AUTOMATION OF THE SEMI-DRY PRESSING CYCLE IN THE CERAMIC TILE COMPACTION PROCESS ON IMPLEMENTING A CONTROL LOOP IN AN INDUSTRIAL HYDRAULIC PRESS

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1 INTRODUCTION

The relationship between dry tile compaction characteristics and tile behaviour with regard to linear firing shrinkage is well known. Thus, in general, a tile with greater dry compaction will exhibit less shrinkage on firing, than one with lower compaction. This means that if tile compaction values vary with time during the manufacture of a production batch under the same firing conditions, the final outcome will be a lack of dimensional stability in production, yielding deviations in sizes, as well as causing production losses and impaired quality.

Stricter control is therefore required in keeping dry tile compaction constant, bearing in mind that the currently operating hydraulic presses, which are characterized by their great mechanical robustness and reliability, are not fitted with any means to automatically assure that ceramic tile compaction will be held steady.

On the other hand, the mechanisms governing the ceramic tile compaction process are quite well known (1)(2). Thus, it is known that on using a single clay powder, with uniform physico-chemical characteristics, final compaction will almost exclusively depend upon pressing pressure and pressing powder moisture content. Therefore, if there were a method that might allow determining the moisture content of the spray-dried powder by on-line measurements, just prior to pressing, it might be possible, after putting in place the corresponding control loop, to consider implementing a self-regulating system for the pressing cycle, so that working pressure would be appropriately operated upon as a function of moisture content, with a view to keeping compaction constant.

2 PROCEDURE

A capability study was first carried out on the compaction variable, measured as green bulk density (Dapv), in order to determine whether the industrial press would be able to keep the characteristics of the formed tiles constant. The study, run on 30 consecutively formed tiles, showed that for each plate and across plates, the press was CAPABLE of holding compaction steady within an interval of 3 σ, according to set process requirements.

Specific sensors were then selected for measuring the process variables. The determination of the pressing pressure was conducted by means of a pressure transducer connected to the hydraulic circuit of the press. This transducer converts the pressure into a proportional electric signal, which after being appropriately filtered provides the system with the pressure peak value that the press reaches in each cycle.

The moisture content of the spray-dried powder was determined with a moisture sensor, which by the principle of differential infrared radiation absorption allows quantifying the moisture content of the spray-dried powder that is to be processed in real time and without direct contact. This sensor was prepared both with regard to its physical configuration and programming in such a way as to obtain the necessary output in order to function suitably within the control system.

After placing the sensors in their positions in the control chain, the relation was derived that allowed linking the different variables. Thus, by determining the different values for pressing pressure, spray-dried powder moisture content and Dapv of the compacts, a control algorithm was found by multiple regression statistical analysis. The algorithm, which corresponds to the equation

$$Dapv = A + B \times H_{sensor} + C \ \ln P_{P.Hidraulica}$$

allows governing the pressing process on implementing the control system. (A, B, C are constants of the press and the physico-chemical characteristics of the spray-dried powder).

Fig. 1 schematically illustrates the control system that has been installed in the industrial press. Basically, besides the sensors described above, a programmable controller was used with analog as well as digital communication with the standard press control system. The algorithm found and the safety logic have been implemented in the controller, thus allowing the press to be safely controlled during the production process. The spray-dried powder is continuously sampled in the pre-loading hopper and after passing the moisture sensor, the powder is recovered in the feeding hopper.

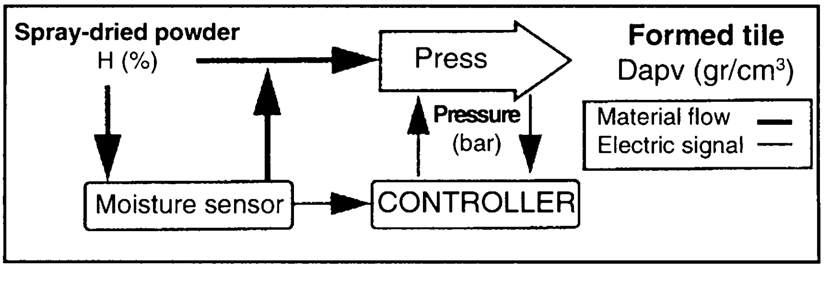

Figure 1. Control system schematic

3 RESULTS

Fig. 2 shows the evolution of the press parameters under automatic control. It can be observed in the plot that the real pressing pressure (PREAL) evolves according to the pressure calculated by the control algorithm (PALG), as a function of the moisture content of the spray-dried powder (Hsensor). In this case, the set Dapv was fixed at 2.13 (g/cm^3), and the compaction value was shown to keep within an admissible interval of ± 0.015 (g/cm^3).The regions in which moisture content varied sharply corresponded to press downtime duringwhich the control system was deactivated and the press was put on standby.

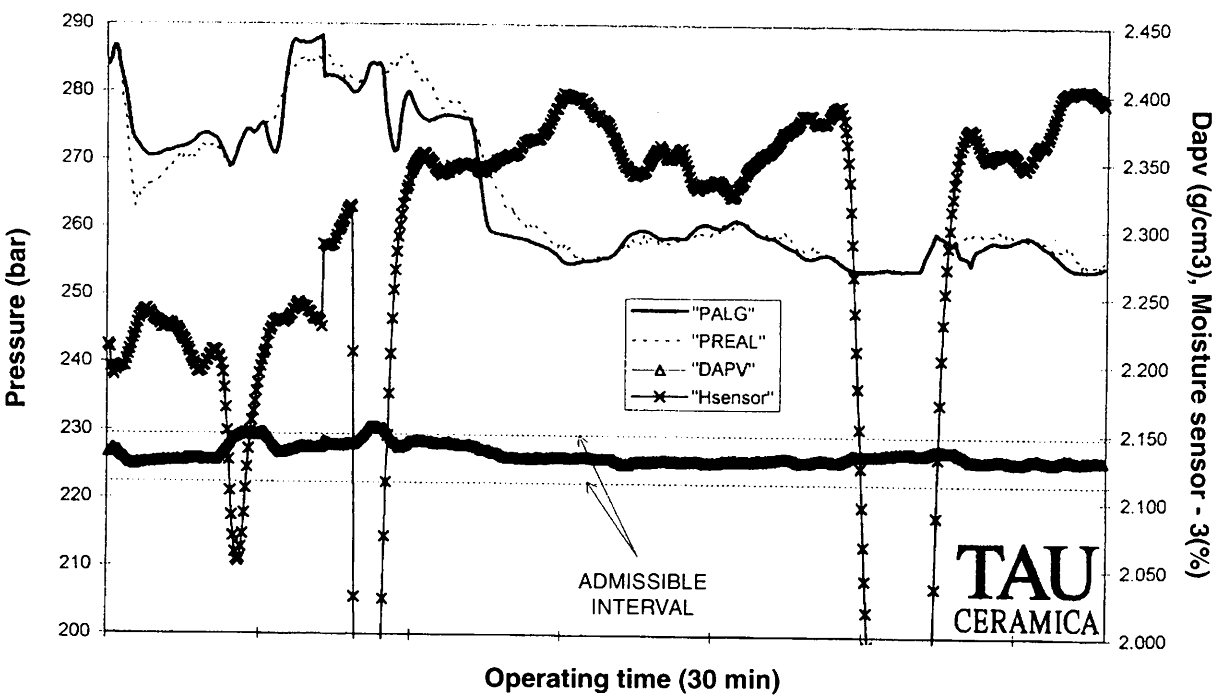

Figure 2. Evolution of press parameters under automatic control

4. REFERENCES

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