

FUNDAMENTAL MANUFACTURING PROCESSES

Heat Treating

SCENE 1.

CG: Review

white text on black

tape 63, 12:00:15-12:03:49

review music

SCENE 2.

tape 506, 19:07:04-19:07:24

parts pulled from heat, glowing,
and transferred to quench for
cooling

NARRATION (VO) :

HEAT TREATING PROCESSES ARE USED TO ALTER THE
METALLURGICAL STRUCTURE AND MECHANICAL PROPERTIES
OF METALS OR ALLOYS THROUGH THE USE OF CONTROLLED
HEATING... ,
AND COOLING CYCLES.

SCENE 3.

tape 505, 17:03:27-17:03:59

heat treating operation

CG: Mechanical Properties

Tensile Strength

Ductility

Impact Strength/Toughness

Hardness

NARRATION (VO) :

THE PURPOSE OF MOST HEAT TREATING PROCESSES IS TO
ALTER THE MECHANICAL PROPERTIES OF METALS. THESE
MECHANICAL PROPERTIES INCLUDE:
THE METAL'S TENSILE STRENGTH,
THE DUCTILITY OF THE METAL,
THE IMPACT STRENGTH, OR TOUGHNESS OF THE METAL,
AND THE HARDNESS OF THE METAL.

SCENE 4.

continue previous shot

tape 514, 00:00:50:00

freeze frame, blue background

CG: Through Hardening Processes

Increase the strength &
hardness throughout an
alloy's cross-section

Surface Hardening Processes

Create different properties
at the surface than at the
center of a metal structure

Softening Processes

Decrease the hardness
of metals and alloys

NARRATION (VO) :

HEAT TREATING PROCESSES CAN BE CLASSIFIED INTO
THREE GROUPINGS:
THROUGH-HARDENING PROCESSES THAT INCREASE THE
STRENGTH AND HARDNESS THROUGHOUT AN ALLOY'S CROSS-
SECTION,
SURFACE HARDENING PROCESSES THAT CREATE DIFFERENT

PROPERTIES AT THE SURFACE THAN AT THE CENTER OF A METAL STRUCTURE,
AND SOFTENING PROCESSES THAT DECREASE THE HARDNESS OF METALS AND ALLOYS.

SCENE 5.

CG, SUPER: Heating Stage

tape 507, 21:07:27-21:07:40

parts going into furnace

CG, SUPER: Quench/Cooling Stage

tape 507, 21:09:45-21:09:58

parts being quenched

CG, SUPER: Reheat/Tempering

Stage

tape 507, 21:10:50-21:11:00

parts going through tempering furnace

NARRATION (VO):

HEAT TREAT HARDENING PROCESSES USUALLY HAVE THREE

STAGES:

A HEATING STAGE TO TRANSFORM THE METALLURGICAL

STRUCTURE OF AN ALLOY...,

A QUENCH, OR COOLING STAGE TO PRODUCE A HARDER

METALLURGICAL STRUCTURE...,

AND A REHEAT, OR TEMPERING STAGE TO ACHIEVE THE

DESIRED HARDNESS AND STRENGTH LEVEL IN A

METALLURGICAL STRUCTURE.

SCENE 6.

REPLACE NARRATION IN SCENE WITH

tape 515, 01:06:17-01:06:37

tape 506, 18:05:22-18:05:40

hot parts in window

tape 514, 00:17:02-00:17:19

GRAPHIC: austenite's face-centered cubic crystal structure

tape 514, 00:17:22-00:17:38

GRAPHIC: austenite's face-centered cubic crystal

structure, carbon particles appear

tape 505, 17:24:33-17:24:55

zoom out, parts going into furnace

NARRATION (VO):

HARDENING PROCESSES BREAK DOWN AN ALLOY'S FERRITE

AND CEMENTITE BY HEATING THEM TO WITHIN THE

AUSTENITIC RANGE. WITHIN THIS RANGE, AN ALLOY CAN

DISSOLVE MUCH MORE CARBON. THE CARBON CONTENT IS

THE MAJOR FACTOR IN DETERMINING THE PROPERTIES

THAT CAN BE DEVELOPED IN STEEL.

SCENE 7.

REPLACE NARRATION IN SCENE WITH

tape 515, 01:07:05-01:07:23

tape 506, 18:09:23-18:09:42

parts coming out of quench tank

tape 508, 22:01:13-22:01:32

parts being quenched

NARRATION (VO):

THE KEY TO HARDENING IS THEN PREVENTING THE

FERRITE AND CEMENTITE FROM RE-FORMING WHEN THE

ALLOY IS COOLED BACK TO ROOM TEMPERATURE. THIS IS

ACHIEVED THROUGH QUENCHING, OR COOLING THE ALLOY

TOO QUICKLY FOR THE FERRITE AND CEMENTITE TO FORM
INTO PEARLITE.

SCENE 8.

tape 501, 12:11:07-12:11:15

parts quenched in brine

tape 508, 22:01:22-22:01:30

parts quenched in water

tape 503, 15:20:04-15:20:10

parts coming up out of synthetic
polymer

tape 507, 21:08:43-21:08:48

parts coming up out of oil
quench

tape 502, 14:12:29-14:12:37

parts using air quench

NARRATION (VO) :

THE VARIOUS QUENCHING MEDIUMS INCLUDE:

BRINE, WHICH QUENCHES FASTEST...,

WATER...,

SYNTHETIC POLYMERS...,

OIL...,

AND AIR, WHICH QUENCHES SLOWEST.

SCENE 9.

tape 505, 17:08:33-17:08:46

parts coming out of quench

NARRATION (VO) :

ONCE PARTS ARE HEATED AND QUENCHED THEY ARE

STRONGER, HARDER, AND, UNFORTUNATELY, MORE

BRITTLE.

SCENE 10.

tape 505, 17:18:02-17:18:38

pull back, parts going through
tempering furnace

NARRATION (VO) :

THIS BRITTLINESS IS REMOVED THROUGH THE TEMPERING,

OR DRAWING PROCESS. HERE, THE HARDENED STEEL IS

REHEATED TO A TEMPERATURE BELOW ITS LOWER

TRANSFORMATION TEMPERATURE AND THEN AIR COOLED.

SCENE 11.

tape 507, 21:14:10-21:14:29

flame hardening operation

CG, SUPER: Case Hardening

Methods

Differential Heat
Treating

Differential Metal
Structure

NARRATION (VO) :

THERE ARE TWO METHODS OF CASE HARDENING:

DIFFERENTIAL HEAT TREATING,

AND DIFFERENTIAL METAL STRUCTURE.

SCENE 12.

tape 498, 07:18:28-07:19:00

induction heating operation

CG, SUPER: Differential Heat

Treating

NARRATION (VO) :

DIFFERENTIAL HEAT TREATING BRINGS ONLY THE SURFACE

OF A STEEL PART RAPIDLY UP TO ITS AUSTENITIZING

TEMPERATURE WHILE KEEPING THE INTERIOR WELL BELOW

THAT POINT.

SCENE 13.

CG, SUPER: Flame Hardening
tape 507, 21:18:17-21:18:36
flame hardening operation
CG, SUPER: Induction Hardening
tape 504, 16:05:13-16:05:31
induction hardening operation

NARRATION (VO) :

THE TWO PRIMARY TYPES OF DIFFERENTIAL HEAT
TREATING ARE:
FLAME HARDENING...,
AND INDUCTION HARDENING.

SCENE 14.

CG, SUPER: Differential Metal
Structure
tape 514, 00:27:54-00:27:57
ANI: part in furnace
tape 514, 00:28:01-00:28:11
ANI: cutaway of part in furnace
tape 514, 00:28:16-00:28:27
ANI: surface of cutaway
highlights in furnace
tape 514, 00:28:30-00:28:40
GRAPHIC: cutaway cooled down,
surface altered

NARRATION (VO) :

DIFFERENTIAL METAL STRUCTURE PROCESSES ALTER THE
CHEMICAL COMPOSITION OF THE WORKPIECE SURFACE, BUT
NOT ITS INTERIOR. THE ENTIRE WORKPIECE CAN THEN BE
SUBJECTED TO THE SAME HEAT TREATING CYCLE. THE
SURFACE RESPONDS MORE TO HEAT TREATING, BECOMING
HARDER THAN THE INTERIOR.

SCENE 15.

tape 499, 09:06:30-09:06:52
carburizing operation
CG, SUPER: Carburizing
Nitriding
Carbonitriding

NARRATION (VO) :

DIFFERENTIAL METAL STRUCTURE CASE HARDENING
PROCESSES INCLUDE:
CARBURIZING...,
NITRIDING...,
AND CARBONITRIDING.

SCENE 16.

tape 497, 05:22:01-05:22:26
parts being stress relieved
CG, SUPER: Annealing
Normalizing
Stress Relieving

NARRATION (VO) :

ALTHOUGH MOST HEAT TREATMENT IS DONE FOR HARDENING
AND STRENGTHENING PURPOSES, THERE ARE SEVERAL
PROCESSES USED TO SOFTEN METALS, INCLUDING:
ANNEALING...,
NORMALIZING...,
AND STRESS RELIEVING.

--- FADE TO BLACK ---

