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Development of a New ATD-P Tester for Hard Wear Resistant Materials

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Abstract

The aim of presented studies was to develop a new geometry of the overflow part of standard ATD–C tester for derivative thermal analysis in a way that it would allow to obtain samples for abrasion and mechanical properties tests in the same mould without the need of cutting them from a block of material. The pattern of new ATD–P tester has parts reflecting implemented samples. Computer simulations regarding initial verification of new tester were performed in NovaFlow software. Chromium cast iron melts were made for testing the sampler in real conditions and TDA analysis for casting material were conducted. The sandmix was prepared on silica sand matrix per the ALPHASET technology. This new solution greatly simplifies the preparations of materials difficult to machine.

Keywords: Crystallization, TDA, ATD tester

1. Introduction

There is a vast variety of methods that allow to prepare samples for the studies. Various cutting tools are often used for sample preparation, like for example cut-off wheels which are very useful for materials with low hardness. The sample can be easily cut from any place of casting, but there is a problem when material is hard and difficult to machine [1, 2]. Department of Foundry Engineering of Silesian University of Technology constantly conducts research of wear resistant chromium cast irons [3]. During the preparation of samples many disadvantages associated with the cutting of material were encountered. Cut-off wheels wear out very quickly and all cutting process lasted very long because of the properties of chromium cast iron [4]. For this reason, an idea concerning development of new tester for studies of crystallization with the possibility of obtainment of simple and quick to prepare samples for abrasion and mechanical properties tests was born [5].

2. Description of research

New tester ATD – P is based on existing tester ATD – C [3]. Till now the samples for tests were cut from the cylindrical part of the tester using cut-off machine, but this method generated difficulties because of chromium cast irons high wear resistance [6-12]. Therefore, rose a concept to use the overflow part of ATD – C tester for casting easy to obtain samples for testing the abrasion resistance and mechanical properties. ATD – P tester allows to cast samples with 10x10 mm cross section in the same mould which is used to measure the crystallization process.

In order to maintain thermal parameters occurring in ATD – C tester the dimensions of the overflow part of the new tester were chosen in a way so that the volume of overflowing metal was the same as in ATD – C tester. Figure 1 presents the scheme of test stand equipped with ATD – P tester mould with thermocouple placed inside connected with Crystaldigraph device and computer.

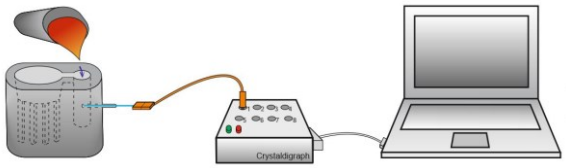


Fig. 1. Scheme of test stand

Computer simulation of crystallization and filling processes in new tester was performed to eliminate the risk of occurrence of shrinkage cavities and porosity in cast samples as well as to ensure that each part of moulds cavity, especially samples with small cross section, will be filled. Simulation was executed using NovaFlow and Solid software.

The next step was melting of chromium cast iron with 20% of Cr content. Using new ATD – P tester and Crystaldigraph device the changes of temperature in time during the filling of the mould and crystallization the casting was registered.

3. Results of research

Figure 2 presents the scheme of new ATD – P tester with characteristic elements marked in the cavity of mould. Figure 3 shows the model of pattern equipment. Figure 4 shows results of computer simulation prepared for chromium cast iron poured into ATD – P tester, presenting shrinkage, temperature distribution at the moment of testers fulfilment and distribution of crystallization times.

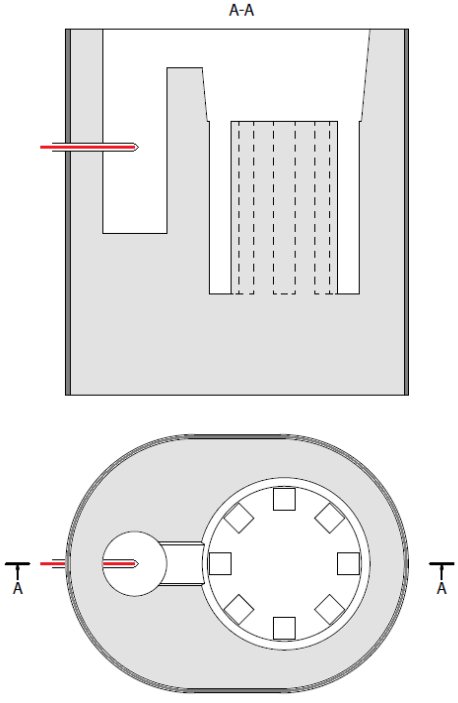


Fig. 2. Scheme of ATD – P tester

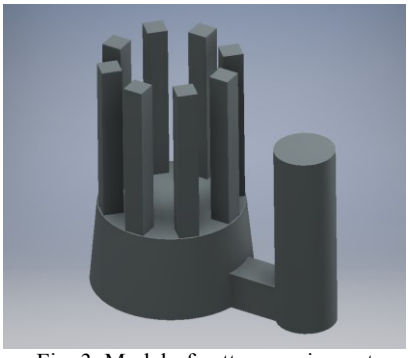


Fig. 3. Model of pattern equipment

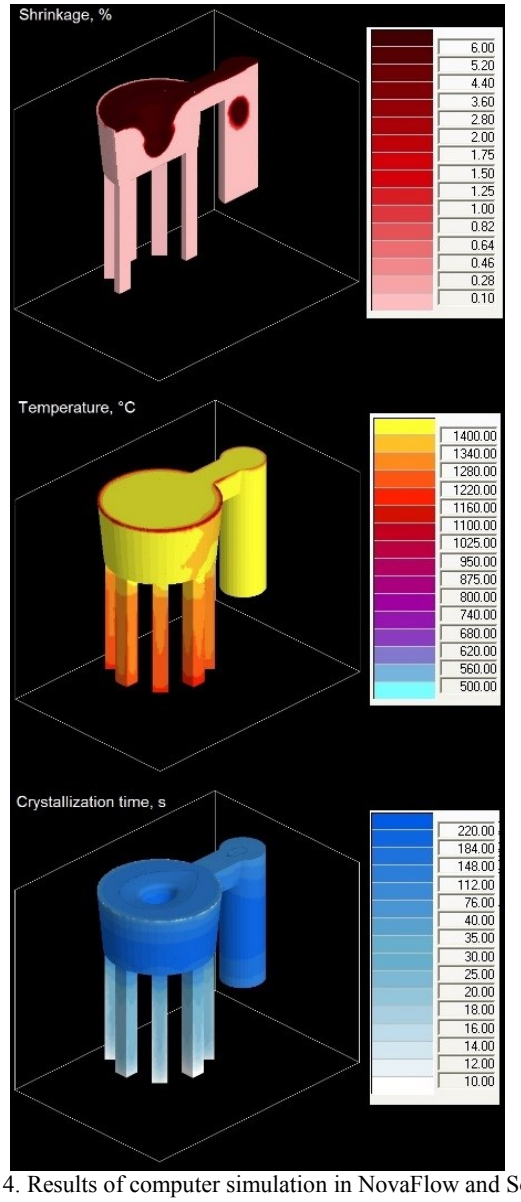
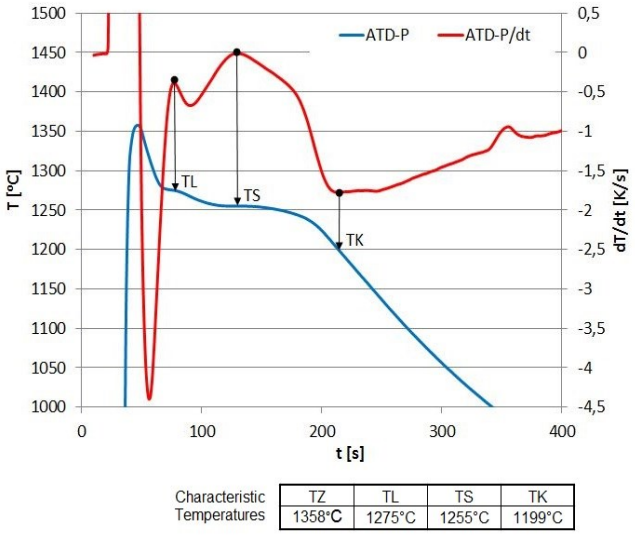


Fig. 4. Results of computer simulation in NovaFlow and Solid

After obtaining simulation results the mould from ALPHASET sandmix was prepared. Coating based on zirconal was applied on prepared moulds surface. Chromium cast iron was melted in induction furnace. The mould with thermocouple placed inside was filled with molten metal and the temperature changes over time were recorded using Crystaldigraph device. On Figure 5 the temperature and crystallization curves were presented.



Characteristic Temperatures	TZ	TL	TS	TK
	1358°C	1275°C	1255°C	1199°C

Fig. 5. TDA curves

Figure 6 presents the casting after removing from mould. It can be seen that all samples for test were casted well.

Fig. 6. Obtained casting

4. Conclusions

ATD – P tester is a good alternative to ATD – C tester in the field where preparation of samples extracted from the tester may be problematic from tribological point of view. Cutting off the samples and grinding their surfaces so they are ready for the testing is a matter of minutes instead of hours in the case of ATD – C tester.

In comparison to different methods of crystallisation measurement ATD – P tester allows to perform one mould for both crystallization process measuring and preparation of the samples for further tests instead of two moulds which increases the metallic yield.

Computer simulation of filling and crystallization processes proved that sample area of the tester is free of shrinkage porosity and shrinkage cavities.

ATD – P tester allows to use different sandmixes. The measurement of the crystallization process and the samples can be obtained with the use of a certain sandmix which is an advantage over commonly used shell moulds used for TDA analysis and sample preparation.

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