



VANGUARD STEEL LTD.

PRODUCT MANUAL

TOOL STEELS-AISI O-1

AISI O-1 UNS T 31501

LOW MANGANESE, OIL HARDENING-DIMENSIONALLY STABLE, COLD WORK TOOL STEEL

TYPICAL ANALYSIS

C.	Mn.	Si.	Cr.	W.	V.	Mo.
0.90	1.00		0.50	0.50	0.15	

AN ECONOMICAL MEDIUM-ALLOY OIL HARDENING STEEL. SAFE AND UNIFORM HARDENING WITH GOOD MACHINABILITY, MINIMUM SIZE CHANGE. THIS STEEL HAS EXCELLENT ABILITY TO KEEP A KEEN CUTTING EDGE. IT HAS HIGH WEAR RESISTANCE WITH SATISFACTORY TOUGHNESS.

TYPICAL APPLICATIONS

MACHINE TAPS, STAYBOLT TAPS, THREAD CHASERS, MILLING CUTTERS, REAMERS, PRECISION SHAPING KNIVES AND WOODWORKING TOOLS, DIE PLATES AND PUNCHES, HIGH-PRODUCTION CUTTERS FOR PAPER AND SIMILAR THIN MATERIALS, ROLLER DIES, COLD WORK DIES AND ROLL FORMING APPLICATIONS, ETC.

THERMAL TREATMENTS

DEGREES IN CELSIUS

FORGING

1050-850°

ANNEALING

**740-760° TENSILE STRENGTH AS
ANNEALED (41-48 TONS/SQ. INCH)
191-219 BHN**

HARDENING

**780-820° IN OIL OR HOT BATH
(200-230°) MIN. SOAK 10 MINUTES**

**TEMPERING MAXIMUM WEAR
TEMPERING MAXIMUM TOUGHNESS**

**150-205°
230-315°**

**QUENCHING MEDIUM
OBTAINABLE HARDNESS - HRC
WEAR RESISTANCE
TOUGHNESS
DISTORTION IN HEAT TREATING
MACHINABILITY
RED HARDNESS**

**OIL
63-66
MEDIUM
MEDIUM
VERY LOW
HIGH
LOW**



VANGUARD STEEL LTD.

PRODUCT MANUAL

TOOL STEELS-AISI A-2

AISI A-2 UNS T 30102
5% CHROME AIR HARDENING-COLD WORK TOOL STEEL

TYPICAL ANALYSIS

C.	Mn.	Si.	Cr.	W.	V.	Mo.
1.00			5.00		0.15	1.00

A DEEP HARDENING STEEL WITH EXCELLENT TOUGHNESS, OUTSTANDING WEAR RESISTANCE AND GOOD MACHINING PROPERTIES.

TYPICAL APPLICATIONS

TOOLS AND DIES FOR BLANKING, PUNCHING, PIERCING, BENDING, PLANISHING, FORMING, EMBOSSING, TUBE AND ROD DRAWING, DEEP DRAWING, THREAD DRAWING, SHEAR BLADES, TRIMMING TOOLS, GAUGES, GROOVED ROLLS, HEAVILY STRESSED WOODWORKING TOOLS, ETC.

THERMAL TREATMENTS

DEGREES IN CELSIUS

FORGING

1050-900°

ANNEALING

**840-870° TENSILE STRENGTH AS
ANNEALED (44-51 TONS/SQ. INCH)
204-234 BHN**

HARDENING

950-980° IN AIR OR OIL.

**TEMPERING MAXIMUM WEAR
TEMPERING MAXIMUM TOUGHNESS**

**175-205°
DOUBLE TEMPER AT 480°**

**QUENCHING MEDIUM
OBTAINABLE HARDNESS - HRC**

**AIR
63-65**

**WEAR RESISTANCE
TOUGHNESS
DISTORTION IN HEAT TREATING
MACHINABILITY
RED HARDNESS**

**HIGH
MEDIUM
LOWEST
MEDIUM
HIGH**



VANGUARD STEEL LTD.

PRODUCT MANUAL

TOOL STEELS-AISI D-2

AISI D-2 UNS T 30402

11-1/2% HIGH CHROME - DIMENSIONALLY STABLE, COLD WORK TOOL STEEL

TYPICAL ANALYSIS

C.	MN.	SI.	CR.	W.	V.	MO.
1.50			11.50		0.80	0.75

A DEEP HARDENING STEEL WITH EXCELLENT TOUGHNESS, OUTSTANDING WEAR RESISTANCE AND GOOD MACHINING PROPERTIES. TUNGSTEN-MOLYBDENUM-VANADIUM VARIANT OF THE HIGH-CARBON, HIGH-CHROMIUM, TYPE OF STEEL.

TYPICAL APPLICATIONS

HIGH-EFFICIENCY CUTTING TOOLS (DIES AND PUNCHES), BLANKING TOOLS, WOOD-WORKING TOOLS, SHEAR BLADES FOR CUTTING THIN MATERIALS, THREAD ROLLING DIES; DRAWING, DEEP DRAWING AND EXTRUSION TOOLS, PRESSING TOOLS, COLD ROLLS FOR MULTIPLE ROLLER STANDS, GAUGES, PLASTIC MOLDS, ETC.

THERMAL TREATMENTS

DEGREES IN CELSIUS

FORGING

1050-850°

ANNEALING

**800-850° TENSILE STRENGTH AS
ANNEALED (44-51 TONS/SQ. INCH)
204-234 BHN
FURNACE COOLING TO 600° AT ABOUT
10° PER HOUR**

HARDENING

970-1000°

**TEMPERING MAXIMUM WEAR
TEMPERING MAXIMUM TOUGHNESS**

**175-205°
DOUBLE TEMPER AT 480°**

**QUENCHING MEDIUM
OBTAINABLE HARDNESS - HRC.
WEAR RESISTANCE
TOUGHNESS
DISTORTION IN HEAT TREATING
MACHINABILITY
RED HARDNESS**

**AIR
63-65
VERY HIGH
LOW
LOWEST
LOW
HIGH**



VANGUARD STEEL LTD.

PRODUCT MANUAL

TOOL STEELS-AISI H-13

AISI H-13 UNS T 20813

5% CHROMIUM, HOT WORK TOOL STEEL.

TYPICAL ANALYSIS

C.	MN.	SI.	CR.	W.	V.	MO.
0.40			5.00		1.10	1.30

DESIGNED TO RESIST ABRASION AND WASHING ACTION; IT HAS EXCELLENT SHOCK RESISTANCE. THIS STEEL HAS ENOUGH RED HARDNESS TO RETAIN ITS PROPERTIES AT HIGH OPERATING TEMPERATURE.

TYPICAL APPLICATIONS

DIES FOR HOT METALWORKING, (SHEARING, FORMING, PUNCHING, EXTRUDING, AND TRIMMING), DUMMY BLOCKS, AND MANDRELS. ALSO USED FOR STRUCTURAL APPLICATIONS WHERE HIGH ENGINEERING STRENGTHS AT ELEVATED TEMPERATURES ARE REQUIRED.

THERMAL TREATMENTS

DEGREES IN CELSIUS

FORGING

1100-900^o

ANNEALING

**800-840° TENSILE STRENGTH AS
ANNEALED (44-51 TONS/SQ. INCH)
204-234 BHN**

HARDENING

1040-1080°

TEMPERING

600-650°

NITRIDING

500-520° GAS OR SALT BATH

QUENCHING MEDIUM

AIR

OIL

OBTAINABLE HARDNESS - HRC.

50-54

52-56

WEAR RESISTANCE

MEDIUM

TOUGHNESS

VERY HIGH

DISTORTION IN HEAT TREATING

VERY LOW

MACHINABILITY

HIGH

RED HARDNESS

HIGH



VANGUARD STEEL LTD.

PRODUCT MANUAL

TOOL STEELS-AISI S-7

AISI S-7 UNS T 41907
SHOCK RESISTING TOOL STEEL

TYPICAL ANALYSIS

C.	MN.	SI.	CR.	W.	Ni.	MO.
0.50			3.25			1.40

DESIGNED FOR USE WHERE THE ABILITY TO WITHSTAND REPEATED BLOWS AT NORMAL OPERATING TEMPERATURES IS MORE IMPORTANT THAN THE ABILITY TO RESIST WEAR AND ABRASION

TYPICAL APPLICATIONS

HAND AND PNEUMATIC TOOLS FOR CHIPPING, PUNCHING, RIVETING, AS WELL AS DRIFT PINS, GRIPPERS, MANDRELS, HEAVY DUTY BLANKING AND FORMING DIES, AND SHEAR BLADES.

THERMAL TREATMENTS

DEGREES IN CELSIUS

FORGING

1120-950°

ANNEALING

**815-840° TENSILE STRENGTH AS
ANNEALED (45-52 TONS/SQ. INCH)
187-223 BHN**

HARDENING

925-950°

**TEMPERING MAXIMUM WEAR
TEMPERING MAXIMUM TOUGHNESS**

**205-260°
480-540°**

QUENCHING MEDIUM

**AIR SECTIONS GREATER THAN
2-1/2" FLASH OIL QUENCH**

OBTAINABLE HARDNESS - HRC.

45-57

**WEAR RESISTANCE
TOUGHNESS
DISTORTION IN HEAT TREATING
MACHINABILITY
RED HARDNESS**

**MEDIUM
VERY HIGH
LOWEST
MEDIUM
HIGH**