocarbon reforming heater is the “work-horse” of many synthesis gas production processes converting a wide range of hydrocarbons processes feedstocks to syngas.

Foster Wheeler’s capability in designing Steam Reformers is very well proven by the experience accumulated in more than 50 years and the considerable number of units designed, built and operating all over the world (over 100).

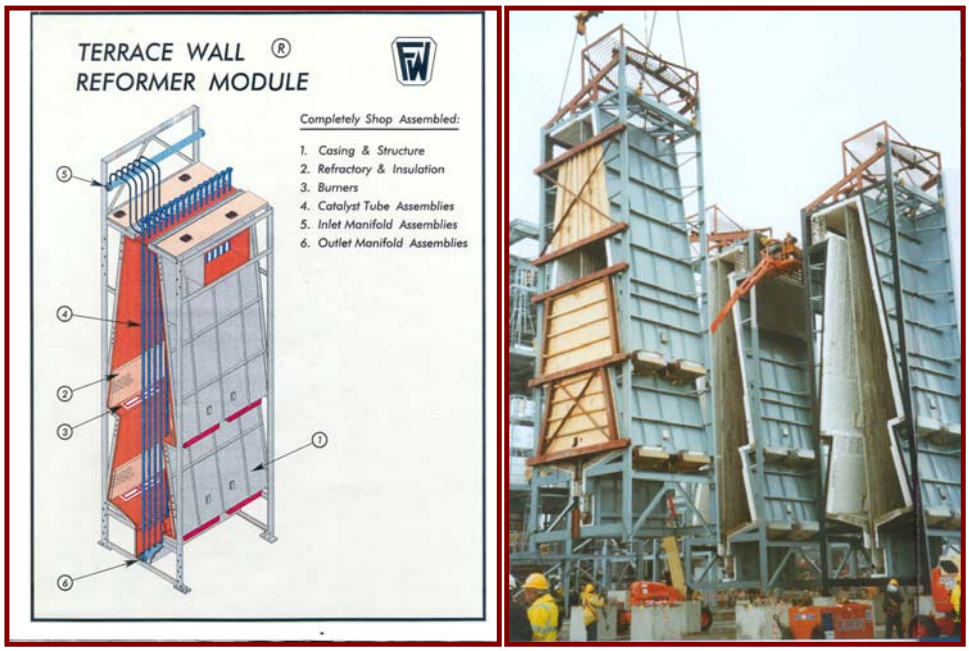
Foster Wheeler reliability in supplying these critical equipment is particularly valuable due to the capacity to design not only Terrace Wall Reformers but also down firing units.

This peculiar experience – unique in the market – allows FW to provide the best solution to the specific requirement of every single Client; the selection between the two options is dictated by techno-economic considerations.

In the furnace the reforming of steam-hydrocarbon mixtures is accomplished in catalyst filled tubes.
The reformer reaction is endothermic, requiring high level heat input, and is performed in the radiant section of the heater. For a safe, reliable and efficient operation, the following considerations are important:

1. The process heat demand in the catalyst tubes varies significantly from inlet to outlet
2. The heat distribution along the length of the furnace shall be uniform
3. The circumferential heat flux on the tubes shall be as uniform as possible

The convection section is used to recover heat from flue gases with the aim to improve the overall efficiency of the plant and can be placed on top of the radiant section in case of Terrace Wall design to save plot area.



4. EXPERIENCE

Methanol Casale has a long standing presence in methanol production plants, as it has 18 methanol converters in operation (plus 4 under construction), with capacities ranging from 460 to 2900 MTD for a total installed capacity of 11,180,000 MTY. This represents about 35% of the world-installed capacity.

It is worthwhile mentioning that this market share has been achieved in the last ten years thanks to the introduction of new technologies that have been always very successful. Methanol Casale is without any doubt at present the most innovative company in its field.

More in detail, out of these 18 converters, 4 are plate-cooled converters, three gas-cooled and the other one is steam-raising. The oldest one is in operation since 2002 and three more converters are under construction.

This type of converter is in operation also in two ammonia plants, with axial-radial designs, and operating conditions much harsher then in methanol plants.

The synthesis gas preparation section is a part of the plant where Casale intervention is not as well known, but even here Casale has quickly achieved significant success by the installation of the axial-radial pre-reformer.

Even more importantly, Casale has already 11 burners installed for synthesis gas generation in different fields, i.e. ammonia, CO and methanol production. Out of that number, there are 4 autothermal reformers used in ammonia or methanol plants.
Methanol Casale has also built a completely new grass-root methanol plant in Russia, with a capacity of 1350 MTD, and a second one, for the same client, with a capacity of 1500 MTD is almost completed and will be started up this year.

In both these plants Casale's scope included the detailed engineering and supply of most of the materials, plus supervision of construction and commissioning.

Foster Wheeler has been at the forefront of methanol technology for many years. It has provided methanol plants that have been designed according technology licensed by Casale, Lurgi and ICI. In addition to engineering, procurement and construction services for complete plants, Foster Wheeler has executed plant improvements and revamps, has provided reforming furnaces for methanol plants built by others, and has provided studies and other technical consultancy services to players in the industry sector.

5. THE CONTRACTING CAPABILITIES

Foster Wheeler is an International Project Management and Engineering organisation providing a broad range of professional engineering services and products.
With over a century of experience, Foster Wheeler has earned a reputation for engineering excellence based on leading edge technologies, the skills of thousands of dedicate people and a global structure that spans six continents.
Connected by advanced electronic links Foster Wheeler's ISO 9001 (or equivalent) certified centers (17 as a whole) all work to a common

engineering philosophy. The shared expertise and close co-ordination between engineering centers enables Foster Wheeler to offer seamless project management and execution. The worldwide resources of Foster Wheeler are available to complete our clients' projects on time and within budget, wherever they are located.

Through its strategically located operations centers, Foster Wheeler has designed, supplied and installed thousands of process, power and industrial facilities in more than 125 countries. Foster Wheeler offer tailored services capable of making virtually any type of facility more efficient, productive and environmentally friendly. Foster Wheeler accounts for more than 9000 technical employees worldwide.

Foster Wheeler is organized and staffed to act as Main Contractor with sole responsibility for design, procurement, construction and commissioning of large process plant complexes, with guaranteed performances on a Lump Sum Turn Key basis. If such comprehensive scope and contractual terms are not applicable, the company organization is equally adaptable to carry out any phase or phases of the total engineering process, at client's request.

The following major projects either executed in the last years or under execution should be highlighted:

- Lomellina WTE project in Italy (compl. year 2007)
- SET Combined Cycle in Italy (compl. year 2007)
- BaPCo Refinery facilities in Baharein (compl. year 2007)
- Voghera Energia Combined Cycle in Italy (compl.2005)
- Tamoil Refinery facilities in Switzerland (compl.2004)
- Chempetrol Polypropylene in Czech Republic (compl.2002)
- Exxon Chemical Alcohol project in Singapore (compl2001)
- Tupras Refinery upgrading in Turkey (compl.2001)
- ISAB Energy IGCC Complex in Italy (compl.1999)

6. CONCLUSIONS

Methanol Casale has a very important reference that has been made available to the alliance: a plant Methanol Casale has designed having a capacity of 7000 MTD to be built in the Middle East; at present the basic design is completed. This plant, based on natural gas, will produce AA grade methanol.

The flow sheet foresees a combined reforming, where the desulphurized natural gas is firstly pre-reformed in a Casale axial-radial unit and then split into two streams. One stream is sent to a primary reforming unit and then joined with the remainder. The mixed flow enters the Auto Thermal Reformer, where it is mixed with oxygen to complete the reforming step.

The synthesis gas produced in the ATR is cooled to generate high-pressure steam; all the heat necessary for methanol distillation is recovered internally.

In this gas preparation section most of the equipment is a single unit, with the exception of the high-pressure waste heat boiler, that will be in two bodies in parallel.

The synthesis loop is characterized by the use of the Casale plate-cooled converter. This is a single vessel unit, recovering heat by generating process steam and preheating the fresh feed gas to the converter.

Thanks to the high conversion per pass achievable, the downstream equipments are all single units, and the piping sizes are still within the normal standards.

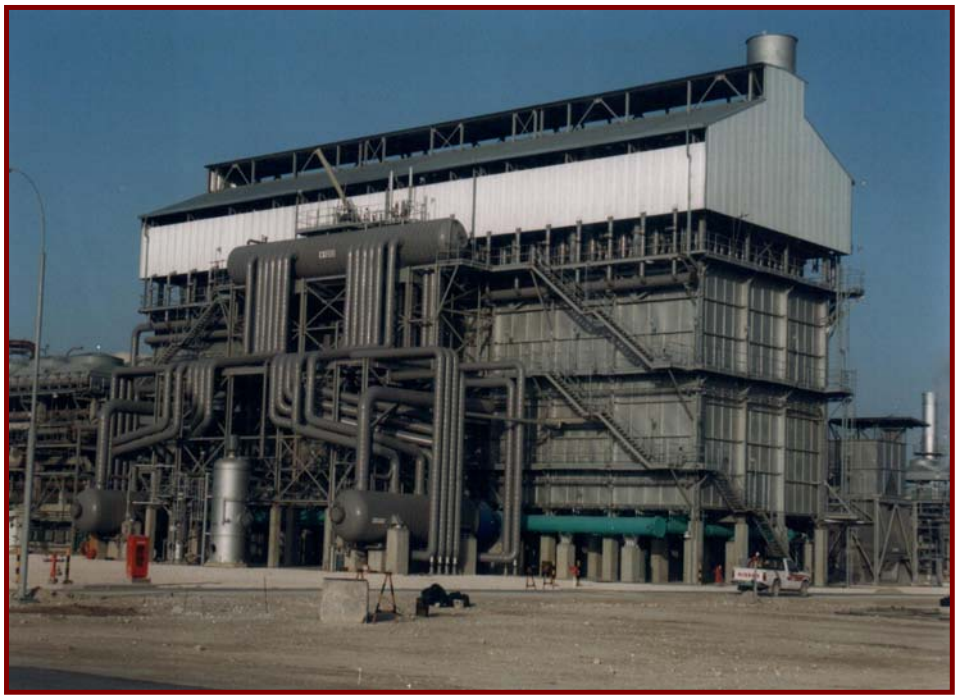
The distillation is a three columns system.

An air separation unit (cryogenic type) is foreseen to supply oxygen to the ATR.

The established Alliance would like to bring to potential Customers attention the fact that a new player, with the relevant capabilities and references, is available in the market to supply delivered and erected methanol production facilities.

Terrace Wall Steam Reformer - 50,000 Nm3/h Hydrogen plant

The Alliance is characterized by the unique fact of having available, on an exclusive basis, the best technologies on the market for each part of the plant, and the capability to execute in the best way the largest projects, as proven by the long history of the two partners.



Top Fired Steam Reformer - 2750 MTPD Methanol plant