



Moldex3D
MOLDING INNOVATION

CAE模流分析技術在模具異 型水路設計之應用

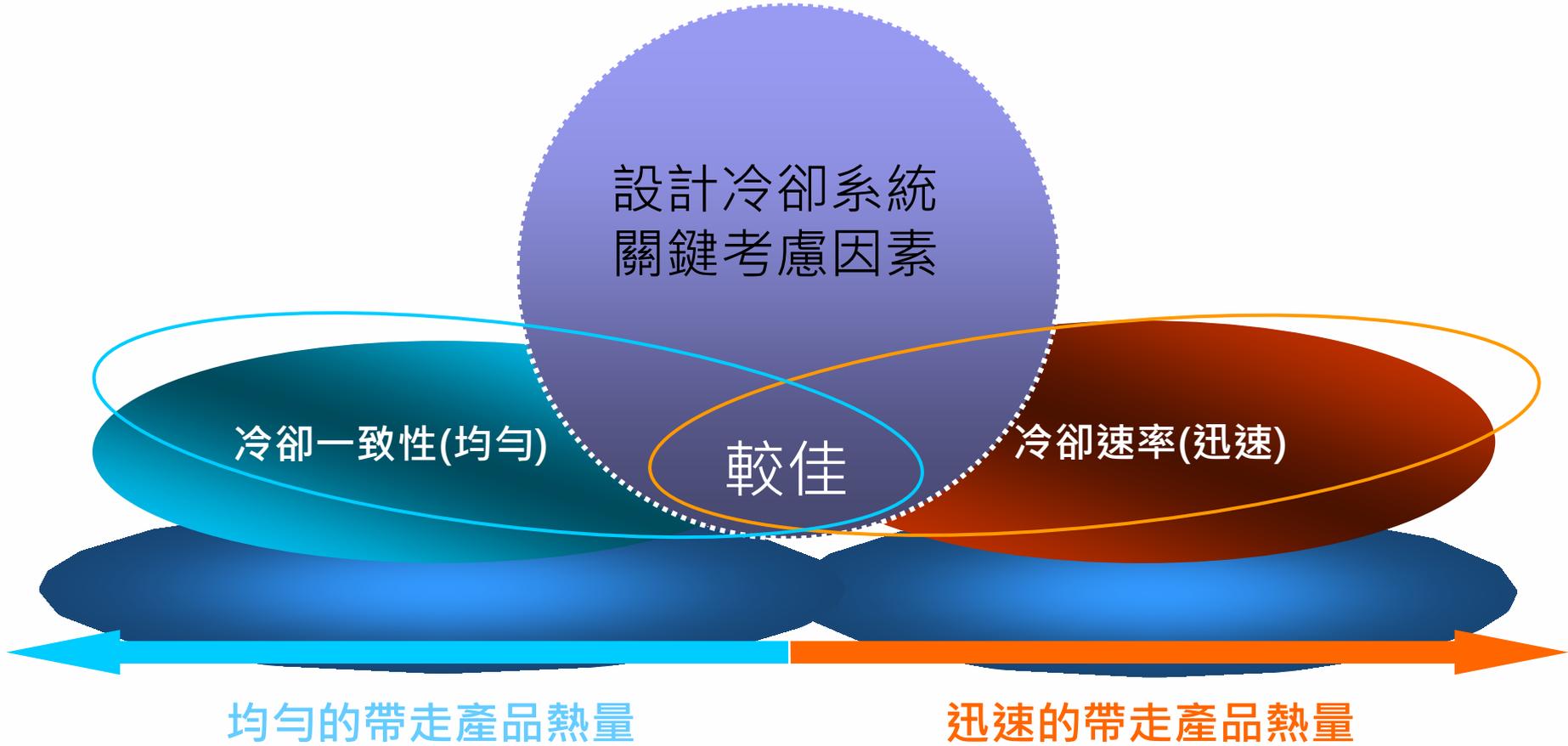
科盛科技

大綱

- > 模具冷卻系統目的與涵義
- > 冷卻系統設計品質影響性
- > 何謂異型水路
- > 異型水路設計評估關鍵
- > 異型水路案例應用

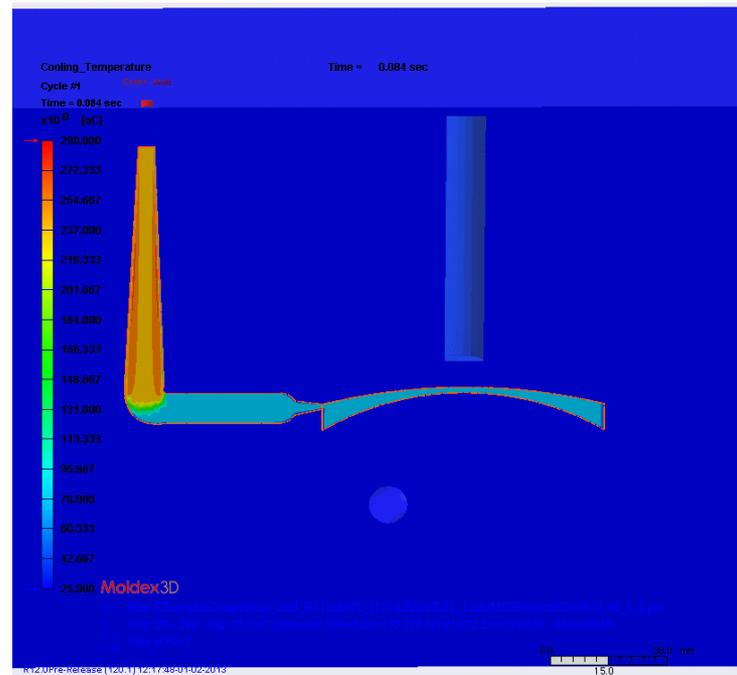
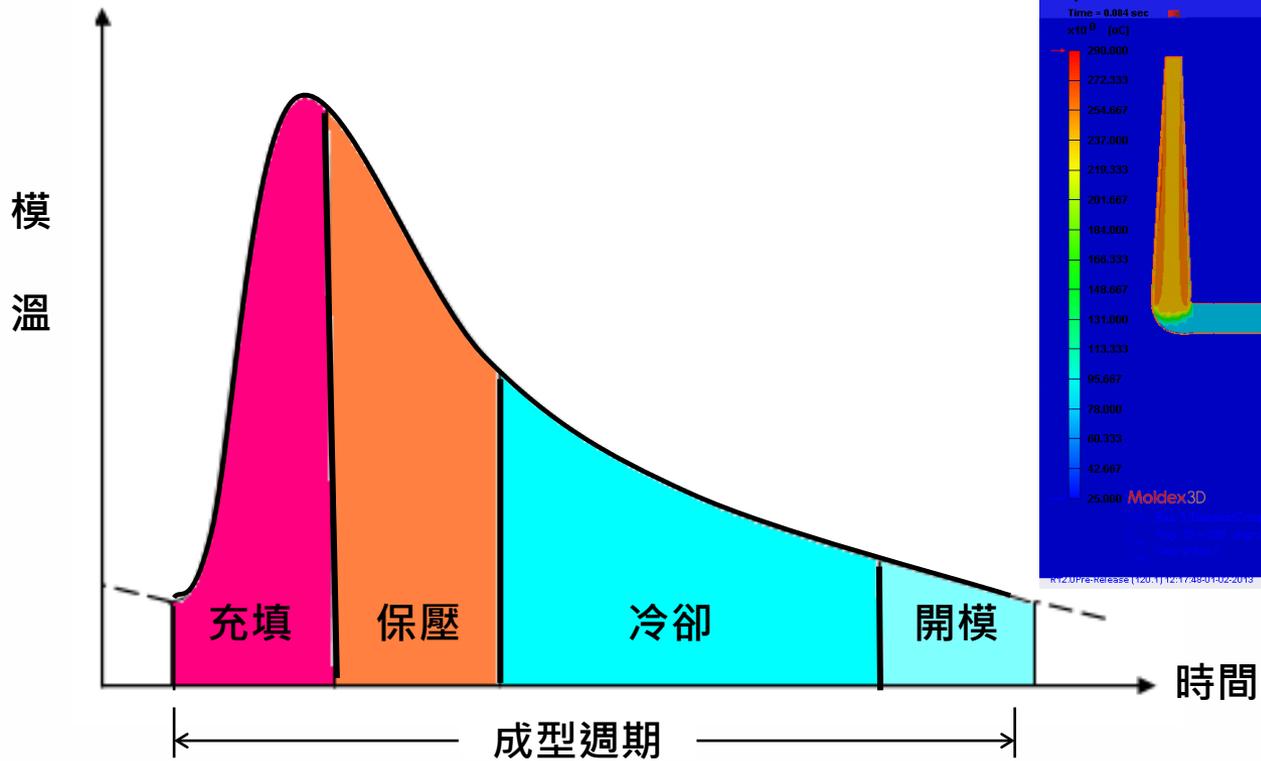
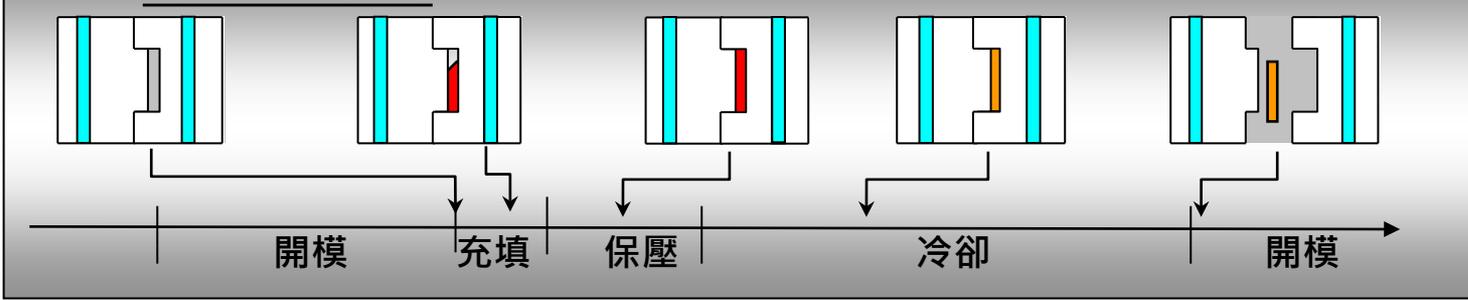
模具冷卻系統目的與涵義

設計冷卻系統關鍵考慮因素?

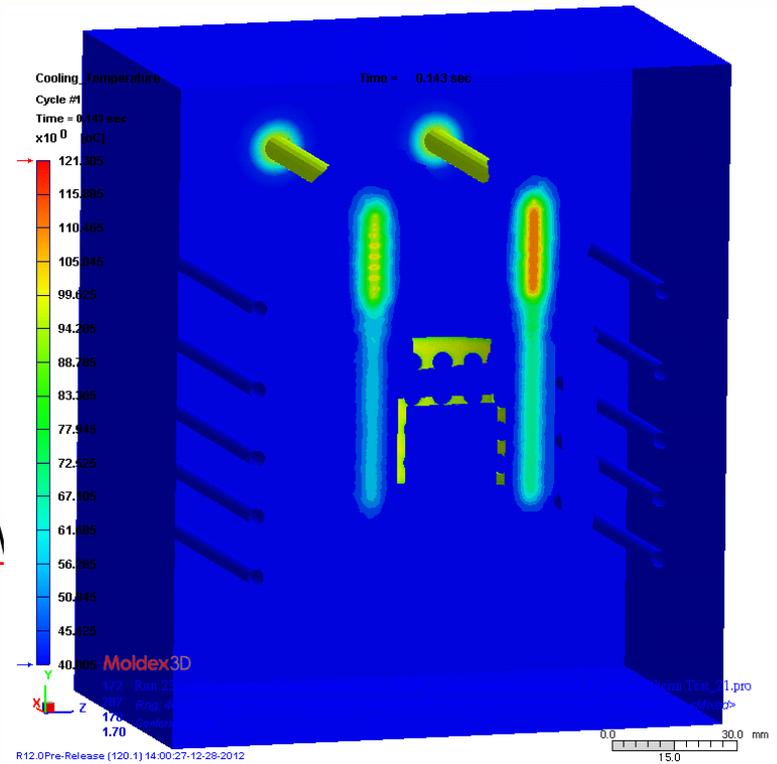
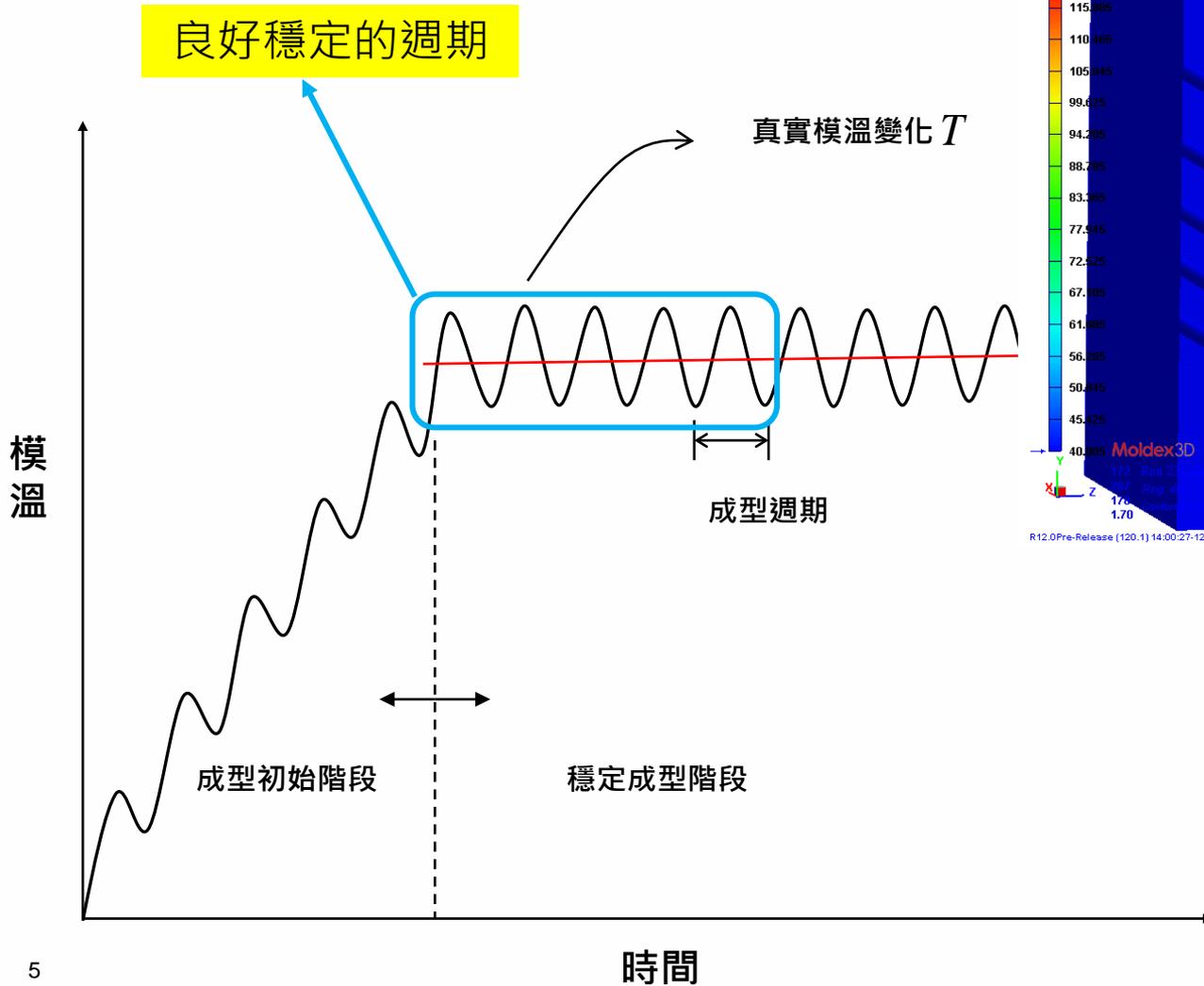


單一成型週期內的模溫變化

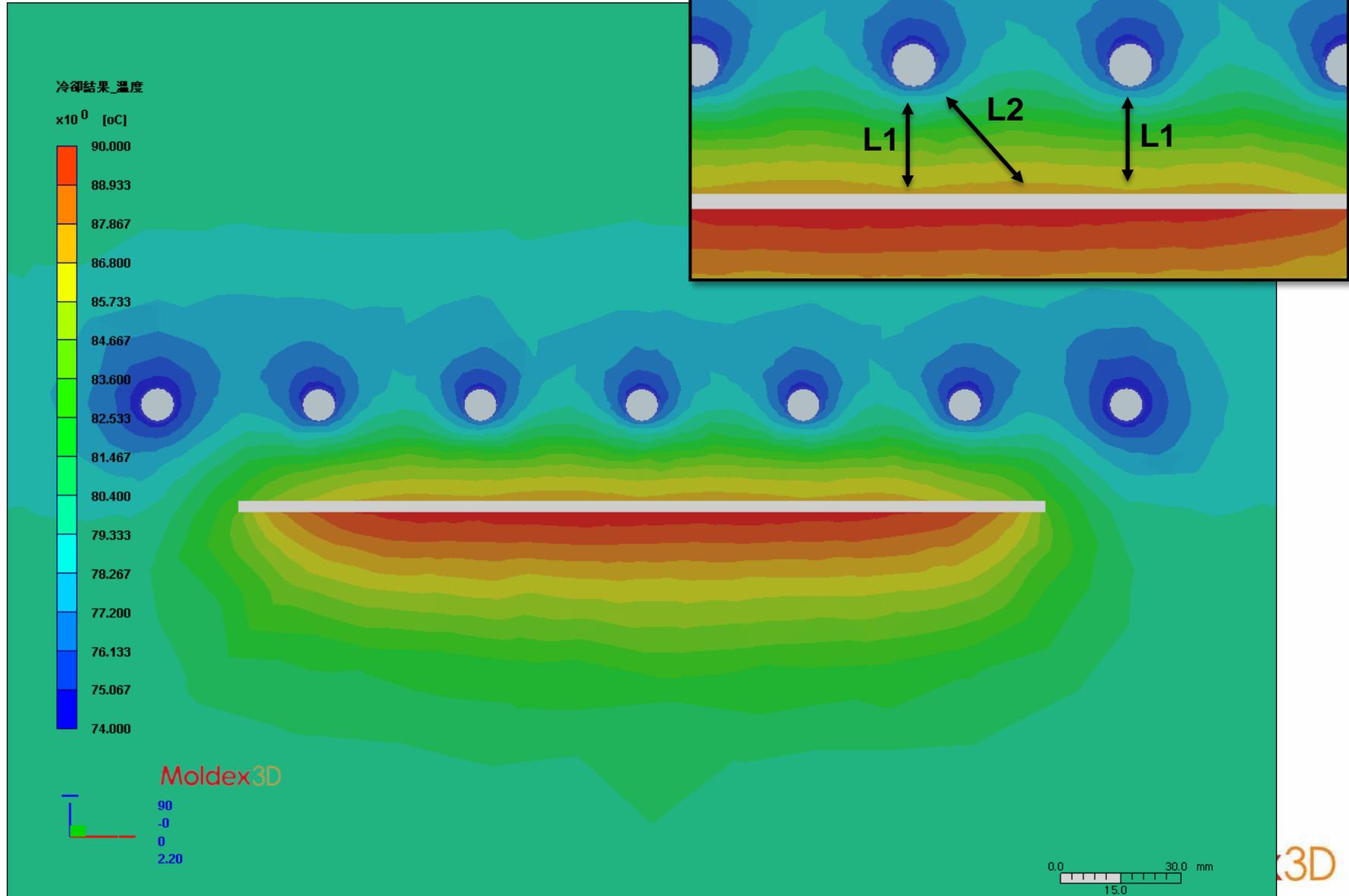
射出成型程式



連續成型週期的模溫變化歷程

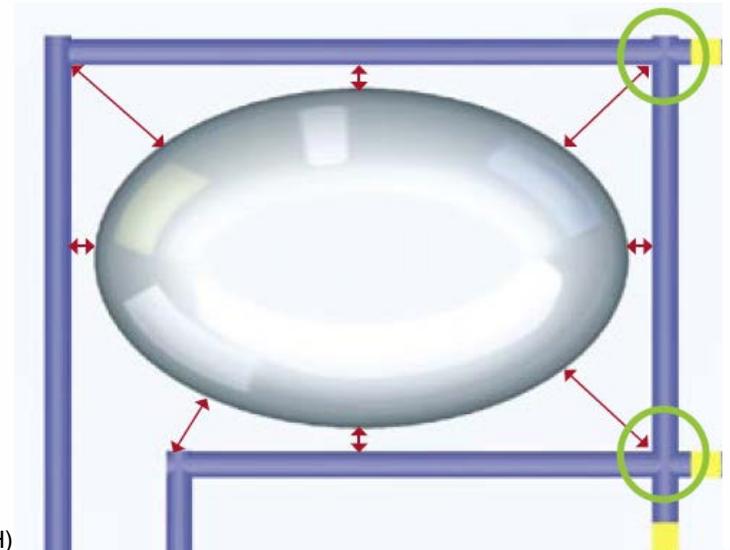


冷卻系統設計概念



異型水路簡介

- > 什麼是異型水路？
 - 依照產品外型所設計的冷卻水路
- > 為何要使用異型水路？
 - 為了增加冷卻效率。使用異型水路時，產品的冷卻率差異可以最小化
 - 為降低成型時間與成本
 - 為了提升產品品質



Source: EOS whitepaper, Siegfried Mayer (EOS GmbH)

異型水路簡介

> 何時使用異型水路?

- 當產品幾何複雜時，有些積熱區傳統水路無法到達，因此無法有效散熱。這時就需要異型水路。

> 如何製造異型水路?

- 傳統的製造方式很難製造異型水路。
- 雷射燒結法
- 真空燒焊法。

異型水路有何優點？

- > 在射出成型過程中使用異型水路可以幫助：
 - 改善產品品質如凹痕及翹曲
 - 降低成型時間
 - 加強積熱區的散熱效率
- > 異型水路設計評估關鍵
 - 產品溫度分布均勻性
 - 冷卻水管壓力損耗
 - 冷卻水路進出口溫差
 - 週期時間
 - 變形改善



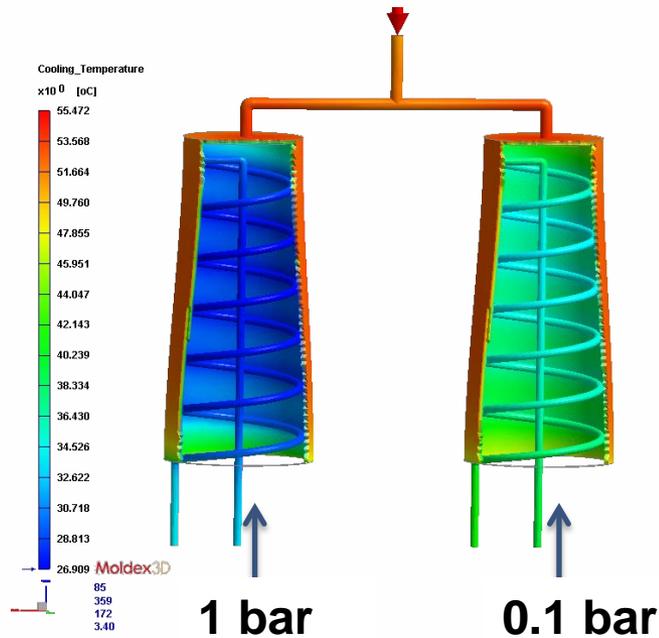
水管壓降設定

- > 可定義壓降為水管邊界設定
- > 輸出所需要的水管流速及壓降於記錄檔內

> 效益

- 估計所需要的模溫機尺寸

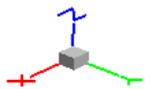
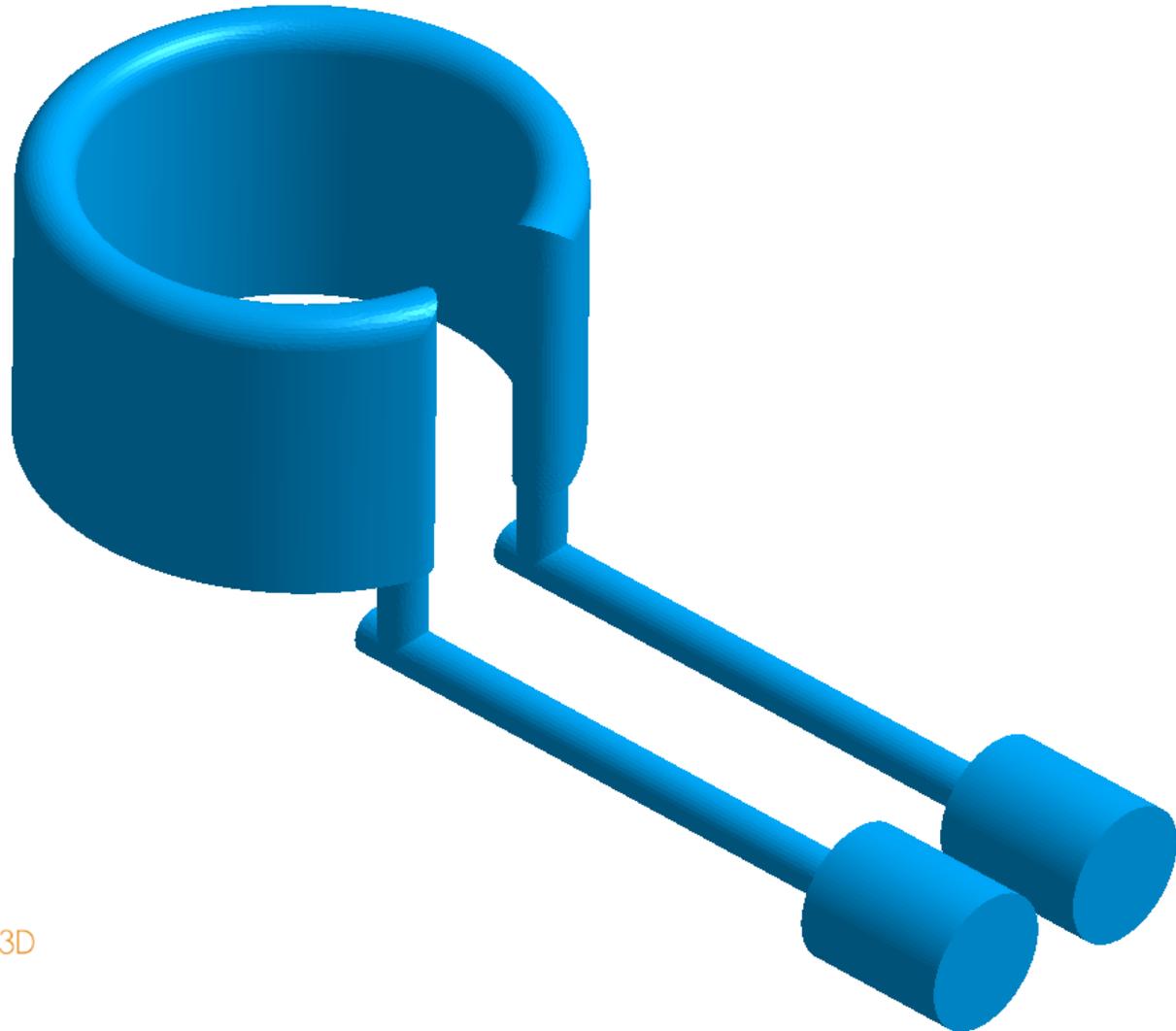
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Coolant Flow Rate      = 1.22e+001 cc/sec
Coolant Pressure       = 1.00e-001 bar
<\Cooling_Channel_1>
<Cooling_Channel_2>
Coolant Flow Rate      = 4.20e+001 cc/sec
Coolant Pressure       = 1.00e+000 bar
<\Cooling_Channel_2>
```



傳統溝槽式水路設計驗證

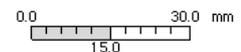
網格模型_實體模型

Coolant-1:Water



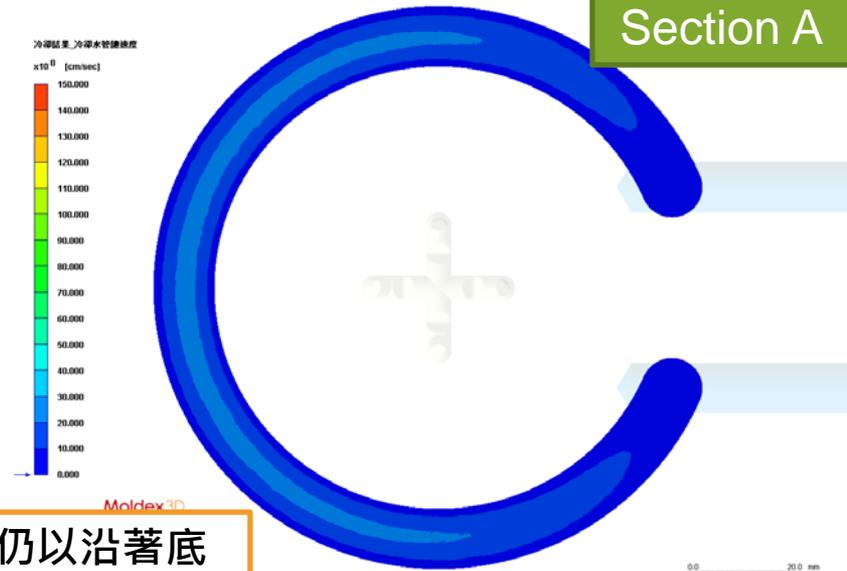
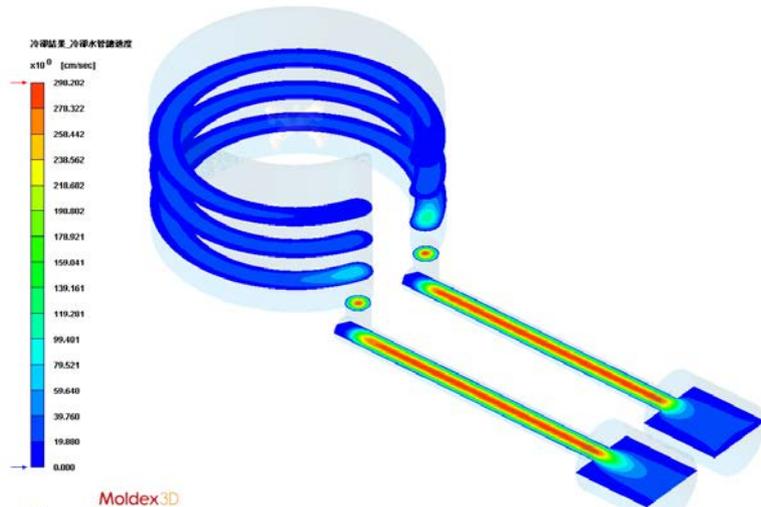
Moldex3D

54
359
133
1.90



Moldex3D

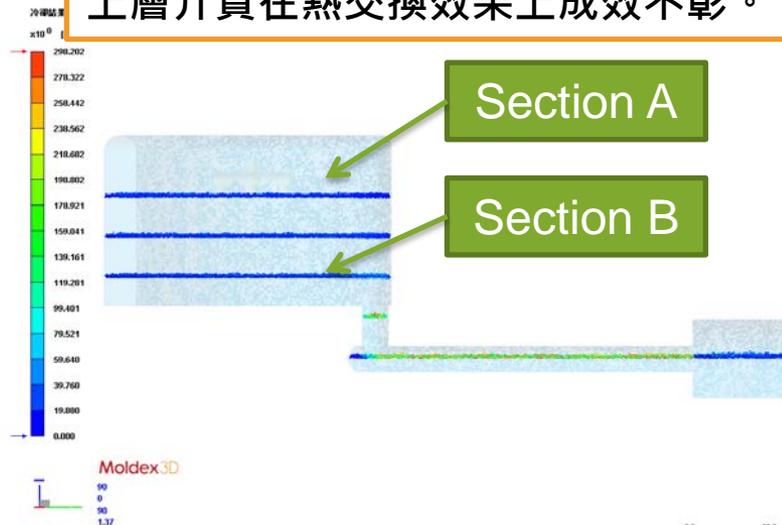
驗證冷卻水路介質流速變化



Moldex3D

Moldex3D

由速度場分布可以發現，水管內介質流動時，仍以沿著底層流動為主，上層介質流速緩慢甚至呈現死水狀態，因此上層介質在熱交換效果上成效不彰。

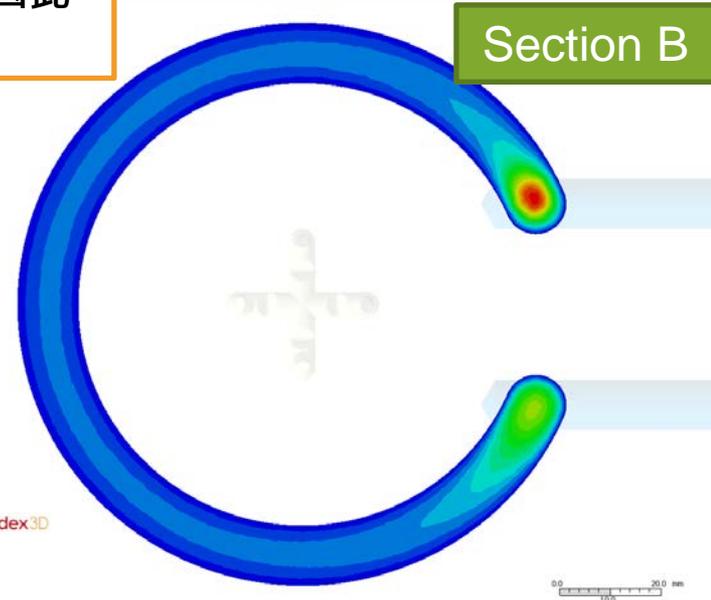


Section A

Section B

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Moldex3D

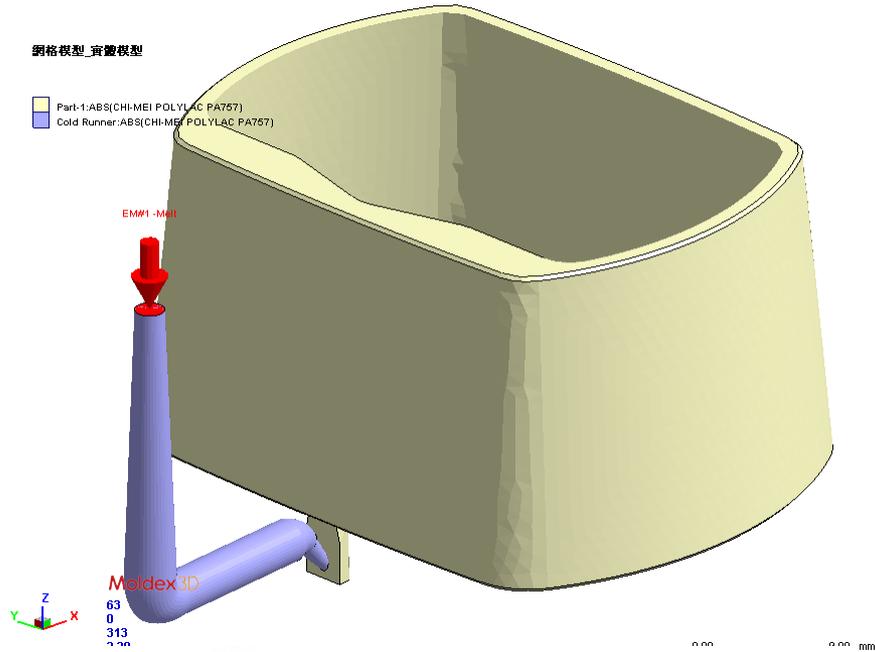


Section B

異型水路實際案例

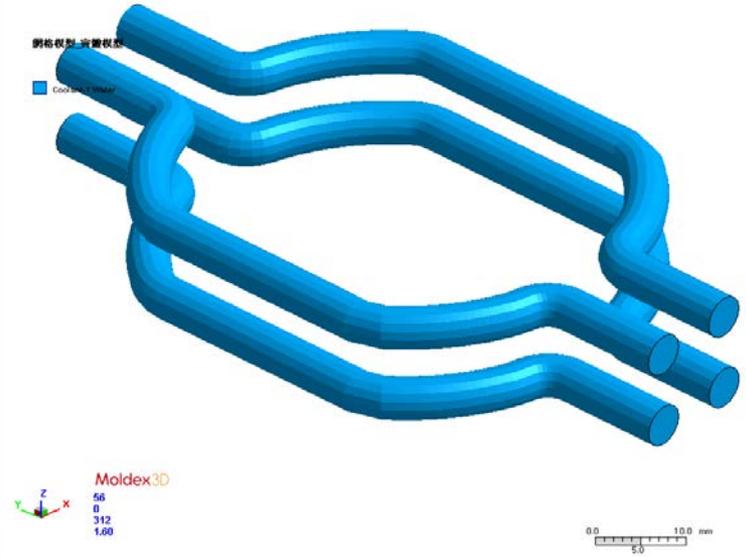
網格模型_實體模型

- Part-1:ABS(CHI-MEI POLYLAC PA757)
- Cold Runner:ABS(CHI-MEI POLYLAC PA757)



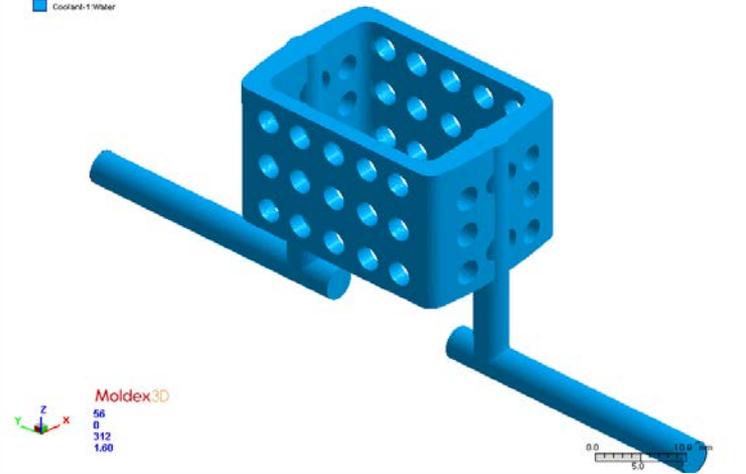
網格模型_實體模型

- Coolant=Water



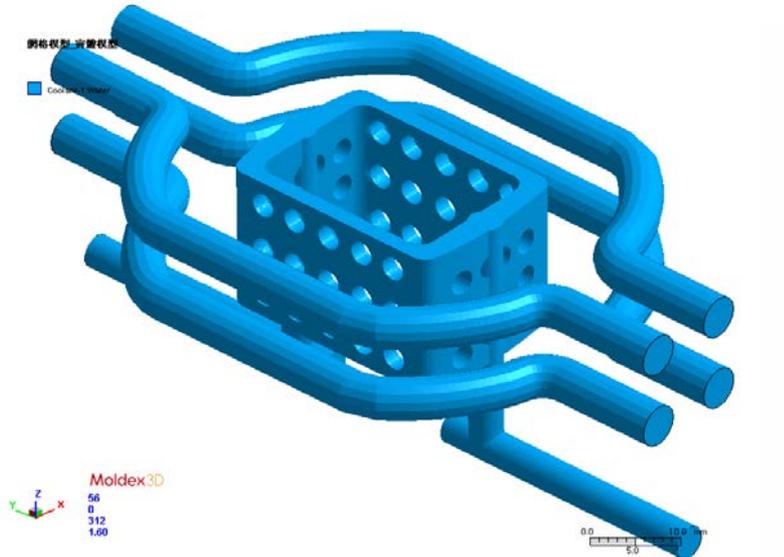
網格模型_實體模型

- Coolant=Water

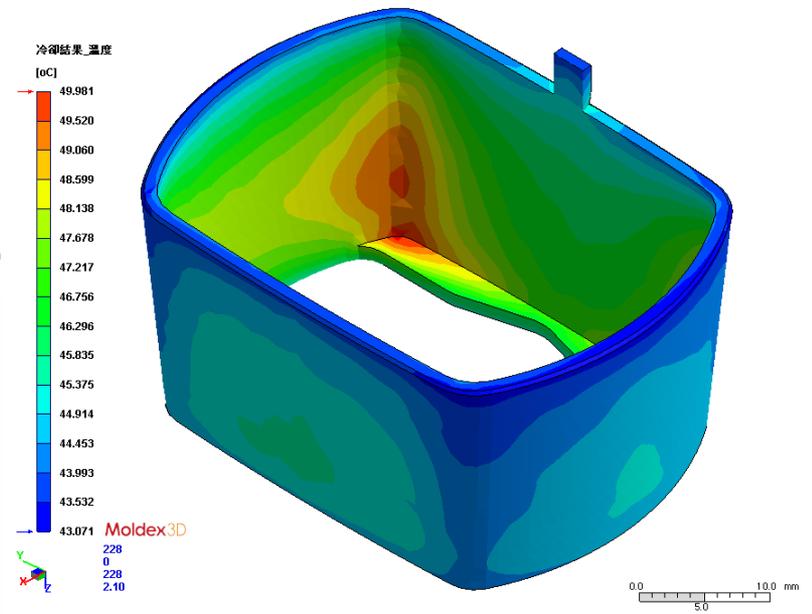
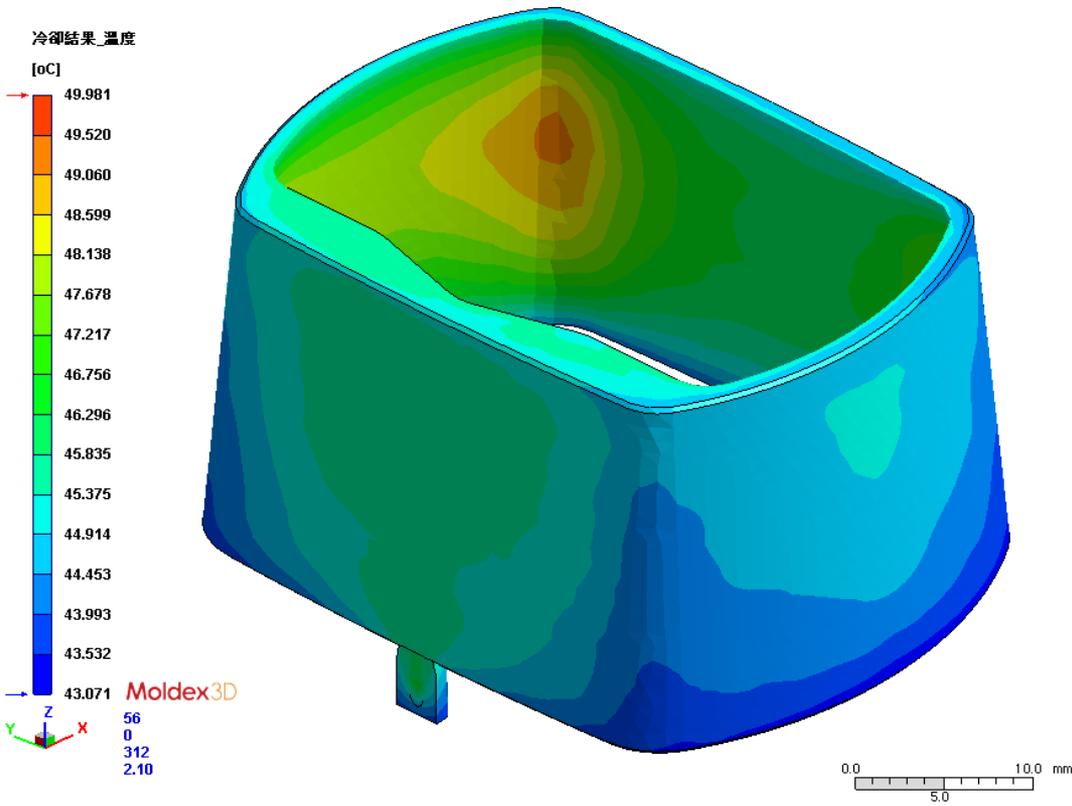


網格模型_實體模型

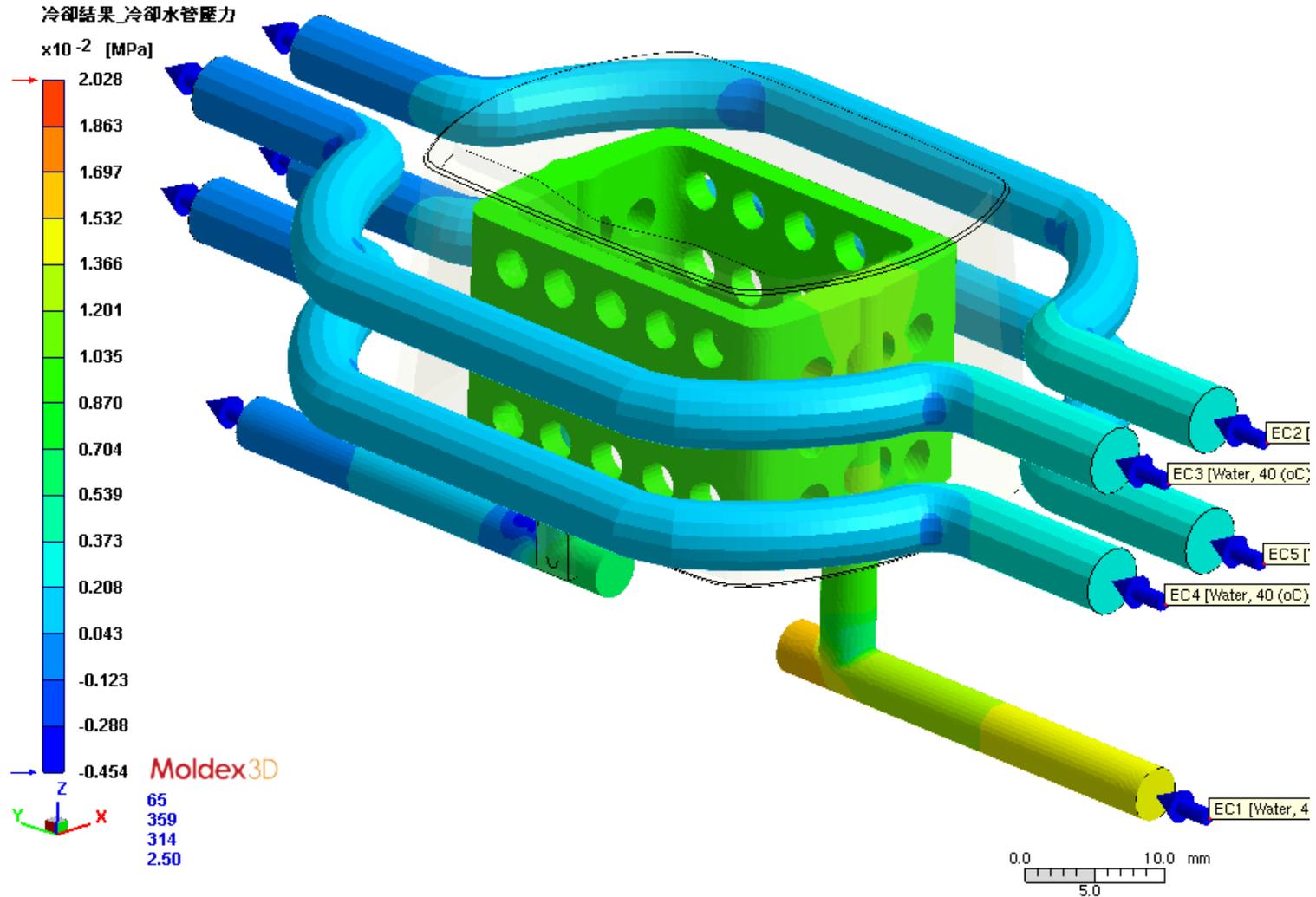
- Coolant=Water



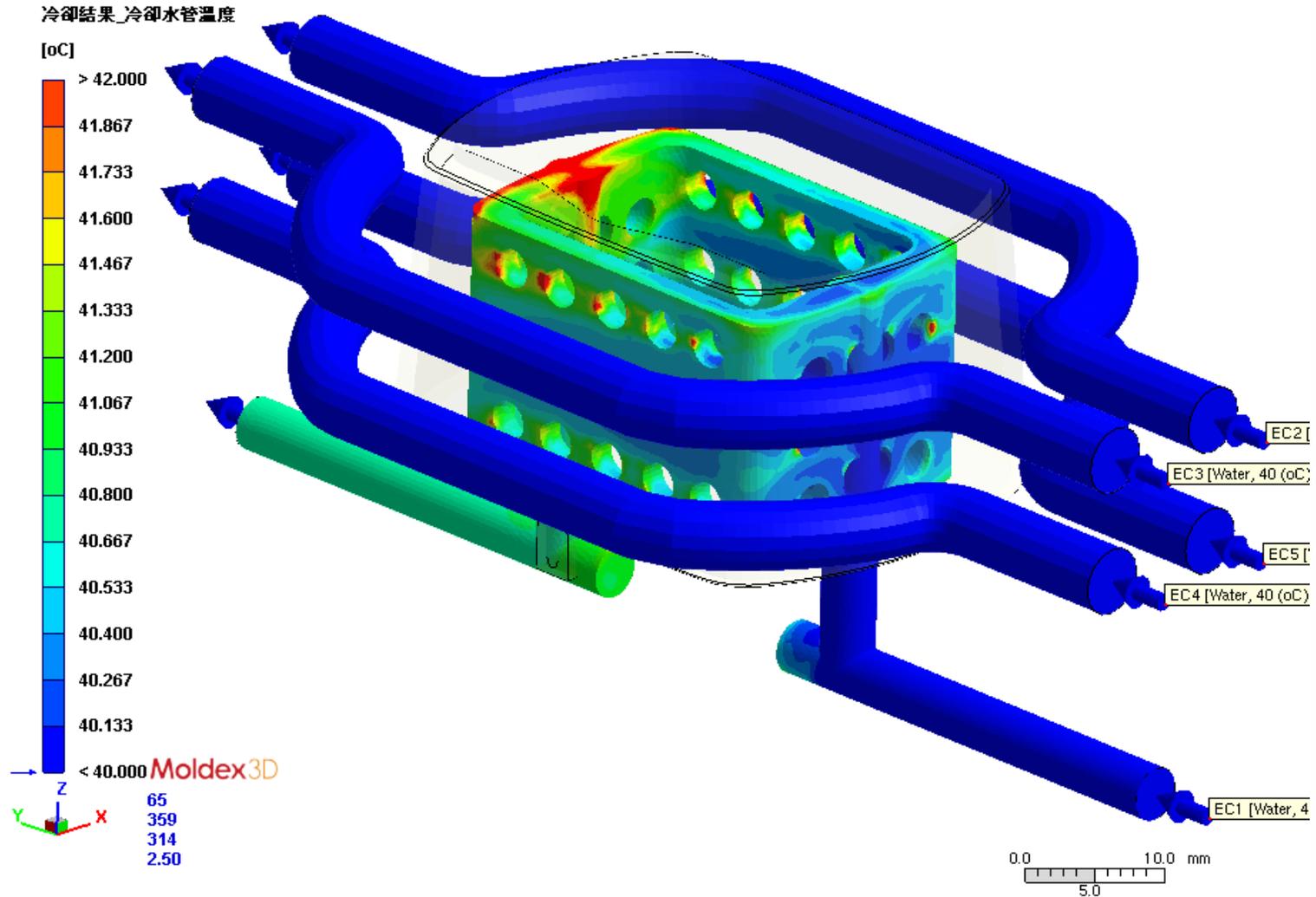
異型水路實際案例



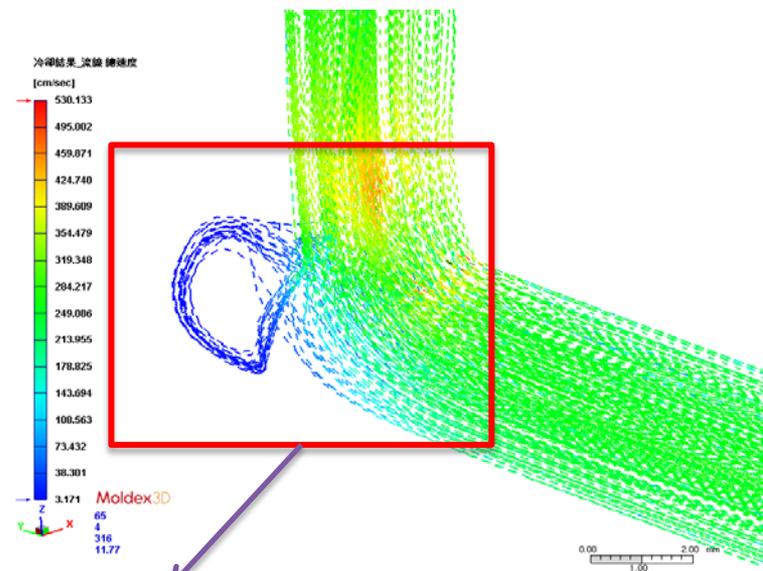
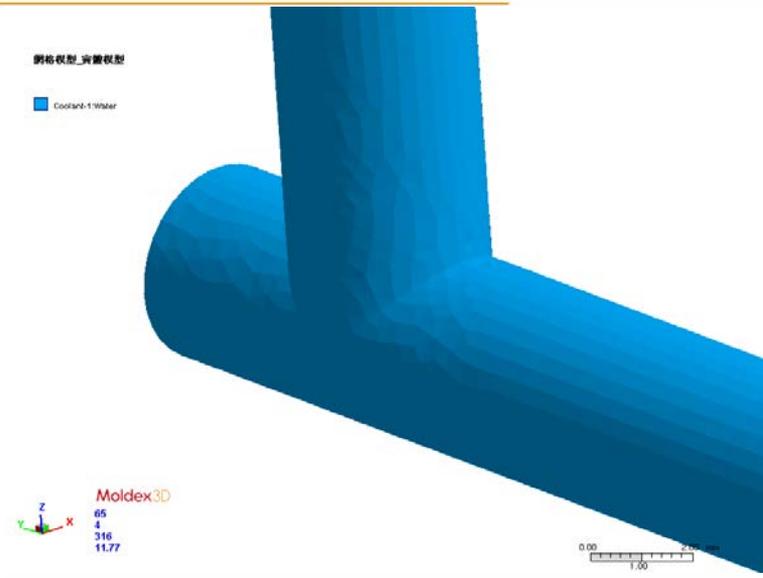
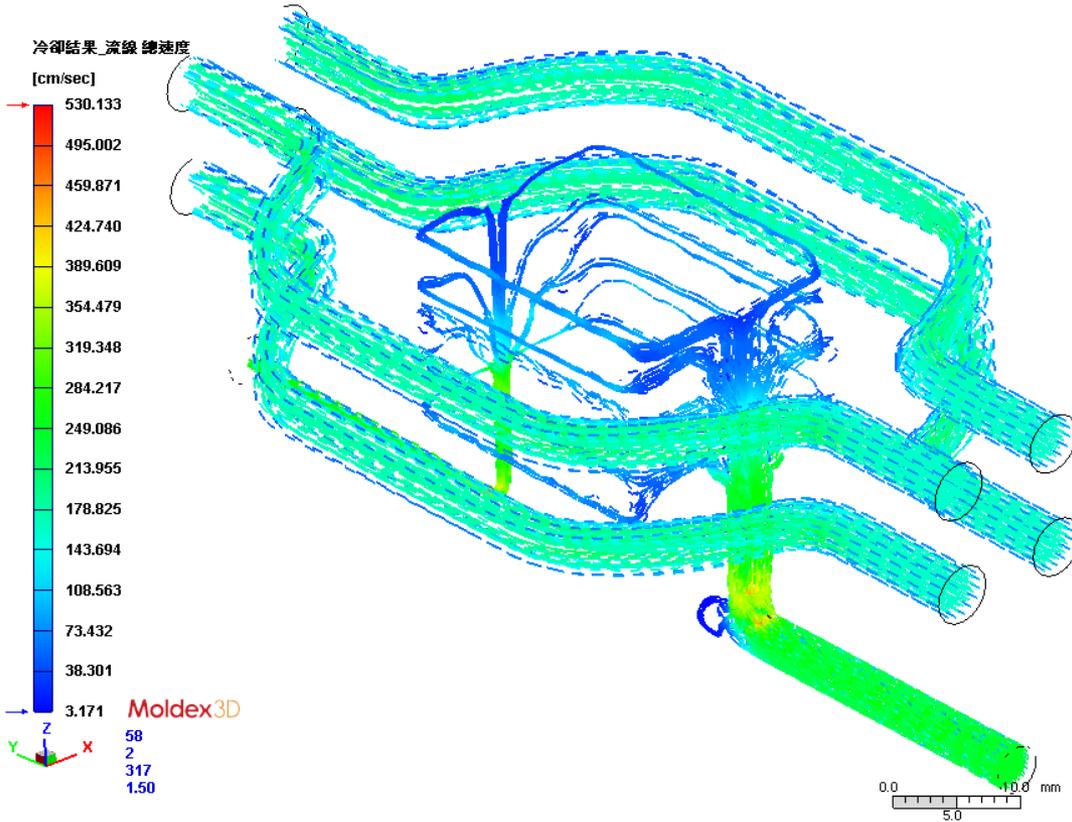
異型水路實際案例



異型水路實際案例



異型水路實際案例

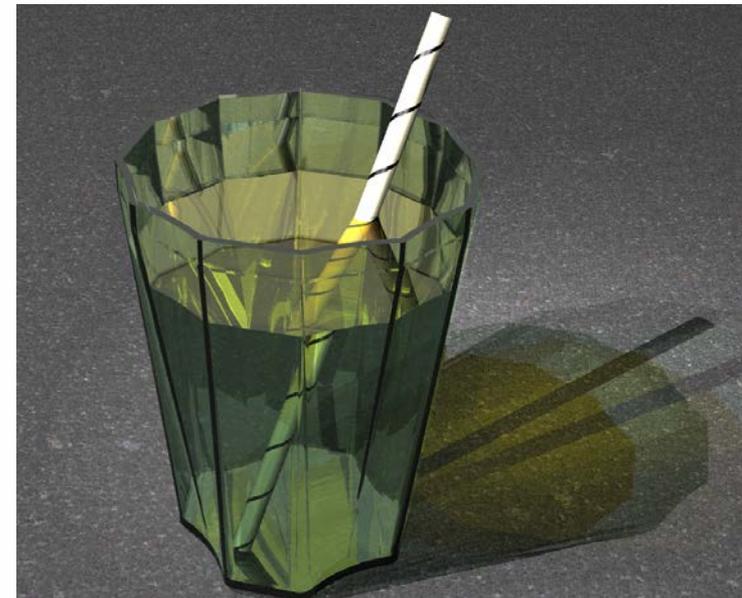
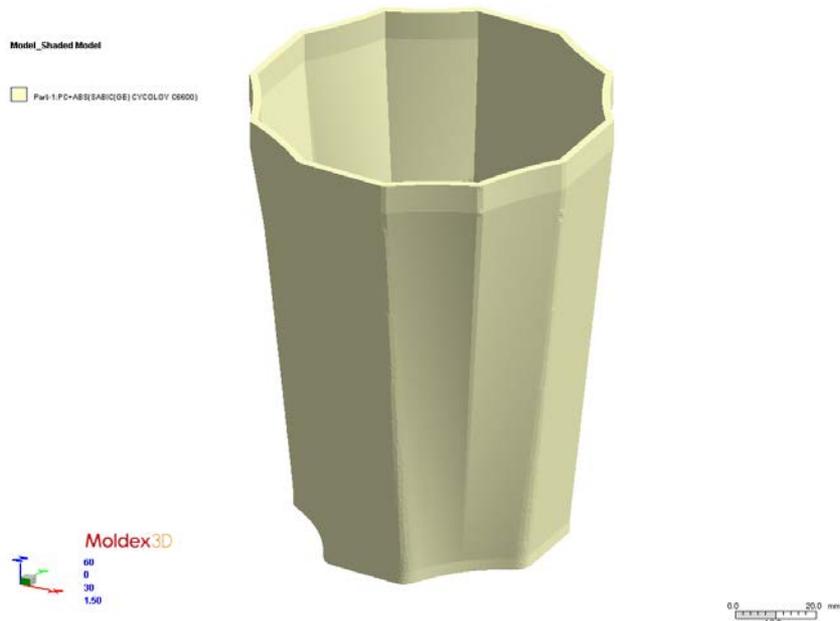
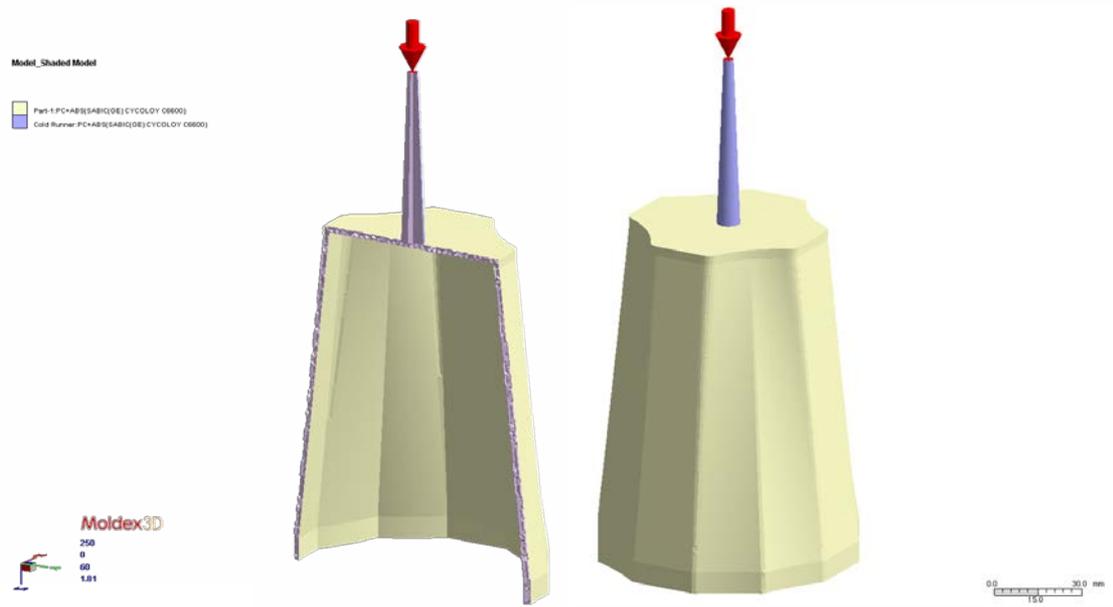


流動死水高風險處

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產品幾何資訊

- 產品長度： 90 mm
- 產品寬度： 90 mm
- 產品高度： 120 mm
- 產品厚度： 2 mm

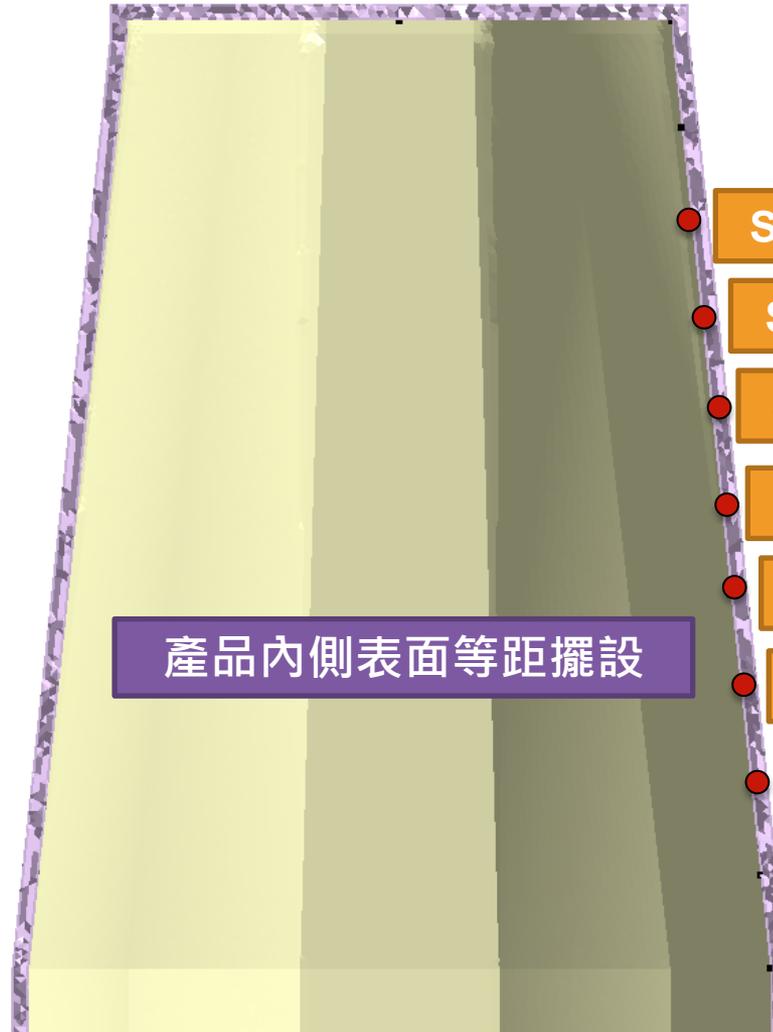


溫度感測節點分布位置

Model_Shaded Model

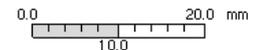
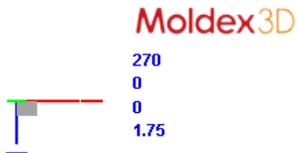
Part-1:PC+ABS(SABIC(GE) CYCOLOY D6600)

Sensor Node



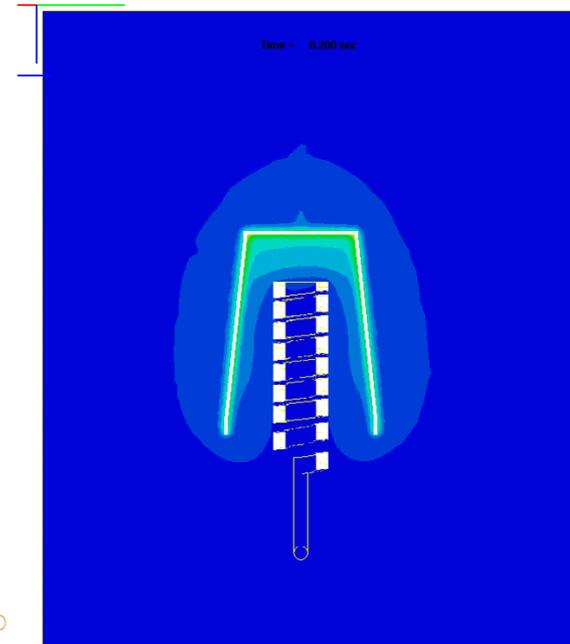
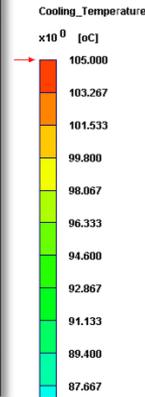
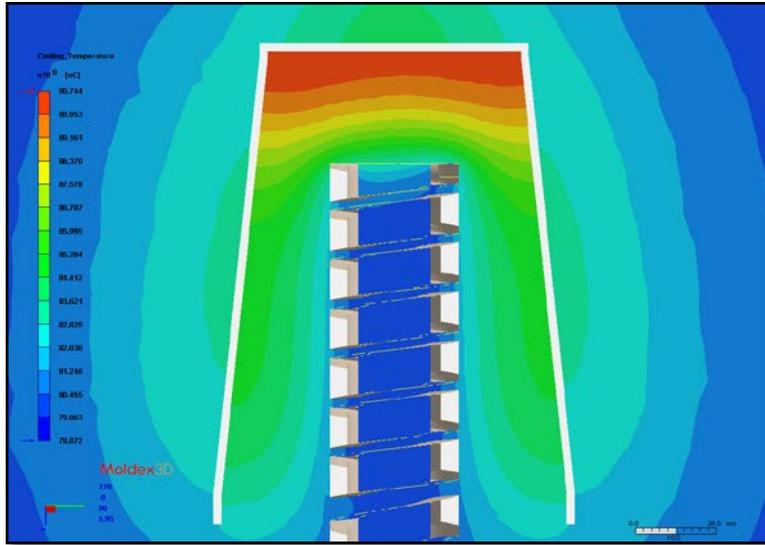
溫度感測節點

產品內側表面等距擺設

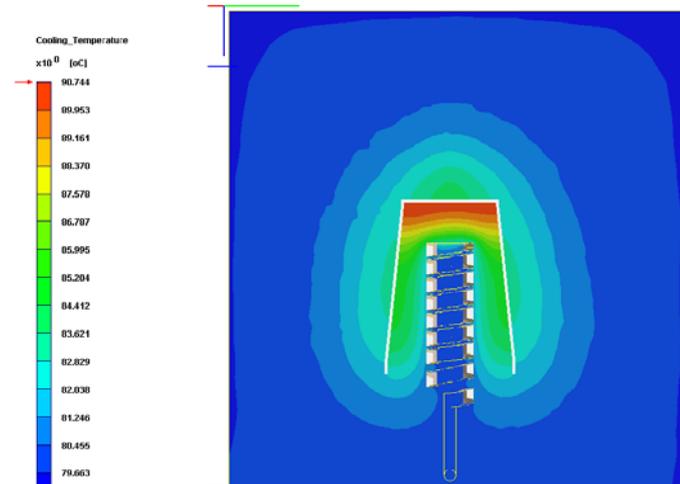


模具溫度剖面動態歷程

週期溫度分布歷程剖面動畫



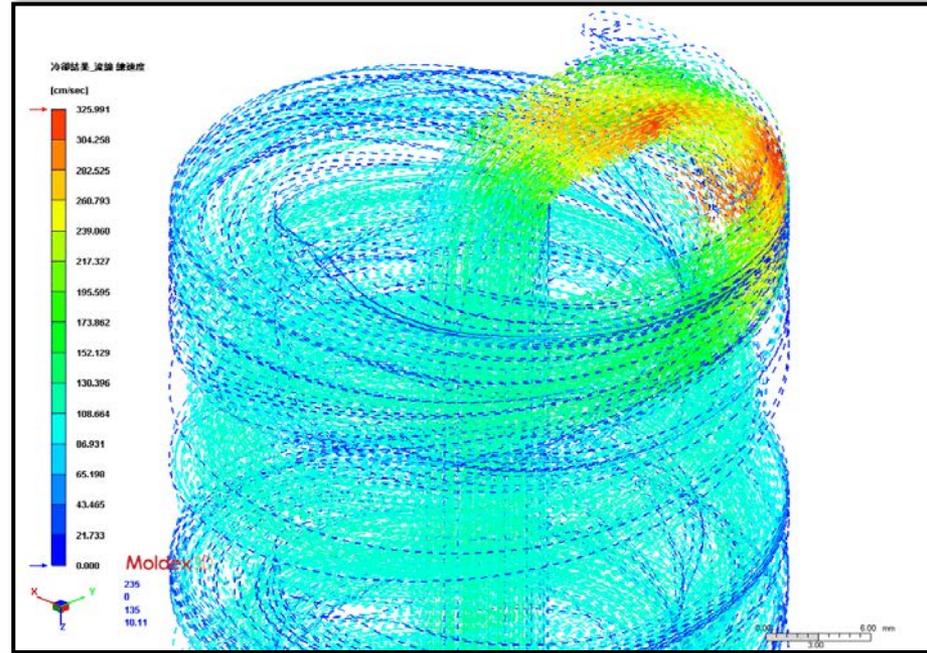
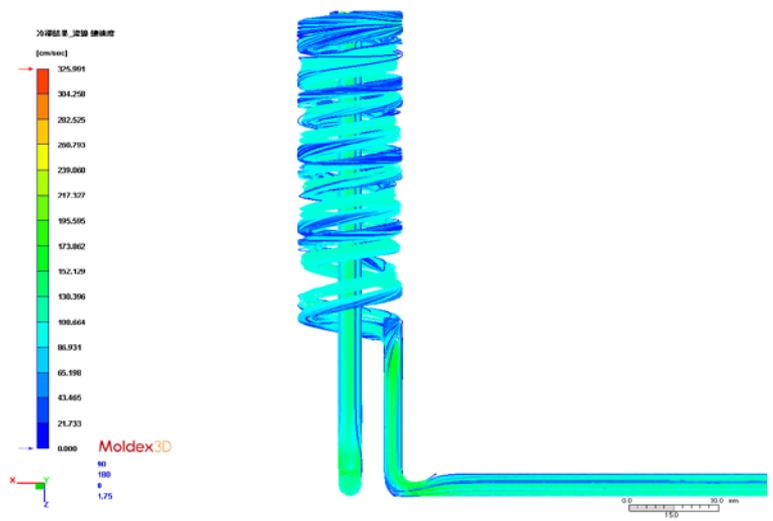
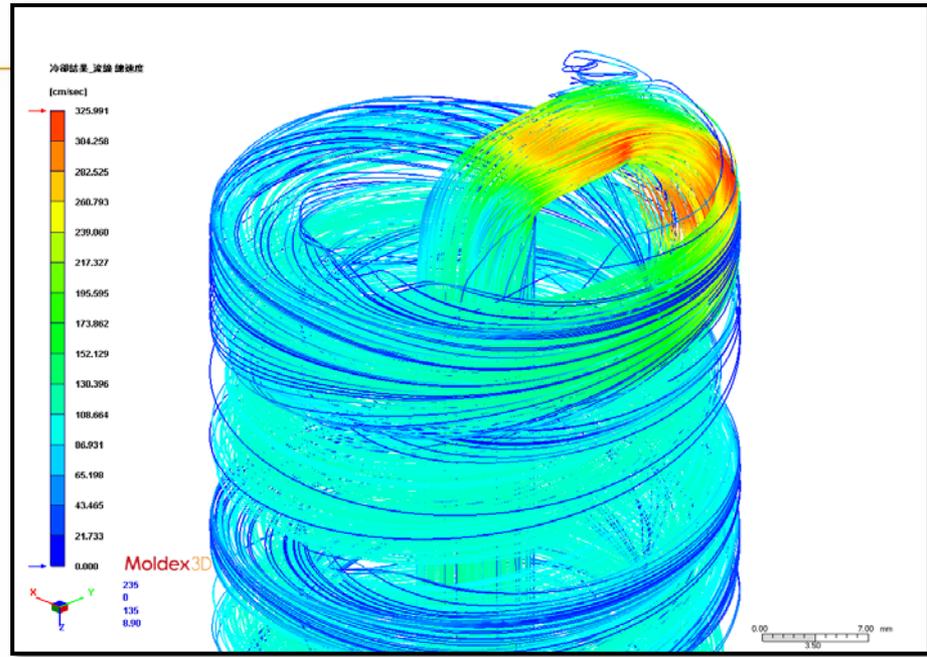
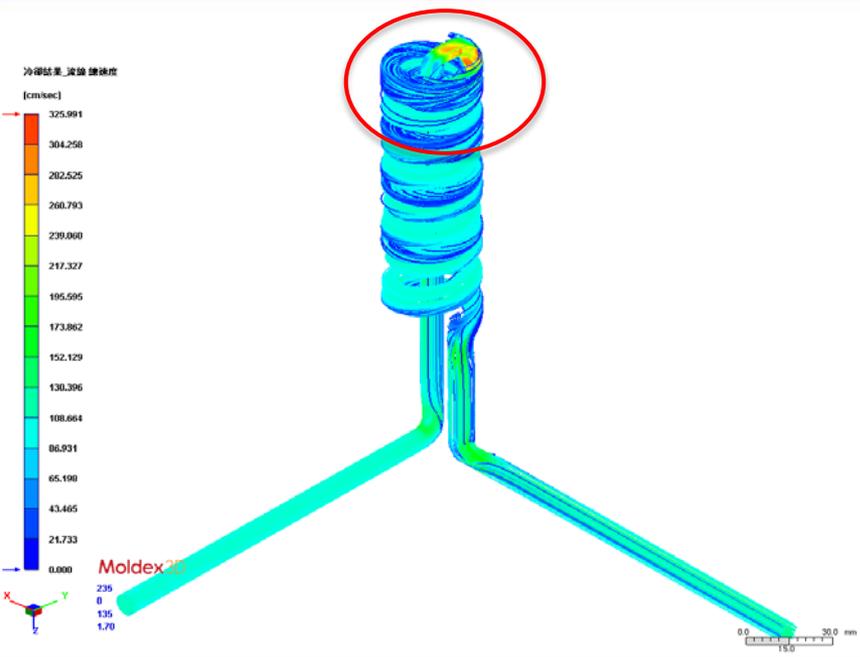
溫度顯示範圍：79~105 °C



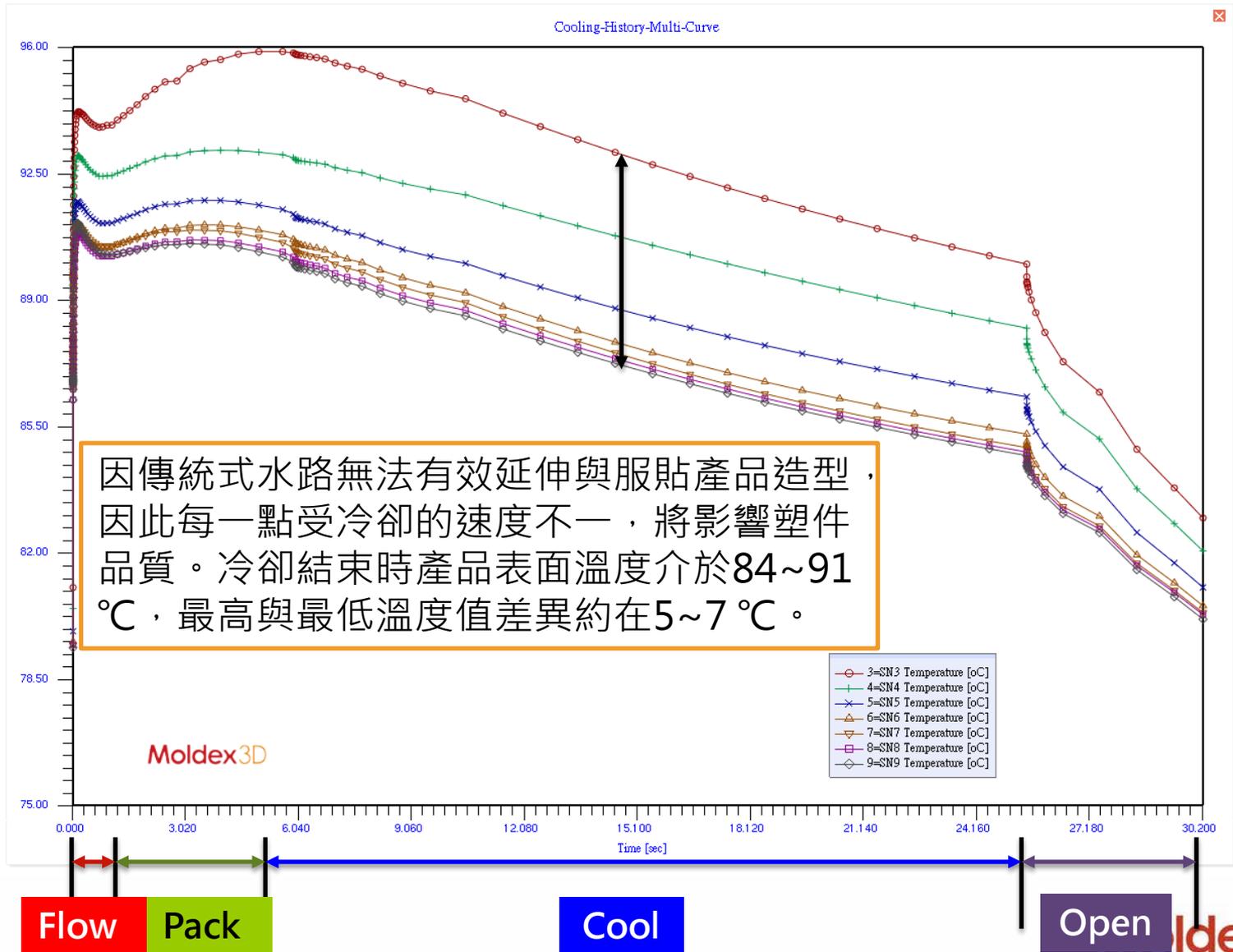
冷卻結束瞬間
模具剖面溫度範圍79~91 °C



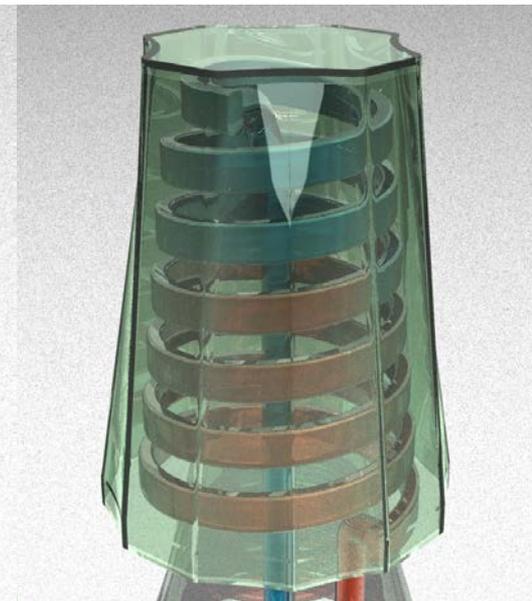
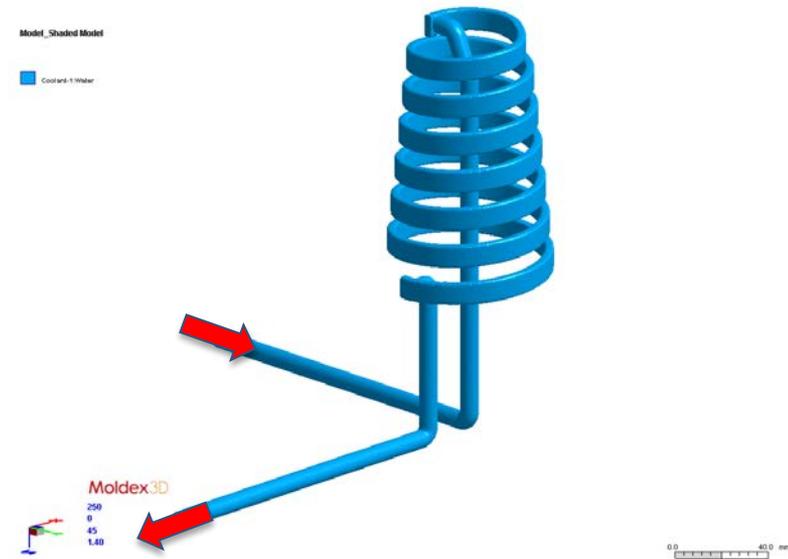
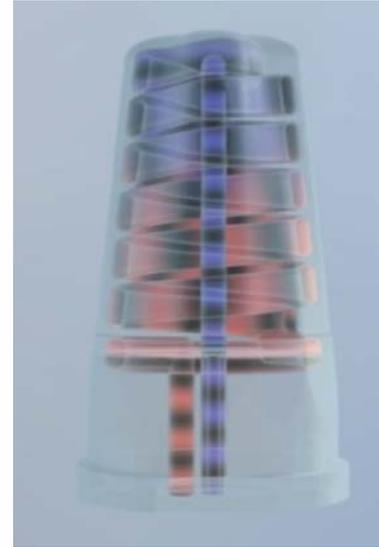
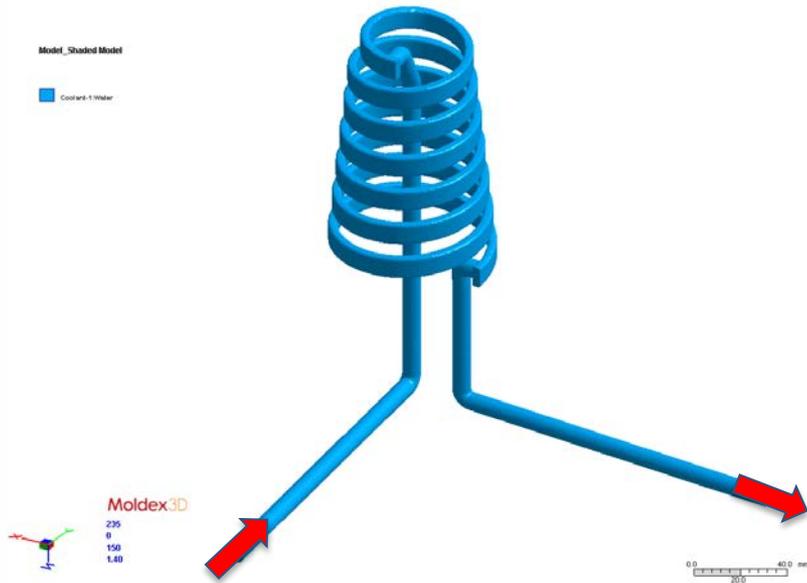
冷卻水路速度場流線分布



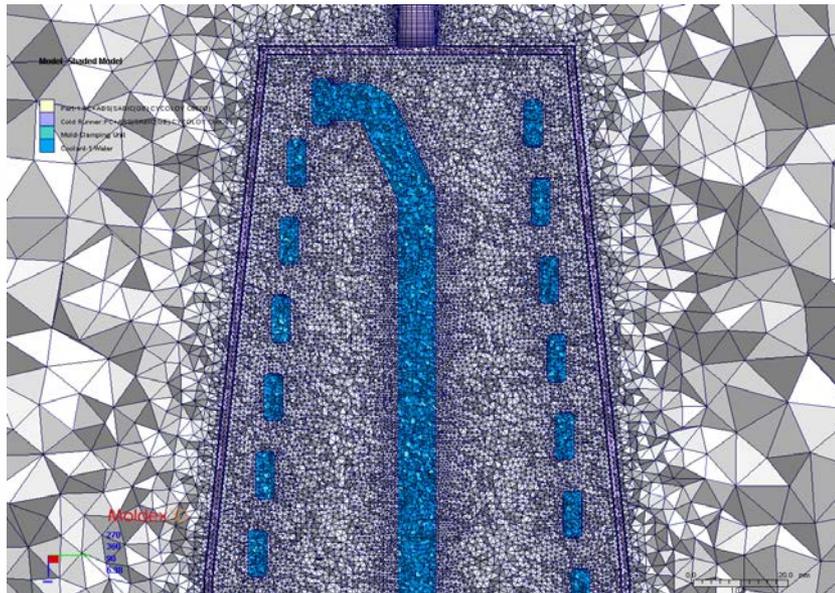
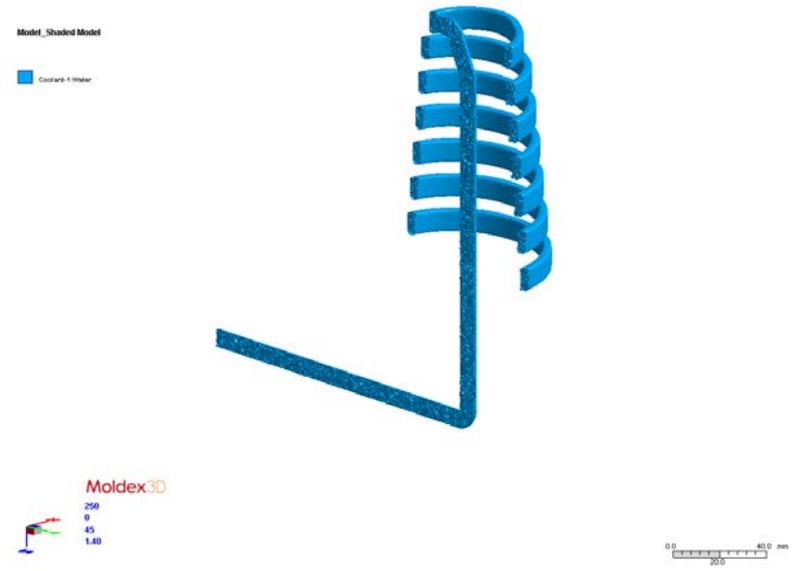
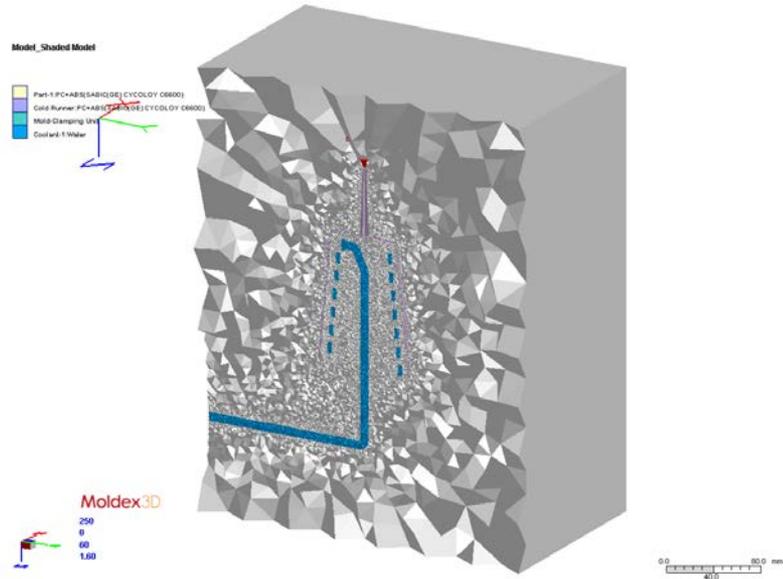
模具表面溫度歷程曲線



異型冷卻水路設計方式

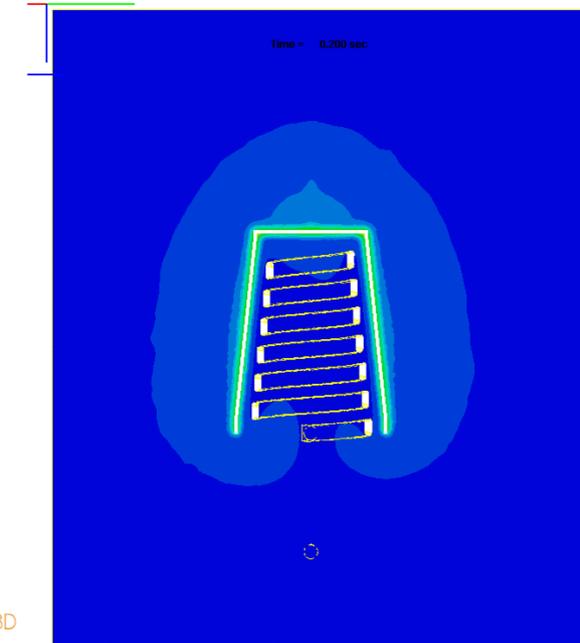
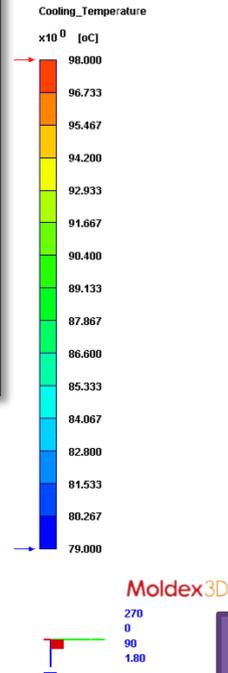
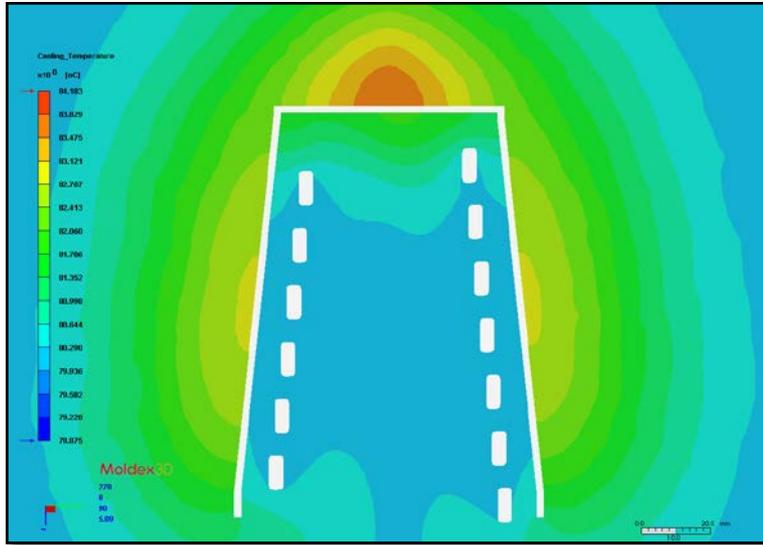


異型冷卻水路設計方式

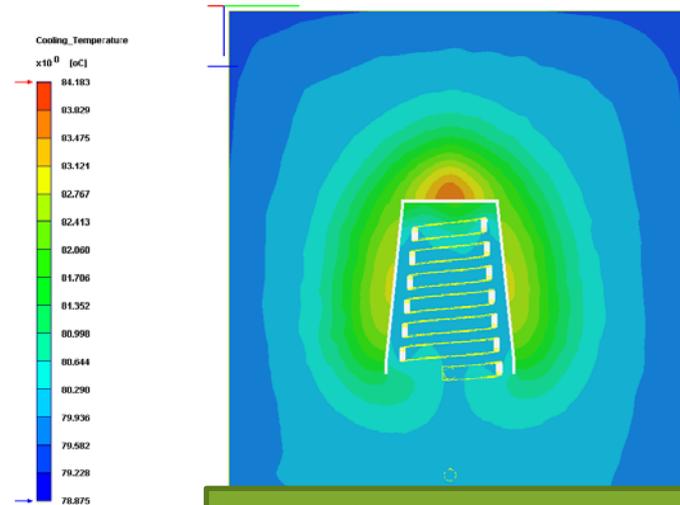
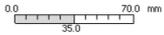


模具溫度分布

週期溫度分布歷程剖面動畫

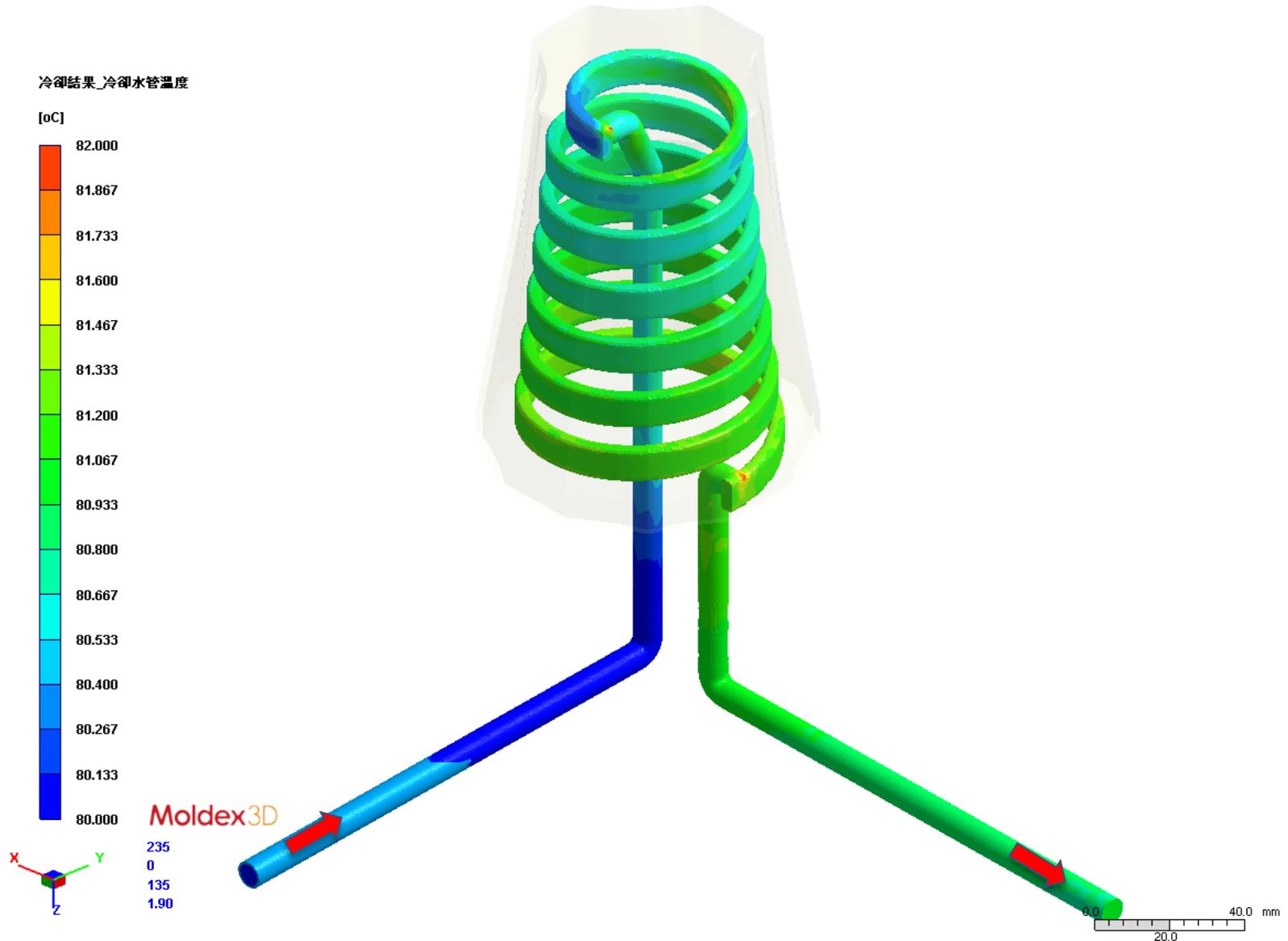


溫度顯示範圍：79~98 °C

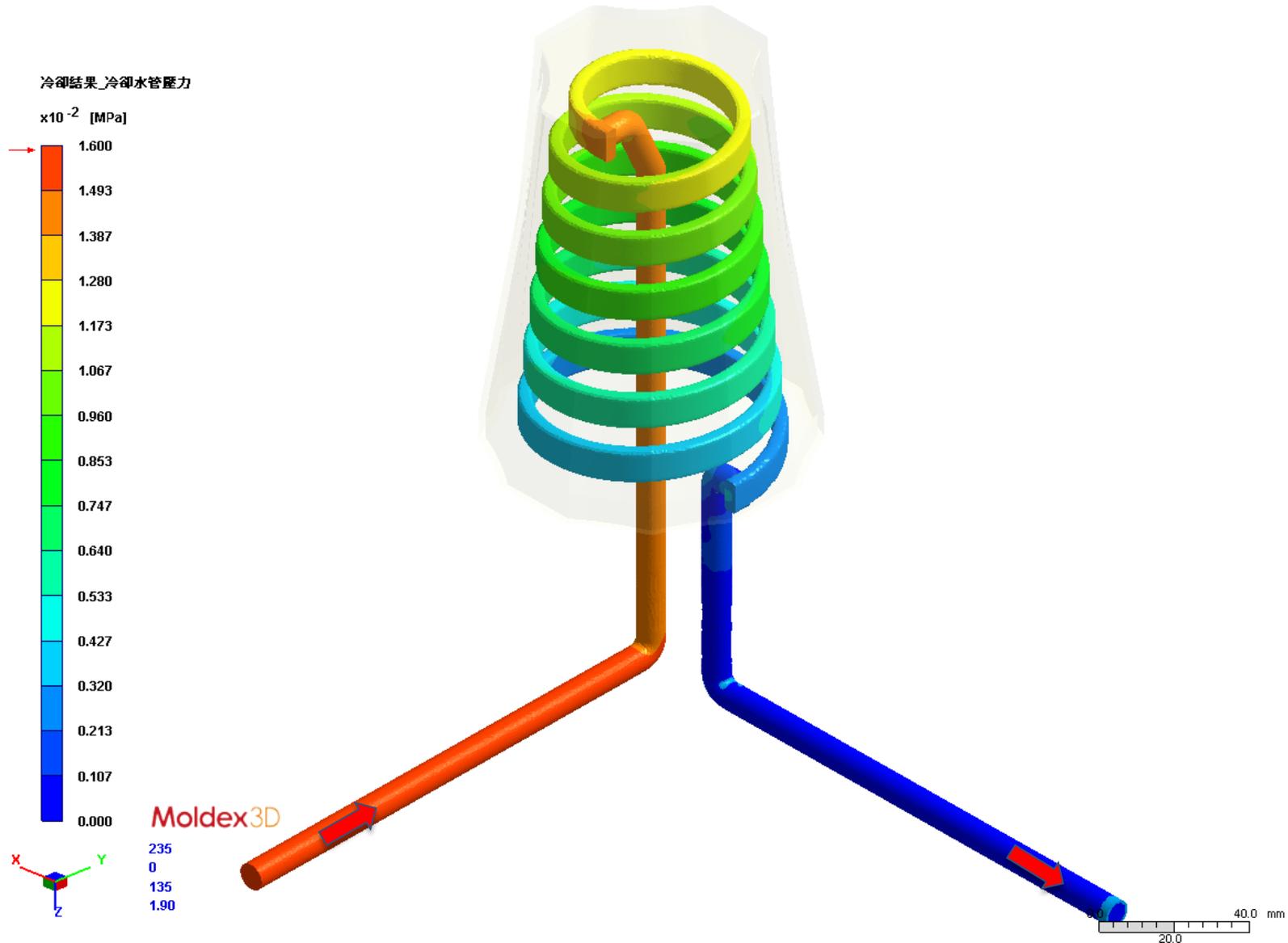


冷卻結束瞬間
模具剖面溫度範圍79~84 °C

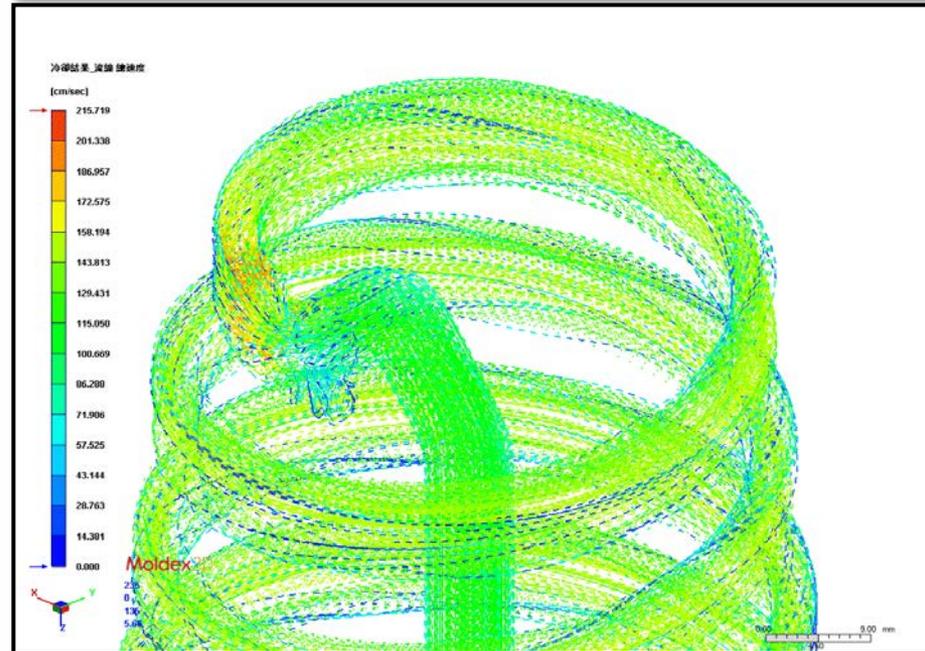
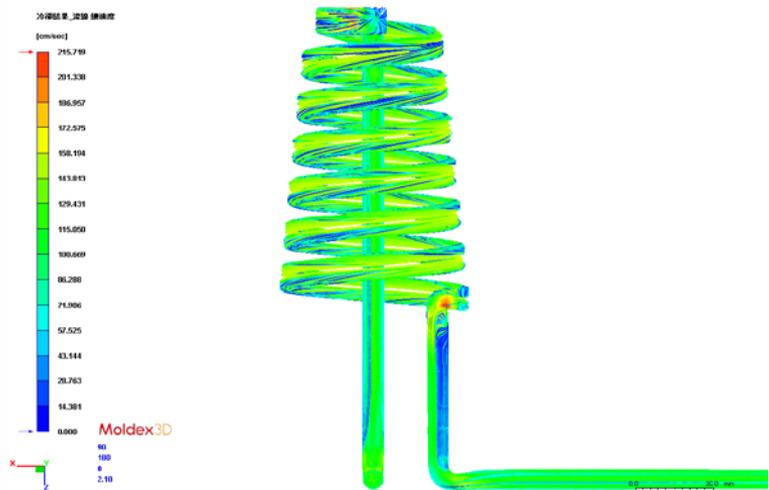
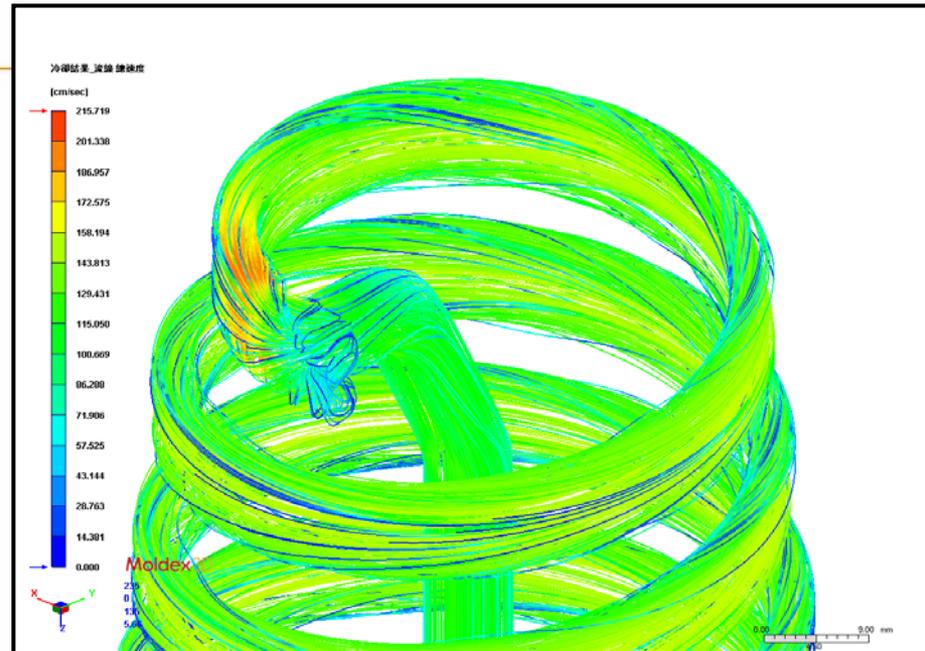
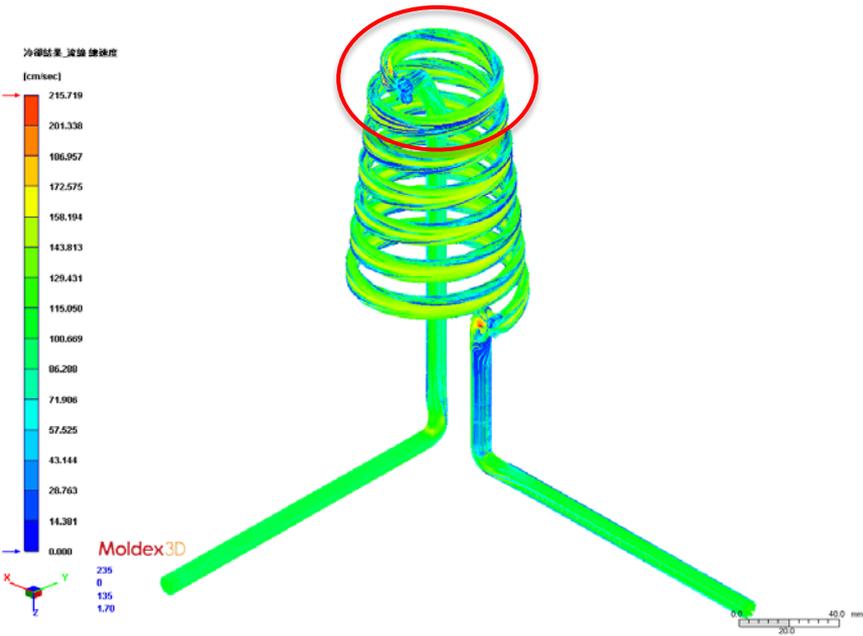
冷卻水路溫度分布



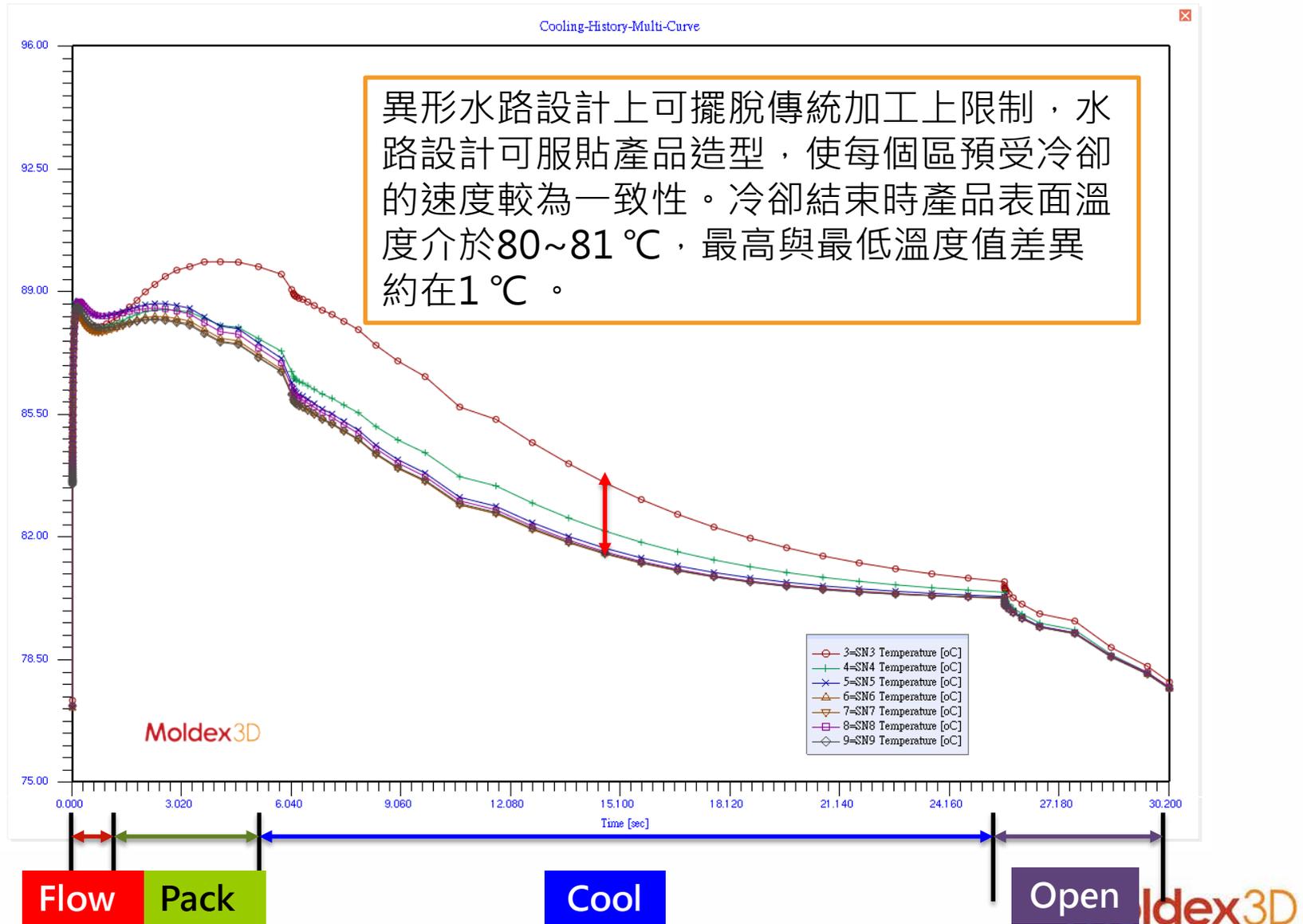
冷卻水路壓力分布



冷卻水路速度場流線分布



模具表面溫度歷程曲線

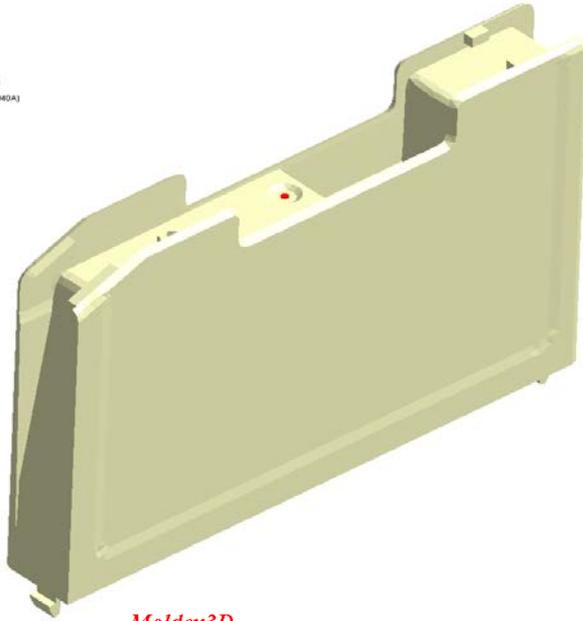


Conformal Cooling Example

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剖视图_背视图

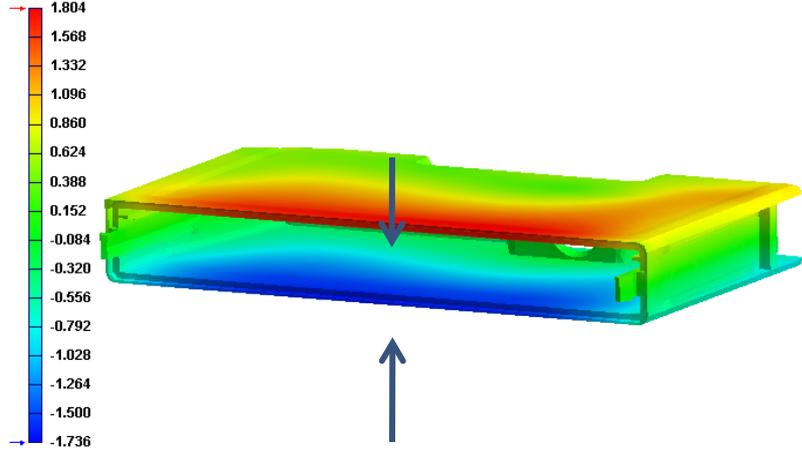
Part 1.PQ(SABIC)(SE)LEXAN 840A
Hot Runner.PQ(SABIC)(SE)LEXAN 940A



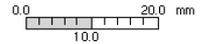
Moldex3D

Warpage_Z-Displacement

$\times 10^{-1}$ [mm]



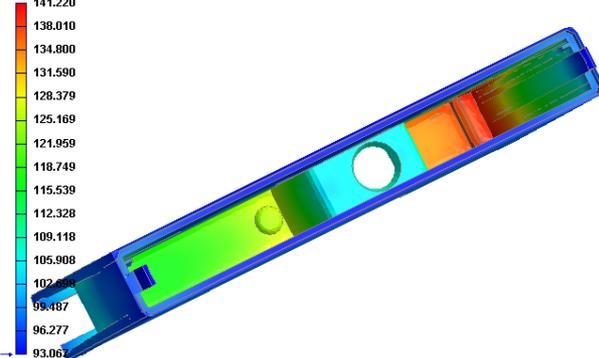
259
359
153
1.80



Moldex3D

Cooling_Temperature

$\times 10^0$ [°C]



271
333
199
2.00

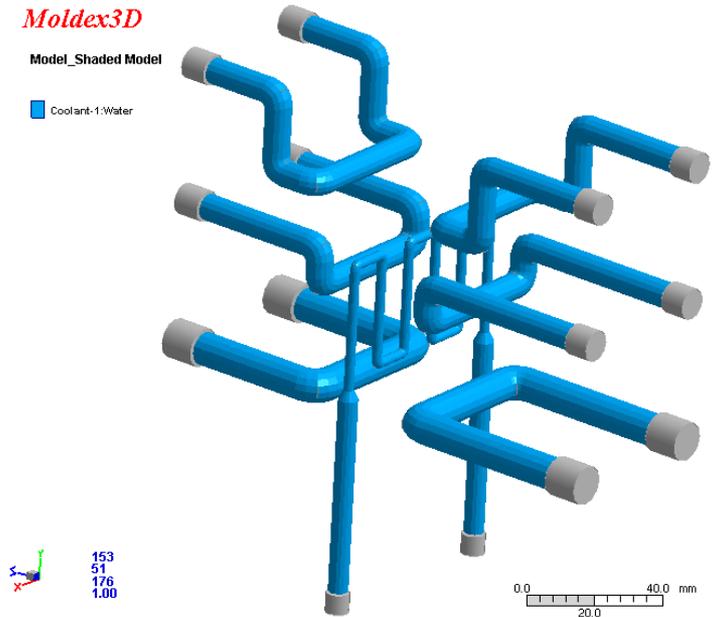
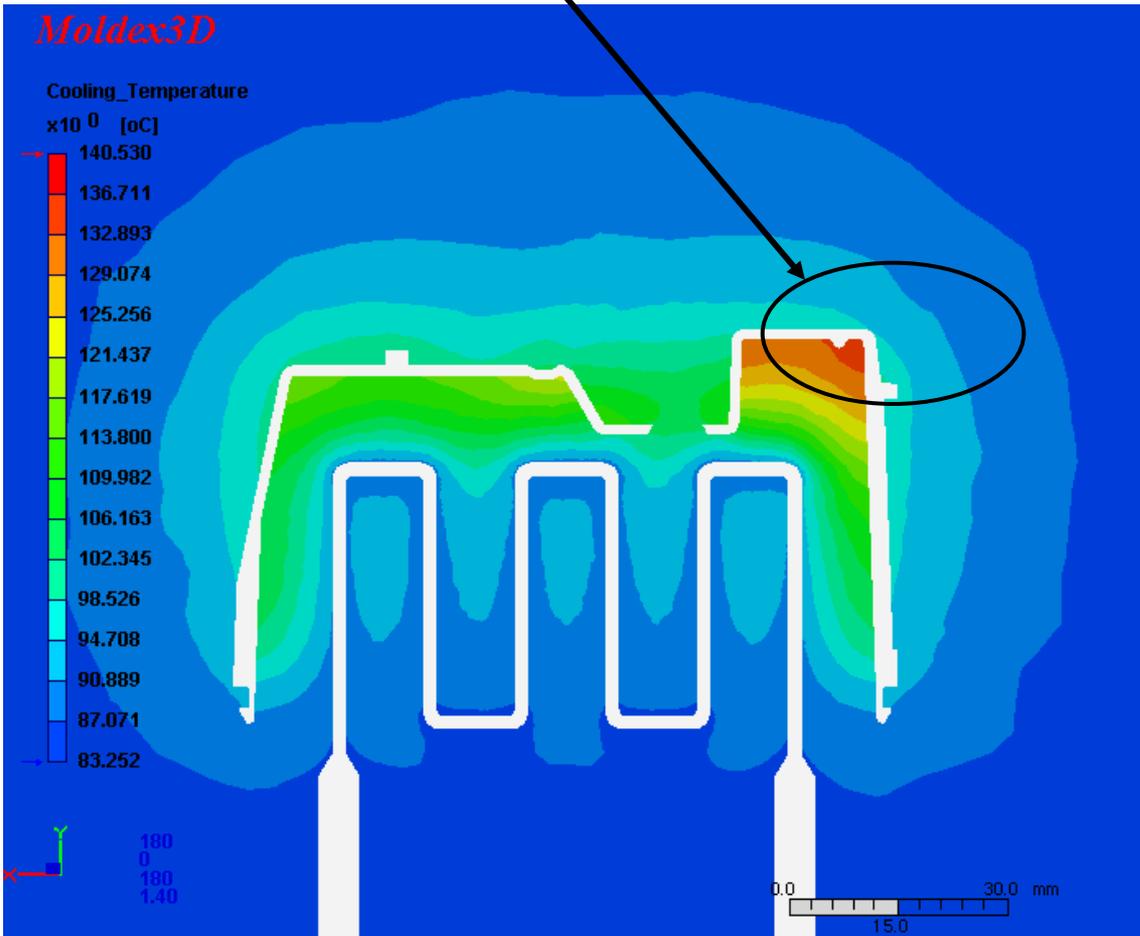


Moldex3D

Mould Cooling Temperature

Mould temperature rising in core

Local temperature rise to 140oC

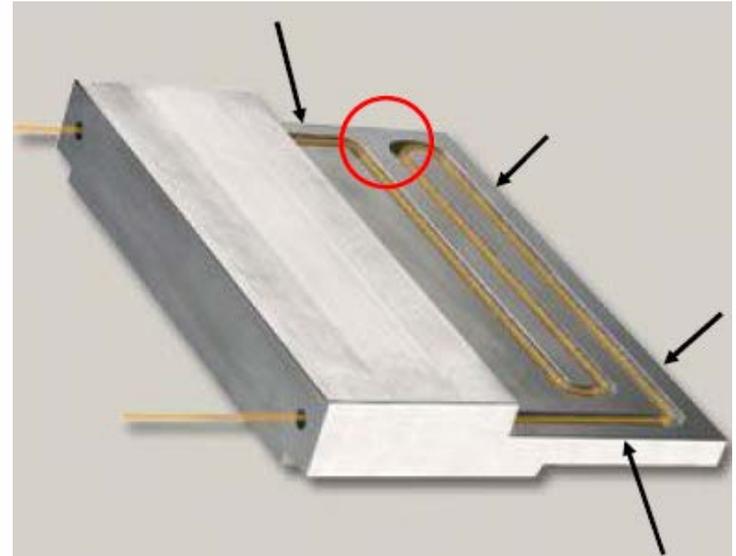


Mold temperature – 90oC

Moldex3D

Conformal Cooling Example

Conformal cooling (順形冷卻) 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.



Mould Cooling Temperature

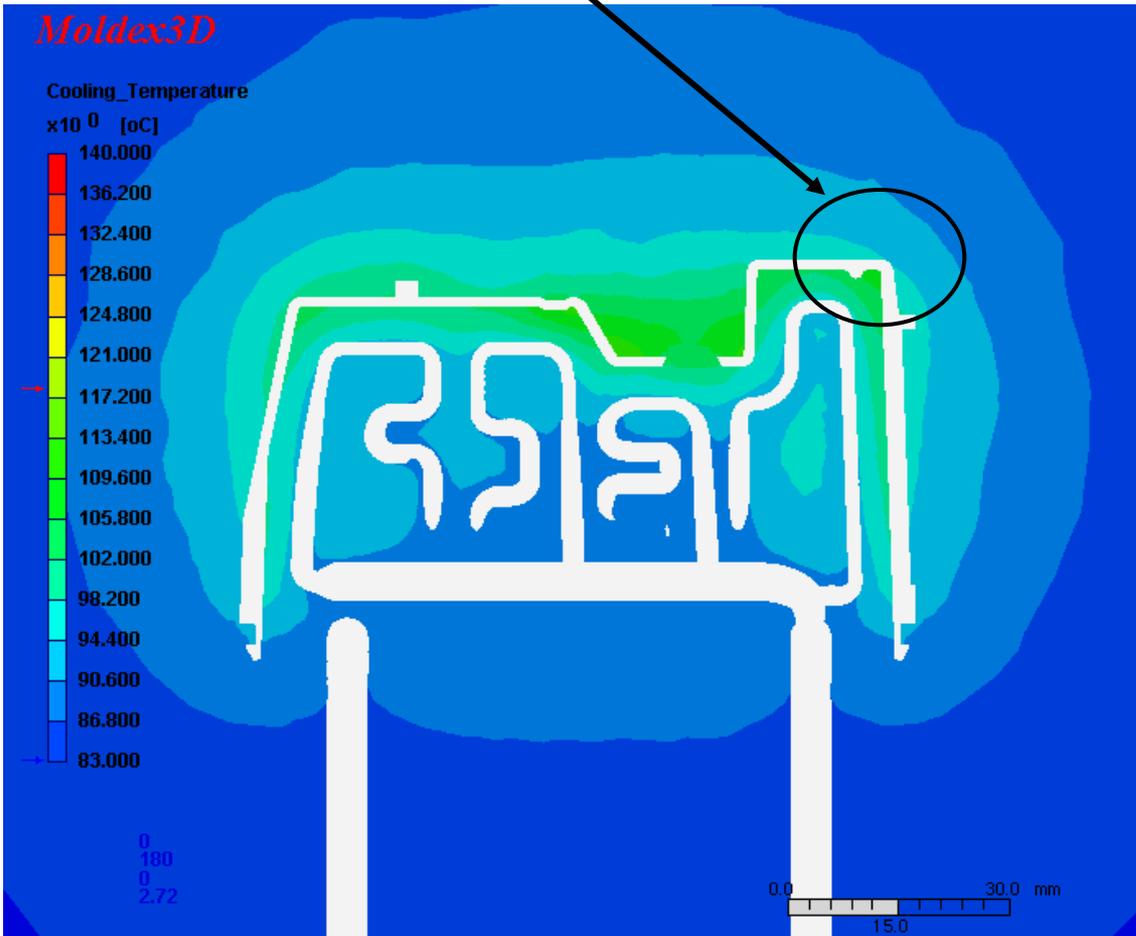
Improved performance verified using Moldex3D

Local temperature drop to 105oC

Moldex3D

Cooling_Temperature

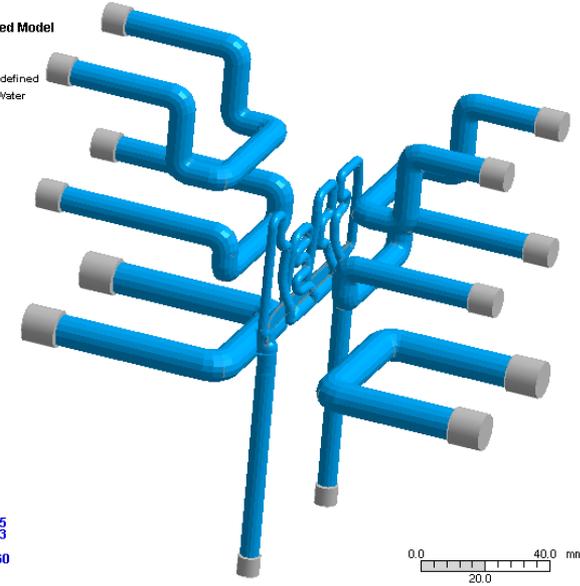
$\times 10^0$ [oC]



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Model_Shaded Model

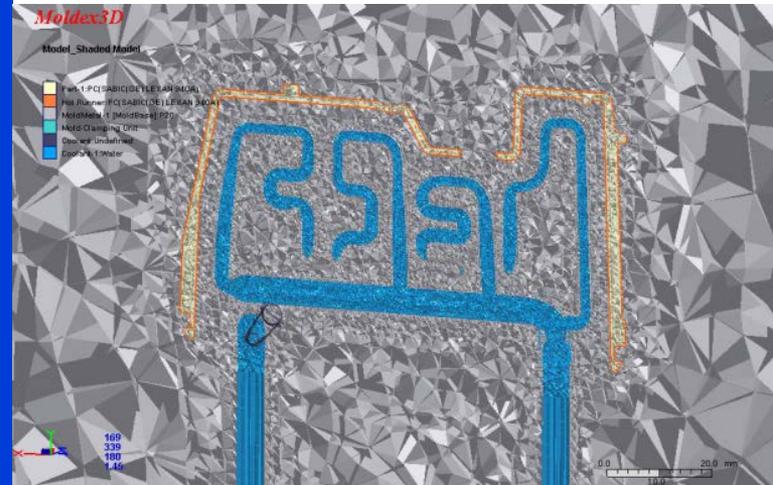
Coolant: Undefined
Coolant-1: Water



Moldex3D

Model_Shaded Model

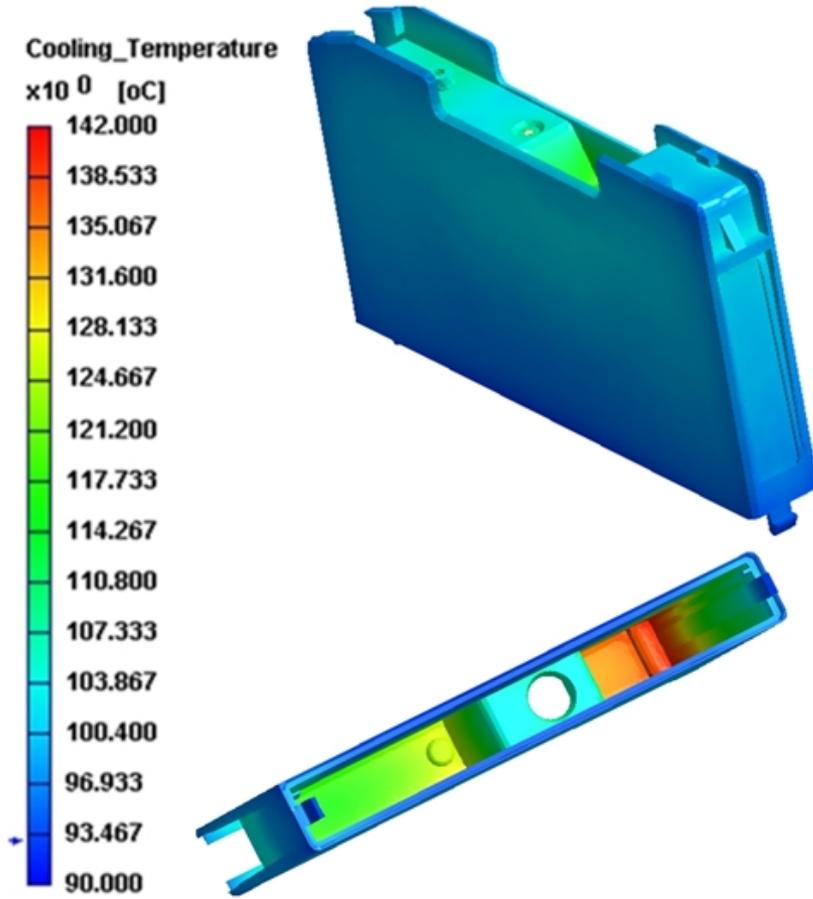
Part: 1 [PCBARRIER] (LEBAN 3004)
Part: 2 [PCBARRIER] (LEBAN 3004)
Assembly: 1 [pcbARRIER] (P2)
Mold Cooling Unit
Coolant: Undefined
Coolant-1: Water



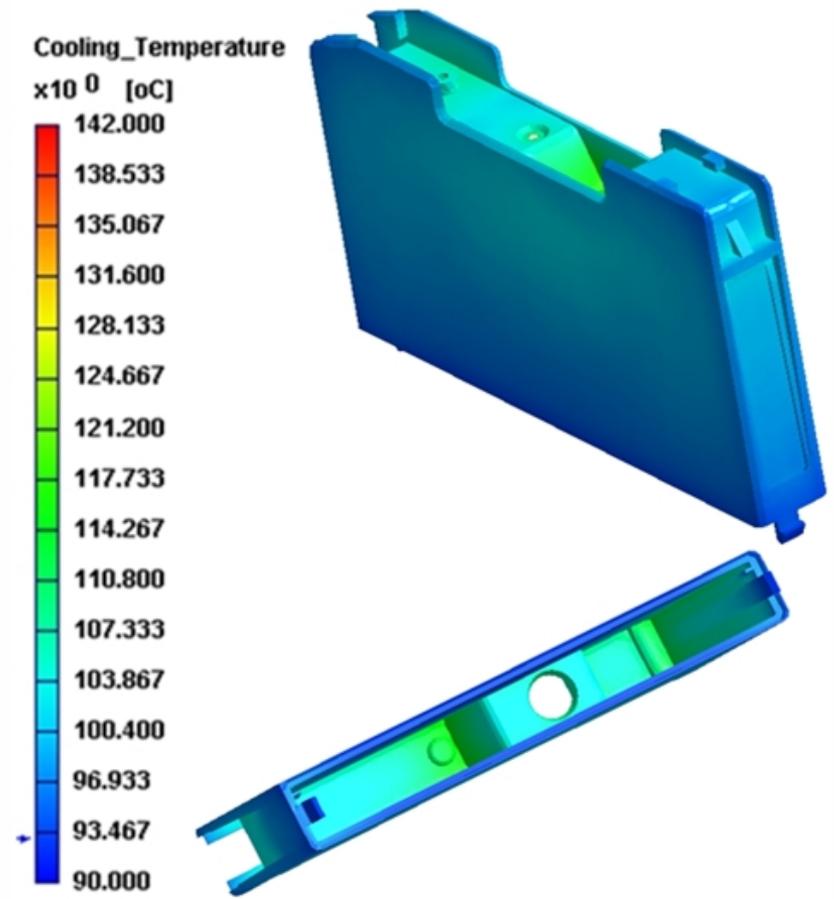
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Part Surface Temperature

Temperature difference across wall thickness reduced 85% from 40oC to 6oC

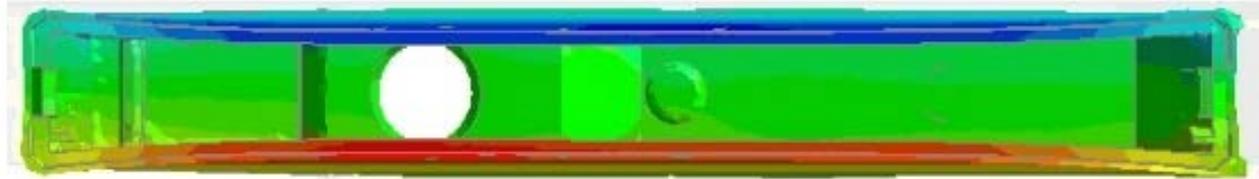
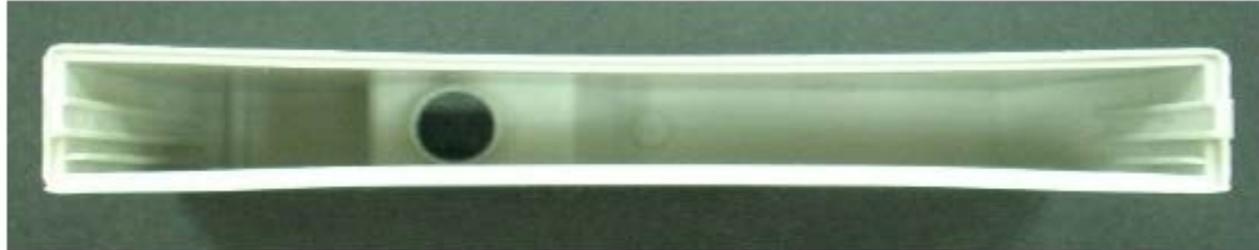


Conventional Cooling



Conformal Cooling

Conventional
Cooling

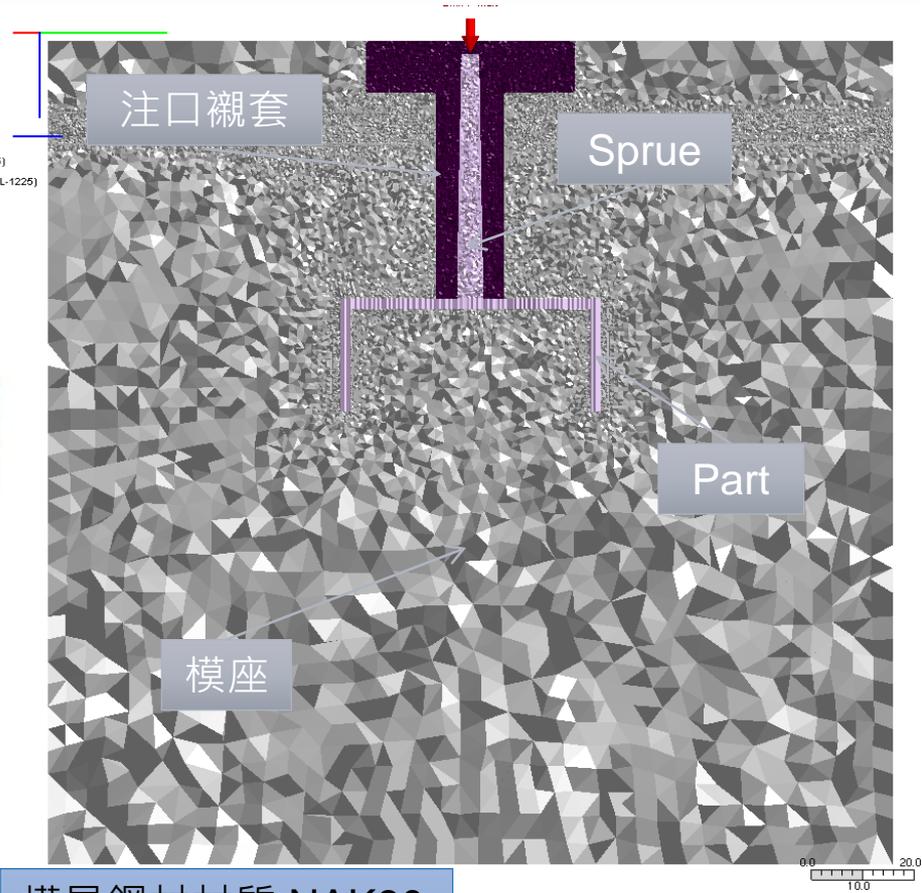
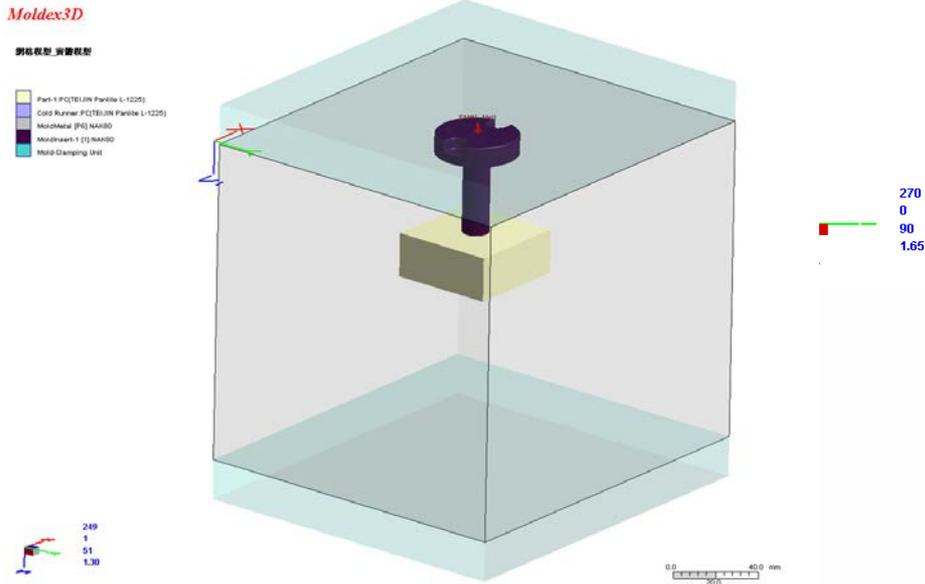
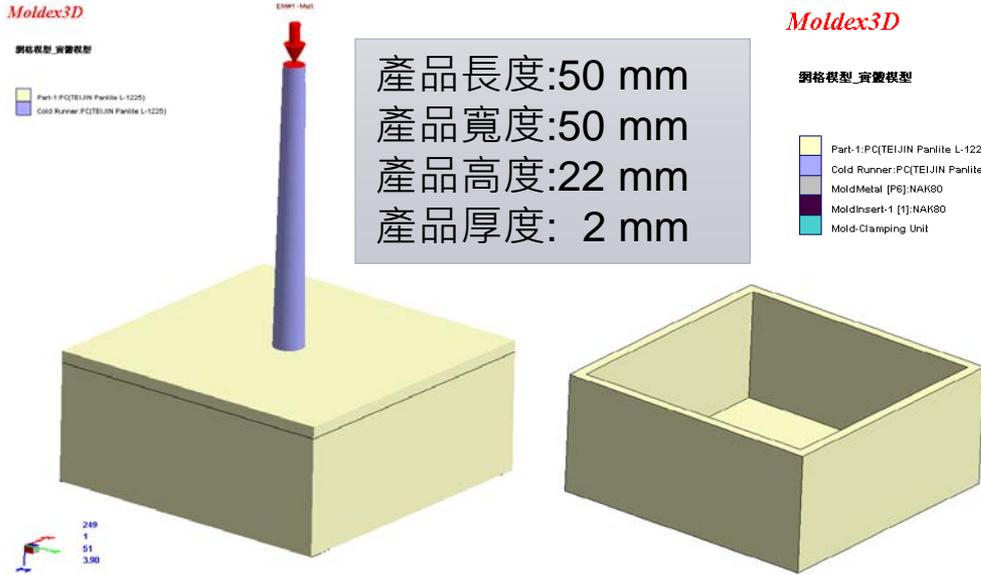


Conformal
Cooling



Warpage is reduced by 26%

測試案例I (傳統注口襯套無水路設計)

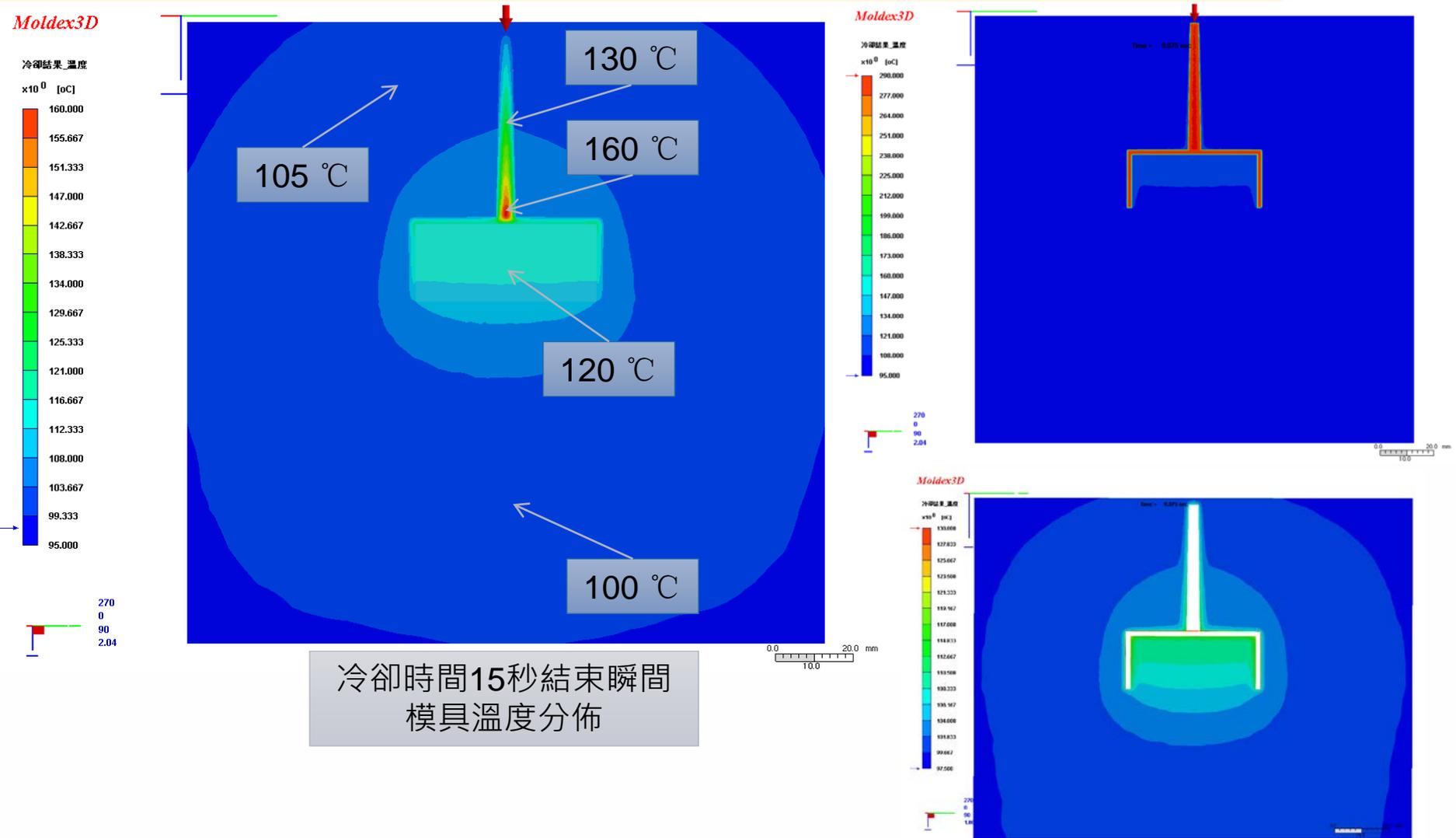


模具鋼材材質:NAK80
產品材料:PC
材料頂出溫度:135°C
模具溫度:100°C
冷卻時間:15s

傳統設計組別

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測試案例I (傳統注口襯套無水路設計)



冷卻時間15秒結束瞬間
模具溫度分佈

成型週期間模具溫度分佈

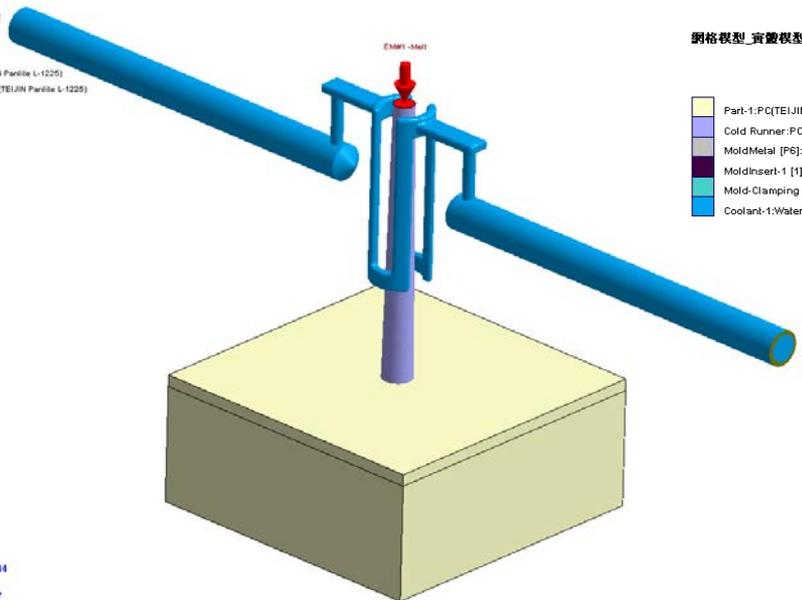
模具溫度分佈範圍:95~160 °C

測試案例I (注口襯套異型水路設計)

Moldex3D

網格模型_實體模型

- Part-1:PC[TEIUN Parilite L-1225]
- Cold Runner:PC[TEIUN Parilite L-1225]
- Coolant-1:Water



244
1
47
0.93

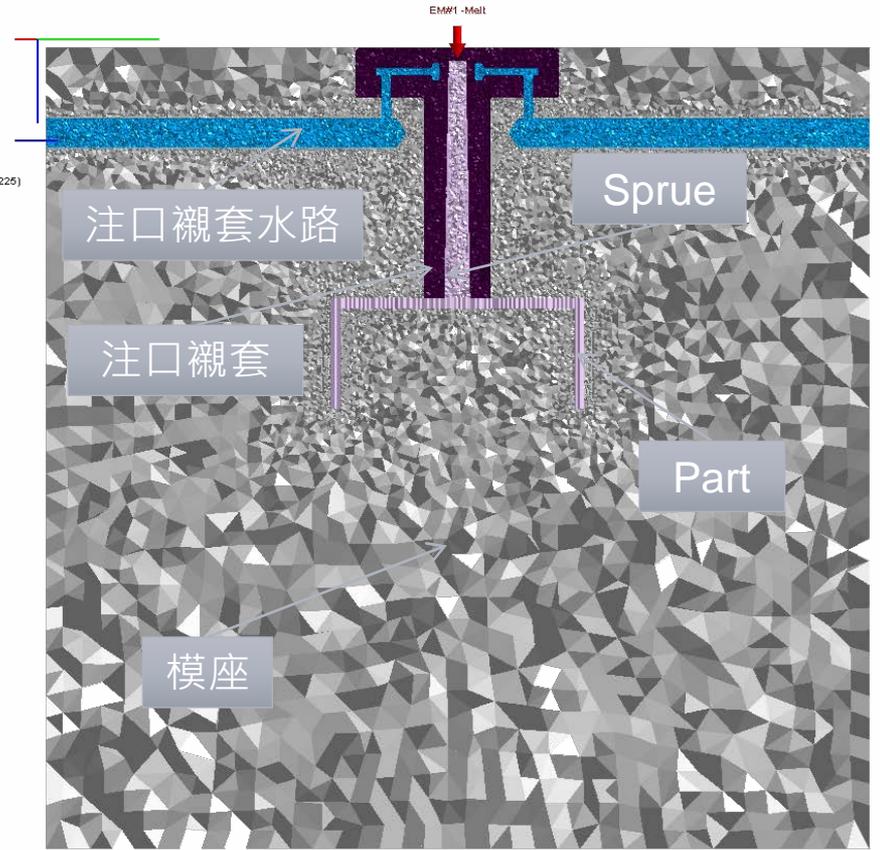
Moldex3D

網格模型_實體模型

- Part-1:PC[TEIUN Parilite L-1225]
- Cold Runner:PC[TEIUN Parilite L-1225]
- MoldMetal [F6]:NAK80
- MoldInsert-1 [1]:NAK80
- Mold-Clamping Unit
- Coolant-1:Water

0.0 10.0 mm
5.0

270
0
90
1.81

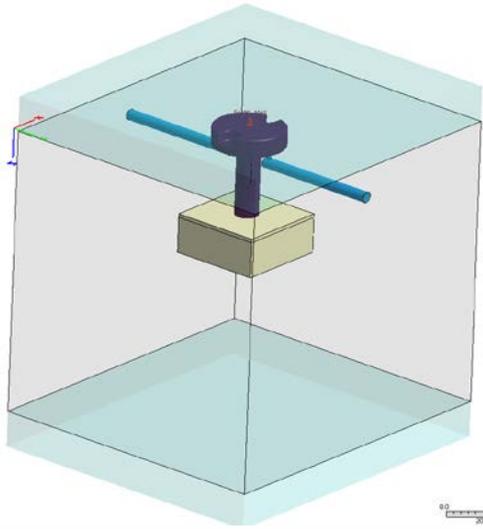


0.0 15.0

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網格模型_實體模型

- Part-1:PC[TEIUN Parilite L-1225]
- Cold Runner:PC[TEIUN Parilite L-1225]
- MoldMetal [F6]:Water
- MoldInsert-1 [1]:NAK80
- Mold-Clamping Unit
- Coolant-1:Water



248
2
90
0.98

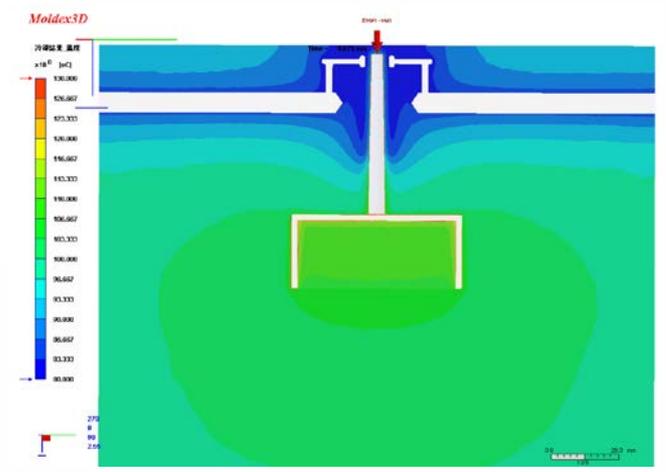
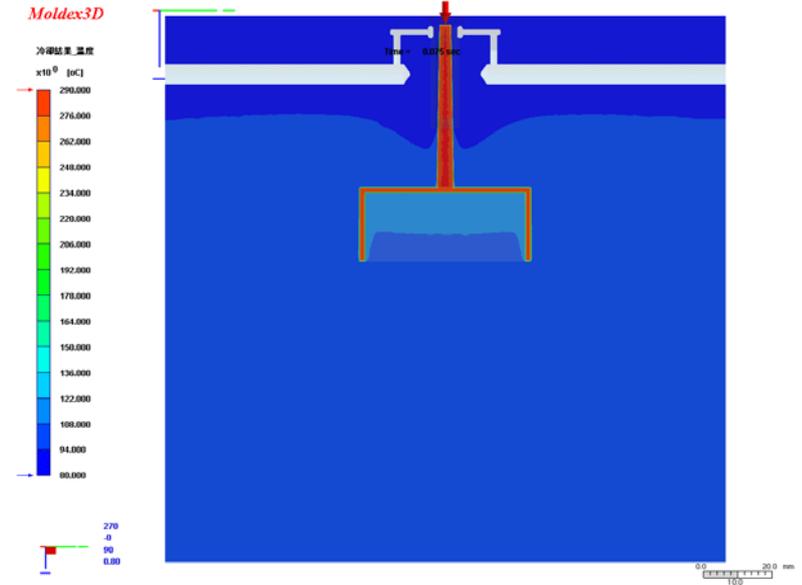
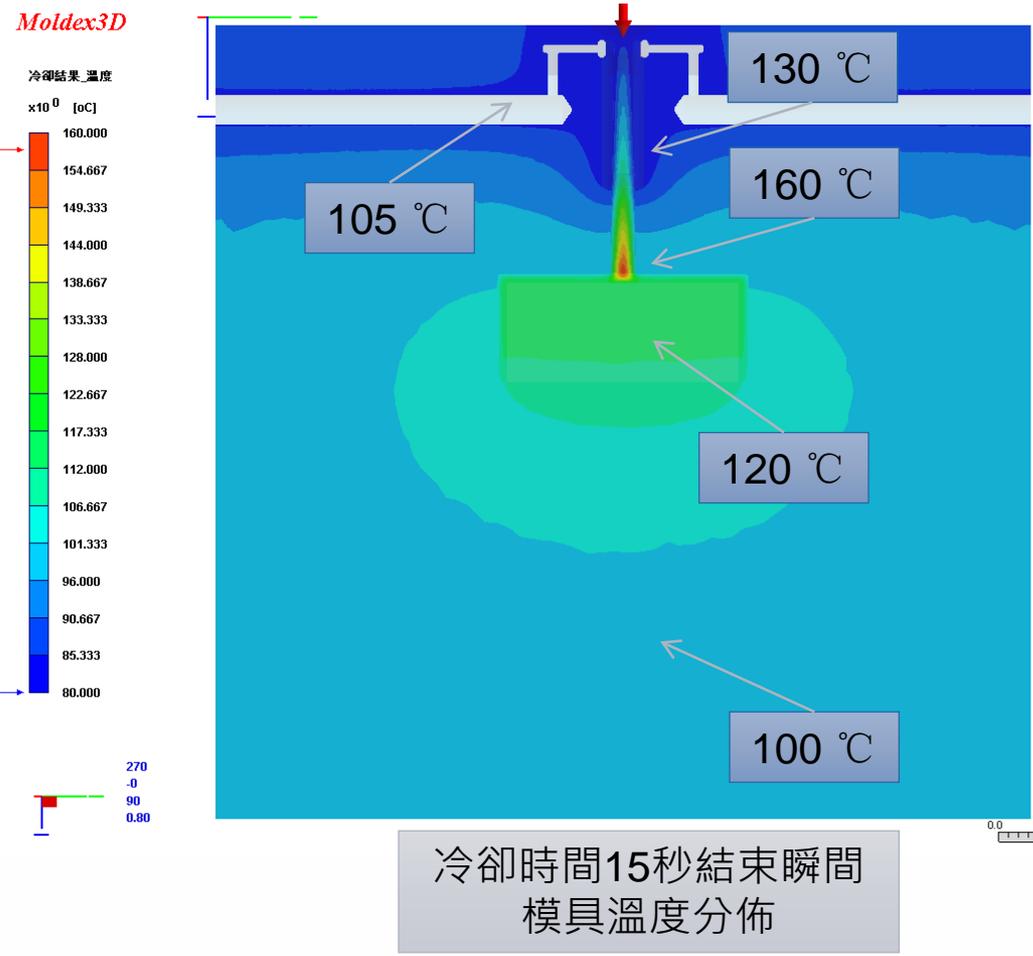
0.0 40.0 mm
20.0

模具鋼材材質:NAK80
 產品材料:PC
 材料頂出溫度:135℃
 模具溫度:100℃
 襯套水路溫度:80℃
 冷卻時間:15s

異型水路設計組別

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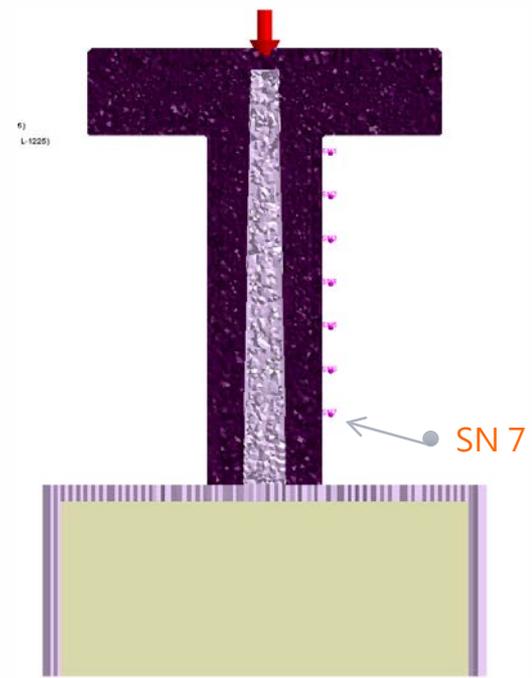
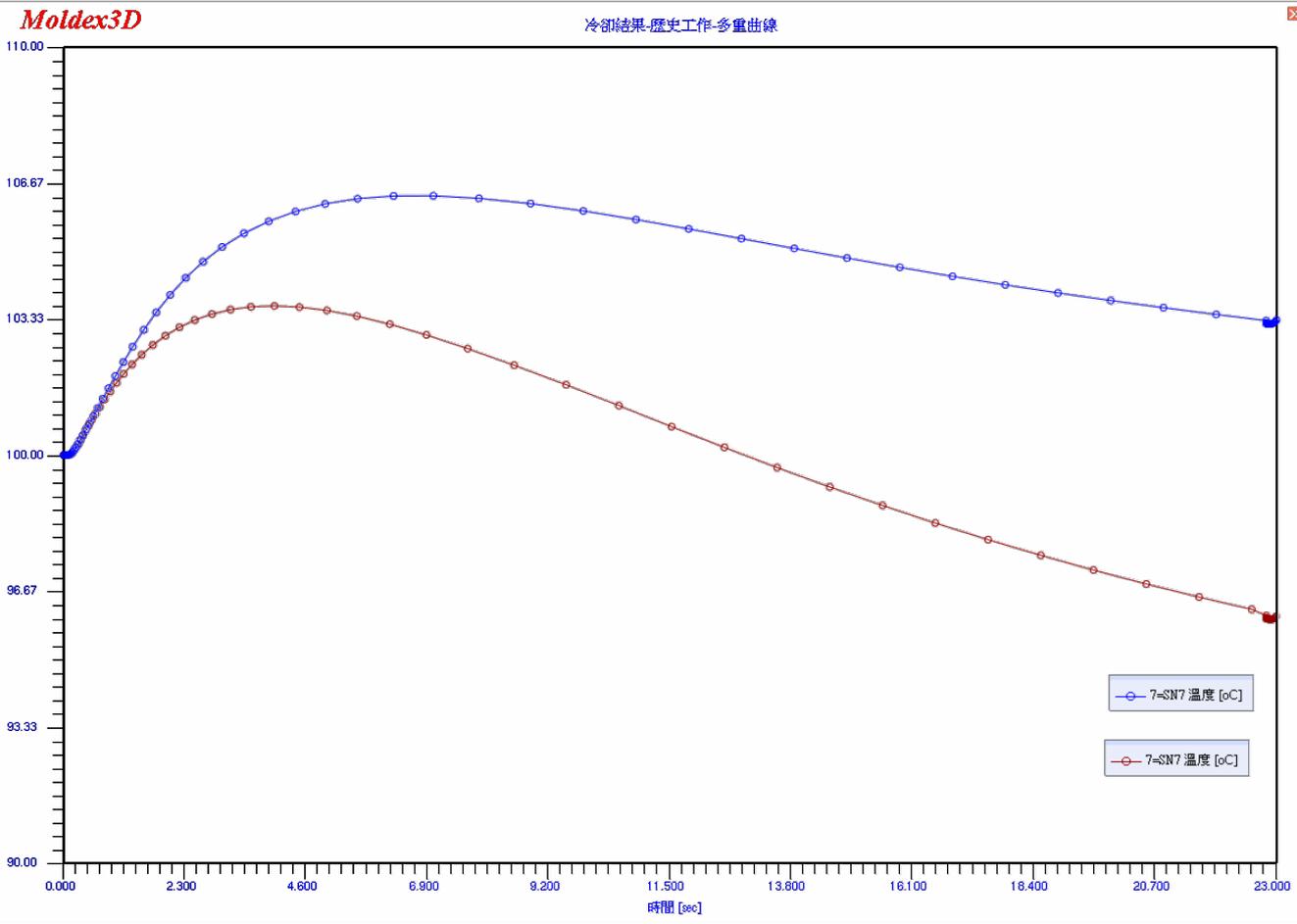
測試案例I (注口襯套異型水路設計)



模具溫度分佈範圍:80~160 °C

成型週期間模具溫度分佈

測試案例I (組別資料比較)

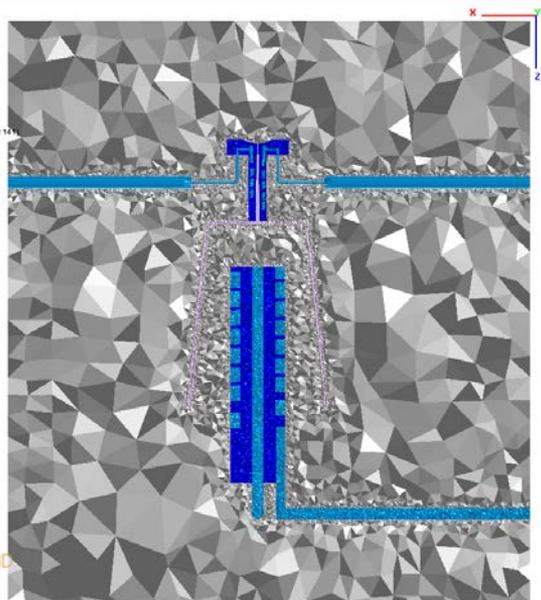


- 注口襯套無水路設計
- 注口襯套異型水路設計

雖然注口襯套靠近澆口外緣處沒有異型水路環繞，但此部分的熱量仍能透過上方襯套內水路傳遞，因此SN7位置上，模具溫度傳遞速率仍較傳統式襯套迅速，減少料頭冷卻時間，進而使成型週期縮短。

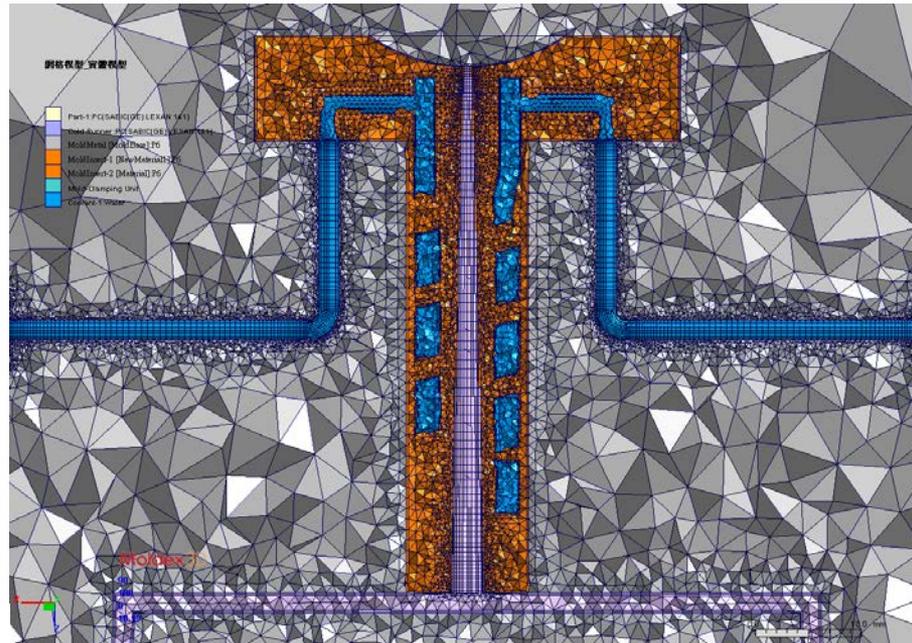
鋼板模型_實體模型

- Part 1-PC(SABIC)(OE)(LEXAN 141)
- Cold Runner-PC(SABIC)(OE)(LEXAN 141)
- MoldSteel [DIN5535] J6
- MoldSteel-1 [DIN5535] J6
- MoldSteel-2 [Material] J6
- Mold Clamping Unit
- Coolant-1 Water



鋼板模型_實體模型

- Part 1-PC(SABIC)(OE)(LEXAN 141)
- Thin-Accur-PC(SABIC)(OE)(LEXAN 141)
- MoldSteel [DIN5535] J6
- MoldSteel-1 [DIN5535] J6
- MoldSteel-2 [Material] J6
- Mold Clamping Unit
- Coolant-1 Water

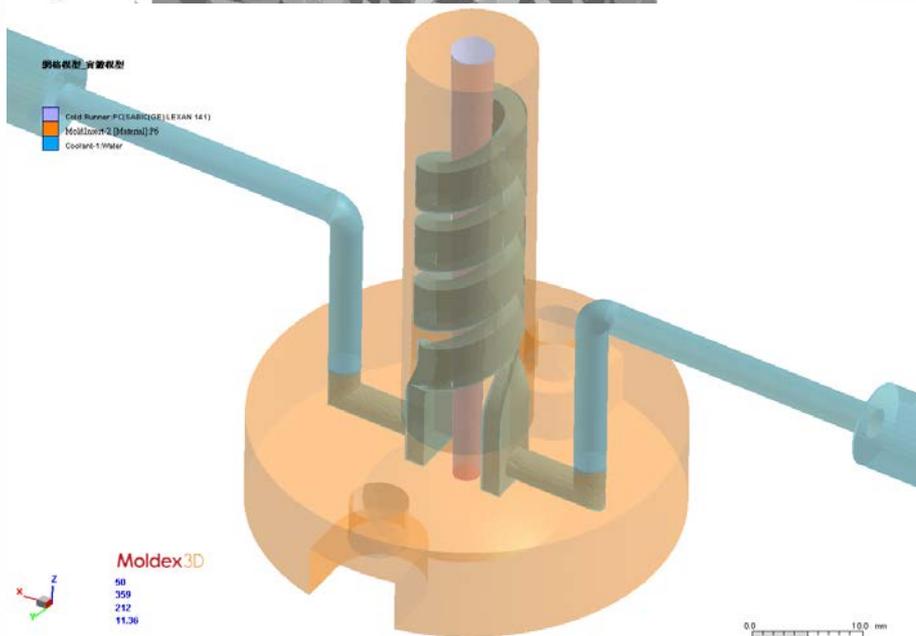


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90
100

Moldex3D
90
100

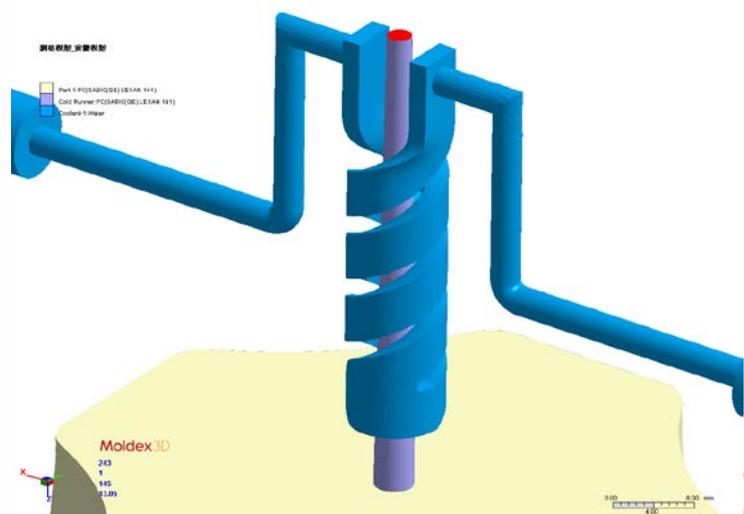
鋼板模型_實體模型

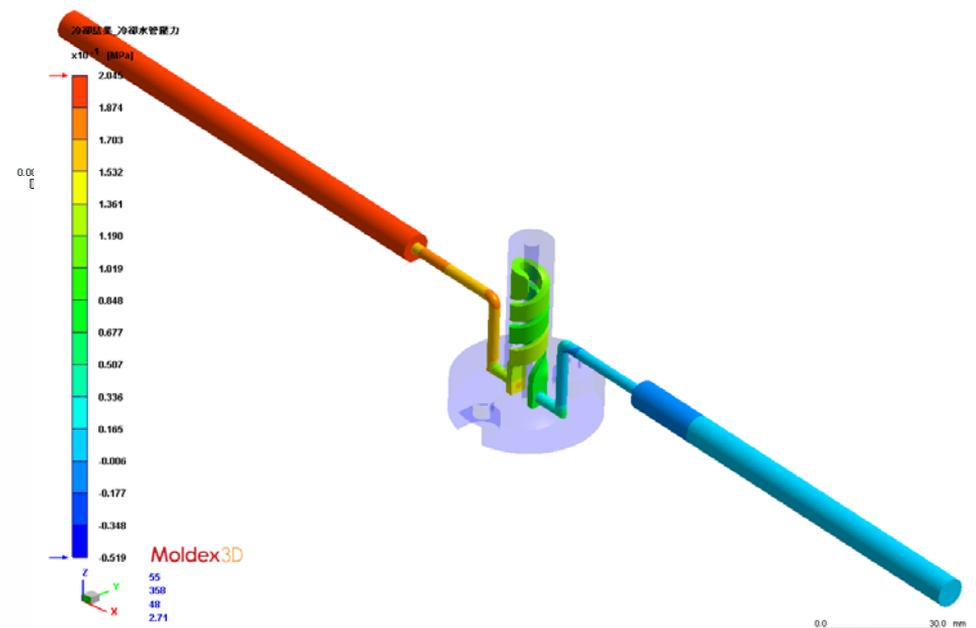
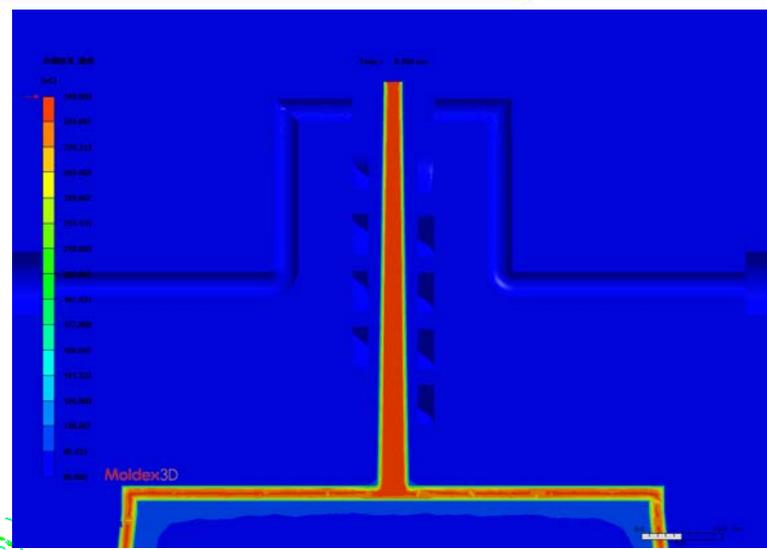
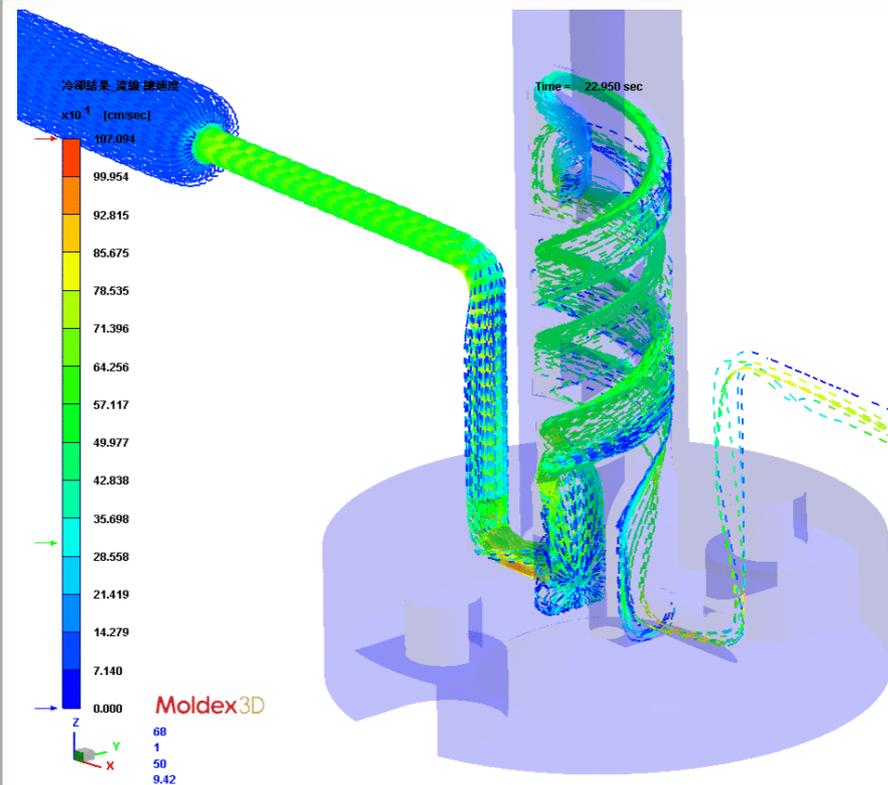
- Cold Runner-PC(SABIC)(OE)(LEXAN 141)
- MoldSteel-2 [Material] J6
- Coolant-1 Water



鋼板模型_實體模型

- Part 1-PC(SABIC)(OE)(LEXAN 141)
- Cold Runner-PC(SABIC)(OE)(LEXAN 141)
- Coolant-1 Water

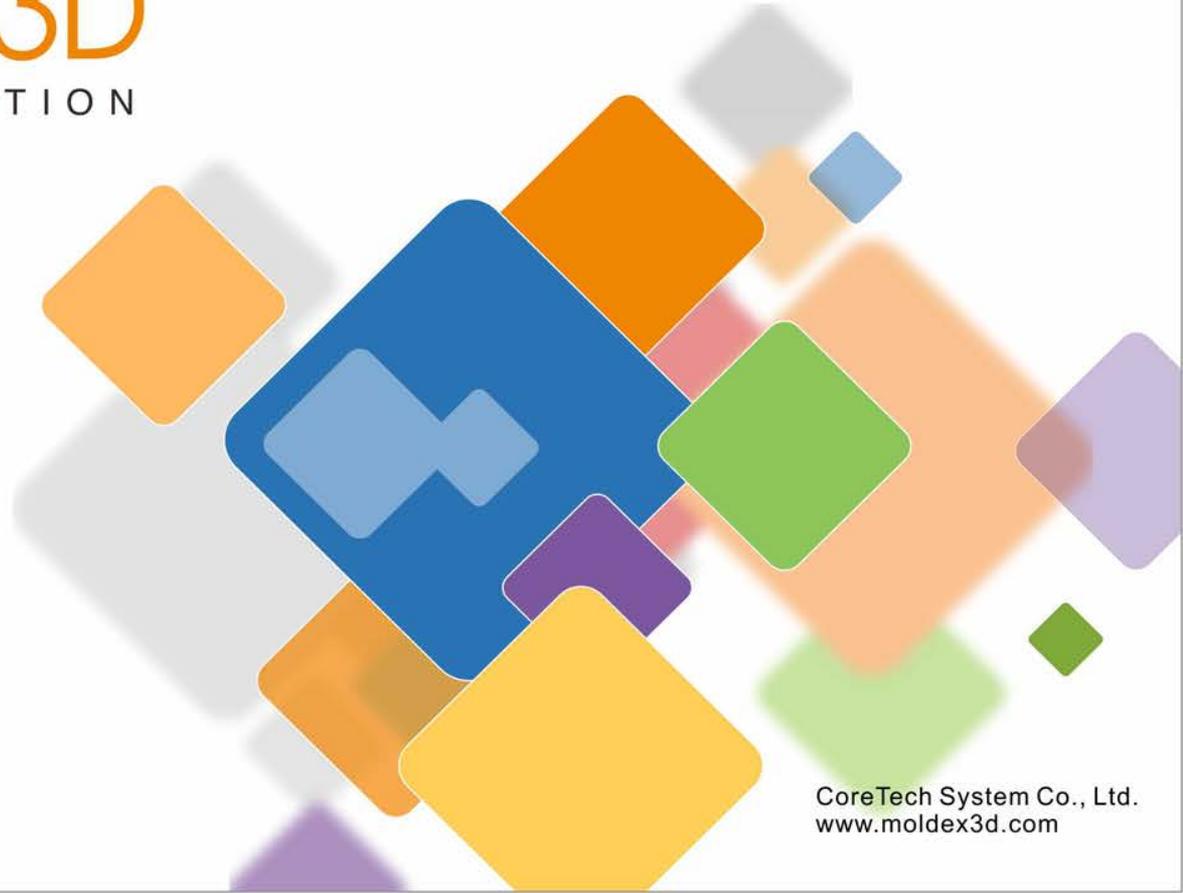






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