2005 WORLD METHANOL CONFERENCE

TITLE

METHANOL CASALE AND FOSTER WHEELER: A NEW ALLIANCE FOR THE METHANOL INDUSTRY

ABSTRACT

METHANOL CASALE AND FOSTER WHEELER HAVE ESTABLISHED A NEW ALLIANCE TO DESIGN AND TO BUILD METHANOL PLANTS.

UNDER THIS NEW ALLIANCE, THE METHANOL TECHNOLOGY OFFERED BY METHANOL CASALE AND FOSTER WHEELER IS THE MOST ADVANCED ONE.

THE PROCESS SCHEME FOR THE SYNGAS PREPARATION IS THE WELL-KNOWN FOSTER WHEELER / BANQUY SCHEME WHILE THE REACTION LOOP IS BASED ON THE USE OF THE UNIQUE METHANOL CASALE SYNTHESIS REACTOR DESIGN.

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

THE PROCESS SCHEME AND THE PROPOSED EQUIPMENT DESIGN CONCEPT WILL ALLOW THE CONSTRUCTION OF A SINGLE TRAIN METHANOL PLANT OF 7000 MT/D. THIS WILL BE THE METHANOL PLANT WITH 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. Active for decades, they have substantially contributed throughout the years to make the history of the petrochemical industry.

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

Recently the two companies have established a preferential Alliance to design and erect methanol plants.

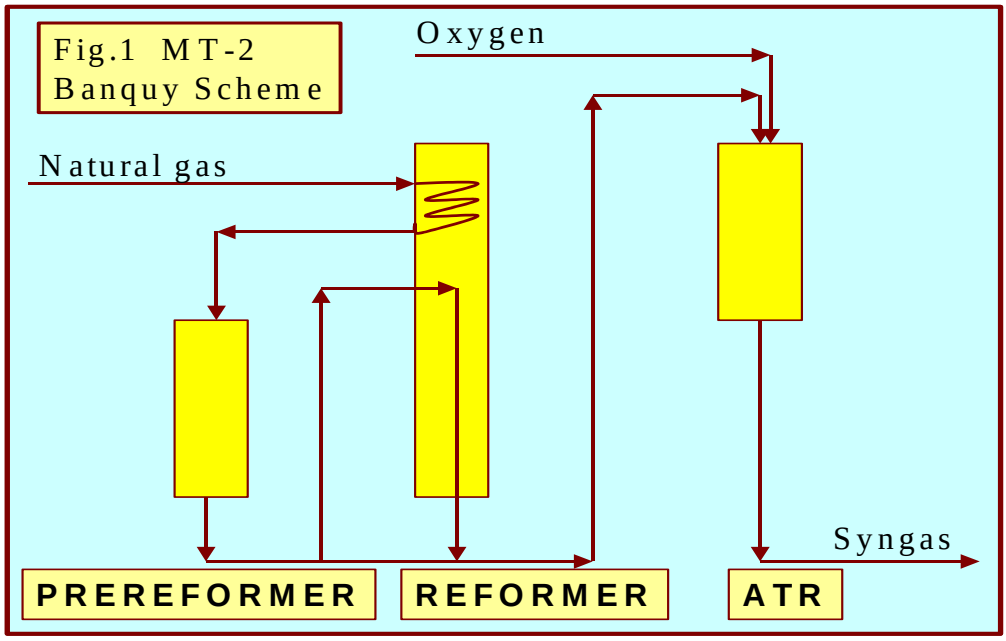
2. THE ALLIANCE

The Alliance is based on the complementarities of the two companies taking advantage from the two companies' capabilities.
Methanol Casale strategy is aimed at developing and licensing technologies like high efficiency reactors, while Foster Wheeler mostly focuses on large projects related activities like engineering, procurement and construction activities.
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 and its primary reforming design.
Both companies have a worldwide large experience and can operate in any environment and supply a wide range of different services and products: from revamping of a synthesis converter to supply of a large methanol plant on EPC basis.
In the agreement the scope of work will be split.
Methanol Casale will provide the license and the basic engineering and supply 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 and makes them available to their Clients.
The proposed plant scheme 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 the primary reforming and the 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 design for prereformer, ATR and plate-cooled converter characterizes even more the syngas production and the synthesis, while distillation is 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, sinking the consumption of oxygen and stabilizing the composition of the feed gas.

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, and 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 higher utilization efficiency.

This 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.

At present three Casale axial-radial pre-reformers have been sold in ammonia plants, the oldest in 2001, while two more are under construction for methanol plants.

The axial-radial pre-reformer is a very simple reactor: it comprises 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 because of 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 small size catalyst - more active than the standard one – can be used;
- 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 in service in two methanol plants and an 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 has been in service for 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.

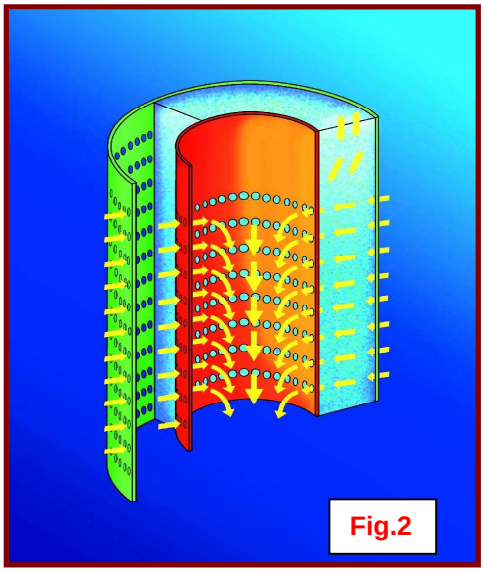


Fig.2

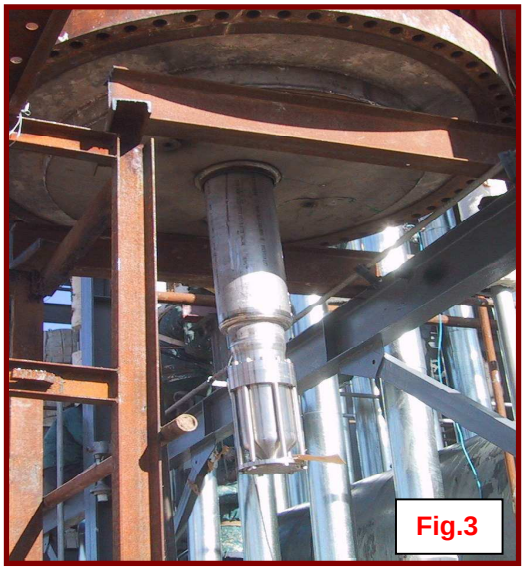


Fig.3

3.1.3. Synthesis converter

Methanol Casale synthesis converters are already well-known in the industry, as they are operating in more than twenty different plants. Most of these converters are 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 design has also been used in new plants from the beginning.
These generations of 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, because it is now possible to build converters which have a much higher capacity in a single vessel, and are also more efficient, therefore allowing a decrease in the size and number of the loop equipment and pipes, and also a reduction in energy consumption.

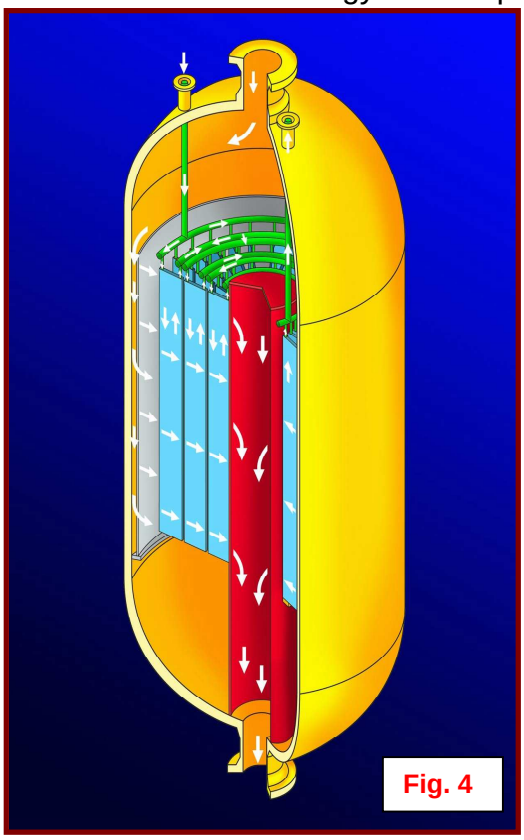


Fig. 4

The main reasons for the high performances and capacity achievable are that the cooling plates do not need a tube sheet, therefore eliminating a constraint in the converter size. Moreover the converter can be designed with an axial-radial flow.
The converter is a pressure vessel containing one or 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.
In this way 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.

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.

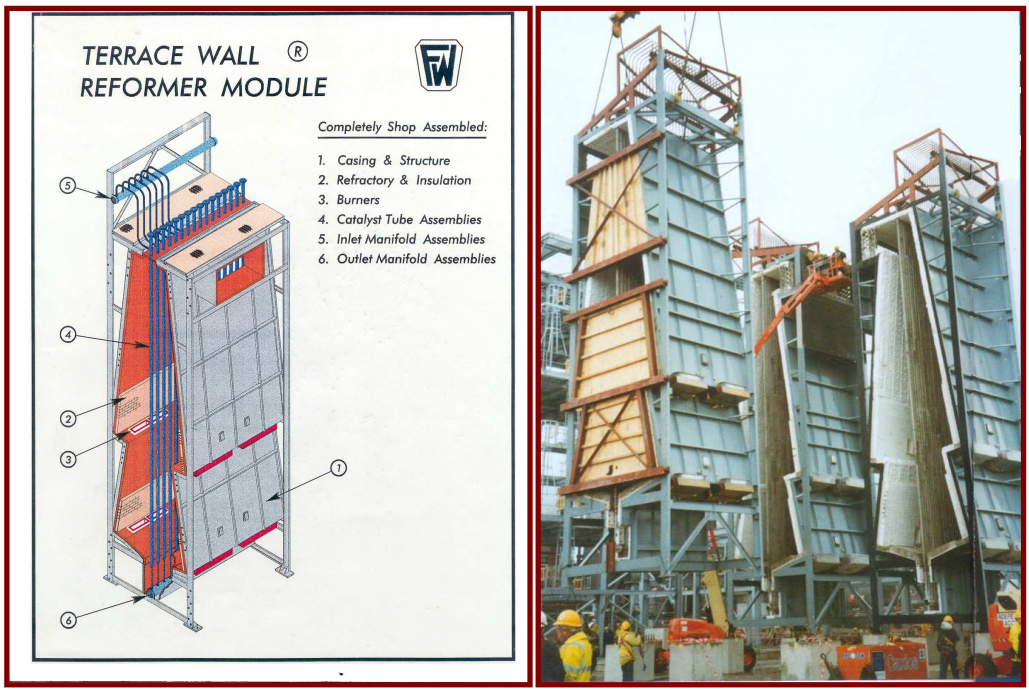
3.2.2. Primary reformer

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, it has 18 methanol converters in operation (plus 3 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 worth underlining 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.

More in detail, out of these 21 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 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 less well known, but also here Casale has quickly achieved significant success by the installation of the axial-radial pre-reformer.
Even more important is the fact that Casale has already 11 burners installed for synthesis gas generation in different fields, i.e. ammonia, CO and methanol production. Out of that 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, in 2006.
In both these plants Casale 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 designed a plant having a capacity of 7000 MTD to be built in the Middle East; at present the basic design is completed. This is a very important reference that is made available to the alliance. The 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.

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.