# Metal Forming

A news letter dedicated to Forging Industry

**Issue : 68** **For Private Circulation** **April 2021**


Dear Fellow Engineers,

While writing last editorial, we all thought that the Pandemic and Covid – 19 are things of the past and that industry is entering Bull phase and every thing is going to be normal. But alas! Covid 19 is bounced back, with more dangerous effect than earlier, trying to take revenge! But I am sure with the lock down on the anvil and control measures being taken by Government and people at large will supress this danger of second phase of Corona also more effectively.

I am sure Steel and Forging industry will take all measures to ensure that things will be normal soon. Fear of migrating workers, infection of inmates with Corona and little slow down in the industry will be managed well by organized efforts by the stalwarts of the industry with cooperation from the Government officials.

I am sure we will be normal soon in the industry.

We are continuing with article in the heat treatment by Mr. Satyajit Kulkarni and also with the second phase of training programmes schedule "on line", which is buzz word today along with Zoom and Google meet.

Hope you will enjoy this article and also promote on line training of your staff for further take off of your industry with better trained staff.

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

FOR YOU

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

Can you describe any two micro structures similar to Corona, useful and harmful, in metallurgical industry, good for machining and bad for fatigue life?

## 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


**Continued from February 2021 issue.....**

### ➢ Heat-treatment Cycle of Crankshaft

The process of heat treatment involves heating of solid metals to specified (recrystallisation) temperatures holding them at that temperature and then cooling them at suitable rates in order to enable the metals to acquire the desired properties to the required extents. All this occurs because of the changes in size, form, nature and the distribution of different constituents in the micro-structure of these metals. All heat treatment processes, therefore, comprise the following three stages of components:

- Heating the metal to a predefined temperature.
- Holding it at that temperature for sufficient time so that the structure of the metal becomes uniform throughout.
- Cooling the metal at a predetermined rate in a suitable media so as to force the metal to acquire a desired internal structure and thus, obtain the desired properties to the required extent. [5]

The typical heat-treatment cycle followed for 41cr4 grade is hardening and Tempering process. The details of hardening and tempering processes are described below.

In this case study the hardening and tempering cycle used is described below.

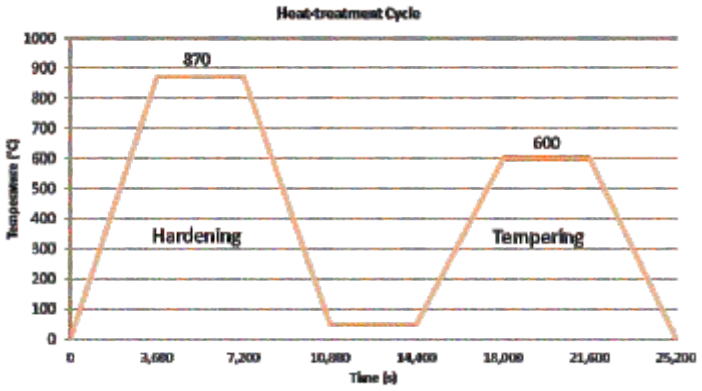


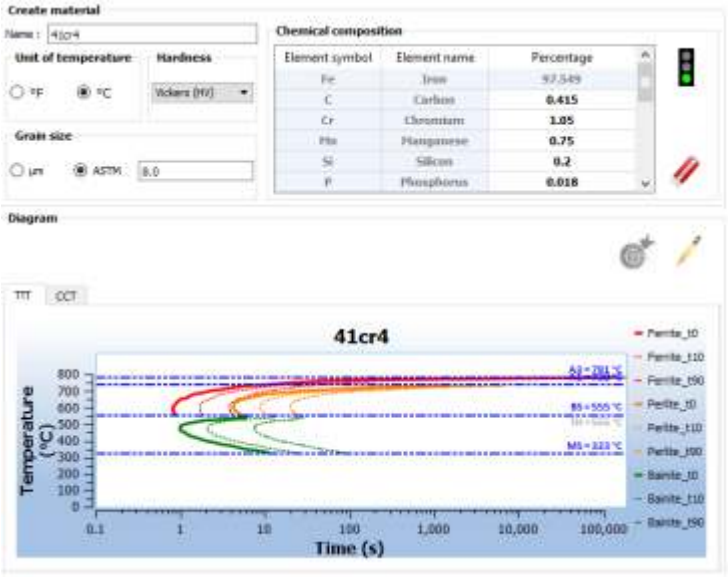

Figure 6 shows heat-treatment cycle. As per the cycle, heat the component up to 870°C which is beyond recrystallization temperature, hold the temperature for some time to get homogenous temperature throughout the component. Making sure that temperature was reached and homogenous, put it in quenching media to cool down to room temperature. In tempering cycle heat the component back to 480°C, allow to soak for some time to get homogenous temperature. In tempering process, cooling media is air. Components are allowed to cool in natural air, to get required properties.

Hardening process, in actual practice, components were stacked into fixture, which goes into a heating furnace. Heat furnace has defined sections viz. pre-heating, heating, soaking. Now a days these furnaces are electric in nature. Then fixtures along with components are dipped into the quenching media, to cool down to room temperature. Then similar process is followed for tempering as well. Instead of dipping into tank, the components are allowed to cool in atmosphere.

## ➢ Heat-treatment Simulation

As per regular practice to carry out simulation input parameters were gathered which includes component geometry, material details, process details like temperature, time. Cooling media.

3D CAD model geometry of forging stage and machining stage is used for deck setup. Various boundary conditions are applied to this geometry. In hardening, process is divided into two different simulation i.e. heating soaking in one simulation and quenching in other simulation. Similarly, simulation setup was done for tempering as well. Figure 7 shows TTT curve which was generated through software utility by taking input




❖ Setup

Figure 14: - Hardening – Heating, Soaking - Deck setup along with various parameter

mesh. Figure 16 shows crankshaft mesh model. The mesh use is of tetrahedron. One of the important parameters was feeding kinematics details. It is one of the crucial parameters for simulation. Correct input parameters are needed for making sure that simulation will end correctly without any errors.

## ➢ Heating and Soaking Results

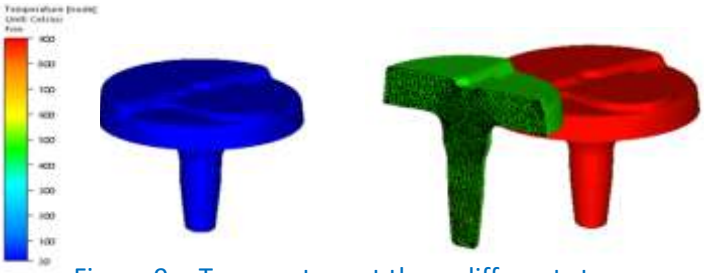


Figure 9: - Temperature at three different stages

In this simulation, it is very interesting to see how temperature increases as simulation proceeds. As temperature rises austenitization varies with the temperature. Figure 9 shows temperature at three stages. 1st image shows temperature at 20°C which is start of the simulation. 2nd image shows at intermediate stage which indicates temperature around 500°C. It shows cut section with tetrahedron mesh. 3rd image shows last stage of simulation where temperature reached 870° C. In Figure 18 there are again three images shown, which indicate percentage austenite phase in the component. Here legend shows limits from 0 to 1. 0 signifies no austenite phase and 1 signifies 100% austenite. 1st image is at start of simulation, which shows no austenite as temperature is 20°C. 2nd image is at intermediate stage which indicates austenite varies from range of 20 – 50 %. Note that, Component stem thickness is small compared to other area, where austenite shown 50%. 100% austenite is seen at end of simulation which is shown in last image.

## ➢ Quenching Setup

There is separate template available for quenching simulation. Same material file was used throughout the heat-treatment simulation. The output file of heating and Soaking simulation along with all the results were transferred to quenching simulation. Remaining parameters used were same as of first simulation. As per input provided by customer quenching media used was "Oil". More the number of elements, greater is the time required. Also, greater the size of the element, less accurate are the results.

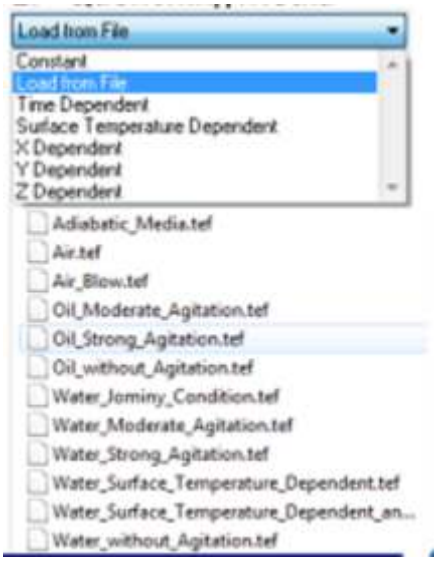



Figure 10: - Various Ways of Quenching

.....To be Continued in next issue.....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# FORGING TECH FORUM

# Training Programme Calendar 2021-2022

## April

**Steel Making and Quality Control**

23 (Fri) **FFTC 1**

April 2021

## May

**Types of Polymers Quenchant & its Application in Forging Industries**

20, or 21, or 25 **FFTC 2**

May 2021

## June

**Raw Material and Metallurgical Quality Control in Forging Die Forging**

13 (Sun) **FFTC 3**

June 2021

## July

**Failure Analysis**

15 (Thu) **FFTC 4**

July 2021

## August

**Raw Material Quality Control for Cold Forging**

12 or 26 **FFTC 5**

August 2021

## September

**Corrosion Basics**

23 (Thu) **FFTC 6**

September 2021

## October

**Spectrometer Calibration, Maintenance, latest Development**

8, or 28 or 29 **FFTC 7**

**FORGING Annual Conference**

October 2021

## November

**Introduction to Sealed Quench Furnace and it's Applications**

25 - 26 **FFTC 8**

November 2021

## December

**NDT Technologies latest Eddy Current case depth measurement**

23 (Thu) **FFTC 9**

December 2021

## January

**Personality Development, Communication skills**

14 (Fri) **FFTC 10**

January 2022

## February

**Forging Product Development**

1 or 4 (week) **FFTC 11**

February 2022

## March

**Surface Engineering and Protection**

( ) ( ) (Saturday) **FFTC 12**

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