# 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** | **150-205°** |
| **TEMPERING MAXIMUM TOUGHNESS** | **230-315°** |
| **QUENCHING MEDIUM** | **OIL** |
| **OBTAINABLE HARDNESS - HRC** | **63-66** |
| **WEAR RESISTANCE** | **MEDIUM** |
| **TOUGHNESS** | **MEDIUM** |
| **DISTORTION IN HEAT TREATING** | **VERY LOW** |
| **MACHINABILITY** | **HIGH** |
| **RED HARDNESS** | **LOW** |

# 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 | 175-205° |
| TEMPERING MAXIMUM TOUGHNESS | DOUBLE TEMPER AT 480° |
| QUENCHING MEDIUM | AIR |
| OBTAINABLE HARDNESS - HRC | 63-65 |
| WEAR RESISTANCE | HIGH |
| TOUGHNESS | MEDIUM |
| DISTORTION IN HEAT TREATING | LOWEST |
| MACHINABILITY | MEDIUM |
| RED HARDNESS | 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 | DEGREÈS IN CELSIUS |
|---|---|
| FORGING | 1050-850$^{\circ}$ |
| ANNEALING | 800-850° TENSILE STRENGTH AS ANNEALED (44-51 TONS/SQ. INCH)<br>204-234 BHN<br>FURNACE COOLING TO 600° AT ABOUT 10° PER HOUR |
| HARDENING | 970-1000° |
| TEMPERING MAXIMUM WEAR | 175-205° |
| TEMPERING MAXIMUM TOUGHNESS | DOUBLE TEMPER AT 480° |
| QUENCHING MEDIUM | AIR |
| OBTAINABLE HARDNESS - HRC. | 63-65 |
| WEAR RESISTANCE | VERY HIGH |
| TOUGHNESS | LOW |
| DISTORTION IN HEAT TREATING | LOWEST |
| MACHINABILITY | LOW |
| RED HARDNESS | 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$^{\circ}$ |
| 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 |

# 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$^{\delta}$ |
| ANNEALING | 815-840° TENSILE STRENGTH AS ANNEALED (45-52 TONS/SQ. INCH) 187-223 BHN |
| HARDENING | 925-950° |
| TEMPERING MAXIMUM WEAR | 205-260° |
| TEMPERING MAXIMUM TOUGHNESS | 480-540° |
| QUENCHING MEDIUM | AIR SECTIONS GREATER THAN 2-1/2" FLASH OIL QUENCH |
| OBTAINABLE HARDNESS - HRC. | 45-57 |
| WEAR RESISTANCE | MEDIUM |
| TOUGHNESS | VERY HIGH |
| DISTORTION IN HEAT TREATING | LOWEST |
| MACHINABILITY | MEDIUM |
| RED HARDNESS | HIGH |