SUMMARY

1 – OVERVIEW OF MG VALDUNES

2 – FORGED MECHANICAL COMPONENTS

• FMC product line
• FMC forging process
• Test & expertise capabilities
• FMC references
• Certifications
• Benefits for industrial customers
• Contacts
OVERVIEW OF MG VALDUNES
OVERVIEW OF MG-VALDUNES

• More than 100 years of experience
• Subsidiary of ASCO Industries till 1998
• MG Valdunes is now a subsidiary of Maanshan Iron & Steel Co, China (Ma Steel)
• Ma Steel is a major figure in the world steel industry
  - Steel production of 18 million tonnes per year, workforce over 40 000 persons
  - Turnover 14 Billion USD
  - Capacity 1 million wheels per year
  - 85% of Ma Steel’s production serves the Chinese market
OVERVIEW OF MG-VALDUNES

• Market Leader for high performance railway wheels, axles and wheelsets
• The most comprehensive portfolio in the wheelset industry
• Highly experienced partner for expert services, product design, approval and maintenance
• High performing R&D engineers providing the best technical products & applications
• A complete range of approvals & certifications worldwide, including IRIS (railway) and ISO9001
• Worldwide agent network – our products are currently in use in over 80 countries
### OVERVIEW OF MG-VALDUNES

<table>
<thead>
<tr>
<th>2 MARKETS</th>
<th>TURNOVER 2015 (M €)</th>
<th>EMPLOYEES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheels, axles and wheelsets for the railway industry</td>
<td>TOTAL: +/- 60</td>
<td>MA Steel</td>
</tr>
<tr>
<td>Forged Mechanical Components revolution parts for industrial applications</td>
<td>Passengers: +/- 35</td>
<td>40 000</td>
</tr>
<tr>
<td></td>
<td>Freight: +/- 15</td>
<td>MG Valdunes</td>
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<tr>
<td></td>
<td>FMC: +/- 6</td>
<td>400</td>
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<td></td>
<td>EWC: +/- 4</td>
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- **Passengers**: +/- 35 employees
- **Freight**: +/- 15 employees
- **FMC**: +/- 6 employees
- **EWC**: +/- 4 employees
PRODUCTION CAPABILITIES

<table>
<thead>
<tr>
<th>DUNKIRK</th>
<th>VALENCEIENNES</th>
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<tbody>
<tr>
<td><strong>Industrial</strong></td>
<td><strong>Rail</strong></td>
</tr>
<tr>
<td>Black wheels</td>
<td>Wheels</td>
</tr>
<tr>
<td>Crane wheels</td>
<td>Axles</td>
</tr>
<tr>
<td>160 employees</td>
<td>Wheelsets</td>
</tr>
<tr>
<td>320 employees</td>
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</table>
OVER € 50 MILLION INVESTMENT IN NEXT 5 YEARS

**DUNKIRK**

- Refurbishment of the 5000 tons press
- 2 new machinery centers for industrial wheels
- Polymer quenching tank
- Painting process (industrial wheels)
- 2 New efficient furnaces for Heat Treatment of Forged Mechanical Components
- Modernization and change of the rolling mill
- Installation of a new workshop for resilient wheels

**VALENCIENNES**

- Modernization of the heating furnace of the Heat Treatment
- 4 New machining centers for complex product
- New line for axles machining and 1 new machining line for standard products
- Shipping zone in a building extension
- Investment in maintenance of motor and passenger wheel-sets
Forged Mechanical Components
FMC PRODUCT LINE

Crane wheels, gears, discs, pulleys, piston heads… for industrial applications

Grades for crane wheels:
✓ 42CrMo5-04 (Cranes)
✓ 42CrMo4 (Cranes)
✓ Class C
✓ 50CrMo4

Grades for gears:
✓ 18CrNiMo7-6
✓ 18CrNi8
✓ 16NiCrMo13
✓ 30CrNiMo8
✓ 42CrMo4
✓ Others…

Grades for brake discs:
✓ 28CrMoV5-08
CRANE WHEELS, SHEAVES, GEARS AND DISCS FOR INDUSTRIAL APPLICATIONS

Diameters:
• 250 mm to 1,400 mm

Block weight:
• 100 kg to 3.2 tons

Crane wheels produced according to:
• DIN 15078, 15079, 15090, 15093…
• SID S466A, S466E
• Upon customer specification & drawings
   (ThyssenKrupp Steel Standards, ACM standards, etc...)
Supply from ASCO Industries Dunkirk
- High quality steel, vacuum degassed, to avoid hydrogen inclusions causing oxidation & cracking
- 3 formats of supply: round ingots, square ingots (3,5T), or bars from continuous casting
- Large range of steel grades to answer most of the mechanical characteristics required by the customers
- Licensed 42CrMo5-04 steel developed with ASCO Industries to guarantee a high level of in-depth hardenability.
• Cutting off with a high degree of accuracy
- Fully automated heat furnace - T°C of 1,320°C
- Capability up to 300 blocks of Ø325mm for serial parts
- Smaller heating furnace + manipulator with a capability of up to 20 blocks of Ø325mm for projects with smaller quantities
- Gas firing with optimization of the heating parameters to achieve a T°C homogeneity inside the furnace and to limit the ignition loss
- Waste recycling, filtering and ventilation systems
Die-forging process with a 6000T press
Forging tools studied to reach a rough size at the closest of the final dimensions
High reduction ratio to optimize the material internal structure
Elastic deformation to achieve a fibrous structure enabling a better control of the shearing stress (vs. granular structure)
Ability to support heavy loads over a long period of time
Reheat of the rough part to a T°C of 850°C during 4 hours followed by a decrease of the T°C in the furnace, and then at ambient air.

- Relieve of the material stress occurred during the forging process
- Work out the fineness of the steel structure to achieve a first level of hardness (250-300 HB)
Rough machining of the stress-relieved part to 5-6 mm of the final dimensions.
• Reheat of the rough machined part to a T°C of 880°C with immediate surface heat treatment
• Rotary motion of the hot part in a water quenching tank
• Hardening by pulverization pressurized water
• Combined with the licensed steel grade, this technology enables to achieve high levels of hardness (up to to 550 HB) in-depth (>15mm)
SURFACE HEAT TREATMENT NORMALIZING FORGING & DRILLING FURNACE STEEL SUPPLY

380-550 HB

5 NORMALIZING

6 ROUGH MACHINING

7 SURFACE HEAT TREATMENT

270-380 HB

4 FORGING & DRILLING

3 FURNACE

2 CUTTING OFF

1 STEEL SUPPLY

Lifetime Reliability

High level of hardness with a regular decrease from the rim to the hub.

Depth in mm
UNEQUALLED LIFETIME
A combination between a high quality steel & a heat treatment know-how

Ø680mm crane wheel
450-500 HB surface heat treatment test results
UNEQUALLED LIFETIME
A combination between a high quality steel & a heat treatment know-how
• Reheat of the part up to 880-920°C depending on the mechanical characteristics to achieve
• Mass heat treatment by water quenching to achieve a high level of fineness of the structure
  - Good resistance of the steel in service
  - Prevention from cracks propagation
• Hardness levels between 320 and 390 HB
• Ongoing investment in an polymer quenching tank
- Qualified workforce
- Numerical machining capabilities
- High levels of accuracy
• Supply and assembly of parts accessories
• Toothed ring
• Bearings and bearing box
• Semi-coupling
• Gears
• Dimensional control of the parts
• Dye penetration test
• Ultrasonic test
• NDT realized by COFREND-certified workers
- Individual marking of each part to guarantee the traceability
- Painting
- Packing
- Documentation & quality certificates (grade, NDT, dimensional, heat treatment, etc.)
- Shipment
MARKING
(Tracking, Traceability and the Lifetime of the wheel)
TEST & EXPERTISE CAPABILITIES

Mechanical contacts between crane rim & rail CEN/TS 13001-3-3

Finite element calculations (ANSYS, ABAQUS & MATLAB softwares)

Material properties  Crane wheel meshing & loading  Crane wheel/rail contact definition

FEA contact calculation  Fatigue calculation
Defect examination

- Broken crane (cast wheel)
- Crane sliding – surface martensite structure
- Cyclic damage, sliding
- Surface shelling
- Local crane wheel flat
- Crane wheel abnormal wear

Root cause analysis

- Samples surface preparation, Samples resin coating for examination. Micrographic examination (picture analyzer: Cleanliness, Grain size, Microstructure). Optical microscopic examination

Recommendations

Samples surface preparation, Samples resin coating for examination. Micrographic examination (picture analyzer: Cleanliness, Grain size, Microstructure). Optical microscopic examination
Input
One wheel per cast per batch of heat treatment  Picking note

Oxy-cutting
Marking of the wheel. Oxygen cutting.  Determination of the variation of residual stresses

Sawing
Bandsaws

Machining
Machining centre (K1C, KU, cross section)  Turning machine (tensile sample)

Tests

1. Mechanical tests
   - Circulation chillers (KV at -20°C/-40°C)
   - Broaching machine (notching KV)
   - Fatigue test (toughness)
   - Tensile test
   - Impact test
   - Hardness test

2. Metallographic tests
   - Cutting-off wheel
   - Micro hardness Vickers
   - Resin coating
   - Polishing
   - Acid etching
   - Micrographic analysis

Output
METALLURGICAL TEST CENTER
### FMC REFERENCES

**STEEL INDUSTRY**
- Arcelor Mittal
- Asco Industries
- Riva Group
- Saarstahl
- Tata Steel
- Valhourec
- Constellium
- Alteo
- Industeel
- Aperam
- Thyssen
- Luttini
- Dillinger Hütte

**CRANE BUILDERS**
- Danieli
- ECL
- Eiffage
- Fayat Group
- Taim-Weser
- Konecranes
- NFM Technologies
- Reel
- SMS Demag
- Kranbau Köthen
- Koch
- Jaslo
- Konecranes

**RAILWAY INDUSTRY**
- Faiveley
- Knorr-Bremse
- Poli
- Qinetiq-UK
- ...

**HARBOURS**
- Cargotec
- Port de Dunkerque
- Port du Havre
- Ports autonomes
- Rijkswaterstaat sea-lock

**OTHERS**
- Karl georg
- Alstef
- CORDM
- Poma
- RBG
- Groupe Fives Stein
- ADF
- Endel
- Lafarge
- Baudin Château Neuf
- ISRO
- STAHL Cranesystems
- Seval
- ...

STEEL INDUSTRY

Handling crane

HARBOURS AND SEA-LOCKS

Harbour gantry crane wheels

Wheels Ø 1.200 mm on a drive axle of a steel ladle transfer car

Wheels at a Sea-lock door in The Netherlands

OTHERS

Wheels for stadium decks

Rocket Launching Pad (Indian Space & Research Organization)
BENEFITS FOR INDUSTRIAL CUSTOMERS

- Renowned trademark worldwide
- Long lifetime products for reduced Total Cost of Ownership (TCO)
- Reliable components to guarantee a high availability ratio
- Broad range of forged mechanical components for industrial applications
- From tailor-made to serial parts
- ‘Can do’ attitude to meet customers expectations
- Expertise and technical support capabilities
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