The development of Grade 100 lifting chains and safety components

1. Introduction

YOKE Industrial Corporation is the largest manufacturing factory of lifting chains and safety components in Taiwan. YOKE runs a constant and strict production facility with quality control in every manufacturing stage from raw materials to the completed product, involving the material selection, hot forging, mechanical machining, heat treatment, assembly and surface treatment. All YOKE lifting products are tested in accordance with ASTM A-952-98 and EN 1677. YOKE is certified by SGS ISO 9002 and has type approval by the main international authorities from BG-PRUFZERT, ABS, ZU, DNV and SABS. YOKE's products are on sale over 50 countries in the world and stands on the leadership of the lifting chains and safety components. YOKE also achieved the 2001 Creation and R&D Award, Small Giant Award and 2002 Excellent Creation and R&D Company by government of Taiwan.

Based on the market necessity, YOKE Industrial Corporation has systematically expanded the factory and trained persons with special ability. YOKE has also provided all popular lifting products as well as many other items for use in the lifting and material handling industry. These items can be seen within the website of http://www.yoke.net and YOKE Catalog. Even though these excellent performances, YOKE still improves actively the product quality, manufacturing technique and sale management, to maintain its superiority in the keen competition of this lifting industry.

Feng Chia University (FCU) is a famous university in central Taiwan. The Department of Materials Science and Engineering (MSE) in this school has excellent performance in the research and development of advance materials. YOKE and High Performance Alloys Lab. of MSE FCU investigate together the high strength low alloy (HSLA) steels. The development of Grade 100 lifting chains components is the first year's project. The goal of this project is to develop the HSLA steels which are suitable for the Grade 100 lifting chains components. The composition design, thermo-mechanical treatments and material testing will be carried out. The optimal materials and thermo-mechanical treatments will be provided after this investigation.

2. Research Background

This project aims to upgrade the HSLA steels, although Grade 80 lifting chains and safety components are the main products now. To enhance the product's performance and safety, it is important to develop the HSLA steels with high strength, high fracture toughness, and excellent workability. The upgrade of HSLA steels to Grade 100 will make recent products have higher mechanical property and higher safety. The Standards of Grade 100 lifting chains and safety components have been built up. Many countries in Europe and America have also taken effort to develop these high performance HSLA steels.

All the Grade 80 products are tested in accordance with ASTM A-952-98 and EN1677-2000. Their standard criteria are described as below. (1) The lifting chains have to be formed by using forging technique. All the forging parts have also been detected by using the NDT tests of magnaflux crack, eddy current and/or ultrasonic detections. These congruent HSLA steels must comprise at least 2 elements among Ni, Cr and Mo elements. Their composition criteria are Ni＞0.4%, Cr＞0.4%, Mo＞0.15%, P＜0.035%, S＜0.035% and Al＜0.025%. (2) Grain size of Austenite: in accordance with the standard of ISO 643, the grain size grade should be higher than 5. (3) Mechanical property testing: MPF, 2.5×WLL; BF, 4×WLL. (4) Dynamic Fatigue Testing: Batch samples of chain and components are tested at 1.5 times the working load limit (WLL) for 20,000 cycles. (Caption: Some special models have to be tested at low temperatures below 40℃. All samples have to be tempered at 400℃ before various testing.) The Grade 100 HSLA steels have higher mechanical properties and will raise the working load limit even at the same sample sizes.

The raw materials for lifting chains and safety components are the HSLA steels. They are distinguished by their ultimate tensile strength as (1) 50kgf (500MPa), (2) 60kgf (600MPa) and (3) 70~100kgf (700~1000MPa). The HSLA steels having ultimate tensile strength ＞130kgf (1300MPa) are called as super-high strength alloy steels. The high performance steels used in the lifting industry comprise the high yielding-strength steels, precipitation-hardening HSLA steels, and ultra-low-carbon bainite (ULCB) steels. According to the microstructures, HSLA steels are separated as low carbon martensite steels, low carbon bainite steels and ferrite/austenite steels. In Taiwan, no special steels are suitable for using as the raw materials of Grade100 lifting chains and safety components till now. Therefore, YOKE cooperates with the High Performance Alloys Lab., MSE FCU and aims to develop the Grade 100 HSLA steels. The research topics involve the composition design, heat treatment, mechanical machining, and materials analysis, etc. Through this research, we will perform detailed investigations into high performance HSLA steels and rise up YOKE's

products quality, image and competition power.

3. Research Processes

1. Survey and summarize the update information and standards of lifting chains and safety component.
2. Design the optimal compositions of HSLA steels, and then prepare the testing samples of these designed HSLA steels.
3. Identify the real compositions of the prepared HSLA steels by using the composition analyzer.
4. Observe the sample's microstructures and analyze the grain size.
5. Carry out the static tensile tests, mid-low temperature impact tests and dynamic fatigue tests.
6. Manufacture the real lifting chains. These real lifting chains are then subjected to heat treatment, manufacturing proof load test, bending test, dynamical fatigue test, etc. Meanwhile, the NDT techniques of magnaflux crack, eddy current and ultrasonic detections are also executed on these real lifting chains.
7. Summarize and further study all the experimental results to find the most optimal manufacturing processes for Grade 100 lifting chains and safety components.
8. Write the final research report.

4. Research Goals

1. Design successfully the chemical compositions of Grade 100 HSLA steels.
2. Develop optimal manufacturing techniques, involving the thermo-mechanical treatments and mechanical working, for Grade 100 lifting chains and safety components.
3. Carry out the necessary analysis of material performances for Grade 100 lifting chains and safety components.
4. Scale up these manufacturing techniques and raise YOKE's lifting products.

5. References

1. "Mechanical Materials", C. H. Hwang, Wen Ching Publishing Co., Taiwan, in Chinese.

2. “Standard Specification for Forged Grade 80 and Grade 100 Steel Lifting Components and Welded Attachment Links”, Designation: A 952/A 952M-98.

3. “Components for Slings-Safety, Part 1: Forged Steel Components, Grade 8”, SVENSK STANDARD SS-EN 1677-1.

4. “Components for Slings-Safety, Part 2: Forged Steel Lifting Hooks with Latch, Grade 8”, SVENSK STANDARD SS-EN 1677-2.

5. “Components for Slings-Safety, Part 3: Forged Steel Self-Locking Hooks, Grade 8”, EUROPEAN STANDARD SS-EN 1677-3.

6. “Components for Slings-Safety, Part 4: Links, Grade 8”, EUROPEAN STANDARD SS-EN 1677-4.