

Test samples of ceramic materials developed at the UFSCar and Unesp laboratories

Lucrative Marriage

A fourteen-year partnership between the university and the company CSN has brought in some US\$ 85 million for the company

MARILI RIBEIRO

Published in June 2003

The greatest difficulty in very successful partnerships between a university and business, when working together in search of technological innovation, is to quantify the gains. By the calculations of the gigantic company Companhia Siderúrgica Nacional (CSN), the improvement in the productivity of their steel mill at Volta Redonda, in the state of Rio de Janeiro, added to the increase in the quality of the steels obtained there, has resulted in gains in the order of US\$ 85 million during the fourteen year period of marriage with the Federal University of São Carlos (UFSCar) and the São Paulo State University (Unesp) of Araraquara. Profits coming from the application of forty one projects for the implementation of new methodologies and processes after research carried out by the Interdisciplinary Electrochemical and Ceramic Laboratory (Liec), which exists in the two universities, along with CSN's own Research Center. For the past three years, this laboratory has made up part of the Multidisciplinary Center for the Development of Ceramic Materials (CMDMC), one of the ten Research, Innovation and Diffusion Centers (Cepids) that make up part of a special program established by FAPESP.

The gains by the CSN through the innovations represent a considerable volume of money for a country with little tradition in giving incentive towards research development. This value is even greater if we consider that a good part of this resulted from evolution in refractory ceramics, an input which less than ten years ago weighed heavily on Brazilian imports. The gains and the reversal of this point in the trade balance were attained thanks to the standards conquered by the Liec and CSN's researchers, who

spread their knowledge all the way through the productivity chain, which stretches from the raw material producers for refractory material manufacture to the steel companies. Currently, many national companies, as is the case with the company Magnesita from the state of Minas Gerais, have turned into exporters of technology on refractory ceramics using magnesium-carbon and magnesium-carbon-aluminum mixtures.

The story of the CSN-Liec partnership started with a well-defined national flavor, following the publicity of an electronic goods firm that had a lot of success and had produced a popular motto, something along the lines of: "Our Japanese are better than their Japanese". Everything started with operational difficulties at the blast furnaces, the heart of the business of a steel mill, where pig iron, the stage before steel, is produced. CSN hired a team of consultants from a Japanese company, who diagnosed a problem of thermal shock in the ceramic burner of the regenerators. Responsible for the supply of hot air for the blast furnace, the paralysis of the operating of this equipment for repairs, scheduled to last for a minimum of six months according to the Japanese technical team, would have created a drama in the production of the mill. Frightened when faced by such a prognosis and probable losses – in the end, the estimation for the repair of the burner was around US\$ 15 million –, the managers at CSN decided to turn to Liec before making a final decision.

Two days of incessant discussions sealed the year 1989 as one of the start of a marriage capable of producing fine fruit. At that time, after the evaluation of the UFSCar researchers, it was seen that the Japanese consultants had precipitated their analysis. There was no problem of thermal shock in the refractory material of the ceramic burner, but there was strong corrosion, which could be counteracted by the installation of filters to remove particles of iron oxide coming from the gas of the blast furnace. The solution presented by the Liec and CSN's engineers ended up extending the life of the ceramic burner by three years, sufficient time to plan and to carry out repairs without hurting production on equipment that,

in later treatment, gained a further four years of life. Everything was done without ever stopping work.

As he likes to remember, while emphasizing each word with the diction typical of a school teacher, Professor Elson Longo, the director of the CMDMC in São Carlos, underlines: "When we arrived at CSN, they were producing 4 million tons of steel per year. Today they are producing 5.5 million tons practically with the same equipment. And this is taking into account that the nominal capacity of the steel mill was only 4.6 million". The gain of 1.5 million tons is due to a complete change in the concept of the refractory material during the fourteen years of mutually living together.

The excellence in the mastery of these ceramic materials was made possible by a combination of investments at the Liec in São Carlos. It was established with resources to the tune of US\$ 400,000, sponsored by FAPESP, the Financier of Studies and Projects (Finep), the National Council for Scientific and Technological Development (CNPq), the Bank of Brazil, and the Companhia Brasileira de Metalurgia e Metais (CBMM). And, even attending to the demands of various large industrial groups present in their portfolio of clients, it annually receives only R\$ 180,000 of private incentive for its maintenance, which costs around R\$ 1.3 million per year. The bulk of the necessary resources comes from financing agencies. As well as FAPESP and the CNPq, there is collaboration from the Coordination for the Training of Personnel at Tertiary Level (Capes).

Accumulation of knowledge - In the specific case of the steel mill, the steels gained enormous competitiveness abroad after the incorporation of the technological conquests. "National steel reaches the United States cheaper than the one produced by them", informs Longo. The gains calculated by CSN of US\$ 85 million through the partnership are



considered to be a conservative estimate. "This is a number a long way away from reality because only the result obtained during the first year in which the innovation is implemented is considered, without taking into consideration later gains", the Professor explains. "Nevertheless, the most important thing is not the number in itself, in spite of it demonstrating that to invest in research gives excellent economic results, but it is necessary to highlight the accumulation of knowledge with the experiments, done in loco, that has been brought to the university and in the formation of new professionals".

Although during the first two years the partnership with CSN had been established on the basis of emergency situations in order to put out fires, afterwards there was a gradual definition of priority and the setting up of a number of projects, together with the engineers Sidiney Nascimento Silva and Oscar Rosa Marques from CSN, which allowed for a deepening of the research in search of solutions to improve the quality of the steel and to give a reduction in production costs, as Professor Carlos Alberto Paskocimas, the coordinator of technological innovation at Liec explained. Today, in a clear sign of the importance of the partnership, CSN keeps



Through the application of innovative refractory material, the useful life of the blast furnace increased by 100%

als, used in prolonging the useful life of the equipment. “The life of a blast furnace, which was on average ten years, is now programmed for twenty”, highlights Longo. One of the aspects studied in depth was the corrosion present in the coating surrounding the crucible. “We sought to evaluate the effects of titanium, which, in contact with the carbon and nitrogen of the pig iron and with the calcium oxide of the slag of the blast furnace, brings about the formation of a protective layer on the refractory coating,” Silva explains.

Torpedo carriage - The next material step of introducing technological innovations into the routine of CSN involved the torpedo carriage, given the job of transporting the liquid pig iron of the blast furnaces to the converters where it will be transformed into steel. One of the problems in the management of this equipment resides in a loss of energy during the filling of the carriage in the blast furnaces and afterwards transporting to the steel plant. The suggestion by the researchers was the installation of a layer of micro porous silica on the refractory cover of the torpedo carriage. Immediately there was a decrease of on average 25° C in the temperature during the transportation of the liquid pig iron to the steel plant. With the new coating on the torpedo carriage, the quantity of pig iron transported rose by 250,000 to 450,000 tons.

The success of each innovation can be quantified by the economy of energy in each phase of the process, in the reduction of inputs, increase in productivity and an improvement in safety conditions. The infinity of details of this type of technological marathon by obtaining improved steels has prospered more than just CSN. Professor José Arana Varela from Unesp, the innovation coordinator at the Ceramic-Cepid informed that the Liec now maintains conventions just as old as that with CSN an example being with the CBMM. There are other partnerships of long standing, with White Martins for some eight years, and with the Brazilian Industry of Refractory Articles (Ibar), for almost ten years. •

PHOTOGRAPH BY JUCA MARTINS/PULSAR

an apartment to house the university researchers who spend periods working at the Volta Redonda mill. They rotate doing research within the mill itself. Currently there are six doctorate professors, three students researching their doctorate degrees, two on their master’s degree and a further three undergraduates, all involved with projects concerning the mill.

“The contribution in knowledge and ideas by the university is a notable point in our area of research and development”, explains Sidiney Silva from CSN. “For example, in the steel mill the researchers find instruments and conditions to carry out experiments with pig iron and liquid steel. We now have a series of simulation plants where they can finalize their studies initiated within the laboratory.”

After starting off by saving the ceramic burner, the Liec researchers, together with those at CSN, introduced various alterations that have guaranteed the performance and the useful life of these blast furnaces, from the change in the refractory material to the manner of manufacturing them. “Only in the improvement of the conditions of the blast furnaces there were twelve projects linked to operational questions, being that, with just the techniques of the addition of titanium into the melting pot or cru-

cible, the lower region of the furnace where continuously the liquid pig iron that is produced accumulates, they have managed an economy valued around US\$ 13 million for the company”, Longo explains. “The crucible is the heart of the blast furnace. It is surrounded with refractory blocks made of carbon and its performance is vital for the production of the mill”, says Silva from CSN.

The innovations applied to the crucible after laboratory research resulted, among other advantages, in a reduction of thermal losses during the process, with a consequent saving economy in the reducing agent (coal that will be turned into coke), imported raw materi-

THE PROJECT

Multidisciplinary Center for the Development of Ceramic Materials (CMDMC)

MODALITY

Research, Innovation and Diffusion Centers (Cepid)

COORDINATOR

ELSON LONGO – Federal University of São Carlos

INVESTMENT

R\$ 1,032,071.98 - during 2002