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Uporaba simulacije za pretvarjanje ulivanja v kokilo z vakuumskim odstranjevanjem zraka v ulivanje v kokilo s klasičnim zračenjem

Conversion of a Vacuum-Assist Casting to a Conventionally Vented Casting with the Aid of Casting Simulation

Izvleček

V današnjih konkurenčnih razmerah je sposobnost izdelati visokokakovostne tlačno ulite sestavne dele ob sočasnem zmanjševanju proizvodnih stroškov in časa, potrebnega za razvijanje, izziv za sodobno livarsko industrijo. Tako pri snovanju novih delov kot pri ponovnem konstruiranju takih delov omogoča računalniško krmiljeno modeliranje veliko prihrankov tako med fazo razvijanja kot v fazi izdelovanja. Z odstranjevanjem napak v ulitkih in s tem zmanjšanje izmečka ter njegove predelave lahko livarji izboljšajo kakovost in stalnost kakovosti izdelkov ter pridejo do boljših konstrukcij, ki omogočajo boljše izkoristke. Simuliranje ulivanja kot orodje za napovedovanje poteka procesa naj se uporabi za celoten proces, za zapolnjevanje forme, napovedovanje livarskih napak, napredne analize, kot so analize toplotnih napetosti in popačenja oblik strojnega dela, kar pomaga pri ustreznem odločanju že v prvih fazah izdelovalnega procesa. Proces ulivanja zajema tudi predhodne faze, kot sta izdelava ulivnega in dovodnega sistema, konstruiranje ulitka, in faze, ki ulivanju slede, kot so čiščenje, toplotna obdelava in strojna obdelava, ki določajo glavne lastnosti strojnega dela. Zato bodo ti različni koraki vplivali tudi na učinkovito delovanje dela, ki je bil vgrajen v končni izdelek in izpostavljen dejanskim razmeram pri uporabi.

Prispevek daje pregled zadnjega razvoja v podjetju Honda Engineering of North America z ekspertizo simulacije, narejene v ESI North America, ki so ga pospešile zahteve industrije. Poudarek je bil na nedavnih raziskavah, ki omogočajo uspešno spreminjanje obstoječega ulivanja v kokilo z vakuumskim odstranjevanjem zraka v ulivanje v kokilo s standardnim zračenjem.

Medtem ko vakuum potencialno pomaga obvladovati zrak v votlinah kokile, predstavlja dodatne stroške z vakuumskimi komponentami, priključenimi na kokilo, in opremo za ustvarjanje vakuuma. Za ta primer študija predstavlja pregled učnih lekcij, ki smo se jih naučili pri preklopitvi z vakuuma na klasično zračenje kokile, kako se je simulacija uporabila za ugotavljanje in popravljanje možnih napak pri ulivanju zaradi sprememb pri upravljanju z zrakom in koristna navodila za uspešno uporabo klasičnega zračenja.

Ključne besede: simulacija ulivanja, konstrukcija kokile, ulitki, tlačno ulivanje, toplotne napetosti, tlačno ulivanje v vakuumu.

Summary

In the current competitive environment, the capability to produce die casting components of high quality while at the same time reducing production cost and development times is a challenge the foundry industry faces today. Whether it is the design of a new component or redesign of existing products, computer aided modeling has proved that there are several cost savings to be gained in the process development and production stage. By eliminating product defects and reducing scrap and rework, the foundrymen can achieve improved and more consistent product quality and more efficient designs that produce higher yields.

Casting simulation provides predictive evaluation tools to be applied on the entire casting process, including filling and solidification defects, and also advanced analysis like thermal stresses & part distortion to assist in making the appropriate decisions at an early stage of the manufacturing process. The casting sequence also involves upstream steps like gating and die design operations and downstream steps like trimming, heat treatment & machining operations that will determine the main properties of the component. As a consequence these different steps will influence as well the effective performance of the part once assembled in the final product and submitted to real conditions of use.

This presentation provides an overview of latest developments, driven by the requirements from the industry with a focus on a recent work involving successful conversion of an existing vacuum-assist die casting to a conventionally vented die design at Honda Engineering of North America with the simulation expertise from ESI North America.

While vacuum assist is a potential solution to manage the air in the die cavities, there is an added cost in the vacuum components connected to the die cavity, and die machine “infrastructure” in providing the equipment to create the vacuum in the die. This case study provides an overview of the lessons learned in making the switch from a vacuum to conventional venting die design, how simulation was used to identify & correct potential defects in the casting due to the air management change, and helpful guidelines for successful implementation of conventional venting.

Key words: casting simulation, die design, die castings, HPDC, thermal stresses, vacuum die casting

1 Uvod

V današnjih konkurenčnih razmerah je sposobnost izdelati visokokakovostne tlačno ulite sestavne dele ob sočasnem zmanjševanju proizvodnih stroškov in časa, potrebnega za razvijanje, izziv za sodobno livarsko industrijo. Tako pri snovanju novih delov kot pri ponovnem konstruiranju takih delov omogoča računalniško krmiljeno modeliranje veliko prihrankov tako med fazo razvijanja kot v fazi izdelovanja. Z odstranjevanjem napak v ulitkih in s tem zmanjšanje izmečka ter njegove predelave lahko livarji izboljšajo kakovost in stalnost kakovosti izdelkov ter pridejo do boljših konstrukcij, ki omogočajo boljše

1 Introduction

In the current competitive environment, the capability to produce die casting components of high quality while at the same time reducing production cost and development times is a challenge the foundry industry faces today. Whether it is the design of a new component or redesign of existing products, computer aided modeling has proved that there are several cost savings to be gained in the process development and production stage. By eliminating product defects and reducing scrap and rework, the foundrymen can achieve improved and more consistent product quality and more efficient designs that produce higher yields.

izkoristke. Pri načrtovanju ulivnega sistema in dovodnih kanalov za tlačno litje je treba zelo paziti, da je tok taline tak, da se vanjo ujame čim manj zraka. Idealni primer je tisti, ki izrine ves zrak v izhod iz kokile in zračnike. Priljubljena metoda za upravljanje z zrakom je, da se odstrani čim več zraka, kar je bila tudi ideja uporabe vakuumiranja kokile. Medtem ko vakuum potencialno pomaga obvladovati zrak v votlinah kokile, predstavlja dodatne stroške z vakuumskimi komponentami, priključenimi na kokilo, in opremo za ustvarjanje vakuuma.

Napredne računalniško podprte tehnologije modeliranja procesov dajejo danes koristne informacije livarskemu inženirju že v prvih fazah razvijanja izdelka. To skrajša čas med fazo zasnove in fazo izdelave v življenjskem ciklu novega izdelka. Podjetje Honda Engineering of North America je spremenilo obstoječ sistem ulivanja v kokilo z vakuumskim odstranjevanjem zraka v ulivanje v klasično zračeno kokilo. Več konstrukcijskih izzivov je bilo povezanih z uporabo vakuumirane kokile. Tudi prihranki časa in zmanjšanje stroškov so motivirali podjetje Honda Engineering of North America, da spremeni več kokil z vakuumskim odstranjevanjem zraka v klasično zračene kokile.

Da bi lahko izkoristili prednosti stroškovnega izboljšanja pri prehodu na klasično zračenje kokil, so morali v podjetju Honda Engineering of North America rekonstruirati celotne ulivne sisteme in dovodne sisteme, da so zagotovili podobne, če ne celo boljše kakovosti delov kot pri ulivanju v kokilo z vakuumskim odstranjevanjem zraka. Rezultat je bila uspešna spremenjena konstrukcija orodja na klasično zračenje, ki je že pri prvih poskusih dalo dobre ulitke.

Prispevek predstavlja pregled učnih lekcij, ki smo se jih naučili pri preklopitvi z vakuuma na klasično zračenje kokile, kako

When designing the gating, runner, and overflows of a high pressure die casting, great care is taken in creating a fluid pattern that minimizes air entrapment, with the ideal pattern being one that “pushes” all of the air to available overflows and vents. A popular method for managing the air is to simply remove as much of it as possible, which is the idea behind using vacuum assist. While vacuum assist is a potential solution, there is an added cost in the vacuum components connected to the die cavity, and die machine “infrastructure” in providing the equipment to create the vacuum in the die.

Thanks to advanced computer aided technologies process modeling provides valuable information that facilitates participation by the foundry engineer early in the product development stage. This reduces the time between the concept stage and production stage in the life of a new component. Honda Engineering of North America converted an existing vacuum-assist die casting to a conventionally vented casting. There are several design challenges associated with using a vacuum vented design. Also, the time and cost saving benefits associated with moving to a conventional venting system motivated Honda Engineering of North America to convert several of their vacuum assisted die design to conventional vented design.

But in order to take advantage of these cost benefits of moving to a conventional die design, Honda Engineering of North America team had to redesign some of their gating, runner and overall system to guarantee similar if not better part quality as the vacuum assisted die design. The result was a successful tooling re-design using only conventional venting which produced good castings from the first run.

This paper describes the lessons learned in making the switch from a vacuum to conventional venting die design, how se je simulacija uporabila za ugotavljanje in popravljanje možnih napak pri ulivanju zaradi spremenjenega upravljanja z zrakom in koristna navodila za uspešno uporabo klasičnega zračenja.

2 Izzivi zaradi slabosti sedanjega sistema s kokilo z vakuumskim odstranjevanjem zraka

S sedanjo konstrukcijo vakuumskega odstranjevanja zraka iz kokile je bilo več težav, zato je podjetje Honda Power Equipment opustilo uporabo vakuuma. Prva omejitev so bili stroški vzdrževanja teh kokil. Odločitev, da se preide z vakuumskega odstranjevanja zraka na klasično zračenje, je bila sprejeta v podjetju Honda Manufacturing zaradi naslednjih vzrokov: prihranek okoli 2000–3000 USD za vsak hladilni zračnik. Prihranki stroškov so se seštevali in za zapleteno kokilo so kmalu dosegli več deset tisoč USD. Hladilno zračenje tudi zmanjšuje zmožnost dobrega spenjanja kokile, če se kaj dodaja na stično površino. Zato je spenjanje zahtevalo več energije. Drugi vzrok za prehod na klasični način zračenja je bilo neugodno nastajanje obrobkov, povezano z vakuumskim sistemom. Kot se vidi na slikah 1 in 2 je vakuumski sistem povzročil čezmeren nastanek obrobkov v ulivnem sistemu, dovodnih kanalih in območjih zračnikov. To je povzročalo, da so obrobki začeli vdirati v votline vodil in kokile se niso več dobro zapirale, kar je pomenilo še več obrobkov v naslednjih ciklih.

Glavni izziv pri spremembi sistema z vakuumskim odstranjevanjem zraka v sistem s klasičnim zračenjem je bil poskus ohraniti čim več sedanjih dovodnih kanalov in ulivnega sistema, da bi se izognili popolni spremembi konstrukcije kokilnih vložkov in nosilnih blokov. V podjetju Honda

simulation identified was used to correct potential defects in the casting due to the air management change, and helpful guidelines for successful implementation of conventional venting.

2 Challenges in Current Vacuum Assisted System

There were several challenges associated with the current vacuum assisted die design so Honda Power Equipment wanted to move away from using vacuum. The primary constraint being the cost maintenance of these dies. A decision to convert the vacuum assisted dies to traditional venting systems was made at Honda Manufacturing due to the following reasons; cost saving of approx. $2,000 to $3,000 on each chill vent. This cost saving would quickly add up and for a complex die as this could amount to tens of thousands of dollars. Chill venting also diminishes clamping capacity by adding to the surface area. This would lead to more power required for clamping. Another reason to move to a more conventional approach is to prevent bad flashing associated with vacuums design. As seen in Figure 1 and Figure 2, vacuum systems can lead to excessive flashing in the chill runner and chill vent area. This in turn leads to the flash starting to enter into the guide pin holes creating a larger issue by not allowing the dies to close correctly thereby leading to more flashing in the subsequent die cycles.

The main challenge of converting from a vacuum assist to a conventional venting system was to try and retain as much of the current runner and gating system as possible so as to avoid a complete redesign of existing die inserts and die holder blocks. Computer modeling was used by Honda Engineering of North America to achieve

Slika 1: Obrobek v kanalu hladilnega zračnika

Figure 1: Flashing in Chill Vent Runner

Slika 2: Čezmerni obrobek v hladilnem zračniku

Figure 2: Excessive Flashing seen in Chill Vent

Engineering of North America so uporabili računalniško simuliranje, da so dosegli ta cilj. Računalniško simuliranje se je izkazalo za učinkovito orodje v livarski industriji s ciljem, da se natančno modelirajo vse fizikalne zakonitosti procesa tako, da se identificirajo in učinkovito krmilijo pomembne spremenljivke. Z opazovanjem celotnega procesa litja v virtualnem okolju na računalniku postanejo težave, povezane s tokovi taline, potek strjevanja in popačenje oblike ulitka livarskemu inženirju nazorne. Simulacija omogoča tudi preizkušanje konstrukcij novih sistemov ulivanja in zračenja ter novih tehnik simulacije poleg spreminjanja tehničnih konstrukcij v zgodnjih fazah razvijanja. S tradicionalnimi pristopi bi bilo to skoraj nemogoče zaradi velikih stroškov po metodi poskusa in napake med proizvodnjo.

Da je računalniško podprto modeliranje zelo uporabno pri konstruiranju, mora izpolnjevati veliko nalog. Simulacija procesov mora biti sposobna natančno modelirati lastnosti za široko območje livarskih zlitin. Tudi procesne razmere

this goal. Computer simulation has proven to be an effective tool in the foundry industry with a goal to accurately model all of the underlying physics of the process so that important process variables may be identified and effectively controlled. By visualizing the entire casting process in a virtual environment on the computer, problems associated with fluid flow, solidification and part distortion become apparent to the foundry engineer. Simulation also allows the testing of novel gating and venting designs and process modeling techniques, along with re-engineering designs in the early stages of development. Within the traditional approach, this would be undesirable due to the high cost associated with trial and error on the production floor.

For computer aided modeling to be successfully implemented into the design stage, it should perform a wide variety of tasks. Process simulation must have the capability to accurately model the properties of a wide range of casting alloys. Also, process conditions like initial melt temperatures, slow shot to fast shot kot začetna temperatura taline, prehod s počasnega v hitro vbrizganje, hitrosti bata, predgrevanje kokile morajo biti opisane tako, kot bi jih predstavil strežnik procesa v livarni. Pri sedanjem konstruiranju mora programska oprema za računalniško modeliranje omogočiti, da se kot končni rezultat dobi ocena, kakšne so zmožnosti modeliranja pri spreminjanju konstrukcije vakuumirane kokile v konstrukcijo kokile s standardnim zračenjem in istočasno biti sposobna izdelati še analizo napetosti, ki pomaga razumeti, kakšne sile delujejo na nosilce kokile. To je kritično pri napovedi, ali se bo kokila deformirala med obratovanjem in ali se bodo pojavljali čezmerni obrobki.

Ta prispevek ni osredotočen na sedanji vakuumski sistem, ampak na ponovno konstruiranje ulivnega sistema z bolj klasičnim zračenjem kokile in na težave, ki so povezane s to spremembo.

3 Sprememba sistema z vakuumskim odstranjevanjem zraka v sistem s klasičnim zračenjem

Odločilo se je, da se v osnovi ohrani obstoječi ulivni in dovodni sistem v kokili z vakuumskim odstranjevanjem zraka. Po pričakovanju so se občutno zmanjšale težave z obrobki, nastopile pa so nove težave z vključki zraka in hladnimi zv ari. Slika 3 kaže tip napak (hladni zvar), ki so nastale v ulitkih, ko se je prešlo nazaj na klasični način zračenja.

Ujet zrak ali zračni vključki predstavljajo večino napak pri tlačnem litju in s tem izmeček. Postavitev mesta vstopa, konstrukcija vstopa in način prelivanja taline so kritični koraki pri krmiljenju zapolnjevanja zadnjih območij kokile in zmanjševanju napak v ulitku. Taka sprememba konstrukcije bi lahko vodila do velikega izmečka zaradi napak v izvedbi ulivnega sistema in s tem

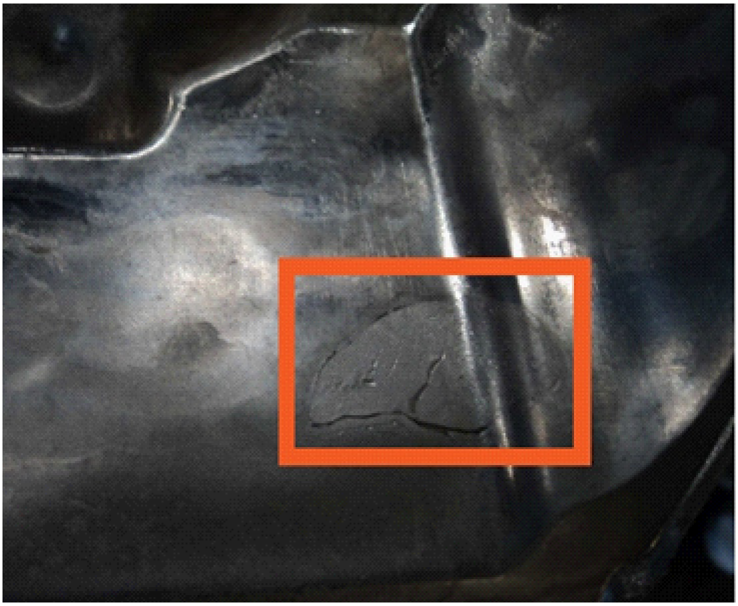
transitions, piston velocities, and preheat of the die must be described just as the operator would on the shop floor. In the current design, the computer modeling software should be able to consider the ability to model vacuum assist and venting design changes on the final outcome and at the same time be able to model stress analysis to assist in understanding the forces on the die holders. This is critical in predicting whether the dies will deform under operating conditions to create excessive flashing.

This paper does not focus on the current vacuum system but on the gating redesign to convert to a more traditional venting design configuration and problems associated with making this change.

3. Redesign of Vacuum Venting to Convention Venting System

In the baseline design it was decided to use the existing gating and runner design as in the vacuum assist process. As expected, the flash problem vastly improved but created issues with air entrapment and misruns. Figure 3 shows the type of defects (misrun / cold spot) seen in the casting when moving to a traditional venting design.

Trapped air or air entrainment contributes to a majority of high pressure die casting defects and rejections. The placement and design of gates and overflows is a critical step in controlling the last areas to fill and reducing part defects. This redesign could lead to a high reject rate due to the gating design imperfections and subsequent filling pattern problems. Instead of retooling the die several times in trial-and-error fashion, the gating was redesigned with the assistance of computer modeling. In order to understand the problems associated with moving from a vacuum assist to a conventional system



Slika 3: Hladni zvar pri klasični konstrukciji zračenja

Figure 3: Misruns in conventional venting design

kasnejših težav pri zapolnjevanju forme. Namesto da bi večkrat predelali kokilo po metodi poskusa in napake, smo za spreminjanje izvedbe ulivnega sistema uporabili računalniško modeliranje. Da bi razumeli težave, povezane s prehodom z vakuumskega odstranjevanja zraka na klasično zračenje, smo pripravili računski model, ki povezuje obstoječo konstrukcijo in hitro analizo, ter uporabili programsko opremo za livarske simulacije ProCAST.

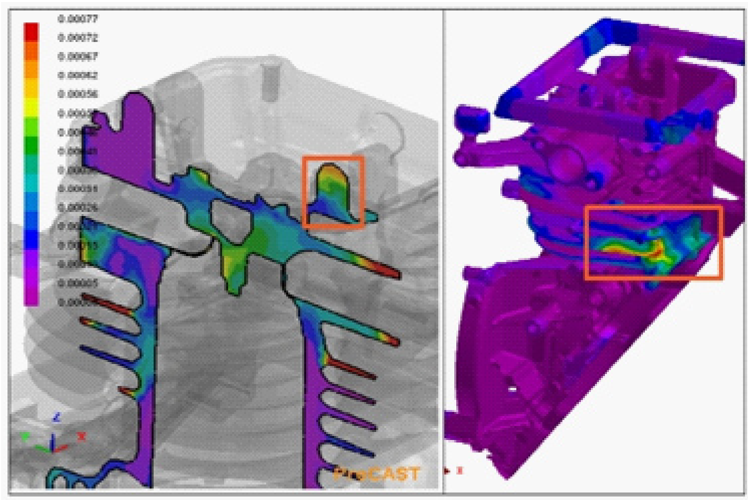
Osnovna razporeditev kaže velike predele poroznosti v območju nihajnega vzvoda in hladilnega rebra, kot kaže slika 4. To so kritična območja v ulitku in treba je bilo dobro razumeti, kaj povzroča ta zaplet. Računalniški model je jasno pokazal, da je bila staljena kovina najprej potisnjena v območje preliva, šele potem pa se je vrnila v nihajni vzvod, kar je pripeljalo do ujetja zraka. Nihajni vzvod se je tudi zadnji strdil, kar je povzročilo poroznost v njem.

Glavni ugotovljen vzrok za to težavo je bil sedanji ulivni sistem iz dveh vstopov na vrhu, ki sta nepravilno usmerjala tok

a computational model was put together based on the existing design and quick analysis was run using ProCAST, a casting simulation modeling software.

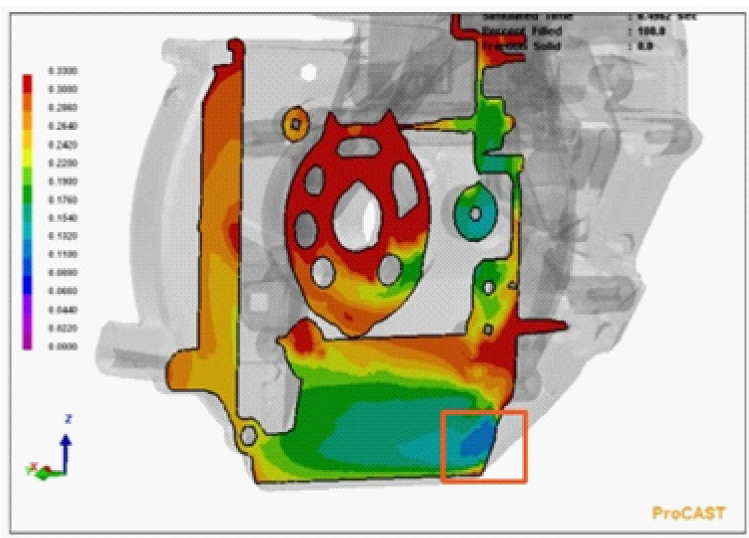
The baseline configuration showed considerable porosity issues in the rocker arm area and the cooling fin areas as shown in Figure 4. These are critical areas in the casting and a clear understanding of what was causing this problem was needed. The computer model clearly showed that the molten metal was being forced in the overflow area first and then the metal was backtracking to the rocker arm, leading to air entrapment. The rocker arms were also the last to freeze leading to porosity issues.

The main reason identified for this problem was the current gating design of the top two gates which were channeling the flow incorrectly into the die cavity. Figure 5 demonstrates some of the challenges faced in moving from a vacuum system to a conventional system. Flow related defects like mixing of the hot and cold metal pushing against may lead to lamination



Slika 4: Osnovna analiza kokile pokaže ujetje zraka v nihajnem vzvodu (levo) in hladilnih rebrih (desno)

Figure 4: Baseline die analysis shows air entrainment in the rocker arm (left) & cooling fins (right)

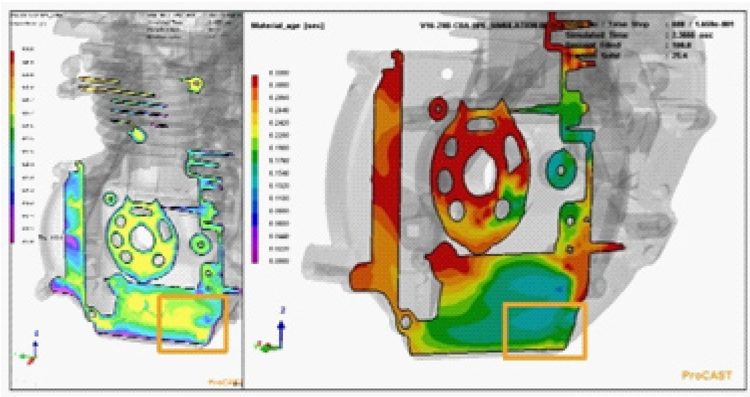


Slika 5: Osnovna analiza kokile kaže različno stare strjene taline okoli kritičnega območja, kar vodi do nepravilne uravnoteženosti toka taline

Figure 5: Baseline die analysis shows different material age around the critical section leading to improper flow balancing

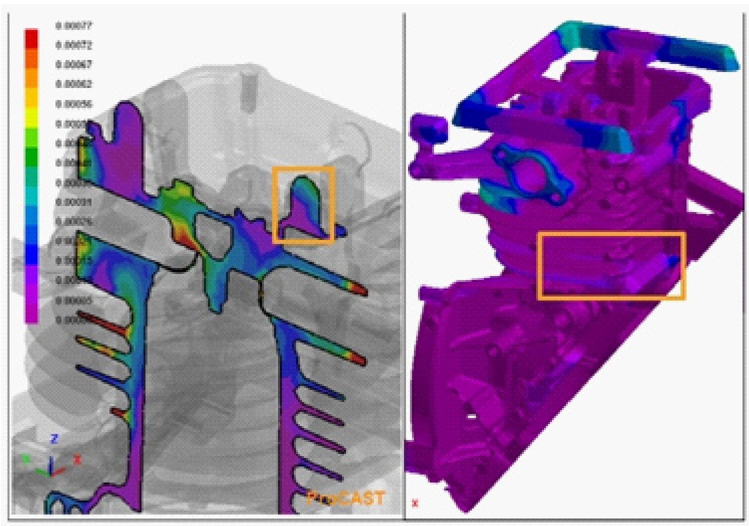
taline v votlino kokile. Slika 5 prikazuje nekaj izzivov, ki nastanejo pri prehodu s sistema vakuumskega odstranjevanja zraka na klasični sistem zračenja. Napake, povezane s tokom taline, kot je mešanje vroče in hladne taline pri potiskanju, lahko povzročijo plastovitost, ki je škodljiva za kakovost končnega ulitka. Mešanje vroče in hladne kovine se pri simulaciji jasno vidi iz črte med staro in novo talino, ki kaže vročo (novejšo) in hladno (starejšo) talino

behaviour which is detrimental to the final part quality. The hot & cold metal mixing is clearly evident in the simulation from the Material Age contour, indicating hot (lower age) & cold (higher age), metal in the critical section, similar to the misrun shown in Figure 3. This is a direct influence of unbalanced gating design and the inability of the venting system to remove the air out of the system effectively.



Slika 6: Končna konstrukcija kaže izboljšane temperaturne gradiente (na levi) in pomeni enakomerno porazdelitev starosti materiala (na desni), kar vodi do manj mešanja in do uravnoteženega toka taline.

Figure 6: Final design shows improved Temperature Gradients (on left) means more uniform distribution of Aging material (on right) leading less mixing & balanced flow behaviour



Slika 7: Spremenjena konstrukcija kaže manjše ujetje zraka na mestu nihajnega vzvoda (levo) in hladilnega rebra (desno)

Figure 7: Modified design showing lower Air entrainments at the rocker arm (on left) & cooling fin locations (on right)

v kritičnem delu, podobno kot pri hladnem zvaru na sliki 3. To je neposreden vpliv neuravnoteženega ulivnega sistema in nezmožnosti učinkovitega odstranjevanja zraka iz sistema.

Nujna bi bila sprememba izvedbe ulivnega in dovodnega sistema ter mogoče tudi mesta preliva. Računalniško modeliranje se je večkrat ponovilo, da so se ugotovile točke zastajanja taline in potrebni so bili spremenjeni prerezi v ulivnem sistemu, da se uravnotežijo tokovi taline v določenih območjih. Taka izboljšana toplotna bilanca je pripeljala do pravilnega temperaturnega

A redesign of the gating and runner system and perhaps overflow placement would typically be needed. Several iterations were run in the computer model to ascertain the choke points and changes were made to make the gates wider or choke them to change the flow balance in certain regions. This improved the thermal balance leading to proper temperature gradient through the troubled areas eliminating the porosity problem as shown in Figure 6.

The redesign of the gating design showed less air entrainment than the baseline analysis. Particle velocity confirmed gradienta v problematičnih območjih, kar je odpravilo tudi težavo nastanka poroznosti, kot kaže slika 6.

Nova izvedba ulivnega sistema kaže na manjše ujetje zraka kot pri osnovni analizi. Hitrosti delcev so potrdile to obnašanje pri tokovih taline. Občutno izboljšanje se vidi v območju nihajnega vzvoda in rebra. Območje nihajnega vzvoda se zapolnjuje počasneje kot prej zaradi nove konstrukcije ulivnega sistema, kar vodi do ujetja manj zraka, ker ima zrak sedaj možnost, da učinkoviteje uide skozi zračnike kot pri osnovni izvedbi. Nova konstrukcija spodnjih vhodov tudi vodi do bolj neposrednega toka taline z dna proti vrhu, ko tok potiska zrak/ujete pline navzgor proti prelivom. Slika 7 kaže spodnje zračne žepe v popravljeni izvedbi ulivnega sistema glede na prvotno konstrukcijo (slika 4) na mestih, kjer sta nihajni vzvod in rebro, kar potrjuje, da nova izvedba omogoča boljšo kakovost ulitka. Dodani so bili dodatni zračniki, da se odstranijo žepi ujetega zraka še v drugih območjih. Predlagano je bilo tudi povečanje prelivnega kanala, da se iz kokile odstranijo ujeti plini. S temi spremembami se je tudi tvorba obrobkov občutno zmanjšala v primerjavi s kokilo z vakuumskim odstranjevanjem zraka.

4 Povzetek in sklep

Ko smo spremenili ulivni in zračilni sistem, se je odstotek dobrih ulitkov povečal s 70 % na 81,5 %, čas izpada proizvodnje se je zmanjšal z 71,5 % na 89,5 % in krajši čas, potreben za odstranjevanje obrobkov s kokile, je pomenil manj dela z obrezovalno stiskalnico. Ta sprememba konstrukcije kokile je pripeljala do znižanja stroškov v primerjavi s sedanjim procesom vakuumskega zračenja. Podjetje Honda Manufacturing je sedaj spremenila 4 kokile z vakuumskim odstranjevanjem zraka na

this flow behaviour. There was a significant improvement seen near the rocker arms and fin area. The rocker arm area filled slower than before due to the gating redesign leading to less air entrapment due to the ability of the air to escape through the vents more effectively than the baseline design. The redesign of the bottom gates also leads to a more directional flow from bottom to top pushing the air/trapped gases upwards to the overflows. Figure 7 shows lower air entrainments in the modified gating design at the rocker arm & cooling fin locations when compared to the baseline design in Figure 4, thereby confirming that the redesign will lead to better part quality.

Additional gas vents were added to eliminate air entrainment pockets in other areas of the component. Also an increased overflow runner size was proposed to eject the trapped gases out of the die. Due to this redesign the flashing situation with the vacuum design was vastly improved too.

4 Summary & Conclusion

After implementing the modification in the gating the venting system, the “as cast” good part percentage increased from 70% to 81.5%. Down time ratio improved from 71.5% to 89.5% and less time cleaning flash from die meant less trouble in trim press. This redesign led to a significant cost saving over the existing vacuum assist process. Honda Manufacturing has currently converted 4 of their vacuum assisted die design to conventional system leading to even more significant cost, time and energy savings.

Advanced casting simulation tools like ProCAST allow the foundry engineer to quickly bridge the gap between design and manufacturing. Optimization or improved efficiency during the manufacturing cycle klasično zračenje, kar je pripeljalo do še občutnejšega zmanjšanja stroškov in večjih časovnih ter energijskih prihrankov.

Napredno orodje za simulacijo litja ProCAST omogoča livarskemu inženirju, da hitro premosti vrzel med načrtovanjem in proizvodnjo. Optimizacija ali izboljšana učinkovitost med proizvodnim ciklom vodi do občutnih prihrankov časa in stroškov. Računalniška analiza je sredstvo za preverjanje idej konstruiranja in ugotavljanja učinkov »kaj, če« z minimalnimi stroški, ker se izognemo dolgotrajnim in dragim predelavam in ponovnim izdelavam orodja.

leads to substantial time and cost savings. Computer analysis provides the means for verifying design ideas and viewing the effects of “what ifs” at minimal costs, by avoiding time-consuming and expensive rework and retooling.