

Economical benefits

- Saving of 40% in operating costs, in comparison with competitor technologies (BAT) using NaOH (wet processes).
- Saving of 95% in absorbing buffer make up costs, in comparison with the existing BATs using disposable solutions.
- Saving of about 25% in energy costs.
- Recovery of SO_x as saleable sulphur. About 96% of sulphur coming from the FCC flue gas is recovered from the buffer solution.

RefinARS and the competitor technologies

The technology used in RefinARS proved to be very profitable in comparison with other techniques, in terms both of environmental impact and of consumption.

PARAMETER	BELCO® LABSORB™ REFINARS TECHNOLOGY	ABSORPTION BY NAOH SOLUTION
Conc. of SO ₂ at stack	250 mg/Nm ³ dry	500 mg/Nm ³ dry
Liquid waste production	1 t/h	9 t/h
Solid waste production (wet)	21 kg/h	1.000 kg/h (Na ₂ SO ₄)
Chemicals consumption	16 kg/h (NaOH and H ₃ PO ₄)	560 kg/h (NaOH)

RefinARS experimental data compared with typical absorption data using NaOH aqueous solutions

Sannazzaro Refinery

Sannazzaro Refinery has a capacity for processing 10 million tons/year of crude oil.

Located 26 Km from Pavia, in the south-western part of the Po Valley, just a few kilometres from the left bank of the river Po, it occupies about a 220 ha site and extends over the communities of Sannazzaro de' Burgondi and Ferrera Erbognone.

Born in 1963 with a capacity of 5 million tons/year, doubled by 1975, revamped between 1988 and 1992 and upgraded with works for improved technology over the last few years, the Refinery today boasts one of the highest complex levels and conversion capacity in Europe.

Technology and efficiency, an advantageous logistic position and flexibility to meet demands from the market and environment make the Sannazzaro Refinery a core business of the Refining & Marketing Division at Eni.

The commitment of the Refinery is not however only focused on production requirements, but, in line with the corporate policies of Eni, also guarantees the safety and health of its activities, protection of environment and an Eco-friendly rapport with the territory.

The Refinery is equipped with operational tooling appropriate to this end, such as the Safety Management System and an Environmental Management System certified with the ISO 14001 International Certification.

All this, together with an accurate policy of investments and thanks to the co-operation of all the employees, has given the Refinery the opportunity of reaching important goals not only in the technological and production field, but also in the field of accident prevention and reduction of environmental impact.



REFINARS

ENI LIFE EVENT
Refinery Absorption and Recovery of Sulphur



The **Life Environment Fund** programme is dedicated to the implementation of the environmental policies of the European Union. Its general aims are the protection of the natural territory and the promotion of sustainable development, in any form.

Life Environment Fund projects

- Must take the form of a demonstrational, pilot or trial project for the particular techniques and methods used.
- Must be of an innovative nature, which may be transferred to the interested sector as a whole and to other European industrial sectors.

People and companies from EU Member States and from Eastern and Central European countries may participate in **Life Environment Fund** according to the procedures established for the particular project.



PLANT AND PRODUCTION CAPACITY

CAPACITIES MAIN PROCESS UNITS	MILLIONS OF TONS/YEAR
2 TOPPING plants (primary distillation)	10.0
2 REFORMING plants	1.5
3 DISTILLATE DE-SULPHURIZATION plants	3.5
1 CATALYTIC CRACKING plant	2.0
1 HYDROCRACKING plant	1.8
CORE PRODUCTION	MILLIONS OF TONS/YEAR
Gasoline production capacity	3.3
Jet Fuel production capacity	1.2
Diesel production capacity	3.4



SANNAZZARO REFINERY

with the contribution of the LIFE ENVIRONMENT FUND

Further information can be obtained contacting the project manager:

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Refining & Marketing Division

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With a market capitalization amounting to over euro 70 billion, Eni is one of the most important integrated energy companies in the world which operates in the oil and gas industry, power generation and oilfield services, construction and engineering. In these businesses it has a strong edge and leading international market positions.

Refining & Marketing - Eni is engaged in the refining and marketing of refined products mainly in Italy, the rest of Europe and Latin America. Through its Agip and IP brands, Eni is leader in the retail market in Italy, with a 36.6% market share.

Refining & Marketing

Eni's refining system in Italy is made up of five wholly owned refineries and a 50% and 28% interest in the Milazzo and Priolo refineries in Sicily, respectively. Eni's wholly owned refineries in Italy have a balanced capacity of 25.2 million tonnes (equal to 504,000 barrels/day), corresponding to over a fourth of Italian capacity and a conversion capacity of over 16.3 million tonnes, with a 58.8% equivalent conversion rate, one of the highest in Europe.

Outside Italy - In Germany Eni holds an 8.3% interest in the Schwedt refinery and a 20% interest in Bayernoil, an integrated refining pole including the Ingolstadt, Vohburg and Neustadt refineries.

Eni holds a 16.33% interest in Ceska Rafinerska (CRC) which owns and manages two refineries, Kralupy and Litvinov, in the Czech Republic. Eni's total refining capacity in Italy and abroad amounts to 681,000 barrels/day.

In refining, interventions are planned for rationalizing refining capacity by balancing production and demand and increasing refinery efficiency and flexibility. These actions will allow to increase conversion rates from the 60% average of the 2000-2003 period to 64% by 2007. Eni also intends to adjust the characteristics of its refined products to the evolution of automotive fuel specifications in Europe, focusing on fuels dedicated to specific market segments by leveraging on its integrated refining-logistics-distribution system.

Logistics - Eni is the leader in storage and transportation of petroleum products in Italy. Its logistical integrated infrastructure consists of storage sites and a network of depots and petroleum product pipelines.

The storage infrastructure is made up of 12 directly managed storage sites all over Italy and of interests in five companies established by the major Italian operators in Vado Ligure-Genova (Petrolog), Arquata Scrivia (Sigemi), Venice (Petroven), Ravenna (Petra) and Trieste (DCT) aimed at reducing costs, increasing efficiency and developing innovative integrated services to customers. For the transport of refined products on land Eni also owns storage facilities, pumping stations and a pipeline network (integrated by leased pipelines). Eni's pipeline network in Europe extends over 3,173 kilometers, of these 1,476 are wholly owned.

Eni's logistic system also makes use of a leased fleet of tanker ships for sea transportation of oil and refined products and a leased fleet of tanker trucks for the distribution of refined products on the retail and wholesale markets.

Retail sales - In Italy, Eni's retail distribution network consist of 4,300 service stations under the Agip brand, with an average throughput of 2.5 million liters.

Eni is implementing a process of requalification and strategic repositioning of its distribution network in Italy and abroad. In Italy Eni is in the final phase in the upgrading process of its retail network by developing its core network made up stations with high throughput and high non oil retail potential, with the objective of reaching European standards in terms of throughput, services provided to customers and automation. Eni targets an Agip branded network consisting of 4,180 service stations, a 30% market share and average throughput of about 2.8 million liters by 2007. Eni's retail distribution network **outside Italy** consist of 1,813 service stations with an average throughput of 2.4 million liters, of which 1,813 in the rest of Europe and 1,544 in Brazil. Retail sales in the rest of Europe amounted to 3 million tonnes with an average throughput of 2,378,000 liters.

Eni intends to develop its presence in selected markets in Europe (Eastern Spain and Southern France and Germany), where it can leverage on logistical and operational synergies and on its well established brand name. In the next four years Eni intends to increase by over 30% the number of Agip branded service stations in the rest of Europe, reaching sales volumes of about 7 billion tonnes and an average throughput of 2.8 million liters in 2007.

The REFINARS • "LIFE 2000" project



Aim of the project

The aim of the Eni R&M RefinARS project is to solve problems arising from the overall environmental impact:

- the Fluid-bed Catalytic Cracking (FCC);
- the related flue gas, coming from the catalyst regeneration, by a worldwide innovative technology, allowing the absorbing solution (or buffer) regeneration and reuse, and simultaneously avoiding the side effects of solid waste production.

The above main objective results in a series of economical, industrial and environmental advantages, due to the innovative technology employed. The first industrial scale demonstration has been carried out on a buffer regeneration plant, built in the Eni's Sannazzaro Refinery.

The issue

The environmental impact of the conversion process in oil refineries. The FCC process is typical of many modern refineries. It is used to transform medium weight and heavy products (i.e. diesel oil from vacuum distillation and atmospheric residues) into a mixture of light products, to be split by distillation into higher value and highly marketable products, like LPG and motor gasoline, with yields greater than 50%.

The FCC process gives, as residue, a sulphur and carbon rich deposit on the catalyst surface. This residue must be burnt out to reuse the catalyst. Then, flue gas coming from this combustion contains SO₂, causing the so called "acid rains" problem, together with other chemical substances. Acidification and atmospheric SO₂ damage sensitive ecosystems, reduce biodiversity as well as detrimentally affects crop production and the growth of forests. SO₂ pollution may also have a significant effect upon human health, particularly among those sectors of the population suffering from respiratory diseases.

The existing remedies. Up to now, the SO_x emission from FCC plants has been hindered by low sulphur charges and applying flue gas desulphurization techniques. To this aim, alkali (CaOH, NaOH) are used to absorb SO_x. Even though it is considered a Best Available Technique (BAT), every process results in a relevant environmental impact, caused by liquid waste (wet desulphurization processes) and solid waste production (dry and semi-dry desulphurization techniques).

The new technology

The innovative technology used by Eni R&M is based on an absorbing buffer which can be regenerated (Belco®/Labsorb™ patented). This solution contains sodium hydroxide (NaOH) and phosphoric acid (H₃PO₄). It allows an overall environmental impact considerably lower than existing BATs for the FCC flue gas desulphurization, included in BREFs issued by the IPTS of Seville.

In fact, the buffer regeneration allows to achieve a negligible environmental impact, both in terms of liquid effluents and in terms of solid waste, generated by the SO_x absorption reactions.

The buffer regeneration process is based on the evaporation of the solution coming from the FCC flue gas desulphurization, and on the following stripping steps. The process gives:

- a gaseous stream, containing SO_x, sent to the sulphur recovery unit;
- the regenerated buffer, which can be recycled to the FCC flue gas desulphurization;
- a minor solid waste.

The schematic flow diagram of the buffer regeneration process is illustrated in Fig.1.

The buffer regeneration plant was completed between July 2002 and May 2003. After the plant commissioning activities, a test campaign was started and completed in September 2004. During such test campaign, the FCC unit was fed by charges with different sulphur content and the circulating buffer flowrate was changed, in order to optimize the process operating conditions.

Main results

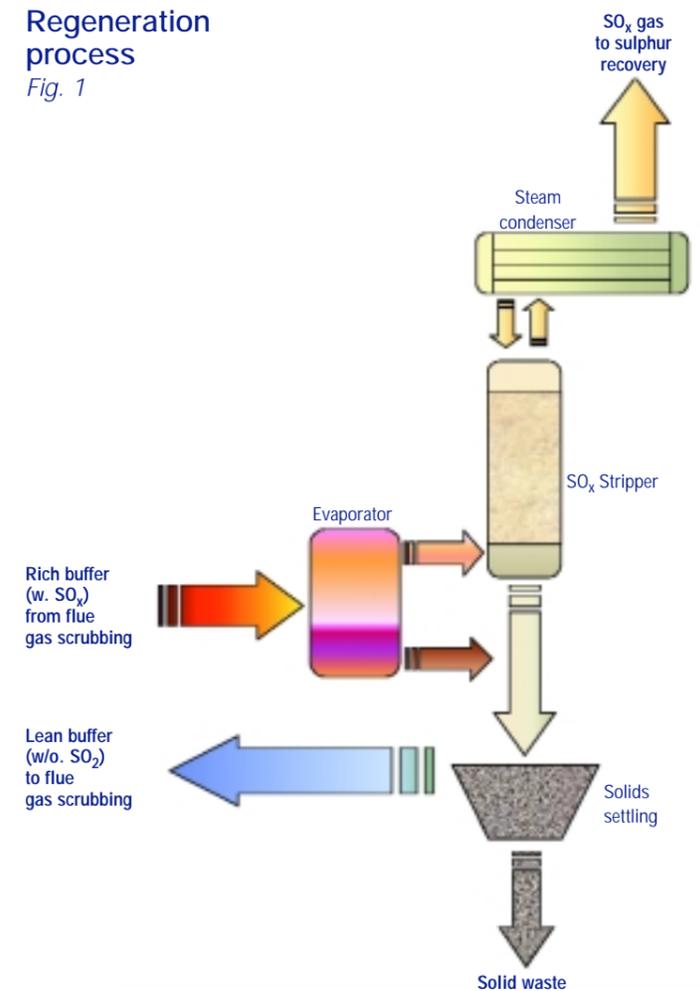
At the end of the test campaign, the results obtained shown a number of environmental and economical benefits. Such results and benefits allow to candidate the Belco-RefinARS technology as a BAT for the FCC flue gas desulphurization.

The REFINARS • "LIFE 2000" project



Regeneration process

Fig. 1



Environmental benefits

- The SO_x concentration at the FCC stack was always lower than 550 mg/Nm³. Due to the process optimization, such concentration was steadily lower than 300 mg/Nm³, as shown in Fig. 2. That means the sulphur emissions were always notably lower than the legal prescriptions.
- The impact on soil was negligible; the solid waste quantity, to be landfilled, was about 500 kg/d.
- As a consequence, the impact of transportation was also negligible.
- The impact on water was very low (ab. 1.000 kg/h of wastewater, with ab. 0,5% wt of suspended solids, ab. 10% wt of total dissolved solids and ab. 750 mg/l of chlorides). Therefore, the impact on the refinery wastewater treatment plant is negligible.

Typical trend of the FCC stack emissions

Fig. 2

