

로터폴 단조공정의 정밀 삼차원 CAE 응용

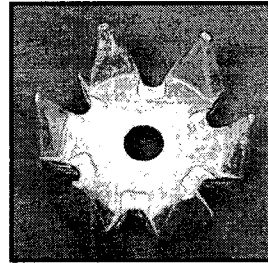
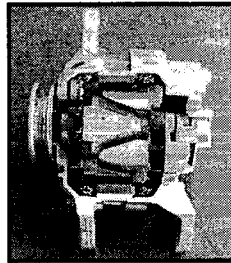
발레오만도

고병호, 강종훈, 백광현



2002. 4. 12

로터 풀 단조공정의 정밀 삼차원 CAE 응용



2002. 4. 12

고병호, 강종훈, 백광현

발레오만도 전장시스템 코리아 주식회사

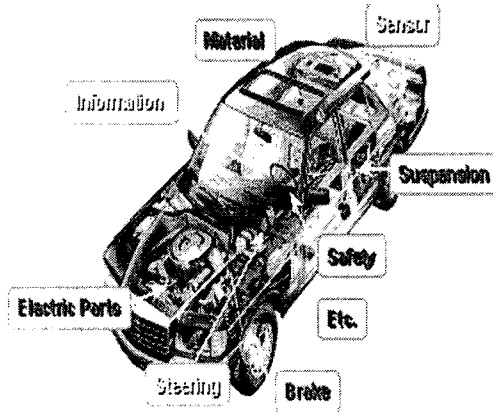
Valeo Electrical Systems Korea



2002. 4. 12

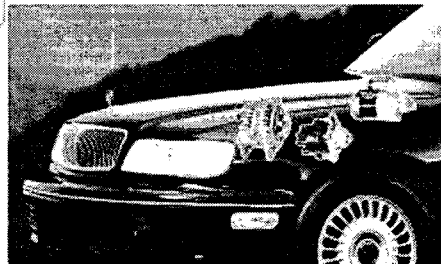
회사 및 제품 소개

■ As the leading manufacturer of automotive parts in Korea



• High quality electrical parts

- Alternator
- Starter motor
- Distributor

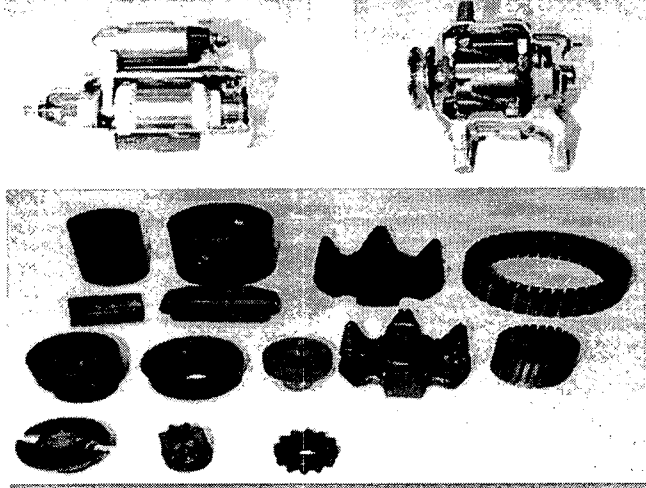


Valeo Electrical Systems Korea

회사 및 제품 소개



■ Specialist in cold and warm forged components

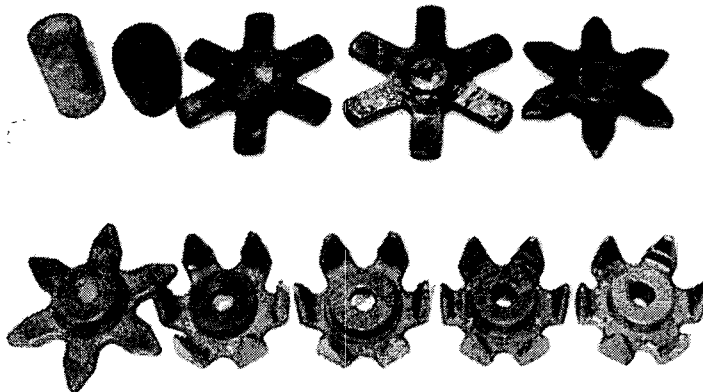


Valeo Electrical Systems Korea

공정 소개



- 제품 : Alternator
- 부품 : Rotor Pole (2pcs. Type), 재질 : AISI 1006
- 공정 : 온간단조 + 냉간단조
- 설비 : 1000ton knuckle joint press (Schuler)

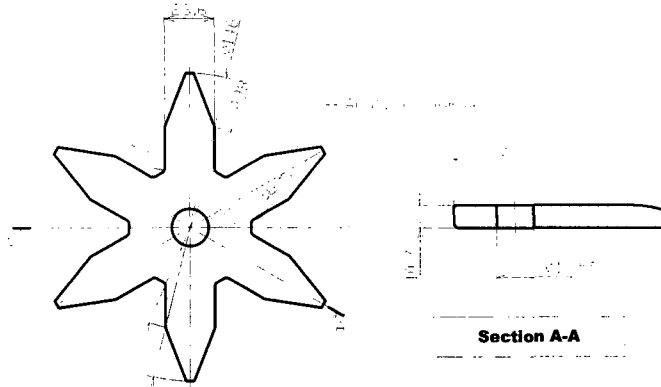


Valeo Electrical Systems Korea

TG9 rotor pole analysis
Material geometries for TG9 products



■ Initial material shape

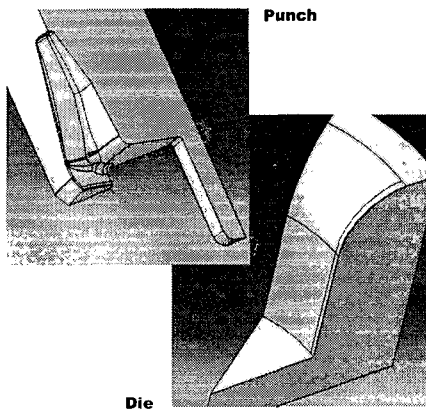


Valeo Electrical Systems Korea

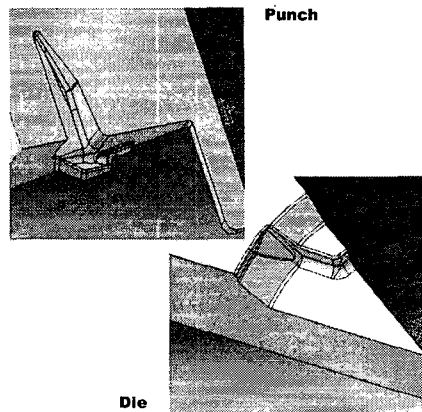
TG9 rotor pole analysis
Die geometries for TG9 products



■ Bending process



■ Sizing process



Valeo Electrical Systems Korea

TG9 rotor pole analysis
해석 조건



■ 소재 조건

▶ AISI 1006

▶ Chemical compositions of AISI 1006 (wt%)

C	Mn	P	S
0.08 max.	0.25 ~ 0.40	0.040 max.	0.050 max.

▶ 유동응력 : $\bar{\sigma} = K \bar{\epsilon}^n$ ($K = 613.97 MPa$, $n = 0.31$)

▶ 마찰상수 : $m = 0.1$ (인산염 피막)

▶ 초기 항복응력 : $\bar{\sigma} = 284.98 MPa$

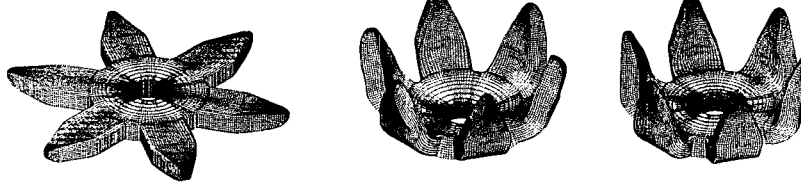
▶ 대칭 조건을 이용하여 1/12만 해석

Valeo Electrical Systems Korea

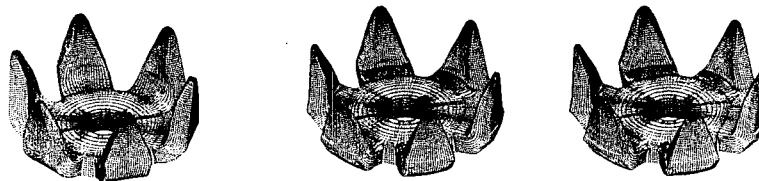
TG9 rotor pole analysis
해석 결과



■ Bending process

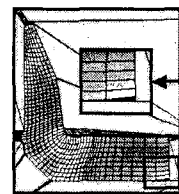
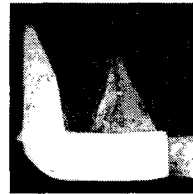
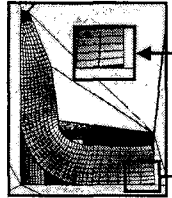
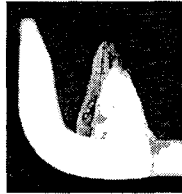
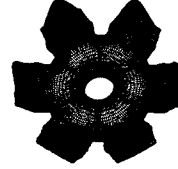
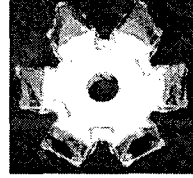
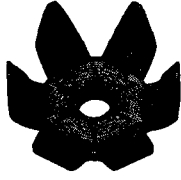
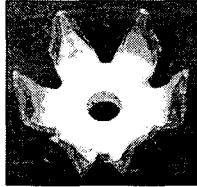


■ Sizing process



Valeo Electrical Systems Korea

TG9 rotor pole analysis
실제 제품과 해석 결과의 비교



Forged

Simulated

Forged

Simulated

Bending process

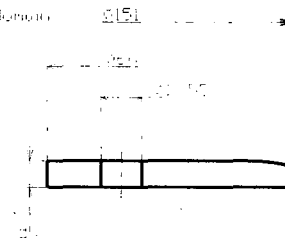
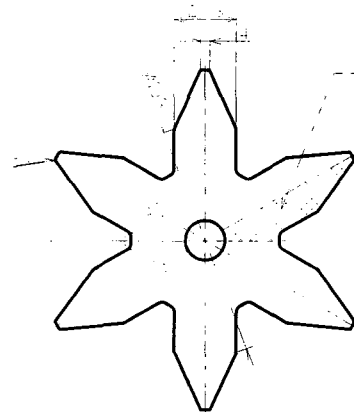
Sizing process

Valeo Electrical Systems Korea

TG11 rotor pole analysis
Material geometries for TG11 products



Initial material shape



Section A-A

Valeo Electrical Systems Korea

TG11 rotor pole analysis
Failure in Material geometry design

■ Bending 공정에서 측면부 chip 발생

The image shows a comparison between a forged rotor pole and a simulated one. On the left, under the label 'Forged', is a photograph of a physical rotor pole with a star-like shape. A square box highlights a specific area on its side, which is magnified in an inset above it, showing a sharp, irregular chip. Below this inset is another small image showing a close-up of the chip's edge. On the right, under the label 'Simulated', is a computer-generated model of the same rotor pole. A square box highlights a corresponding area, which is magnified in an inset above it, showing a smooth, rounded tip without any chips. Arrows indicate the flow from the overall view to the magnified insets.

Forged **Simulated**

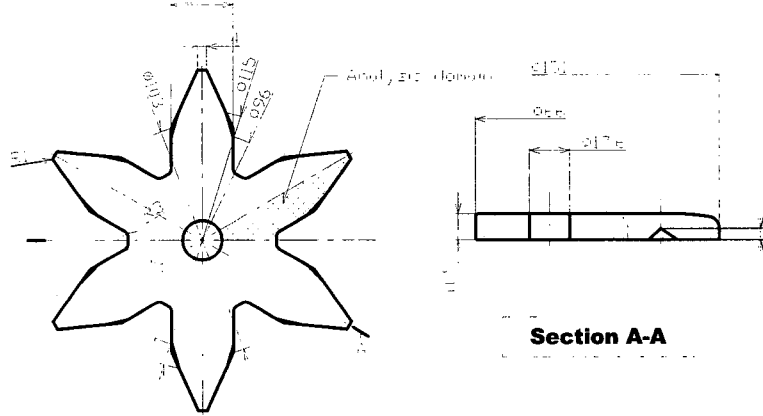
Valeo Electrical Systems Korea

TG11 rotor pole analysis
Surface indentation defects due to material chip

The image shows a comparison between a forged rotor pole and a simulated one. On the left, under the label 'Forged', is a photograph of a physical rotor pole. A square box highlights a specific area, which is magnified in an inset above it, showing a sharp, irregular chip. On the right, under the label 'Simulated', is a computer-generated model of the same rotor pole. A square box highlights a corresponding area, which is magnified in an inset above it, showing a smooth, rounded tip. Arrows indicate the flow from the overall view to the magnified insets.

Valeo Electrical Systems Korea

TG1 rotor pole analysis
Modified material geometries for TG11 products

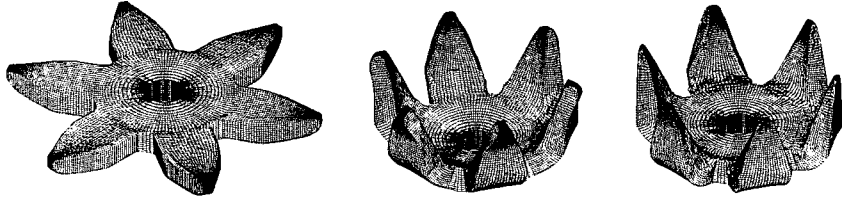


Valeo Electrical Systems Korea

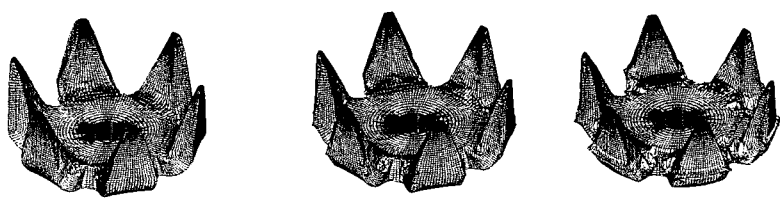
Computer Simulation results of the bending and sizing processes



■ **Bending process**

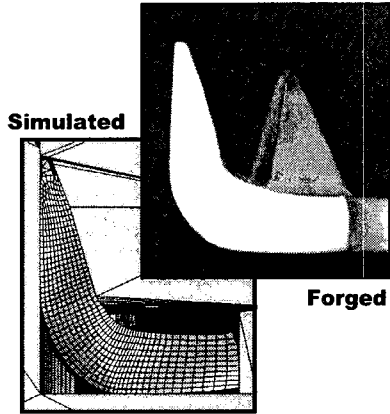


■ **Sizing process**

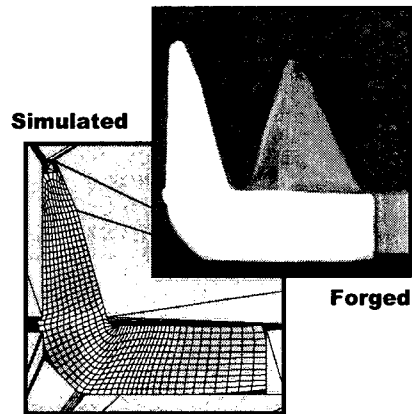


Valeo Electrical Systems Korea

TG11 rotor pole analysis
 실제 제품과 해석 결과의 비교



Bending process



Sizing process

Valeo Electrical Systems Korea

TG11 rotor pole analysis
 Verification of unfilling defects



Simulated



Forged

Valeo Electrical Systems Korea

결 론



- AFDEX/3D를 이용한 3차원 단조 시뮬레이션 기술을 실제 단조공정에 적용하여 결과의 타당성을 검증
- 기존의 시행오차법(Trial and error method)에 비하여 개발기간 단축
- 컴퓨터 하드웨어의 발달과 수치해석 기법의 발전으로 인해 급속히 확산될 전망

Valeo Electrical Systems Korea