

refractory designs for ultraclean steels

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Abstract

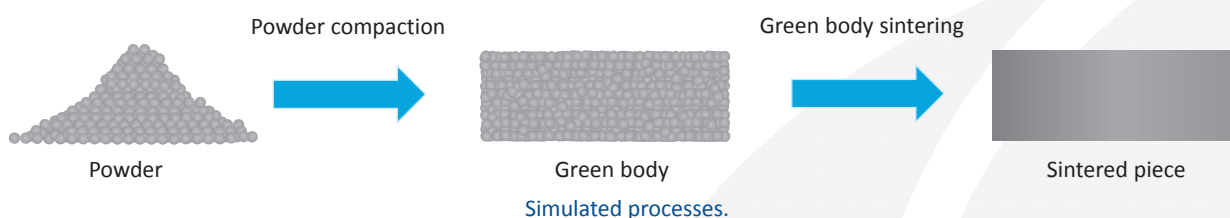
The research on refractory materials has been increased in the last years due to the fact that the metallurgical industry imposes more and more exacting specifications. On the other hand, an interesting way to work with composite materials is the powder technology. This technique consists in producing solid and resistant pieces from powder material. There are two methods to apply this technique: the first method consists in producing the piece by hot pressing and the second method consists in a sintering process after the compaction of the powder. The aim of this work is the generation of a discrete element model that allows to simulate the sintering process of a refractory material. After the model has been adjusted, this is used to look for other mixtures that improve the properties of the sintered pieces. The analyzed process consists in compacting a powder to obtain a green body. After that, the body is subjected to high temperatures to increase the mechanical strength of the piece. Therefore, the compaction and sintering processes are separately studied.

Method

The EDEM[®] software is used to simulate the process through the discrete element method.

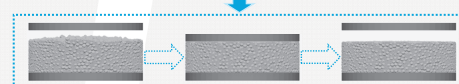
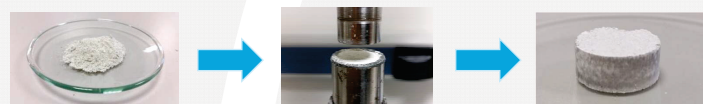
The simulations are carried out in two stages: simulation of compaction process and simulation of sintering process.

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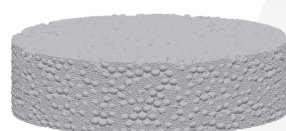
Powder compaction process

To simulate the compaction process a contact model with bonding is used. The created bonds make the particles remain united forming a solid body.



Powder compaction process.

At this model, a set of particles is created inside a die and then an upper puncheon goes down until the green body has the desired height. At the end, the puncheon goes up and the piece is pulled out of the die.

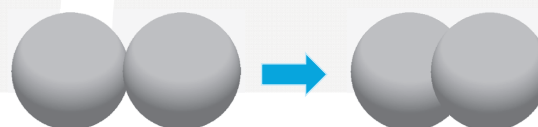


Simulated green body.

Green body sintering process

To simulate the sintering process a contact model is implemented. This consists in increasing the sintering force each timestep. Thereby, the overlap between particles augments as the sintering force is increased. This overlap simulates the neck growth between particles during the sintering.

In this simulation, the green body that was generated during the compaction process is placed over a horizontal surface and remains at rest while the sintering force is acting.



Overlap between particles produced in simulations.

Improvement of the sintered pieces

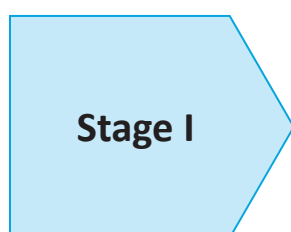
Finally, the mechanical properties of the sintered piece are analyzed and solutions that improve those properties are sought.



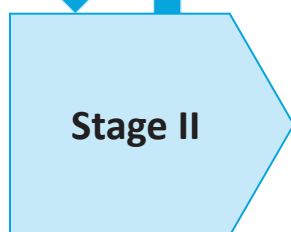
Refractory bricks.



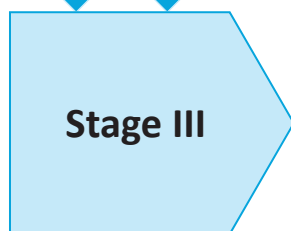
Ladle in a casting process.



Stage I



Stage II



Stage III