Metal Forming

A news letter dedicated to Forging Industry

Issue : 67 **For Private Circulation** **February 2021**

Dear Fellow Engineers,

The world economy was badly hit by pandemic COVID 19.Metallurgical and auto industry was no exception to that. Revival of auto industry was stupendous post COVID 19, which gave boost to the Forging industry. Back log of the orders sharply increased production in auto and forging units, which gave impetus to the steel industry. Government's intention to promote electrical vehicles to reduce pollution and improve environmental condition, has given boost to the introduction of new EVs in the market. Let us hope this positive note continues for effective growth of the Indian industry.

Forging Technology Forum successfully launched it's maiden Virtual conference on 22nd and 23rd January 2021. It was well appreciated by the participants. We are including one of the papers to all readers of Forging Technology Forum's in this newsletter. Hopefully you will enjoy it.

With Best Regards,
Dr. V. V. Kanetkar - Editor

FOR YOU

First Correct Answer will be given one delegate free for any one training programme

What is relative hardness range for a) upper bainite b)Lower bainite c)Martensite for 0.8 % carbon steel?

Use of Finite Element Analysis Techniques for Developing Heat-Treatment Process for Automotive Components

Satyajeet Kulkarni
Manager - EDS
THE AUTOMOTIVE RESEARCH ASSOCIATION OF INDIA, Pune

ABSTRACT

All metal components undergo a primary manufacturing process viz. Casting, forging, machining, stamping, welding etc. These manufacturing processes provide desired shape to the component. Generally, the desired mechanical properties viz. strength, percentage elongation, hardness etc. are achieved through heat-treatment process. Different materials have different heat-treatment cycles. The heat-treatment process depends on type of metal, alloying elements and expected mechanical properties to be achieved. The steel and its alloys typically undergo annealing, hardening and tempering process. Aluminium typically follows aging and precipitation hardening process.

Generally, heat-treatment cycle is standardized based on material and its grade. Theses cycles are followed since decades. Though component geometry becomes very complex in shape during recent times, heat-treatment cycle remains same which results in a greater number of trials required to achieve required results. Now a day's mass production is taken over by batch production in industry revolution 4.0. During this industry 4.0 need of an hour is shorter lead time and faster development cycle with First time right component by maintaining highest quality of components.

In recent times finite element analysis (FEA) techniques are improving to support in all area. In FEA software's validation takes place virtually. It is quite possible to

create shop floor environment virtually and check all possible outcomes out of it. FEA allows us to play with number of process parameters which can be optimized before implementing on shop floor. The use of FEA techniques unable us to achieve First time right component without affecting quality.

1. Introduction & Background

Product development cycle for metal components starts with raw material selection and culminating in the machining of component as shown in figure number 1. This is typical process which industry follows. Raw material selection is purely based on the end mechanical properties (Strength, %elongation, hardness etc.) required to achieve. Current industry revolution is Industry 4.0. In this, revolution is mainly focused on batch production rather than mass production. Industry 4.0 mainly aims at lowering the manufacturing cost and to become more efficient [1]. This means product is changing frequently and accordingly it is required to act on the development cycle. The need of the hour is shorter product development time with "First Time Right" (FTR). To cater to the need of development process FEA (Simulation) technology is used. Use of a virtual environment is helpful for simulating individual manufacturing processes and the total manufacturing system to survive in the competitive market and to understand the process. By driving compatibility between the product design and the assembly plant process, these virtual tools enable the early optimization of cost, apt quality and time to help achieve integrated products, process and resource design, and affordability.[2]

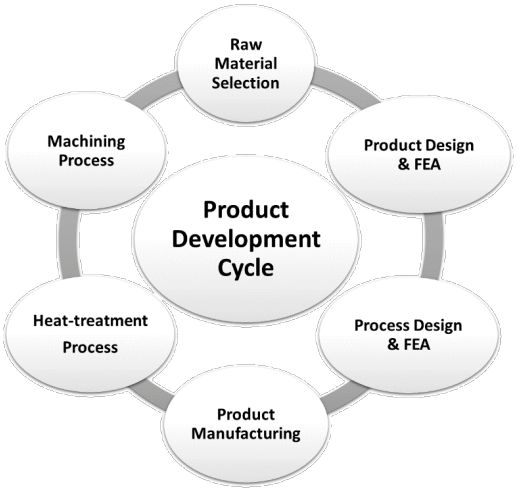

Figure 1: - Typical Product development Cycle.

2. Advantages of Simulating Heat-treatment Process

- Shorter development times with fewer trial runs
- Comprehensive process understanding
- High process stability and quality
- Predictions of component properties
- Elimination of quench cracks
- Prediction of the necessary allowances for hard machining
- Broadening the product range
- Optimal coordination of the individual process steps
- Fewer defective parts
- Extensive material databanks [3]

3. Heat-treatment & its Simulation

Heat-treatment is a fundamental metallurgical process of heating and cooling of metals with varying temperature and varying cooling rate by altering media of cooling viz. air cooling, forced air cooling, water, polymer & oil as shown in figure 2. Materials are subjected to heat-treatment to relieve internal stress, reduce brittleness and to improve machinability. Hardness, strength, toughness and wear resistance is also altered to meet the specific requirements. [3].

Figure 2: - Various Quenching Bath

Heat-treatment Simulation Input Parameters

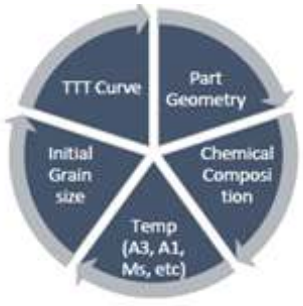

Figure 3: - Heat-treatment simulation input Parameters

4. Case Study

- **Problem Statement**

"Establish co-relation between experimental results and simulation results for heat- treatment process for automotive or non- automotive component."

Due to software capability constraints, following results were compared between experimental and simulation results.

- Defect free Component
- Hardness – 290 -325 BHN
- Microstructure – Tempered Martensite

Due to IoT and industry revaluation 4.0 there are lot of technological changes are happening in recent times. The small and medium enterprises (SME's) are accepting the technological changes to sustain in competitive market. Simulation technology is established everywhere, especially in manufacturing sector viz. casting, forging, sheet metal forming, welding etc.

There are still some areas where simulation needs more research, more iterations to come close to the experimental analysis. Simulation of Heat-treatment process is one of the areas where more work needs to be carried. The heat-treatment process varies with the material. Large amount of accurate material data is necessary to carry out simulation of heat-treatment process. As each material has its own equilibrium diagram, different temperature, different alloying elements etc. Heat-treatment process is solely dependent on material composition. In this case study, steel heat-treatment is discussed. Typical hardening and tempering cycle is discussed, simulated and results were co-related with experimental trials.

Component selected for case study is “Single cylinder Crankshaft”. It is also known as single pin crankshaft. This crankshaft is used in all two wheelers and some of the three wheelers. To manufacture these products, the processes used are Forging and Machining. Figure 5 shows forged crankshaft and figure 6 shows assembly of two crankshafts and connecting rod.

Generally, crankshafts are manufactured in various steel grades viz. low carbon steel, medium carbon steel, micro alloy steel. Micro alloy steels are special grades which does not require heat-treatment process if rate of cooling is controlled. The required properties are achieved by controlling cooling rate. This is possible due to alloying elements such as vanadium, molybdenum etc. In this case the material was 41Cr4. The main alloying elements in FE are Carbon C: 0.415%, Manganese Mn: 0.75%, Silicon Si: 0.2%, Chromium Cr: 1.05 % and phosphorus P, Sulphur S: 0.018 % each [4], and weighed about 2.1 Kg.

Figure 4: - Forged Crankshaft

Figure 5: - Forged Crankshaft

.....To be Continued in next issue.....

FORGING TECHNOLOGY 2021

Virtual Conference on " Forging Technology -Success Stories (Forging & Allied Processes)"

22 - 23 (Fri-Sat) January 2021 Report

After postponing three times in-person conference, Forging Tech Forum was able to organise a virtual conference on 22-23 January 2021.

Due to postponement, a few papers had to be replaced with others (Though of equally high quality). Not only that, a couple of days before the conference, three authors could not be contacted and thanks to Mr. D.G. Chivate we could get others to replace them at the last moment.

Since this was our first experience in organising a virtual conference; to get the feel of the same two demos were held on 17 and 20 January 2021. This was found to be useful as during actual conference hardly any problems were faced.

However, there were a few concerns regarding network availability at Foundry & Forge Training Centre office and also in a few cases at participant's locations. This indicates that at Foundry & Forge Training Centre office we need to have a very strong Wi-Fi network and also power backup all the time.

Coming to the actual conference, Mr. B. V. Joglekar stated the objective of the conference. This was followed by Mr. C. B. Mathur who welcomed all and also gave welcome speech. Then Mr. C.B. Mathur introduced Chief Guest, Mr. Pradeep Goyal, Chairman and Managing Director of Pradeep Metals Ltd, Rabale. Mr. Pradeep Goyal also was a keynote speaker Mr. Pradeep Goyal gave an excellent presentation of the status of Forging Industry in India and what the future lies for the industry.

Mr. R.T. Kulkarni proposed Vote of thanks to the Chief Guest Mr. Pradeep Goyal for his motivational & valuable speech.

After tea break the presentation of papers began. Over six sessions there 16 papers were to be presented. However, due to poor connectivity at the premises of two speakers on the second day in the last session only one paper could be presented.

The quality of presentations was very high. Many participants took active part and through verbal interaction with the speakers could get their knowledge upgraded.

At the end of the presentations Mr. G. N. Rao of Saturn Forgings, summarised the take always from the conference in his valedictory address. During the entire period of conference the number of participants varied between 48 and 55, an excellent participation.

Upcoming Webinars

- Steel making and Quality control
  By Mr. Narendra Shukla.
- Open die Forging Raw material and Metallurgical quality control.
  By Mr. Ravindra Kamble.
- Spectrometer Calibration, Maintenance, latest development.
  By Dr .Naresh Sihag.
- Calibration of Furnace, Thermocouples, Instruments in Heat Treatment Shops.
  By Mr. Nitin Vaidya.
- Intensive Quenching a concept
  By Mr. Bhalchandra Joglekar.
- Raw Material Quality in Cold Forging
  By Mr. Guddimath

For Details Contact

Arkey Technical Training and Research Institute

FOUNDRY AND FORGE TRAINING CENTRE
'Guruprasad', 37/4/A, 6th Lane, Opposite Hotel Laxman,
Prabhat Road, Pune - 411 004 India. 020-25651717, 25670808
Mobile: +91 97647 11315
fftc@arkeycell.com, admin@arkeycell.com I www.arkeycell.com