Using the Power of Water

Cleaning of Core Tools and Decoring of Cast Parts Using High-pressure Water Technology

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Highly demanding cleaning processes are indispensable in the manufacture of moulding material cores and when decoring cast parts. The frequently very complex geometries of the core boxes to be cleaned and of the cast parts requires very high and constant precision of the processes and technical devices which should fulfil this task to perfection. Because complete removal of the residue of moulding material is an elementary quality criterion.

When producing cores, residue of the moulding material must be removed from the cover, from the injection nozzles as well as from the upper and lower parts of the core boxes periodically during each production shift with a maximum of cleanliness (*Fig. 1*).

Otherwise, the result will be negative moulds with genuinely negative characteristics in terms of surface quality. When producing cast parts, there must likewise be no sand-resin residue on or in the cast product following decoring *(Fig. 2)*. Otherwise, the quality of the final product will leave much to be desired – and this frequently involves a high cost risk. One only has to think of the automobile industry where manufacturers offer in part extremely long warranty periods on certain chassis and engine parts. This can only be guaranteed if these parts are also produced and used on a constant level in the envisaged quality. "Pure" precision work on the production line is, therefore, an absolute "core" aspect here for foundries if they wish to be the first choice suppliers for industrial companies from various sectors. As is the case throughout the economy, efficiency and economic aspects also play a role. Given the existence of alternatives, which cleaning process offers the most favourable solution?

Significant differences between the processes

Today, foundries can choose between three completely difference processes for cleaning core boxes: cleaning in an ultrasonic bath, cleaning with dry ice, or – as will be described in detail in this article – cleaning with high-pressure water. These processes are (more) suitable, better, more cost-favourable, quicker, depending on the surface structure and material quality of the parts to be cleaned – in short: more efficient.

Ultrasonic Bath : The (tool) parts to be cleaned are immersed in a more or less highly tempered cleaning bath, in most cases water mixed with lye. Strong, modulated ultrasonic pulses lead to the cavitation effect (cavitation = hollowing), i.e. to the removal of the sand particles from the surface of the tools or cast parts. Whilst this cleaning process has the

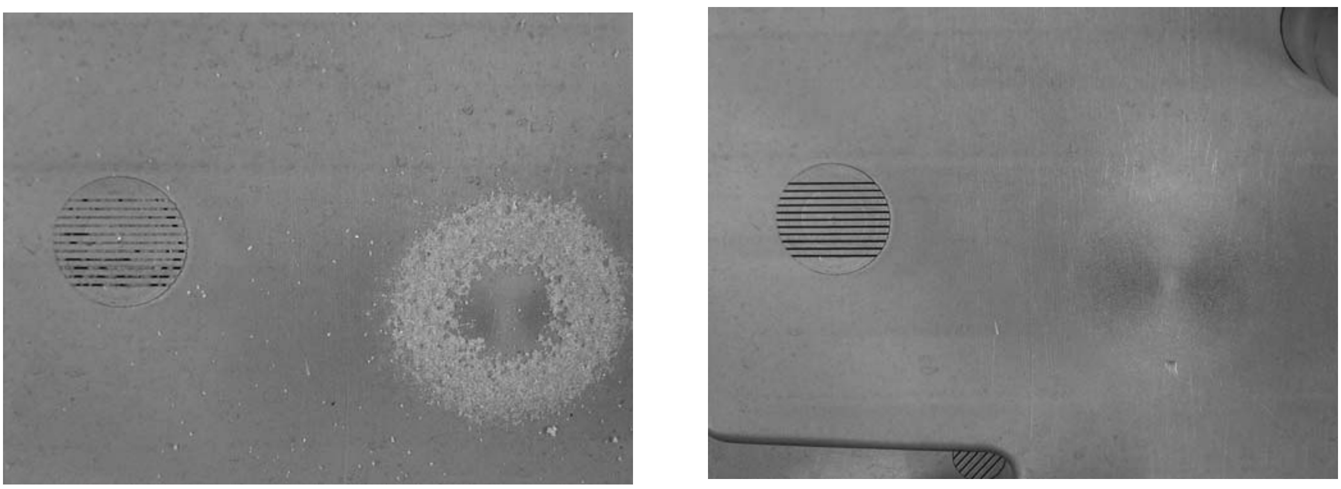

Fig. 1: *Dirty slot nozzle of a core tool (left) and one that has been cleaned with high-pressure water (right)*

Fig. 2: *Engine block in the blasting cabin for decoring with the help of high-pressure water*

advantage that, as a fundamental rule, the cleaning tools must no longer be taken completely apart, it takes two hours in total before the tool is again ready for use in production. Disadvantages of the ultrasonic bath process concern the quality, duration and environmental impact of the cleaning. As the outlet channels behind the slot nozzles are not free from sand residue following the cleaning process, reworking is always required. This also costs additional time which further increases the already high cycle time. The required change of the chemical-burdened cleaning baths is also a negative aspect in terms of environmental protection.

Dry Ice : Small, frozen carbon dioxide pellets are used as a type of “cleaning ammunition”. The particles with a temperature of -79°C are dosed and fed to a compressed air current before being “shot” onto the surfaces of the parts to be cleaned. This is where physics plays its part by ensuring removal of the dirt particles from the surface. The pellets themselves merely cause the “shock cooling” and disintegrate upon impact. Given the severe cooling, a shrinkage effect of varying strength quickly sets in on the base surface and layers of dirt. This causes the remains of sand to become detached from the base surface with the result that they must then only be blown or sucked off. One of the main advantages of cleaning with dry ice is the residue-free evaporation of the cleaning medium.

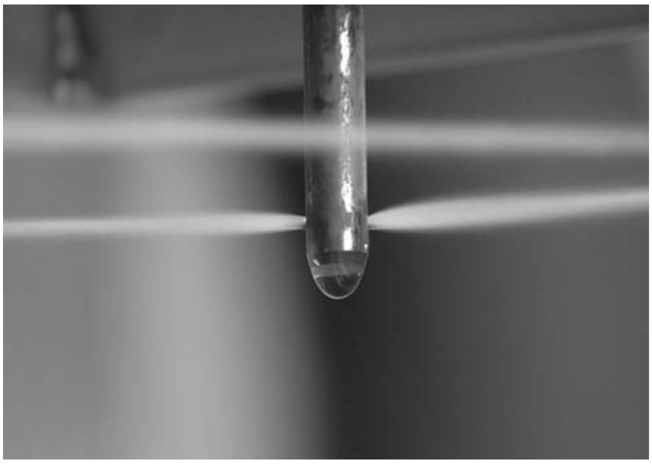

Fig. 3: *Rotating high-pressure water tool*

The disadvantages of the dry ice process include above all the cost-intensive use of dry ice as well as the merely superficial effect. The cleaning pellets do not reach deeper structures with undercuts, thus making these a problem. This means that tool (parts) of this nature either cannot be processed at all in the first place or require cost-intensive subsequent cleaning using a further process. With a cycle time measured in hours, the process is also slow.

High-pressure Water : Automated cleaning devices based on high-pressure water technology, as developed by the terotechnologist *RST GmbH Hamminkeln, Germany,* have proven themselves outstandingly well on the market. This process offers foundries several advantages at the same time. In addition to the very high and constant cleaning quality, it offers above all major cost and time savings. Early amortisation of the acquisition costs and far higher availability of the core tools are the proven advantages of the system. Using the automated **c**ore **b**ox **c**leaning **d**evices (CBCD), cleaning of a core box no longer takes hours – as is frequently the case with other procedures – but is now just a matter of minutes. Tools cleaned with a CBCD are ready for use again after roughly 20 minutes.

Caring Cleaning Even with Complicated Moulds

The central aspect of the device is a robot-guided, rotating, high-pressure water nozzle inside a closed cleaning cabin *(Fig. 3)*. This is controlled by a robot arm and moves over the core box surface along a precisely programmed path, blasting dirt from the deeper undercuts. Variable regulation of the working pressure is possible up to 2000 bar depending on requirements. This hydro-dynamic mould cleaning thus enables individual and caring cleaning even with complex moulds. Following preparation by means of simulation during the planning phase, the working path for the water tool is prescribed for the robot in a teach-in process. Following commissioning of the device, these programmes can be optimised with little effort, thus eliminating even stubborn dirt. In order to ensure that the articulated-arm robot can reach every point to be cleaned in an optimum manner with its water jet nozzle, so-called manipulators manoeuvre the core box components into the correct position. All this is done in a fully automated process chain: the lifting-off of the core injection cover, the separation of the upper and lower parts of the core box, the arrangement of the tool parts in front of the articulated-arm robot, as well as the subsequent bringing back together of the cleaned tool components. The treatment of the tools against rust film using an anti-corrosion agent immediately following cleaning as well as the express drying with specially developed air knives fed with compressed air from high-performance blowers, are also constituents of the automated workflow.

As is the case in many production sectors today, the magic word in terms of the speed of the overall process is the far-reaching or comprehensive automation. A further advantage is the consistently high quality of results. Particularly in this sensitive area of production, the elimination of the human error rate is of major significance from a business management point of view.

Study Confirms Cost Advantages

Depending on the nature and complexity of the cleaning task, one or the other of the processes mentioned offers the best and most economic solution to be chosen by a foundry. There are fundamental criteria which enable a comparative assessment of the processes. In addition to the speed, efficiency and comfort of a solution, above all **costs** quickly become the focal point everywhere. Whenever alternative solutions lead to the same objective, thus necessitating a decision in favour of one of them – and this is normally the case with the cleaning of core boxes and cast parts – the questions to be asked are:

- Which solution is the most cost-favourable?
- What is the short and long-term situation in terms of investment and operating costs?
- When will the acquisition be amortised and what savings potential will then result on a lasting basis?

In summary, the focus of the party taking the decision is on the term “total cost of ownership”.

As regards a comparison of the processes, the provider refers to a study by the *University of Applied Sciences in Gelsenkirchen* published in October 2007. This study involved an extensive analysis of all cost-relevant aspects of economic significance for companies. It is no surprise that RST refers to this study. Because it comes out very clearly in favour of high-pressure water technology *(Fig. 4)*.

The conclusion of the study, which looks at “the calculation of the total costs of the various cleaning processes taking account of the respective cost-centre burdens over the course of an assumed lifecycle of ten years”, is that: “When compared with cleaning processes using ultrasonics or dry ice, high-pressure water cleaning of core boxes is the most economic technology given corresponding utilisation of the device. In addition, the high reproducibility of the optimum cleaning result with the shortest cleaning cycle, as required by industry, must be seen as an advantage in favour of high-pressure water cleaning.”

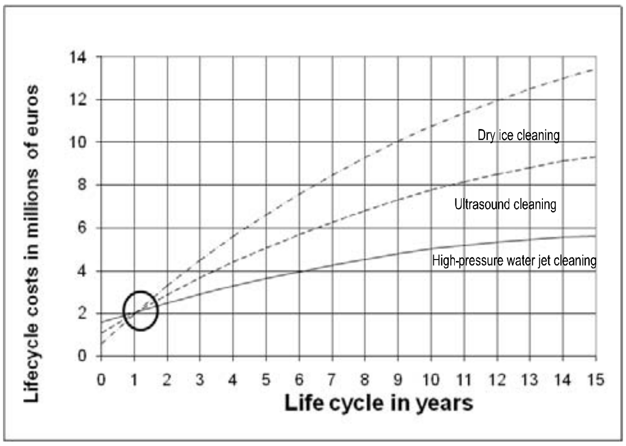

Fig. 4: *Lifecycle costs of core box cleaning devices*

Problem Solver for Industry

Problems of dirt in production affect many branches of industry with automated manufacturing processes. There are only a few of these requirements on parts cleaning in industrial manufacturing which cannot be mastered using the high-pressure, water-jet process from the Hamminkeln-based company. One only has to look at the automotive sector with its constantly rising quality standards and the high number of component suppliers to see that there is an annually increasing need for varying solution approaches and their implementation. Given the diverse requirements in terms of the degree of dirt and spectrum of parts, it is frequently necessary to examine the application-specific cleaning possibilities, to develop and realise individual solutions. As a system integrator and specialist for special solutions, RST faces up to these challenges. In close cooperation with the customer, all fundamental data such as quantity of parts, cycle time and degree of cleanliness as well as water management aspects are discussed using a list of questions.

The relevant parameters such as water pressure, volume flow, travelling speed, design of the water tool are laid down at a college of technology through series of trials with cost participation by the customer.

As a rule, an advance study is then carried out on the basis of the said parameters with selection of the device concept and a rough preliminary calculation, so as to enable budgeting of the required investment.

As cleaning devices are predominantly integrated into existing production lines, account must be taken of local production conditions. Once the customer has presented the concept and the budget in his company, a decision is taken as to whether and when the investment will be made. If RST obtains the order, the above costs for the series of trials are offset against the purchasing price. The provider prepares, supplies and assembles the high-pressure, water-jet device anywhere in the world including commissioning and initial accompaniment of production if desired by the customer.

Editorial Comments

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