Evaluation Report

Cast Iron Production from Sponge Iron (Egypt)

Sponge / Cast Iron Technology Transfer (Egypt)

Egypt

(IDRC Center File Project 92-0808)

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Background (Project Profile)

The small and medium size metal sector in Egypt employs about 80,000 workers and produces 150,000 tones of castings per year. The quality of the products vary according to the chemical constituents and physical microstructure of the casting materials.

The project entitled "Cast Iron Production from Sponge Iron" was designed to develop appropriate industrial practices for the production of ductile iron made of sponge iron and evaluate their technical and economic viability. Two alternative approaches were tried; a) production of high purity pig-iron for the production of engineering quality gray iron and ductile iron castings, and b) direct production of ductile iron castings from sponge iron.

The project which was carried out by the Central Metallurgical Research and Development Institute (CMRDI), in cooperation with the Research and Productivity Council (RPC) of New Brunswick, Canada was allocated a grant by the International development Research Center

(IDRC) a budget of 245,000 CAD. The recipient contributed 150,600 CAD towards the project activities.

A best practice technology for each selected casting was determined. This was adjusted according to alloy specifications, chemical composition and metallurgical features, while taking into consideration the raw materials, charge calculations, melting techniques, furnace type, lining, sequence of melting and alloying, special treatment of liquid iron, molding and core making processes.

The different properties of produced castings were evaluated according to surface quality and internal soundness, as well as specific properties required during service.

The project used the mobile foundry laboratory (MFL) which is equipped with the facilities to measure liquid metal temperature, and to produce samples for spectrographic analysis, and testing of molding and core sands. Apart from the useful role of MFL in evaluating the process which was executed in the foundry, it was useful as it provided control facilities to small and medium size foundries that cannot afford to have their own facilities.

The following results stemming out of this project were reached:

1. High purity pig-iron, which is very low in manganese, phosphorous and sulfur content, is suitable for the production of ductile iron
2. High quality ductile iron castings of suitable mechanical properties were produced from mainly sponge iron.
3. The production of ductile iron using local sponge iron proved to be economical.

Moreover, comprehensive techno-economic evaluation for each of the castings produced by this new technology was compared to the conventional methods of production.

These results were implemented through a second phase entitled "Sponge Cast Iron Technology Transfer" where this new technology was experimented in ten foundries divided into four main groups selected according to their technological level, human resources, marketing and investment capabilities. This second phase of the project took place between 1993-1996.

Methods of Investigation

1. The project documents were reviewed.

2. A meeting with the principle investigator (PI) was conducted, where an overview of the project was discussed.

3. A visit to CMRDI was conducted where the technique was demonstrated and the analytical facilities and the services conducted at CMRDI were visited.

4. The developed training course materials were reviewed.

5. Visits to beneficiaries "Tawakol company for Metal Industries, and Helwan Company for Metal Industries" were conducted.

Objectives of the Project (Phase I and II)

1. The project has in its first phase the development of appropriate industrial practices suitable to small scale foundries in Egypt for the production of ductile iron made from cast iron.

2. The second phase of the project is concerned with transferring the resulting technology to small and medium size enterprises to widen the scope of implementing this technology to ten small and medium size foundries in Egypt.

Objective of This Report

This report aims at evaluating the impact of the two phases of the project; namely the production of cast iron from sponge iron and its technology transfer to the small foundries on the targeted group, the delivery agents and others.

Inputs / Activities

The resources of the project were mainly the grant offered by IDRC in the two phases totaling 484,500 CAD, while the delivery agents offered the foundry facilities and the analytical services at CMRDI. The

recepient contribution amounted to 288,800 CAD. The collaborating agent offered some training and technical assistance. The beneficiaries of the second phase contributed by offering their premises and raw materials for experimentation.

The foundries were categorized into four groups each containing two or three small foundries. The selection was based on the foundry technological level, human resources, marketing and investment capability.

This categorization made the study easier and the implementation unified among these foundries.

The implementation mechanism included a seminar to be held to introduce the technology and identify the problem that the foundries are facing in producing ductile iron and quality casting with the existing material. The seminar was held partly at the CMRDI where the sophisticated analytical equipment, software for modelling, and standadized techniques were available, and partly at the benefeciary premises where the technique is made to be adapted to the circumstances of the targeted foundry. Such input was useful to identify the basic problems as far as adopting the appropriate technique suitable to the kind of furnace and capacity used. The basic problem was the increasing price of low-phosphorous and sulfur pig-iron. The project executed one or two castings with special quality requirements where the mechanical properties, physical characteristics and chemical compositions of such castings were determined and the actual production cost was calculated. This demonstrative implementation mechanism proved very effective as the beneficiaries were receiving non formal training which is in essence a technology transfer process, complying with the original objective of the second phase of the project.

The involvement of foundry personnel led to the realization of a best practice technology of each casting.

Moreover, a training program for the engineers and technicians of participating foundries was carried out. They were introduced to the technology of utilization of sponge iron as the main constituent in the production of ductile cast iron. This was carried out in CMRDI experimental foundry where the new technology was tried on a pilot scale.

Outputs

The planned output of the first phase of the project i.e. producing cast iron from sponge iron, was achieved. The produced cast iron, based on its microstructure characteristics and chemical composition as well as mechanical properties proved to be of high quality and comparable to that produced by the traditional technology using conventional raw materials. This technology was very relevant to the Egyptian metal industry, as sponge iron was produced by Alexandria National Steel and Iron Company at Dekheila, ANSDK, and was sold in the market at a low price. The imported substitute material of the locally produced sponge iron has double the price and it would be useful to the economy to utilize such locally produced material.

This innovative technology, although known and applied elsewhere, it was applied, with little adaptation, for the first time successfully in Egypt.

Context / Environment

The delivery agent, being a reputable scientific institution, which has vast experience with the applied research and development practices and its implementation in the Egyptian industry was an applauded choice for running this project. The facilities at CMRDI are highly secialized and the personelle are highly experienced. This was a great asset to the project.

The visionary leadership, and the vast knowledge and experience of the principle investigator and the cooperation of his staff made this project successful.

At the beginning of the project the economic feasibility was very much in favour of running this project, however by the completion of the project, the price of sponge iron which was locally produced and considered as an essential input of the project was highly increased. This could be partly attributed to the sudden realization that this material could recycled and there is a potential market for its use. This upsetted the economic feasibility of the project as the price difference would not justify doing the operation and it would be easier to import cast iron from abroad.

Outcomes

Reach

The project reached the intended target groups. The production technology conditions were studied for five different foundries. Some specific castings were studied to correlate their properties to the casting conditions. The foundries acquired the know-how for producing cast iron from sponge iron and adjusted the conditions to suit their production procedure and products. The delivery agent used the financial support to strengthen their infrastructure to be able to cope with the demanding experimentation needed.

The output of this project reached a wider circle, the delivery agent were subjected to the systematic methods of developing the know-how, changing the conditions and adjusting the parameters. This have reached the CMRDI staff in the first instance. The acquired technical know-how was incorporated in the training courses offered by the CMRDI particularly that special course which is organized yearly and offered to students coming from Africa and other countries belonging to the region. Moreover, Research Students were allowed to use the experimentation outputs in their projects under the supervision of university staff.

Impact

1. The project produced a know-how where CMRDI developed a technology package to produce cast iron from sponge iron. Annex (1) shows a quality control sheet of produced by using imported pig iron and locally sponge iron. It is quite obvious from the microstructure (and other) analysis that the quality of productes are comparable. This reflects on the knowledge base of the metal industry. The process at one stage was very economic (when sponge iron produced from ANSDK was sold at low price) and reflected on the income of the beneficiaries. Although, at the time of writing up this report, the process is not economically feasible due to the increased price of the sponge iron, it is envisaged that its price will recess again due to the surplus of production expected at ANSDK.

2. The best practice for the technology of producing cast iron from sponge iron was made available to various foundries. This reflected on their performance and production as they adopted new methods of

monitoring and evaluating the quality of their casts. Annex (2) shows a quality control sheet where the micro structure shows distinctly the difference between gray and ductile cast iron.

3. The project added to the training material and practical experiments conducted by the CMRDI. A training course on cast iron was developed. This course was taught to trainees in the metal industry and reflected on their knowledge. Annex (3,4) shows some materials of training course on casting design.

4. The project strengthened the infrastructure of the CMRDI. Software for analyzing chemical composition of a cast became available via the project. Many analytical equipment, including an emission spectrograph were acquired. These facilities and the developed techniques extended the CMRDI capabilities of providing certified analytical services to industries and universities.

5. The project had an indirect impact as one feels the self confidence and the professional pride for those who helped in developing the technique. A capacity building has been demonstrated in developing the skills and knowlege of the young engineers and researchers dealing with the project.

6. This project created the chance and mechanism for interaction among Research and Developing Institutes and the small industries, an avenue which needed support. The foundries visited by the evaluator kept a continuous cooperation with CMRDI after the project experimentation as the right atmosphere was developed.

Lessons learned

During the projrect design and implementation stage, it would have been useful to consult an economist who is fully aware of the Egyptian iron and steel maket. He could provide professional assessment and forcasting of the market change when a by-product of a specific industrial process becomes in demand to be used as an input to a different process / industry.

Enhancement of Outcomes

1. The economic impact of the project could be very positive if an agreement is reached with Alexandria National Steel Company at Dekheila ANSDK.

2. An analysis of this project and its impact on CMRDI capacity building and its reflections on foundaries performance and economics may be published in a document book of this case-study.

Response to Remarks on Evaluation Report

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- The project work on spong iron and its utilization in the production of cast iron was probably among the factors that caused the increased of the prices of sponge iron. A reference to this was added in page (6)

- What could be done during the project desing / implementation is added under "lessons learned".

- What could be done to enhance outcome and how the capacity of CMRDI be transferred to other institutions has been elaborated in the secton entitled "enhancement of outcomes".

Potential Beneficiary/User	How benefit	Extent actually benefited	Factors Helping (+) hindering (-) impact	Potential for future benefit
Delivery agent	gaining an experience in forming new casts, infrastructure was strengthened	A new process has been developed the younger research team gained experience, and more equipment / software were acquired / more training courses were designed	[+] strength of delivery agent [+] experience of PI	The experience gained by the delivery
Smelting industry	Applied new process which could be economically useful	gained experience, collaborated with CMRDI in problem solving	[-] upset of economic feasibility for increase of raw material prices	The process is applied once the raw material price returns to normal