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The Total Quality Programme at Bozel

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Bozel produces calcium alloys (CaSi, CaSiBa, CaSiFe, CaSiMn) and inoculants. It exports its products all over the world, and is recognized by its clients as a high-quality producer. The firm owes its success to the implementation of a quality-assurance programme that is derived from the ISO 9002 international standard.

The paper details the programme, and reports that the implementation of the programme has resulted in an increase in productivity, a reduction in costs, and a rigorous fulfilment of delivery times.

Introduction

Bozel Mineracao e Ferroligas is one of the companies controlled by the Companhia Paulista de Ferroligas, which plays a leading role in the Brazilian production of ferroalloys, and ranks first in the country in its sector. Bozel produces calcium alloys (CaSi, CaSiBa, CaSiFe, CaSiMn), which are used in steelmaking as deoxidizers, desulphurizers, and inclusion modifiers or controllers, and in foundries as inoculants and for the production of MgFeSi.

Bozel's CaSi standard alloy (30 to 33 per cent Ca, 60 to 65 per cent Si, 0,6 per cent max. Al, 0,6 per cent max. C, and the balance Fe) is used in modern steel mills to control the morphology of inclusions present in the steel, thus ensuring that the steel has the isotropic properties essential for its particular use – in maritime oil-drilling platforms, for example.

Because of the high vapour pressure of calcium, it is partially stabilized by its combination with silicon in intermetallic phases. However, in order to guarantee its performance in steel mills, the alloy is injected deep into the steel ladles. The most modern injection techniques are pneumatic injection by lance or by the feeding of wires cored with CaSi deep into the melt.

Lance injection is a process controlled by the high-speed pneumatic transport of reagents. For satisfactory results, it is essential to have, in addition to the correct process and equipment, CaSi with a granulometric distribution of a very restricted range. Even the shape of the grains can affect the injection efficiency.

In cored-wire injection, the alloy should have a controlled granulometric distribution to ensure the necessary compaction (kilogram of alloy per metre of wire).

In addition, the alloy's chemical composition should be uniform to ensure the reproducibility of the metallurgical results, and the non-metallic contamination and impurity levels should remain below the limits permissible for the use of the alloy.

The uniformity and cleanliness of high-calcium alloys are not achieved easily in the smelting process. For 1 t of alloy, up to 0,6 t of slag is produced. This slag has a density very close to that of the metal, and its separation requires careful ladle treatment and ingot casting.

To maintain satisfactory production efficiency for the whole range of its products, Bozel has incorporated the ISO 9002 quality-assurance management system. This wide-ranging programme is aimed at an increase in competitiveness and expansion into new international markets.

The quality-assurance programme at Bozel has been fully approved by leading Brazilian steel plants and foundries, and it is about to be approved by accredited international organizations.

Quality-assurance Programme

Quality assurance, high productivity, low costs, and timeous deliveries form the objectives of any business manager. Total Quality Control (TQC) is the most suitable means of attaining this. Its application has been recognized by the International Standards Organisation by their creation of the 9000: 1987 series.

The ISO 9000 Quality System comprises four models:

9001 Model for quality assurance in projects and the development of production, installation, and technical assistance

9002 Model for quality assurance in production and final testing

9003 Model for quality assurance in inspection and final testing

9004 Guidelines on the implementation of the ISO 9000 series.

The complexity of the production process used at Bozel makes the ISO 9002 model the most applicable.

Bozel has opted for ISO 9002 and has broadened its scope by incorporating after-sales technical assistance. The company's quality system is specified in its *Quality Assurance Manual,* which covers the following:

- quality-management responsibilities
- critical analysis of contracts
- document control
- supplies control
- tracking
- statistical control of processes
- inspection and testing

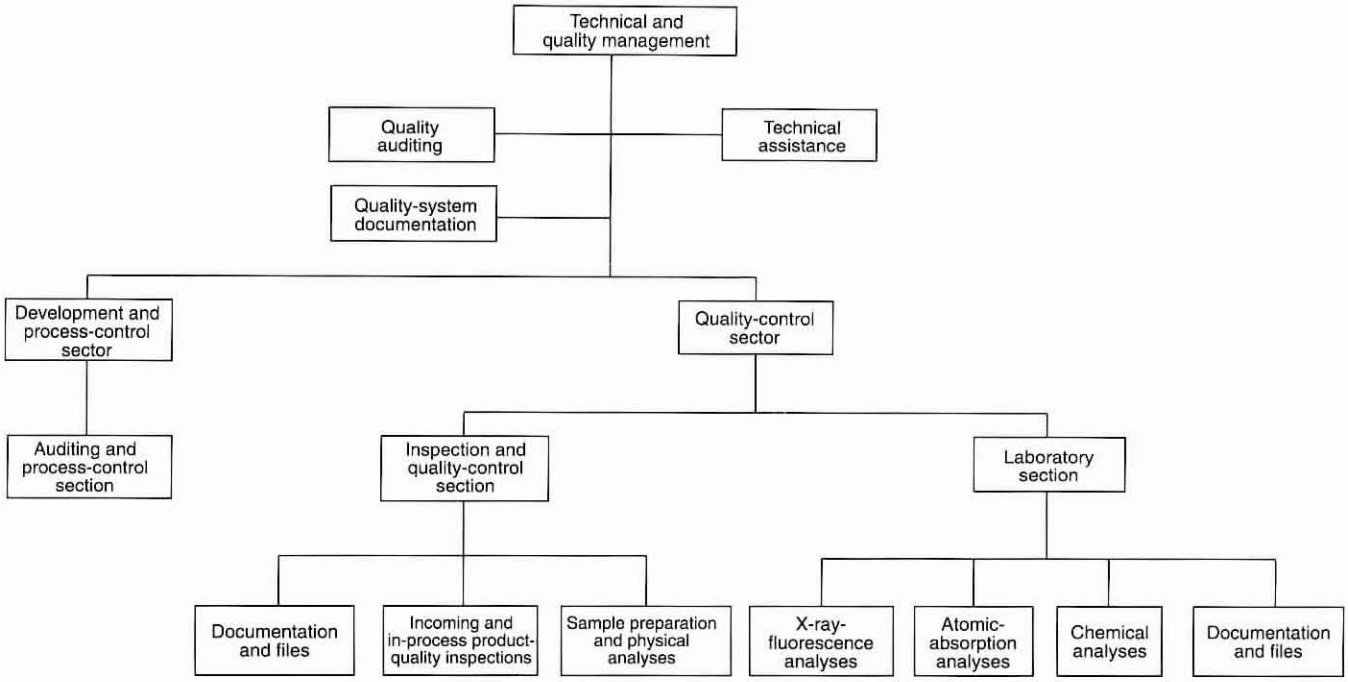

FIGURE 1. Organizational chart for the technical and quality departments at Bozel Mineracao e Ferroligas

- calibration of equipment
- non-conformity control
- handling, storage, packing, and despatch
- quality records
- auditing
- training
- technical assistance.

The implementation of the quality-assurance programme, introduced in 1988, has developed in the following stages:

- administrative re-organization, with the creation of the quality-management programme, which is shown in its present form in Figure 1
- re-equipment of laboratories (X-ray and atomic absorption)
- modernization of productive equipment (PLC for the furnaces, substitution of electrode columns, insertion of new mills)
- normalization of the production process and quality-control requirements
- general personnel training
- issuing of the *Quality Assurance Manual (QAM)*
- maintenance of the system.

Because of the programme's in-built provision for constant updating, it functions as an efficient instrument for the improvement of the company and for the optimization of its profitability.

Some Applications of the Programme

The production of ferro-alloys consists of the following steps:

- the receipt of raw materials
- pyrometallurgical reduction in submerged-arc electric furnaces
- ladle treatment and casting
- crushing and screening (packing)
- despatch.

Figure 2 presents a simplified flow chart, with references to the quality-control points where specific standardization and quality-control reports are generated. Through this system, it is possible to track a product back to its raw-material origins, and investigate a possible case of non-conformity and so ensure its eradication. The characteristics of tracking and non-conformity control are prescribed in the QAM, and contribute towards the reduction of re-working, and hence a reduction of costs.

The productivity of electric furnaces is directly related to the uniformity of their loads. Correct loads are ensured by the application of the chapter entitled 'Calibration of equipment' in the QAM.

The electric and thermochemical equilibrium of the reduction process depends on the ratio of carbon to oxides in the feed. In Brazil, the quartz and limestone, as the raw materials for the production of CaSi, are of uniform chemical composition. The carbon balance for the control of the process is undertaken by the application of the 'Statistical control of the process' with respect to the quality of the charcoal, which is the major source of carbon.

Through 'Technical assistance' in the application of alloys, it has become possible to develop, in consultation with each client, individual quality requirements for specific processes.

In this way, the implementation of all the elements contained in the QAM from 'Critical analysis of contracts' to 'After-sales technical assistance' have enabled Bozel to optimize its producer–client relations.

Results of the Programme

The following can be regarded as the results of the programme:

- increase in productivity of the factory from 45,4 to 62,5 t per man per year, an improvement of 37,5 per cent
- 18,3 per cent reduction in production costs
- reduction from 28,6 per cent to 1,8 per cent in re-working

in the final stage of the production process (packing)

- increase in client–producer and personnel satisfaction (not quantified)
- improvement in the quality of the products, especially in relation to their homogeneity expressed by a reduction in their granulometric range of about 30 per cent (Figures 3 to 5)
- increase in the average content of calcium in the CaSi, as shown in Figure 6
- increase of more than 100 per cent (mesh-size line) in the area of comminution efficiency, as shown in Figures 7 and 8, without the need for additional investment in equipment.

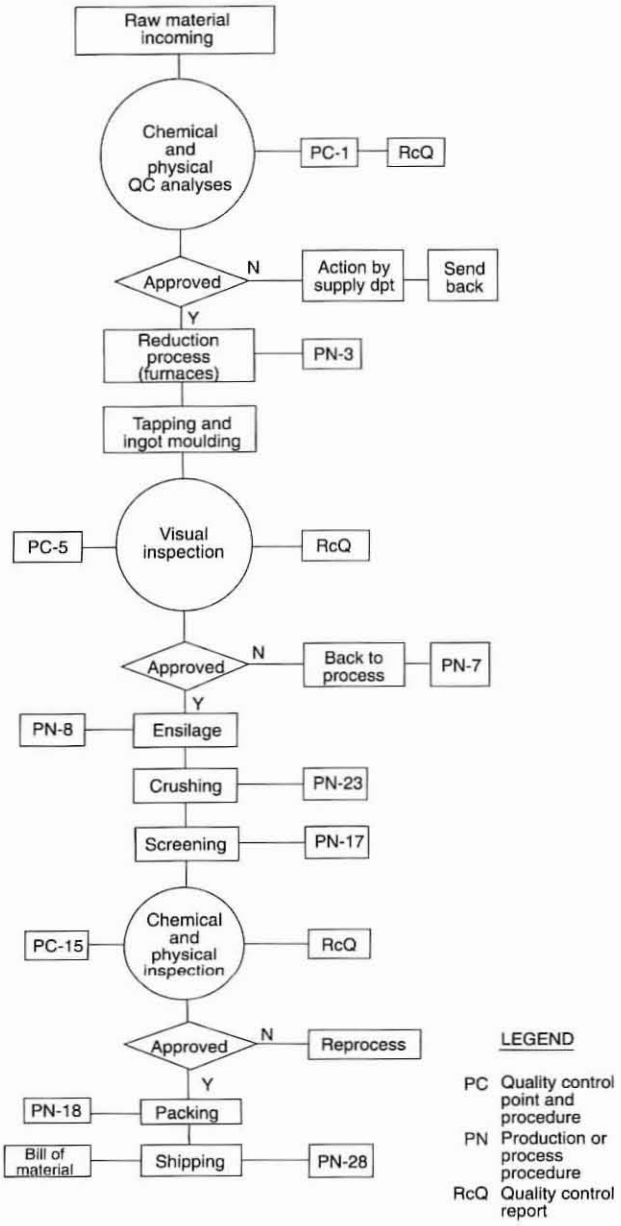

FIGURE 2. A simplified example of a production flow chart

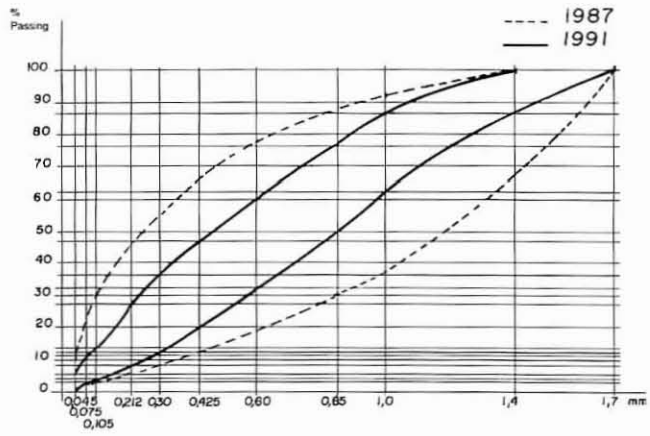

FIGURE 3. Size distribution of CaSi in cored-wire injection

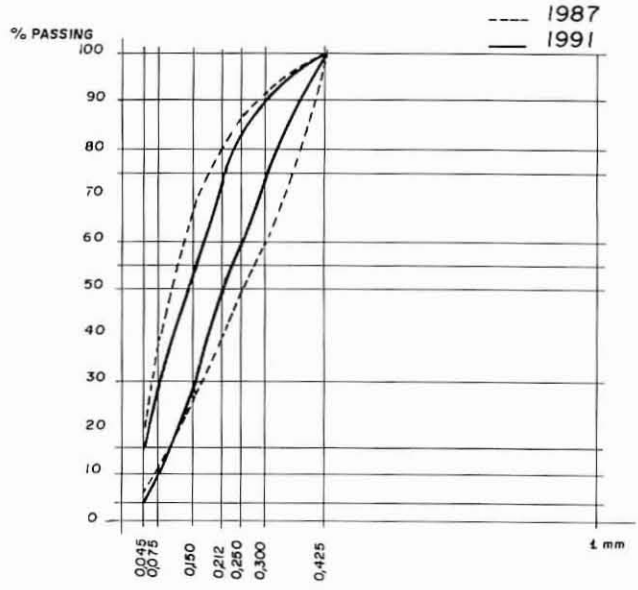

FIGURE 4. Size distribution of CaSi in pneumatic injection quality

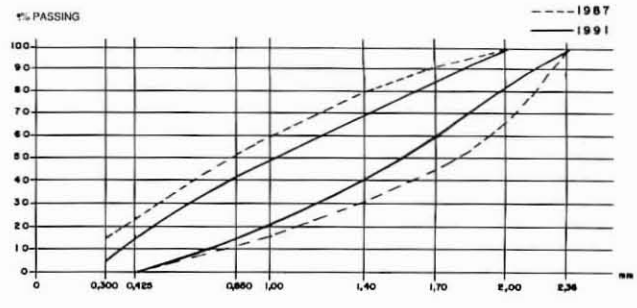

FIGURE 5. Size distribution of CaSi in particle size 8 x 48 mesh

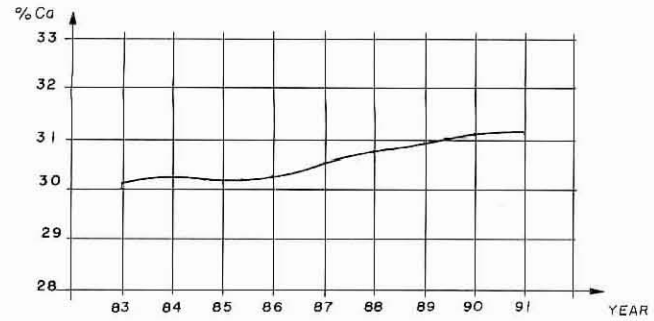

FIGURE 6. Average calcium content of CaSi in the final product

FIGURE 7. Evolution of the production rate of CaSi core-wire

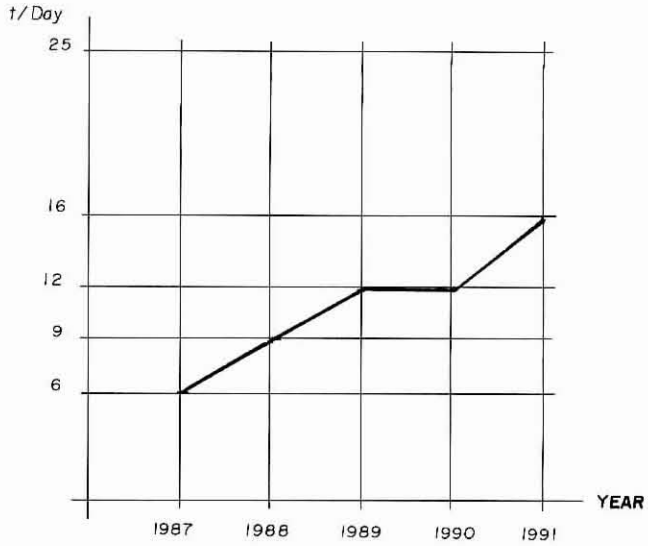

FIGURE 8. Evolution of the production rate of milled CaSi

Conclusion

The complementary phase of the programme, with new investments in casting and in packing, and the implementation of the QAM aim at increasing the productivity to 85 t per man per year, a further reduction of production costs by 8 per cent, total elimination of re-work in packing and, finally, the opening up of new markets and the development of new products.

Within a few years, Bozel has achieved significant progress through its quality-assurance programme. The consistent application of this programme has been the company's means of maintaining its competitiveness.