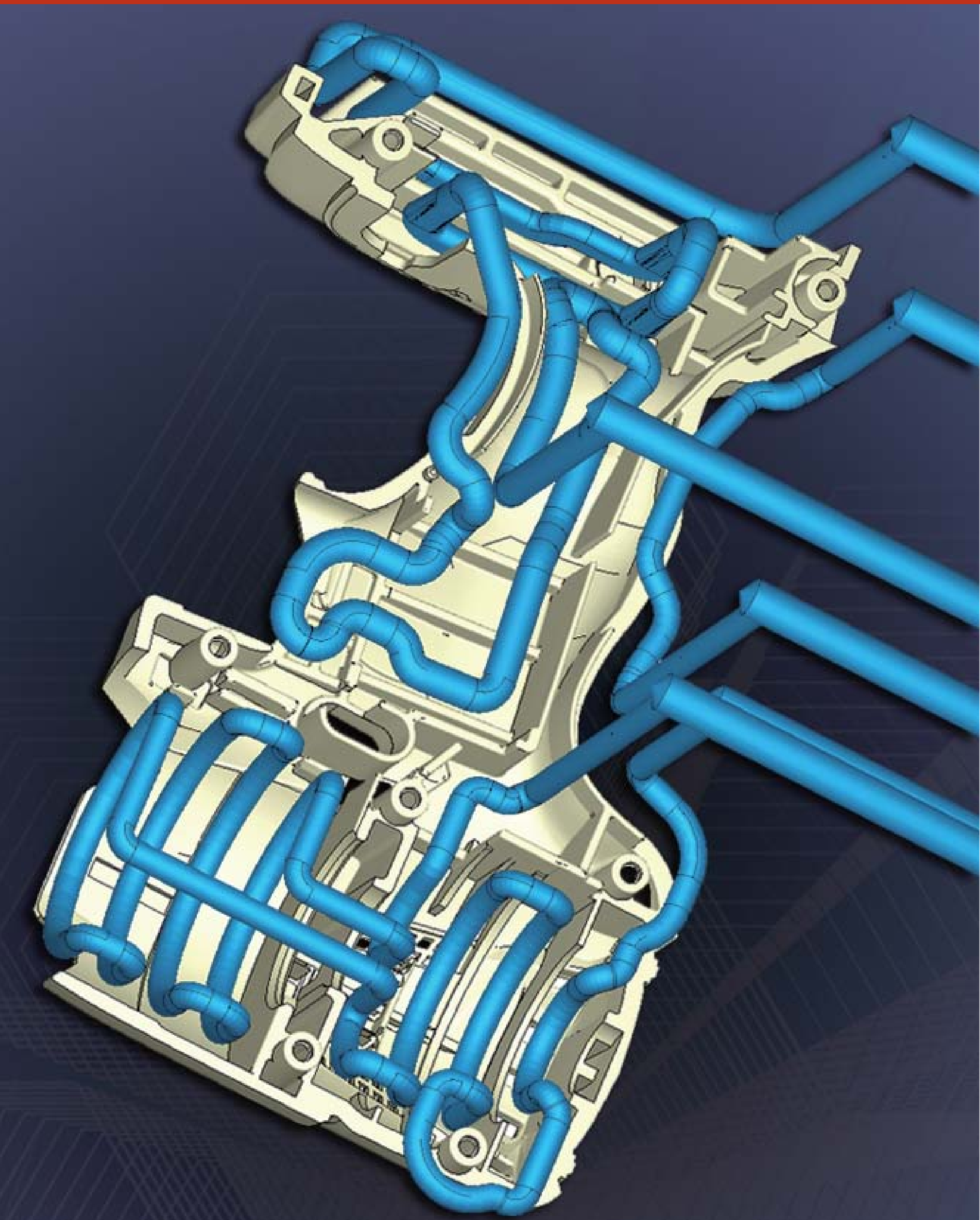
Molding Innovation

FEB. 2012



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Moldex3D

또다른 멋진 해법- Moldex3D R11.0, 형상적응냉각의 설계검증과 3차원 냉각해석의 그 첫걸음을 내딛다

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지난 십여년간 여러가지 참신한 사출성형기법이 고급품질과 원가절감을 목표로 개발되어왔다. 냉각은 품질과 사이클타임 관점에서 사출성형의 가장 주요한 단계이다. 따라서, 어떻게 효과적인 냉각시스템을 설계하는가는 항상 중요한 관건이 되어왔다. 다양한 냉각해법중에서 형상적응냉각(conformal cooling)이 원감절감과 냉각시간단축에서 성공을 거듭하고 검증되어 주요관심사가 되고있다.

CAE 소프트웨어가 냉각레이아웃 설계의 효과성을 평가하고 설계초기단계에서의 잠재적 설계문제를 검증하는데 성공적 적용될 수 있다. 일예로, 냉각채널내 압력, 온도 및 유속과 같은 물리적 성질을 실제와 같이 3 차원으로 나타낼 수 있다. 사용자는 해석결과를 바탕으로 잠재적 설계문제를 탐지할 수 있으며 나아가, 냉각시간예측을 통하여 사용자는 냉각시스템에서의 사이클타임 효과를 감지할 수 있게된다.

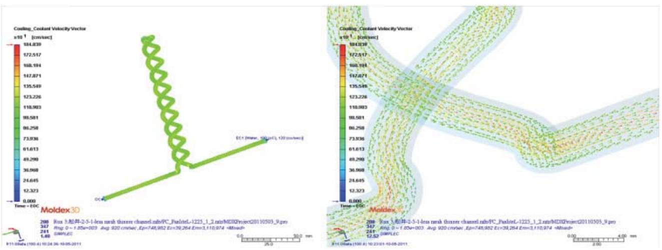

그림 1. 이중나선형 냉각채널 내부의 속도벡터

냉각채널내의 유동거동을 예측하는 최신기술을 탑재한 Moldex3D 로, 제품설계자나 금형설계자는 자신의 설계를 최적화할 수 있는 유선(streamline), 속도벡터와 같은 정보값을 얻어 활용할 수 있다. 그림 1 은 이중나선형 냉각시스템 내부의 속도벡터를 보여주며, 그림 2 는 배플냉각시스템 내부의 유선을 보여준다. 두 결과 모두 3 차원으로 실제와 같은 신뢰성있는 정보를 제시한다. 형상적응냉각 데모나 사례등에 관하여 보다 상세한 정보를 원하시면 이곳 www.moldex3d.com 을 방문해 주시기 바랍니다.

그림 2. 배플냉각채널 내부의 유선(stream lines)

또한 이번 호에 레이저 신터링(laser sintering)과 형상적응냉각응용(conformal cooling applications)에 관한 두가지 기술문서를 포함하며, 이를 통해 작금의 성장시장에서 보다 선진화된 첨단기술을 만나보시기 바랍니다.

- Direct Metal Laser Sintering Technology Applications on Conformal Cooling System Development
- Introduction of Composite Technology, Combining Machining with Selective Laser Melting for Metal Powder Forming

Direct Metal Laser Sintering Technology Applications on Conformal Cooling System Development

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Introduction of Direct Metal Laser Sintering (DMLS) Technology

With increasing product complexity but shorter development time, how to improve mold cooling efficiency to reduce cycle time has been an important issue in injection molding process. One crucial factor to reduce cooling time is a high efficiency cooling channel design. And conformal cooling is the solution. In addition, conformal cooling is also helpful in improving some product defects such as sink mark and warpage. By using some non-conventional methods such as laser sintering, cooling channels can get closer to the cavity surface than using traditional method. This resolves local heat accumulation problems and provides a more efficient cooling channel. Manufactured by EOS GmbH, the direct metal laser sintering (DMLS) machine can be utilized to compensate the insufficiency of traditional CNC and EDM tooling method. It can easily manufacture cooling channels with any geometry.

Cooling efficiency comparison - conformal cooling channel vs. conventional cooling channel

The geometry of a conformal cooling channel is more complex than a conventional cooling channel. Thus, it is more difficult to manufacture through traditional tooling method. However, by using non-traditional manufacturing method such as DMLS, cooling system layout is not restricted. Conformal cooling channel offers a better cooling efficiency to lower the cycle time. In addition, due to the lower mold temperature difference, some product defects such as warpage and sink mark can be avoided. Product quality is thus improved effectively.

EOSINT M series is the DMLS equipment manufactured by EOS GmbH. The procedures of laser sintering start from melting metal powder by laser beams. Follow by that is a layer-by-layer additive forming step. At the end, the sintered part will be harden and milled to the final tool insert. The metal powder developed by EOS can be fully reused. And there are several options of the powder for each specific use.

As to cooling channel design, there are many research works related to optimization theory. Basically, cooling channel should be as close to the cavity as possible; however, mold strength is a great concern. There exist some experimental rules for cooling channel design. Figure 1 shows the relation among the three important design parameters.

Figure 2 shows a case from PEP. A conventional and a conformal cooling channel were compared with a 20 ℃ mold temperature drop and 20 seconds cycle time reduction. The product in Figure 3 is a give-away golf ball. It needs to be produced in large quantity (20 millions) with a low cost. Through DMLS tooling method, this four cavity tool took only 50 hours to build up while the productivity increased 20%.

Moldex3D Molding Simulation on Conformal Cooling Channel Design Validation

DMLS is only a technique in manufacturing conformal cooling channels. The cooling system design itself is the crucial factor for success. But how can we validate the design? Molding simulators such as Moldex3D can help with an efficient and economic way. Through molding simulations, we can quickly understand the effects of cooling systems on cycle time and product quality. The simulation results provide useful indices for cooling system re-design. Using this kind of computer-assisted mold trial method can save mold development cost most effectively.

Figure 4 is a children cup case provided by EOS GmbH. In this case, a conventional baffle design was compared with a conformal cooling design (as shown in Figure 5).

Through Moldex3D simulation (Figure 6), we can see the mold temperature distribution range drops from 79~91℃ (conventional) to 79~84℃(conformal). Since conformal cooling design keeps the same distance between cooling channel surface and cavity surface, the cooling rate differences at the part surface can be much smaller than a baffle design. Also, the heat spot can be relief further. According to the data from EOS, cycle time can be reduced by 42% if conformal cooling design was applied.

Conclusion

The concept of conformal cooling is getting popular nowadays since its effect is significant. DMLS method can compensates the insufficiency of traditional CNC and EDM tooling method and manufacture complex cooling channels which traditional tooling method cannot reach.

Through molding simulators such as Moldex3D can effectively reduce actual mold trial times. It provides a quick tool for design validation in purposes of design optimization and cost reduction.

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Keyword: DMLS, conformal cooling, injection molding.

Acknowledgement

In appreciation of EOS GmbH to provide research report and figures.

Wall thickness of molded product (in mm)	Hole diameter (in mm) b	Centerline distance between holes a	Distance between center of holes and cavity c
0 - 2	4 - 8	2 - 3 x b	1.5 - 2 x b
2 - 4	8 - 12	2 - 3 x b	1.5 - 2 x b
4 - 6	12 - 14	2 - 3 x b	1.5 - 2 x b

Figure 1 Conformal cooling design rules

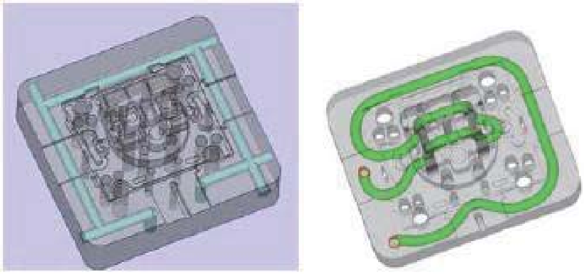


Figure 2 PEP case: conventional cooling design (left) and conformal cooling design (right)

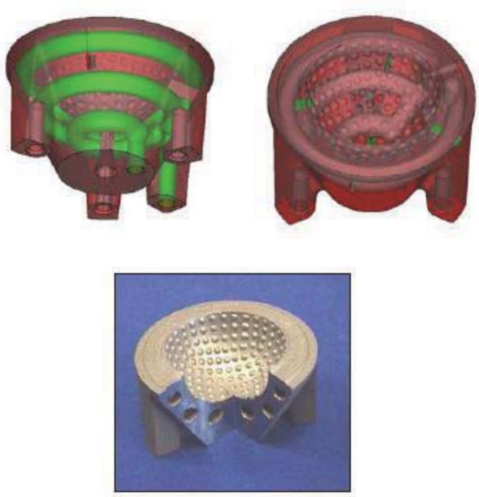
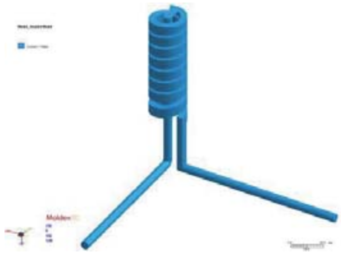


Figure 3 Golf ball mold insert with a conformal cooling channel design

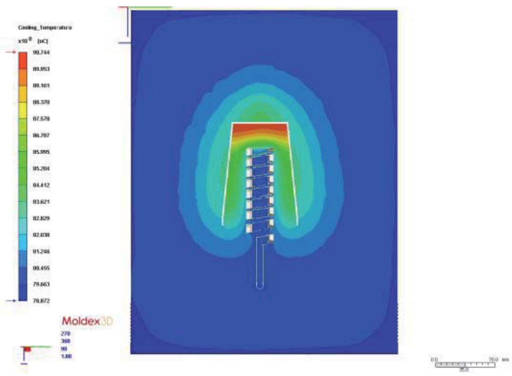
Figure 4 EOS children cup case



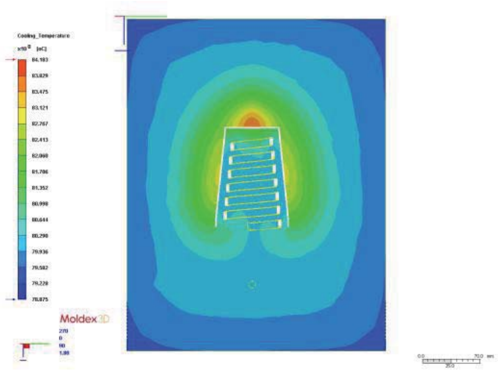
(A)

(B)

Figure 5 Baffle design (A) and conformal cooling design (B)



(A)



(B)

Figure 6 Mold temperature distributions at the end of cooling (A) baffle design (B) conformal design

Introduction of Composite Technology, Combining Machining with Selective Laser Melting for Metal Powder Forming

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In recent years, in view of shortening product lifecycles, the rapid prototyping (RP) technology has been applied to the manufacturing of injection molds. For example, in Europe metal powder selective laser sintering (SLS) technology or selective laser melting (SLM) technology, which is originally one of the RP technologies, have been used for direct manufacturing of metal parts and further developed for the manufacturing of components of injection molds.

During the forming process based on the conventional selective laser melting (SLM) technology, the inherent defects during laser scanning, such as powder splashing in the bath, spheroidization, and powder sticking, may cause the shaped part to have dimensional inaccuracies and higher surface roughness. The technology combining machining with selective laser melting for metal powder forming process originally developed by the Panasonic Corporation (formerly known as the Matsushita Electric Industrial Co., Ltd.) is exactly the solution to make up for such shortcomings of conventional SLM technology. The composite technology combining machining with SLM integrates the layer-by-layer additive forming technology by selective laser melting (SLM) with conventional high-speed machining technology. It combines the two opposite manufacturing processes, the layer-by-layer additive forming process and the subtractive machining process, and integrates material technology, computer software technology, laser sintering technology and computer numerical control technology. In comparison with the layer-by-layer metal powder forming process realized by simple selective laser melting, this composite technology can be a one-time process for creating an integrated component with conformal cooling and air venting functions, such as high-precision molding parts with complex surface profiles that are difficult to perform follow-up machining processing on. The machining precision can be below ± 0.005 mm, and the hardness after heat treatment can be higher than Hrc 50. The cooling time of the mold components manufactured using this composite technology can be effectively reduced. In addition, the trapped air can be removed, so that the injection molding efficiency can be increased and the quality of the molded products can be improved. Therefore, this composite technology combining machining with SLM is particularly suitable for manufacturing high-precision molds for injection molding.

Manufacturing Process of Composite Technology, Combining Machining and SLM for Metal Powder Forming

The Manufacturing process of this technology is shown in Figure 1. (1) The laser melts the metal powder spread on the metal base plate; (2) Repeat spreading the metal powder and laser melting for the layer-by-layer additive forming until the thickness reaches the effective cutting length of the tools; (3) Perform the cutting action on the side wall of the stacked layers with small-diameter tools; (4) Repeat the selective laser melting, layer-by-layer additive forming, and high-speed machining processes; (5) Eventually, a precise, three-dimensional surface profile of the machined work piece can be obtained. The difference between the conventional SLM technology and the composite technology combining machining and SLM can be distinguished according to Figure 2.

Practical Application-
Auxiliary Fuel Tank for Automobiles (60% Reduction in Cooling Time)

Figure 3 shows the components for the jet pump (JP) and overflow (OF) section of the auxiliary fuel tank used in automobiles which are manufactured using the composite technology combining machining and SLM for metal powder forming. Because the technology can incorporate conformal cooling channels inside narrow parts which are difficult to be cooled using the conventional manufacturing methods, the cooling time for the entire mold is reduced from an original 25 seconds to 10 seconds.

In addition, the accuracy of the dimensions of the plastic parts close to the round base and the snap fit are increased. (See Table 1)

	Evaluation Item					
	①		②		③	
Cooling time	**Steel （water）**		**Laser Sintering （water）**		**Laser Sintering （air）**	
	JP	**SNAP FIT**	**JP**	**SNAP FIT**	**JP**	**SNAP FIT**
25	80	130	59	59	80	94
18	80	130	59	59	_	_
15	80	130	59	58	80	100
10	80	130	58	69	_	_

Table 1 Cooling performance evaluation

Application of Moldex3D Molding Simulation Techniques for Design Verification of Conformal Cooling Channels

How conformal cooling channel designs may achieve the desired results, including reductions in cooling time and improvement of product quality, is often difficult to grasp before the mold trial. But with such tools as molding simulator, it is possible to verify the efficacy of the cooling channel design before mold manufacturing, thus achieving the goal of effective cost reduction.

Since we know that the ideal cooling system must take into account the distribution, type, fluid temperature, flow rate and cooling time for the fluid channels. An effective fluid channel design matches the fluid channel to the profile of the product, so as to achieve the goal of uniform heat removal. Figure 4 shows an example of a machinery chassis provided by the OPM laboratory. Due to the complex geometry of this product, the core side is designed with a total of two sets of cooling channels distributed close to the product surface. Figure 5 shows the differences between a conventional cooling channel design and the conformal cooling channel design. The Moldex3D was used to analyze the two cooling channel designs and then compare the results with the on-site data. According to the on-site ejection criterion provided by the OPM laboratory, there shall not be any shrinkage of the product surface. Under this criterion, the conformal cooling channels can have a cooling time 10 seconds less than that of a conventional cooling channel (Figure 6). Figure 7 shows the comparison of the sink mark displacement for the conventional cooling channel, with a 30-second cooling time, and the conformal cooling channels, with a 20-second cooling time. According to the results, the values and locations predicted by the software are very close to the on-site cases.

Conclusion

In this article, the composite technology combining machining and SLM for metal powder forming and the application of conformal cooling channels are described. Compared with the layer-by-layer addition metal powder forming using conventional selective laser melting technology, the composite technology not only retains the advantages of flexible manufacturing capability but also has the advantage of high-speed and high-precision machining. It features a one-time manufacturing process for creating an integrated component with conformal cooling channels and air venting functions, which can even be a high-precision molding parts with complex surface profiles that are difficult to perform follow-up machining processing on. In addition, Moldex3D was used for analysis and comparison of the conventional and conformal cooling channel designs, and reasonable verification results were obtained. Moldex3D is an effective tool for design verification of cooling channels to reduce manufacturing costs.

Keyword:：metal powder, laser melting, layer additive, milling, conformal cooling, cooling time, venting.

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In appreciation of OPM Laboratory Co.,Ltd. to provide images and statistics.

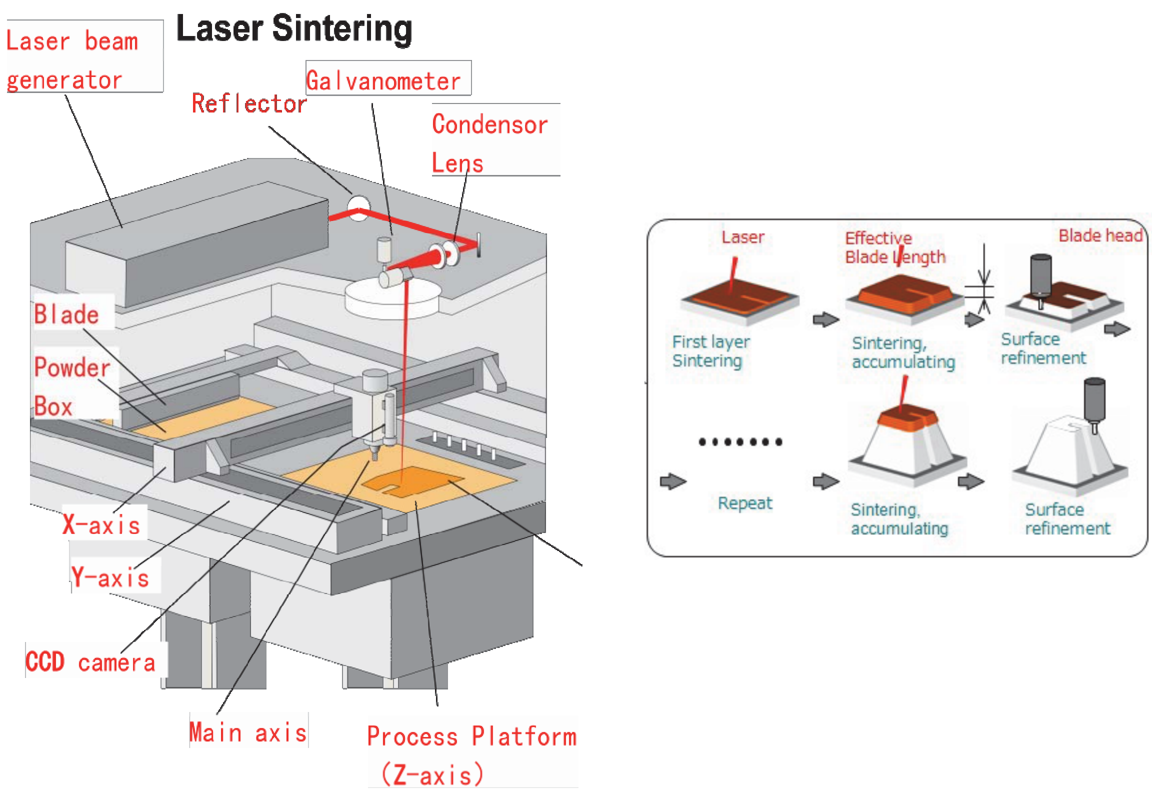
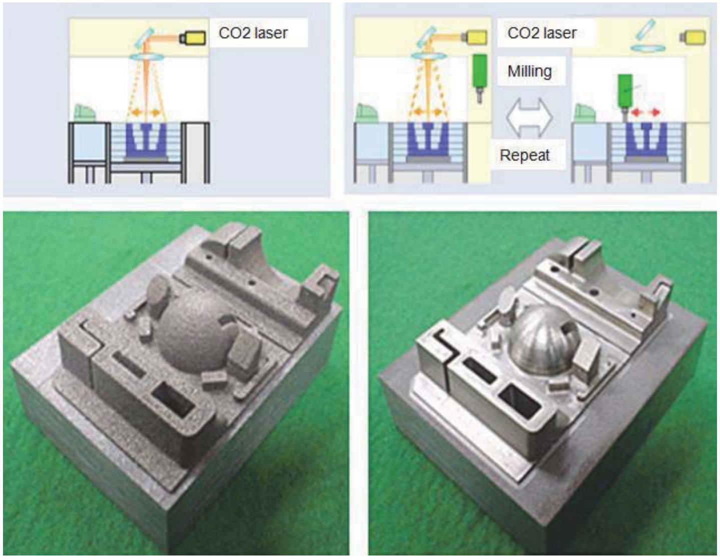


Figure 1 Laser sintering facilities and processes



（A）　　　　　　　　（B）

Figure 2 SLM technology (A) and hybrid technology (B) comparison

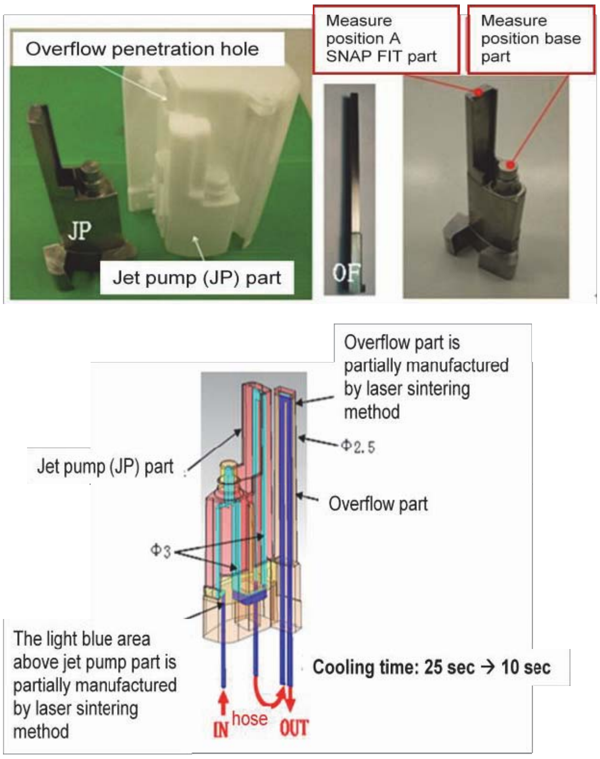


Figure 3 Auxiliary gas tank cooling improvement case

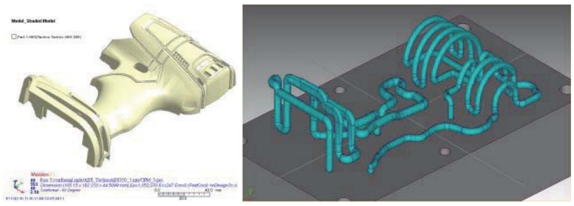
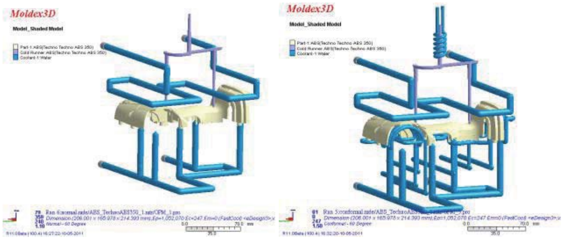


Figure 4 Machine tool cover model and conformal cooling design

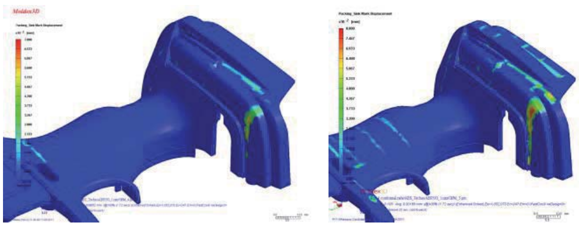


(A) (B)

Figure 5 Conventional (A) and conformal cooling (B) design

(A) (B)

Figure 6 (A)Conventional and conformal design cooling time comparison (B) Sink mark location



(A) (B)

Figure 7 Sink mark displacement comparison

(A) Conventional cooling (B) conformal cooling

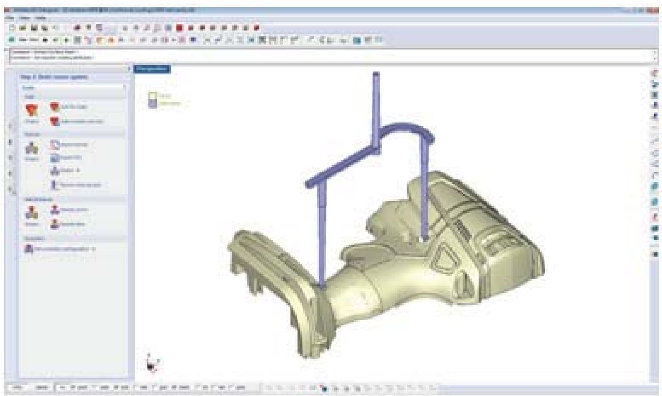
R11.0 신기능: 3D 냉각 채널을 바로 가져오기—이제 R11 에서 가능합니다

Moldex3D R11.0 내에서, 3D 냉각채널내 냉매성질을 예측가능하거나 비원형 단면을 시뮬레이션할 수 있다. 이번 Moldex3D R11.0 신규버전에서는 보다나은 냉각시스템 설계를 보다 효과적으로 이루기위하여 3D 냉각채널기능에서 많은 향상과 개선이 이뤄어졌다.

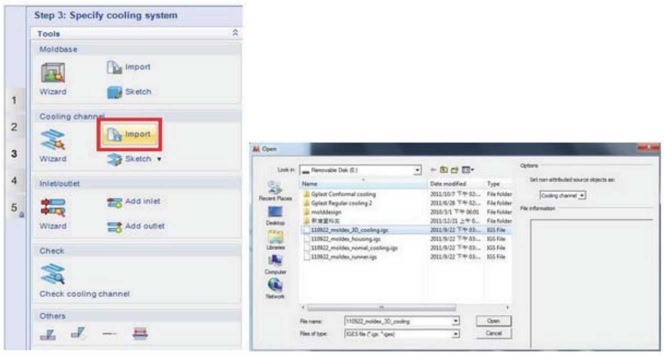
3D 냉각채널 가져오기(import) 지원(eDesign project)

Moldex3D Designer 는 3D 냉각채널을 구축하기위한 매우 직관적인 방법을 제공한다. 다음과 같은 절차에 따라하면 3D 냉각채널을 쉽게 가져올 수 있다:

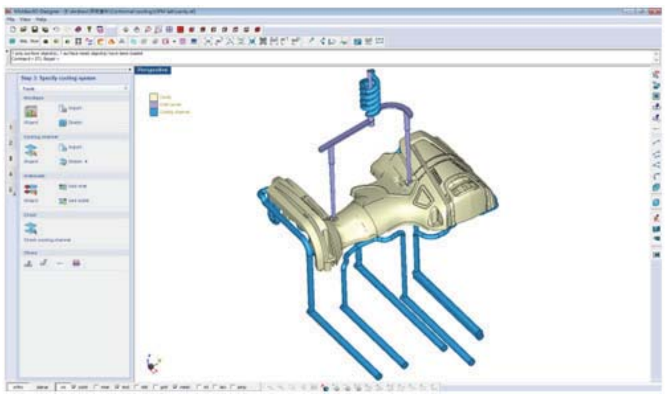
1. 캐비티 모델과 런너 모델을 가져온다



2 3D 냉각채널을 가져오기 위하여, 3 단계(step 3)의 "import"아이콘을 클릭하여 3D 냉각채널을 지정하기만 하면된다. 지원파일포맷은 .stl, .iges, 및 .stp 이며, 서피스(surface)파일(.stl)이 아니더라도, 서피스를 프로그램 스스로 추출한다. 냉각채널 속성옵션을 지정한 후 가져오도록 한다.



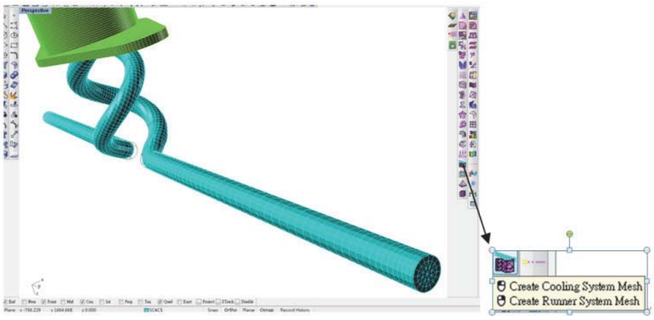
3. 가져온 냉각채널이 아래그림에서 청색으로 나타난다. 이렇게, eDesign 에서 비원형 냉각채널을 쉽게 가져올 수 있다. 나머지 단계는 Moldex3D Designer 의 일반적인 단계와 같다.



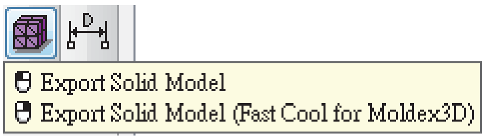
3D 냉매속성 예측 (Solid project)

Moldex3D Mesh 로 복잡한 냉각시스템을 구축할 때 매우 유연하게 대처할 수 있다. 그 절차를 보면 다음과 같다:

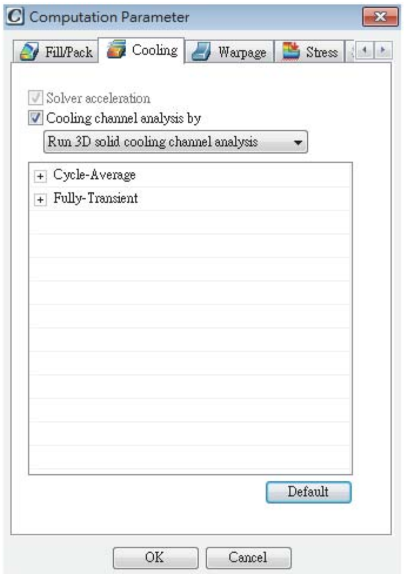
1. 냉각시스템 메쉬(cooling system mesh)를 생성한다



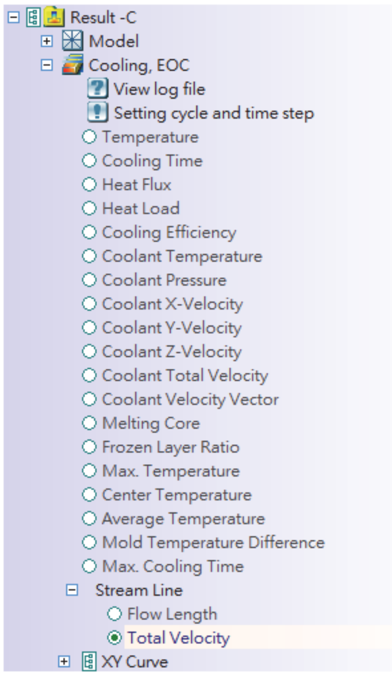
2. 솔리드모델(Solid Model)을 내보낸다(Export)



3. Moldex3D 공정설정(process settings)에서, "Run 3D solid cooling channel analysis(3D 솔리드냉각채널로 해석하기)"로 설정한다. 즉, 아래그림에서 보듯이 "computation parameter (연산설정)"창 아래 "Cooling(냉각)"옵션탭 내용중 "Cooling channel analysis by(냉각채널해석 방식)"를 체크하여 활성화시키고 "Run 3D solid cooling channel analysis (3D솔리드냉각채널로 해석하기)"를 지정한다.



4. 냉각해석결과로, 냉매의 압력, 온도 및 속도를 얻게 된다.



Moldex3D 형상적응형 냉각채널 솔루션을 통해서 냉각 효과를 극대화

성공 사례: 마쓰이 MFG 주식 회사

본 사례의 목적은 형상적응냉각설계(conformal cooling design)과 표준냉각설계(normal or conventional cooling design)간 냉각효과를 비교하고자 함에 있다. 아래 그림에서 보듯이, 본 모델은 매우 복잡한 형상으로 두께변화가 심하다. 형상적응냉각설계로 냉각시간을 10 초(약 33%) 단축하였다.

종래에는, 냉각채널은 제품형상에 맞추어 제조할 수 없었기 때문에 냉각효율이 제한적일 수 밖에 없었고, 특히, 복잡한 형상의 제품인 경우 더욱 그러하다. 근래들어, 고등제조기술의 발전으로 형상적응냉각채널의 제조가 가능해졌다. 반면, 그 복잡한 형상으로 인해 냉각채널설계의 검증과 최적화 자체는 더욱 난해해진 것도 사실이다.

Moldex3D 냉각해석은 요구냉각시간을 결정할 뿐만 아니라, 금형내 온도변화를 쉽게 파악할 수 있게 해준다. 나아가, 3차원 냉각채널해석을 통하여 냉매유량, 압력손실, 와/사류 영역등과 같은 냉의 거동을 예측할 수 있다. 이로써, 형상적응냉각 채널설계의 최적화를 통하여 냉각효율을 개선하는 것을 더 이상 문제가 되지 않는다.

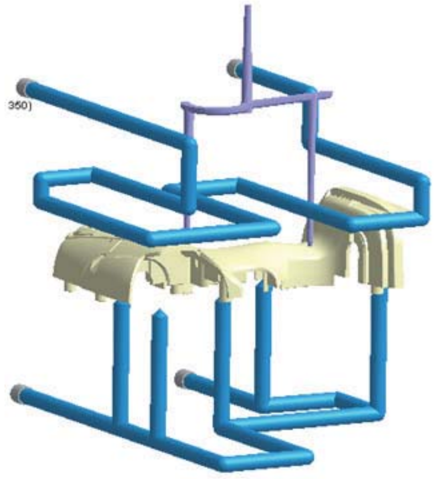
Moldex3D 의 형상적응냉각해석으로 구현할 수 있는 것은 다음과 같다:

- 냉각효율 증대. 파트전체에 걸친 냉각율 차이를 최소화
- 사이클타임 단축 및 원가 절감
- 보다 나은 제품품질 획득

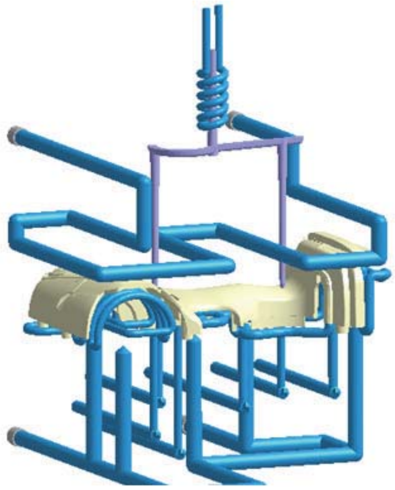
제품치수정보는 다음과 같다:

- 길이:162.23 mm
- 폭:105.15 mm
- 높이:44.51 mm
- 주요두께: 약 3mm

본 사례에서, 표준냉각설계와 형상적응냉각설계의 효율을 비교하고자 한다. 표준냉각설계는 코어측에 배플을 사용하는 반면, 형상적응냉각설계는 제품형상에 꼭맞는 냉각채널을 사용한다.



a. Conventional cooling design

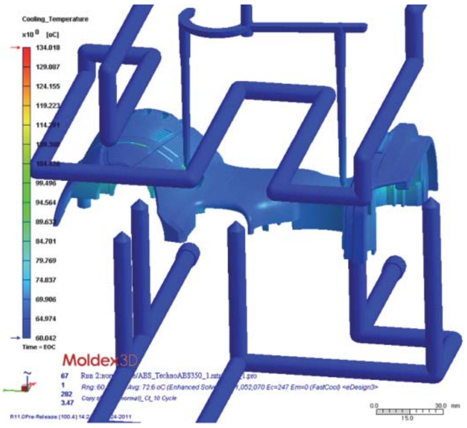


b. Conformal cooling design

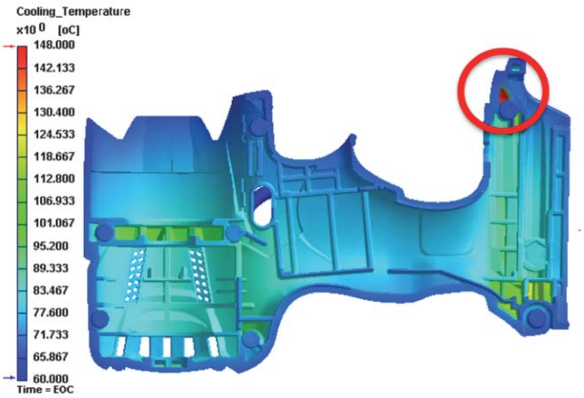
형상적응냉각은 캐비티표면에서 수직으로 일정한 거리가 떨어지도록 파이프를 위치시켜 설계한다. 그러나, 형상의 제약조건으로 냉각라인을 위치시킬 수 없는 장소가 여전히 존재하기도 한다. 여기서, 평균채널직경은 4mm; 캐비티표면에서 파이프중심까지의 거리는 8.3mm; 파이프간 거리는 9mm 이다.

본 설계의 시뮬레이션 결과는 아래와 같다:

표준설계에 대하여 냉각종료후(EOC) 파트표면의 온도분포를 보여준다. 온도범위는 60.04 – 134.2℃이고, 캐비티측은 온도가 낮고 꽤 균일한 분포를 나타내지만, 코어측은 파트표면온도의 지역별 편차를 보여준다. 적색원으로 표기한 최고온도영역을 살펴보면 냉각채널이 전혀 통과하지 않은 결과가 자명하다.

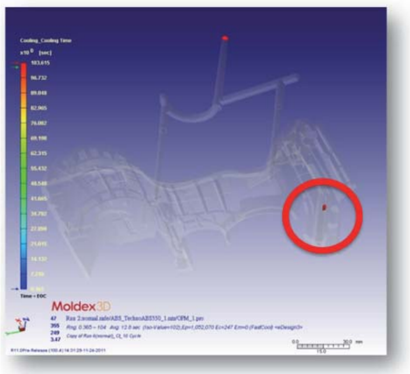


a. surface temperature is around 57.82 – 129.95 ℃

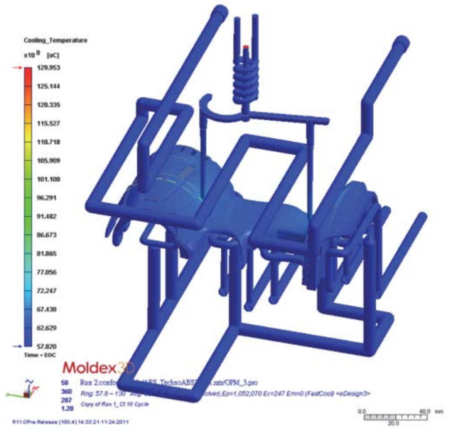


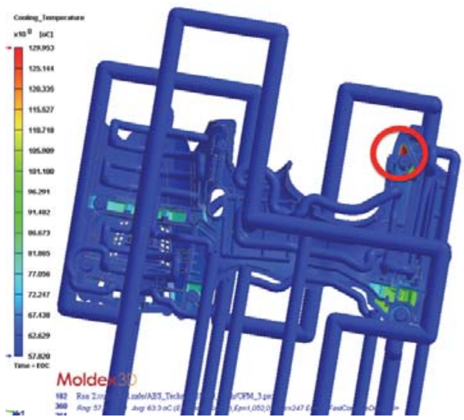
b. Highest temperature is shown in red circle.

아래그림은 지시된 영역에 대하여 요구되는 냉각시간을 보여준다. 냉각시간은 보압종료이후 취출온도까지 냉각시키는데 필요한 시간으로 정의된다. 예측값이 약 101.55 초이므로 기본 냉각시간 20 초는 충분하지 않음을 알 수 있다.

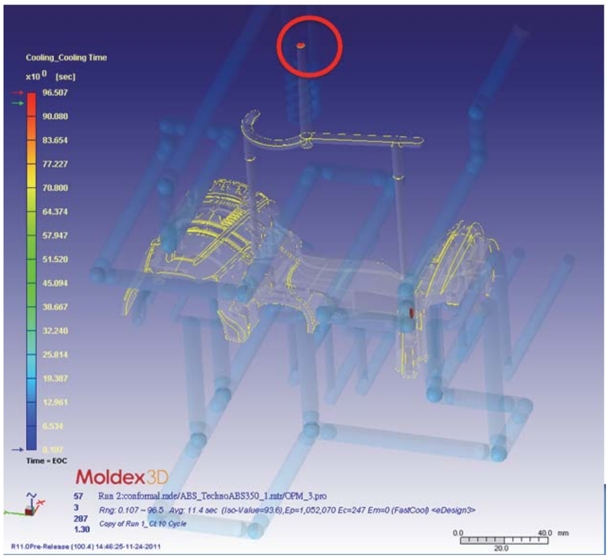


다음으로, 형상적응냉각에 대하여 냉각종료 후의 파트표면의 온도분포를 보여준다. 온도범위는 57.82. – 129.95 ℃ 로， 표준설계 경우보다 낮을 뿐만 아니라, 코어측 온도분포가 더 균일함을 알 수 있다.

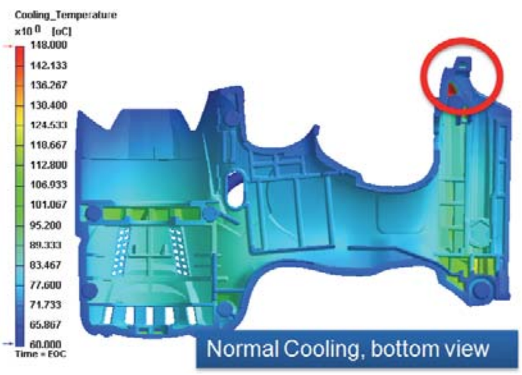




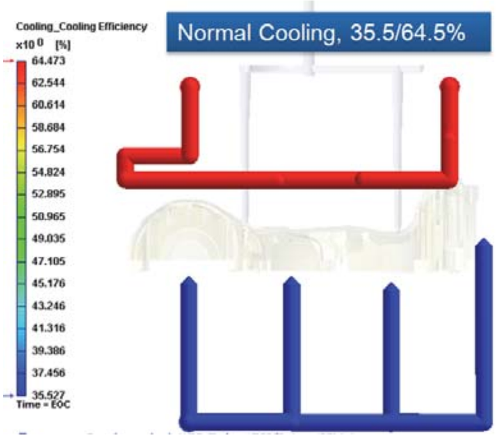
냉각시간을 보아도, 최대요구냉각시간 또한 96.51 초로 단축되었다.

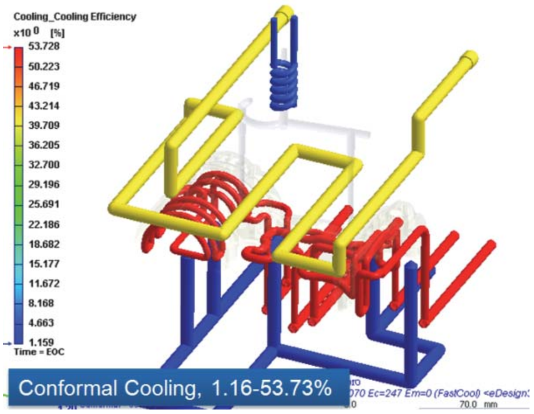


두 경우 모두 동일한 온도범위에서 살펴보면, 형상적응냉각채널이 코어측에서 대부분의 열을 효과적으로 제거한다는 것을 알 수 있다. 그러나, 냉각채널이 해당영역(적색원 표기)을 통과하지 않기 때문에 최대온도영역은 여전히 존재한다

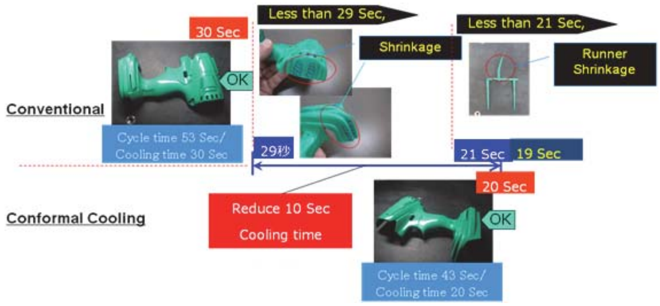


다음은 냉각효율비교를 나타낸다. 표준설계에서 배플이 파트의 코어측까지 도달하지 않기 때문에, 하측 냉각채널은 전체열의 1/3 만을 흡입하는 반면, 형상적응냉각설계에서는, 냉각효율이 최고 53.73%에 달한다. 형상적응냉각과 함께 사용한 배플냉각채널의 효율은 매우 낮은 1.16%에 지나지 않는다

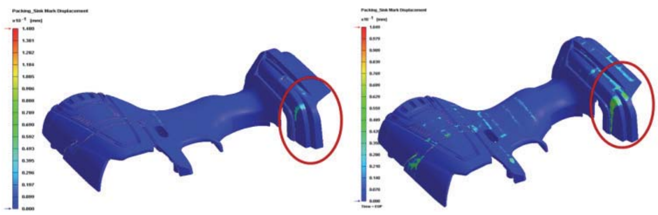




사이클타임 역시 냉각설계에서 고려해야 할 주요한 요소로서, 표준냉각과 교할 때, 형상적응냉각은 동등한 제품품질을 얻었음에도, 10 초까지 즉 33%까지 단축시켰다.



다른 예로, 싱크마크를 제품품질의 한 지표롤 사용될수 있는데, 냉각시간이 각각 30 초와 20 초인 표준설계와 형상적응설계의 싱크마크를 비교한 결과를 아래에서 볼 수 있다. 이 경우 각각 0.07mm 와 0.08mm 로 거의 차이가 없다.



Displacement 0-0.148mm Displacement 0-0.105mm

요약하면, 냉각채널이 제품표면까지 다달으지 못하는 표준냉각설계에서의 냉각효율은 제한적이고, 개선하는데 그 한계에 부딛치게 된다. 이러한 경우, 형상적응냉각설계로 동등한 제품품질을 유지하면서도 효과적으로 냉각시간을 줄이고 냉각효율을 개선할 수 있다. Moldex3D 가 이 형상적응 냉각설계의 효과를 면밀히 예측하는 유용한 도구를 제공한다.

Synergy of True & Full 3D Simulation and Conformal Cooling

Key Benefits

- Warpage Improvement.
- Cycle time reduction: about 400,000 seconds are saved annually and productivity enhancement.
- Long-term unsolved quality deviation is fully resolved.
- Recycling of cooling fixture is eliminated and profitability is enhanced.

This case study aims to compare the cooling effect of conformal cooling with the normal cooling design. As shown in the figure below, this model has a very complex geometry. Also, thickness variation is large. With conformal cooling channel design, cooling time was dropped by 10 seconds (33%).

With the more and more challenging marketing and customer demands, technologies which can ensure the better quality, cost performance, time to market…and etc., are always what we would absolutely look for. This is the same for the injection molding industry — As we know, the cooling time often occupies of 70% of the injection cycle and critical for most of the warpage issues. When process optimization and quality improvement is a priority, we always try to find some lights in this cooling stage.

The customer of this successful case study, Gplast, is from Coimbatore, India. With more than three decades of experience and expertise in Tool and Die making, injection molding and die casting, Gplast is very well known for its achievements in Electronics, Precision Machine Tools and Transport.

Warpage is the first priority since product quality is affected a lot. However, due to the geometric limitation, revising process conditions or other efforts could not really lead to satisfying enhancements. Since conformal cooling is one of the key advantages of Gplast, it is decided to use the true and full 3D Computer Assisted Engineering (CAE) tool to evaluate the effectiveness of the customized cooling layout designs.

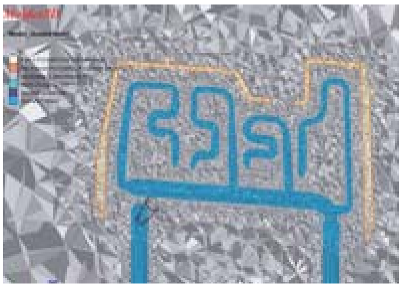


Fig. 1. Cooling channels and mold base – true 3D mesh model for simulation accuracy

One of the important concerns in this case is – the traditional 1D runner or cooling layout is not capable for simulating correct results due to theoretical and functional limitations.

After using Moldex3D/Solid for complete simulation of the original cooling layout design, the analysis result shows the internal temperature is quite high and there is a region with heat accumulation. The mold temperature difference results in the non-uniform shrinkage – finally it leads to the warpage problem which is related with thermal effect.

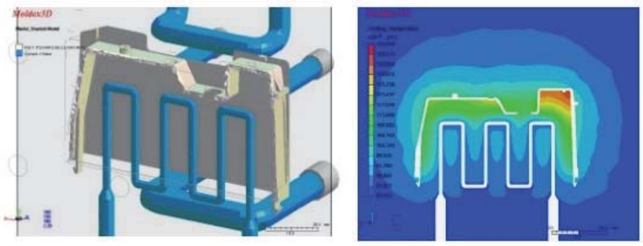


Fig. 2. Original cooling layout (left) and the mold temperature difference (right)

To improve this warpage problem, conformal cooling design is applied for solutions. Moldex3D is again used for performing reliable analysis via complete and high-performance 3D simulations. After revising the cooling system, the mold temperature difference is greatly reduced from 40°C to 6°C – about a 85% improvement. In addition, the temperature of the corner region (with exceeding heat in original design) is much more uniform.

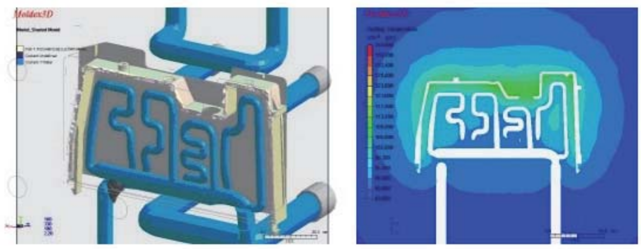


Fig. 3. Revised cooling layout (left) and the mold temperature difference (right)

Compared with the original design, the Z-displacement of the revised cooling system is reduced 25.6%. The target of the cooling system optimization is successfully reached by such an outstanding warpage improvement. In this case, Moldex3D simulation results are highly consistent with the real injected parts, and prove

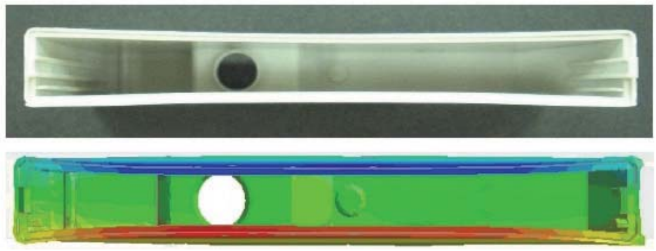


Fig. 4. Warpage of original design – real injected part and simulation result

Fig. 5. Warpage results of revised design with conformal cooling –real injected part and simulation result

Behind the Scene

This is just one of many successful cases done in Gplast. The synergy of true 3D Simulation and conformal cooling design capability proves not only the quality issues like warpage can be effectively eliminated, but also the product development cycle time would be improved. The true 3D Simulation plays an important role – assists to identify the connections between revised cooling designs and the results. Without these analysis results, it would be difficult to precisely evaluate the contribution of different conformal cooling layouts. The application of Moldex3D brings the real confidence for both product development and the performance of conformal cooling designs.

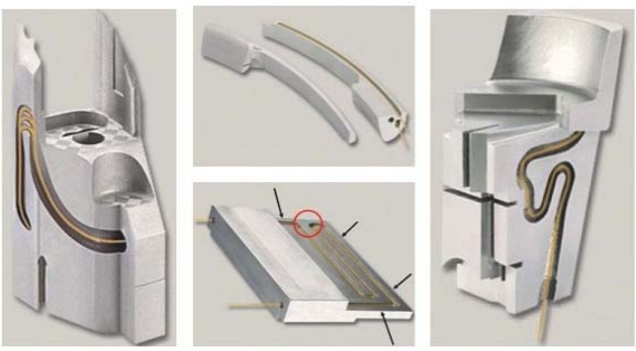
In short, the real performances of this case include:

- Warpage Improvement
- Cycle time reduction (Annual: about 400,000 seconds are saved) and productivity enhancement
- Long-term unsolved quality deviation is fully resolved.
- Recycling of cooling fixture is eliminated and profitability is enhanced.

One of the fundamental reasons for choosing Moldex3D in spite of being a customer to other CAE tools in the market was that we were looking for a professionally true and full 3D customized solution in terms of analysis and who can be a strong partner working with us in providing the best solutions. After these successful cases, we feel that Moldex3D is truly supporting for conformal cooling, and the effectiveness is satisfying. In addition, the technical support and service quality of EUC Tech and CoreTech teams is very impressive and far beyond our expectations! We are glad that we made the right decision. (Mr. G.D. Rajkumar, the Director of Gplast)

About Conformal Cooling

Conformal cooling is defined as the ability to create cooling / heating configurations within a tool that essentially follows the contour of the tool surface or deviates from that contour as thin / thick sections of the part may dictate for optimal thermal management. The objective typically is to cool or heat the part uniformly. Conformal cooling provides a tremendous advantage in mold tooling through significant reductions in cycle times. Other than the obvious piece-cost savings, other tangible benefits include tool, equipment and floor space savings. (Source: Gplast)



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