



**Consorzio Interuniversitario Nazionale
“La Chimica per l’Ambiente” - INCA**

INCA Laboratory in Cagliari

Brief description

The National Interuniversity Consortium “Chemistry for the Environment” (INCA) has established in Cagliari the Laboratory of Environmental Chemical Engineering. The latter one is currently hosted by the Interdepartmental Center of Environmental Science and Engineering (CINSA) of the University of Cagliari and located in Via San Giorgio 8 (Cagliari). At this stage the Laboratory occupies 120 squared meters, 100 of which are dedicated to equipment and facilities, while the rest remains for offices.

Laboratory capabilities

The Laboratory is able to provide its scientific support to identify alternative processes and operating conditions with respect to traditional ones in the framework of chemical, metallurgical and petrochemical industry located in Sardinia, Italy. In particular, the Laboratory might become the key point in the field of “Green Chemistry” in Sardinia. The laboratory, together with CINSA, might become the focal point for experimental tests of site remediation techniques, also related to abandoned mining sites, with the aim of identifying the most appropriate technique when real situations, also within Sardinia, are taken into consideration.

In addition, advanced technologies based on self-propagating high-temperature reactions for environmental applications with particular emphasis to the inertization of zinc hydrometallurgical wastes as well as the degradation of chloro-organic compounds will be addressed within the Laboratory.

Performed research and/or analysis

The laboratory might be able to provide its contribution in several topics related to the INCA activity “Green Chemistry”, which may be defined as the utilization of a set of principles that reduces or eliminates the use or generation of hazardous substances in the design, manufacture and application of chemical products. The activity may be

related to the engineering of new synthesis technologies which make use of alternative feedstock/starting materials, alternative reagents, solvents and catalysts as well as the identification of alternative operating conditions. The contribution may be of processing type, i.e. related to already existing processes, as well as synthesizing in nature, i.e. developing alternative catalysts through advanced technologies.

In the first case, once the alternative process will be proposed after the preliminary studies and tests, technology development is required at least at the laboratory scale. In particular it will be necessary to identify the best reactor configuration to perform the new synthesis process. It should be noted that for classical chemical processes fixed and variable costs related to reaction units are typically 10-25% of the total ones, being the more relevant costs those ones where the separation units are involved. However, reactor performance clearly determines the operating conditions of the separation units, thus typically representing the core of most chemical processes. The choice of the best reactor is most of the time not easy since several possibilities exist (continuous or batch, single or multi-phase) like for example spray towers, bubble columns, membrane reactors, catalytic distillation columns, fixed or fluidized beds, also of circulating type, transport reactors, chromatographic reactors, trickle beds, etc.

The Laboratory contribution may be then summarized in the development of the experimental set-up of the best reactor to perform the alternative synthesis process and its consequent design. To reach this goal, thermodynamic, fluodynamic and kinetic information on the reacting system under investigation are needed, including the identification of possible mass and heat transport phenomena that might characterize the reactor behaviour. The design activity mentioned above will be conducted through an extensive use of reactor simulation tools to guarantee an easier selection of the most suitable ones. The final choice of the best reactor will be based on the quantitative evaluation of: interphase mass transport phenomena which are typically encountered when heterogeneous chemical reactions occur and often represent the limiting step of the entire reacting process; the effect of gravity forces which may be responsible of preferential mass fluxes within the reactor; mixing characteristics as well as chemical species distribution among the phases which might be simultaneously present within the reactor; with the final aim of maximizing conversion levels of reactants and selectivity towards desired products.

The Laboratory may also provide its contribution in the “Green Chemistry” field through the development of alternative catalysts.

In particular, the Laboratory aims to synthesize and test catalysts based on complex oxides characterized by spinel microstructure or perovskite type containing cobalt, copper, chromium and manganese. These catalysts, to be applied to oxidation reactions of carbon monoxide and in general of hydrocarbons, dehydrodimerization,

hydrogenation, pyrolysis and dehydrogenation reactions, will be prepared through self-propagating high-temperature synthesis (SHS). The INCA Consortium Unity Cagliari 1, that makes the establishment of the Cagliari Laboratory feasible, has a specific expertise in the SHS technology, which is characterized by significant energy saving with respect to classical technologies besides its intrinsic simplicity. The catalysts prepared through such a technology will be compared with traditional ones to demonstrate their capabilities in guaranteeing less drastic operating conditions. These advantages may be due to atomic structural defects generated by very high quenching rates typically occurring in SHS processes. In parallel, the SHS technology will be also addressed towards environmental applications such as the degradation of chloro-organic compounds as well as the inertization of zinc hydrometallurgical wastes. In particular the latter one has been the subject of a recent patent filed by INCA Consortium.

To summarize, the Cagliari Laboratory of the INCA Consortium might represent the key point for the environmental applications of chemical reaction and reactor engineering.

Laboratory equipment

The environmental chemical engineering Laboratory of INCA Consortium, can take advantage of the equipments which belong to the Cagliari 1 Unit (see the web site <http://www.dicm.unica.it/~cincotti/gruppo/index.html>). In particular, a top level electronic microscopy equipped with EDX KEVEX microanalysis is available. The first equipment investments performed by the Laboratory are an X-Ray Diffractometer (Philips model APD) and an ICP-OES (Varian model VISTA MPX). A batch reactor (PARR model 4520) to investigate reaction kinetics in multiphase systems is also available.

Relationship with the territory

Extremely interesting relationships with the territory may be foreseen for the environmental chemical engineering laboratory since it may become the key point at the regional level in the following scientific and technological topics: Green Chemistry, Site remediation, Self-propagating reaction processes for the environment, Mechanochemical processes for the environment. In this context, it should be noted that a huge investment (about 350 million of euros) is foreseen, in the field of site remediation in Sardinia, with particular emphasis on abandoned mine sites, also because of the recent UNESCO approval of the Sardinian Geomining Park.

As for the topic Green Chemistry in Sardinia, it should be emphasized that the current activities will be soon connected to the industrial sites operating on the territory. It is also worth mentioning that the Laboratory may take advantage of the favorable situation from the research grants point of view since Sardinia will be included in the list of European Regions which will receive special funds by the European Community during the period 2000-2006.

Collaborations with public institutions

The Laboratory will develop strategic partnerships with the Department of Geoengineering and Environmental technologies (DIGITA), the Department of Chemical Engineering and Materials (DICM) and the Interdepartmental Center of Environmental Science and Engineering (CINSA) with the final goal of becoming the ideal medium to test and evaluate site remediation technologies, also from abandoned mining sites, in order to identify the most appropriate technique when real situations, also within Sardinia, are taken into account.

Stage activities

Although the Laboratory is not involved in a continuous activity of stage organization, one of the aim is to reach a critical mass of people to fulfill these type of needs which come from the territory. On the other hand, it should be mentioned that the Laboratory is actively working in collaboration with CINSA in the framework of the International PhD in Environmental Science and Technology which will be jointly awarded by the University of Cagliari, the University of La Verne (Greece) and Aveiro (Portugal).