

Casale Group

1. History of the Casale Group

The Casale Group has been active in the field of technology development and engineering for 85 years, beginning in 1921 when Dr. Luigi Casale developed one of the first processes for the synthetic production of ammonia and founded Ammonia Casale. Over the years the company has diversified and presently the Casale Group, formed of four independent companies: Ammonia Casale, Urea Casale, Methanol Casale and Casale Chemicals, offers its services in the fields of ammonia, urea, methanol and derivatives production.

From the very beginning, the success of the Group was linked to its ability to develop innovations and introduce them to the market. Casale's dedication to the development of innovative technologies to respond to the challenges of the industry began with its founder, who developed one of the first ammonia processes. This process was innovative as it was the first to produce anhydrous ammonia and the first to become available to any producer, opening the way to the growth of the modern ammonia production industry.

This trend has been preserved and nurtured as central to the company's culture by subsequent management teams. Innovations and diversification have been the driving force of Casale Group in the last twenty five years, and they have been the key to most of its past and recent successes.

Casale Group's innovative concepts over the last twenty years have found wide acceptance in the market, making a great contribution to the progress of the ammonia, urea and methanol industries. With the axial-radial catalyst bed and the 'in-situ' modification concept, Ammonia Casale opened the way to improve existing ammonia plants with low investments.

With its High Efficiency urea reactor trays and various novel revamping technologies, Urea Casale has given urea producers a way to increase their installed capacity with low capital cost.

With the ARC methanol converter, Methanol Casale has enabled ICI methanol plants to increase production with the same gas feed and decrease operating costs.



Casale Headquarters

The success of the technologies developed by the Casale Group is evidenced by the number of contracts awarded to the companies of the Group in the last twenty years, which is indicated in Table 1:

Table 1: Contracts awarded to Casale Group in the last 20 years	
Ammonia Casale	193
Urea Casale	88
Methanol Casale	33
Casale Chemicals	94
Group Total	408

As a result of all of these contracts, 75 million t/y of ammonia, 21 million t/y of methanol and 41 million t/y of urea are now produced worldwide with Casale technologies or equipment. Casale's attitude to innovation is further evidenced by the fact that, over the same period of time, the group has filed about 1200 patents all over the world.

The Group has physically grown considerably in the last twenty years and has recently built its own office building in Lugano with 2500 m² of working area, housing about 110 people. The Group has performed projects with over 200,000 engineering man-hours per single project (including external resources).

The companies in the Group can offer a complete range of services and technologies for project implementation, complete plant revamping and new plant construction, with full use of innovations and experience. These services include: technical audits - advisory and consultancy services for improved plant performance; feasibility studies; licensing of proprietary technologies; basic & detailed engineering; project management; procurement services; plant construction management; plant commissioning, start-up and optimization; project contracting on a turn-key basis; after-sales technical services

2. Fertilizer and Methanol Plant Revamping

The Casale Group has vast experience in the revamping of fertilizer and methanol plants, with more than 280 plants revamped in the last 20 years. Combining its deep know-how with its advanced technologies, the Casale Group can tackle the most difficult challenges in terms of plant revamping. Capacity increases of up to 60%-80%, and in some cases even more, and significant energy savings can now be obtained with the revamping technologies and schemes developed by Casale.

Every revamping project is developed on a case-by-case basis, and Casale uses the best combination of its technologies to reach the project targets. The following general revamping philosophy is, however, followed for every project:

the plant should always be upgraded with the most modern technologies
 maximise efficiency of existing equipment, especially in the synthesis section
 minimise the duration of any plant shutdown
 minimise modification to the existing plant.

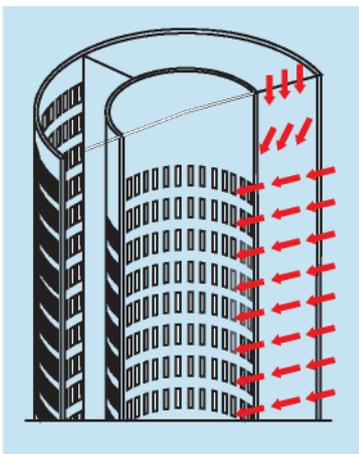
With this philosophy, Casale keeps the return period on project investment as short as possible.

In the next sections, an overview is given of the most significant technologies used by the Casale Group for the revamping of fertilizer and methanol plants.

Ammonia Casale

Ammonia Casale, founded in 1921, is the oldest company of the Casale Group and one of the oldest leading engineering firms operating in the field of ammonia production. In the last 20 years, Ammonia Casale has gained a leading position in revamping ammonia plants thanks to continuous technological development. During this time, more than 170 ammonia plants have been revamped by Ammonia Casale.

Fig. 1: Gas distribution in an axial-radial catalyst bed



Axial-radial Catalyst Beds

Axial-Radial Shift Converter

Existing shift converter can easily be transformed to the axial-radial design by introducing new vertical cylindrical perforated inlet and outlet walls in prefabricated sections, which are assembled inside the existing converter vessel.

Axial-Radial Synthesis Converter

The ammonia converter is one of the most critical items when planning a revamp to save energy or increase capacity, and Ammonia Casale has developed various synthesis converter designs to be able to offer to the industry always the most efficient and advanced solution for its needs.

All Casale ammonia converter designs are based on the axial-radial bed design that guarantees highest efficiency, with the use of 1.5-3 mm size catalyst, and lowest pressure drop.

Pseudo-Isothermal Synthesis Converter

In order to cope with demands for very large increases in plant capacity, requiring the highest possible increase in converter efficiency in order to maintain the feasibility of the revamping approach, Ammonia Casale has developed the pseudo-isothermal ammonia synthesis converter, which is able to push the efficiency of the Casale converter even further than the three beds intercooler design.

Secondary Reformer Burner

Ammonia Casale has developed, through its sister company Casale Chemicals, a new secondary reformer burner design utilizing advanced fluid dynamic simulation techniques.



Secondary Reformer Burner.

Advanced Ammonia Plant Revamping Schemes

In addition to the various technologies described above, which are focused on improving the efficiency of the key equipment items of ammonia plants, Ammonia Casale has developed various

innovative revamping schemes to drastically increase plant capacity and reduce energy consumption. Based on the combination of the most appropriate technology for improving efficiency of the key items

With modification to the process steps, these schemes can reach capacity increases of up to 60-80 % and reductions in energy consumption of 10-20 %.

Urea Casale

Urea Casale was established in 1991 and from the beginning its activity has concentrated on the revamping of urea plants, rapidly building up its know-how and experience in this field. Thanks to intensive and successful technological development, Urea Casale has been able to rapidly penetrate the market, revamping 87 plants since its foundation.

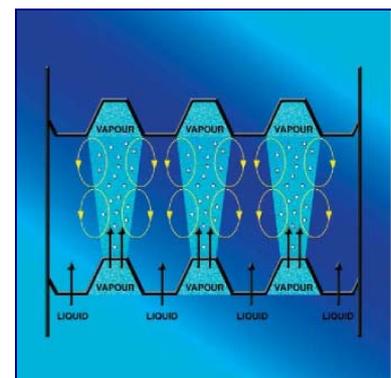
The most important technologies developed by Urea Casale are as follows:

Casale-Dente High Efficiency Trays

This was one of the first technologies to be developed by Urea Casale and still is a fundamental element for any revamp aimed at increasing the capacity and reducing the energy consumption.



25% capacity increase in ammonia plant.

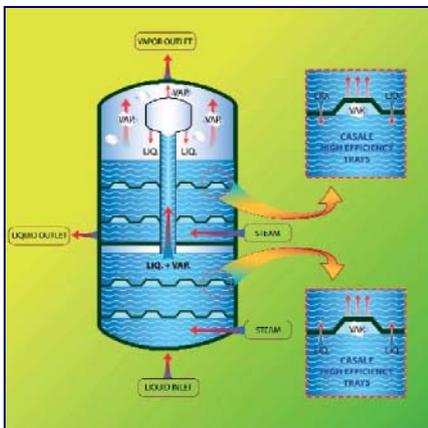


Casale-Dente high efficiency trays.

Developed through an accurate understanding and modeling of the urea reaction system, the Casale-Dente high efficiency trays (HET) design improves the tray geometry, producing much better mixing between the liquid and vapour phases

Casale High Efficiency Hydrolyser

One issue that has become very important in the urea industry is the elimination of pollutant compounds. In order to eliminate pollutants from liquid emissions, Casale has developed a new increased efficiency hydrolyser, called the high efficiency hydrolyser (HEH), which enables a user to completely eliminate urea from the process condensate.



High Efficiency Hydrolyser.

HEC (High Efficiency Combined) Process

The development of this process opened the way to very large capacity increases, 50% or more, in conventional total recycle plants. The process is based on the combination of a conventional total recycle reactor (secondary reactor) with a very efficient "once-through" reactor (primary reactor) having upstream a carbamate condenser to control the heat balance, and a HP decomposer downstream to recycle most of the unreacted NH_3 and CO_2 directly into the secondary reactor. The HEC has the unique feature of achieving a very high average CO_2 conversion, and low energy consumption.

VRS (Vapour Recycle System) Process

This technology has been developed for the revamping of stripping plants and is used in certain cases to drastically increase the capacity of these plants.



Conventional Total Recycle Plant Revamped with the HEC Concept.

Methanol Casale

Methanol Casale was founded in 1994 and, following the trend established by Ammonia Casale, has dedicated a lot of effort to develop technologies for the revamping of methanol plants. With 30 plants revamped since its foundation, Methanol Casale has become a leader in methanol plant revamping.

The following section outlines the most important technologies developed by Methanol Casale.

Axial-Radial Pre-Reformer

The same technology used for ammonia plants is also used for methanol plant revamping.



Casale grass-roots methanol plant.

ARC Synthesis Converter

The ARC synthesis converter is an adiabatic, quench-cooled, single vessel converter with very effective quench mixing. This design was originally developed to increase the efficiency of the ICI quench lozenge converter, but it has also been successfully used for brand new converters.

Pseudo-Isothermal Synthesis Converter

The ARC is a very simple and efficient converter, but being an adiabatic converter, it has the intrinsic limitations of this type of design. In order to go beyond these limitations without incurring all of the limitations and mechanical complexity of conventional isothermal converters, Casale has developed the pseudo-isothermal methanol synthesis converter.

This converter, based on direct heat removal from the catalyst bed with plate elements, reaches the maximum converter efficiency, with the catalyst beds operating always along the maximum reaction rate curve, thus obtaining the maximum possible conversion.

ATR unit

In order to drastically increase the capacity of conventional synthesis gas generation units in methanol plants, one of the most efficient ways is the installation of an additional autothermal reformer (ATR) unit. Methanol Casale has developed a proprietary design for ATR units, which is based on a very efficient burner design.

Large Capacity Increase using Methanol Casale Technologies

Utilising the most appropriate of its proprietary technologies, combined with the correct modification to the process steps, Methanol Casale makes drastic capacity increases in existing plants possible.

3. New Plant Construction

Boosted by the creativity necessary to improve existing plants and the experience gained from the successful applications of many new concepts, the Casale Group has developed innovative processes for grass-roots fertilizer and methanol plants responding to respond to the growing demand for new plants in low gas cost areas.

Ammonia Casale has traditionally been involved in designing grass-roots ammonia

plants, with more than 100 units built in the first years of its history. More recently, even though it has mainly focused on plant revamping, it has also increasingly developed and supplied technologies for grass-roots plants.

In the field of methanol, Methanol Casale has designed and supplied two grass-roots plants, of 1,350 and 1,600 t/d capacity, as well as the world's largest methanol plant, currently at an early stage of realisation, with a capacity of 7,000 t/d.



ATR Burner

4. R&D Activities

As can be seen from the large number of innovative technologies developed, the Casale Group has invested and is still significantly investing in technology development. The Casale R&D department is also putting a lot of effort into developing the right process design models. For investigating, analysing and visualising complex phenomena, the R&D department avails itself of the right specialists and of advanced tools, such as computer-aided techniques with applications ranging from chemical process design to fluid dynamics evaluations.

Several of the technologies developed by Casale are typical examples of how the combination of these tools and this expertise can lead to the development of innovative concepts.

At present, to shape future Casale technologies, various R&D programs are being implemented in different fields (see previous sections), involving also the construction of pilot facilities.

In addition to new technologies, Casale has also developed, and continue to

develop, innovative mechanical designs for very critical equipment, such as HP process boilers, to improve their reliability.

5. Job Opportunities

Casale Group is a dynamic engineering company based on know-how, experience and innovation, therefore always looking for brilliant, motivated and young engineers to improve its operative structure.

The following summary highlights the typical position and responsibilities for young engineers willing to start their career in a leading engineering company.

Process Department

The *Process Department* is composed by three sections.

There are two sections dedicated to the process design of the ammonia, methanol and urea projects, respectively (new and revamped plants design), while the third one is focused on the research and development activities, including mathematical modeling and fluid-dynamic calculation.

Joining The Casale *Process Department*, the chemical engineers, aerospace and mathematical engineers will be part of a group of experienced people, working on chemical plant design and on the design of proprietary items.

The main activities they will be involved in are the process plant simulation and optimization, the preparation of the flow diagrams and the related heat and material balances.

Together with the other technical departments, the engineers will prepare the equipment specifications, including rotating and static items and will define the Process and Instrumentation Diagrams (P&ID) designing the plant process control philosophy.

Your job will be in a fast paced environment and supported by the Casale experienced technical background.

Quite often business trips will enable you to acquire international experience by directly contacting the Client's representatives.

Project Management Department

The *Project Management Department* is responsible for the execution of projects from contract award up to project completion.

During the project life, the *Project Management Department* is required to perform the contract analysis, definition

of the project organization required to reach the project goals, cost control, planning and monitoring of project progress and project engineering coordination.

In this department, the Project Manager plays a key role in executing the project and, together with the Project Engineers and Planners, they constitute the project team dedicated to the project, to executing the contract and representing the Company vis-à-vis the Client.

The Project Engineer coordinates the engineering activities between the engineering sections, in full conformity with the contract and project needs.

The Planner is dedicated to the planning and monitoring of project activities, as well as to rescheduling the project according to the project's evolution.

Engineering and Construction Department

The *Engineering and Construction Department* is responsible for the engineering and field supervision of the project developed by Casale. It is composed by several sections, each responsible for one of the disciplines involved in the plant design and construction.

The *Equipment Design Section* is responsible for the mechanical design and engineering of static equipment, mainly pressure equipment such as pressure vessels, heat exchangers, boilers and relevant internals.

The main activities of a mechanical engineer in the Casale *Equipment Design Section* are the management of pressure vessels, heat exchangers and related equipment supply, including the preparation of technical specifications, preliminary design and Vendor follow-up; mechanical design of proprietary equipment based on finite element analysis and internally developed methods

In the framework of the mechanical engineer's activity, he maintains contact with clients and suppliers and participates in technical meetings with them.

The *Equipment Drafting Section* is responsible for all of the activities of the Company relevant to drafting and internal graphic drawings, ranging from main equipment to promotional presentations.

The main activities of a Drafting Engineer in the Casale *Equipment Drafting Section* are the designing all of Casale equipment through the use of instruments such as CAD 2D and 3D, checking construction drawings received from our suppliers, as well as actively partaking in the research and development of new technologies.

The *Machinery Section* is responsible for the selection and the engineering of rotating equipment such as centrifugal pumps, centrifugal compressors, reciprocating pumps, reciprocating compressors and steam turbines.

The main role of a mechanical engineer in the *Machinery Section* will be the management of equipment supply, including the preparation of technical specifications, preliminary selection, technical evaluation of bids and Vendor follow-up.

In the framework of the mechanical engineer's activity, he maintains contact with clients and suppliers and participates in technical meetings with them.

The *Electrical Section* is responsible for the electrical design and engineering of MV and LV electrical systems relevant to new and revamped plants.

The main activities of an electrical engineer in the Casale *Electrical Section* is the study of the electrical standards of the end user country, the preparation of technical specifications, the electrical system design and the management of all electrical items, including Vendor follow-up. In the framework of the Electrical engineer's activity, he maintains contact with clients, third parties and suppliers and participates in technical meetings with them; when required, the electrical engineer also participates in field site surveys to collect data.

The *Instrumentation Section* is responsible for the Instrumentation and Control design relevant to new and revamped plants.

The main activities of an Instrumentation engineer in the Casale *Instrumentation Section* will be the preparation of technical specifications for control and safety systems, the selection and sizing of field instruments and valves according to process requirements and the management of all instrumentation bulk items, including Vendor follow-up.

In the framework of the instrumentation engineer's activity, he maintains contact with clients, third parties and suppliers and participates in technical meetings with them; when required, the instrumentation engineer also participates to field site surveys to collect data

The *Piping and Layout Section* is responsible for the plant layout and piping design and engineering relevant to new and revamped plants.

The main activities will be the piping basic and detailed engineering relevant to new and revamped chemical plants.

The piping engineer will be able to analyze and develop piping activities, manage and organize external resources and keep contacts with clients and suppliers, participating in technical meetings both in the office and at the client's site; the piping

engineer also participates to field site surveys to collect data.



The Casale Office Building in Lugano.

The *Construction Section* is in charge of the supervision during on-site installation of Casale proprietary equipment such as converters, reactors, exchangers and columns' internals.

The preparations of technical specifications related to the installation works are also included in this section.

The field engineer spends his time in the office, preparing specifications and procedures, but mainly in field supervising installation works.

He also participates in the development of new designs, checking the installation features, maintains contact with clients and suppliers and acts as connection between field and office.

Quality Department

The *Quality Department* is responsible for verifying the internal quality of the Company, through internal audits and the application of the internal procedures, as well as the quality of the goods made and supplied by manufactures. This check is done by verifying and approving technical documents issued by manufacturers, through technical meetings and inspection activities performed at the manufacturers' workshops. The staff of the Quality Department is composed of qualified specialists, trained through specialized courses and professional experience at the manufacturers' premises.

Information and Communications Technologies Department

Casale Group *Information and Communications Technologies Department's* mission is to choose, install and manage hardware, software and communication equipment needed for Group operations. The department is committed to meet the Casale Management's policies and strategies relevant to the ICT infrastructure, as well as to keep the technological tools

pertaining to it up to date, efficient and effective.

The department operates in the following areas: networking, security, communication, intranet / extranet / internet infrastructure, ERP applications, CAD/CAE applications, Scientific Computing applications, Help Desk and more.

People working in the department have the following main qualifications: help desk engineers, system engineers, database and ERP professionals, web application developers and CAD/CAE applications professionals.

For more information regarding the Casale Group of Companies, please contact:

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