

... **VANGUARD STEEL LTD.**

**PRODUCT MANUAL**

**ALLOY STEELS- 4140**

**AISI /SAE 4140 (UNS G 41400)  
CHROMIUM-MOLYBDENUM STEEL**

**TYPICAL ANALYSIS**

| <b>C.</b> | <b>Mn.</b> | <b>P.</b> | <b>S.</b> | <b>Si.</b> | <b>Cr.</b> | <b>Mo.</b> |
|-----------|------------|-----------|-----------|------------|------------|------------|
| .38/.43   | .75/1.00   | .035 MAX. | .040 MAX. | .15/.35    | .80/1.10   | .15/.25    |

THIS CHROMIUM-MOLYBDENUM ALLOY STEEL IS OIL-HARDENING STEEL OF RELATIVELY HIGH HARDENABILITY, AND IS AMONG THE MOST WIDELY USED AND VERSATILE MACHINERY STEEL. THE CHROMIUM CONTENTS PROVIDES GOOD HARDNESS PENETRATION AND THE MOLYBDENUM IMPARTS UNIFORMITY OF HARDNESS AND HIGH STRENGTH. THIS GRADE IS ESPECIALLY SUITABLE FOR FORGING AS IT HAS SELF-SCALING CHARACTERISTICS IT RESPONDS READILY TO HEAT TREATMENT AND IS COMPERATIVELY EASY TO MACHINE IN THE HEAT TREATED CONDITION. IN THE HEAT TREATED CONDITION TENSILE STRENGTHS OF 170,000 PSI. FOR SMALL SECTIONS AND 140,000 PSI. FOR LARGER SECTIONS ARE ATTAINABLE, ALL COMBINED WITH GOOD DUCTILITY AND RESISTANCE TO SHOCK. THIS STEEL RESISTS CREEP IN TEMPERATURES UP TO 540 DEGREES CELSIUS AND MAINTAIN ITS PROPERTIES EVEN AFTER LONG EXPOSURE AT THESE RELATIVELY HIGH WORKING TEMPERATURES. IN THE HARDENED AND TEMPERED CONDITION, THIS STEEL POSSESSES GOOD WEAR RESISTANCE. THE WEAR RESISTANCE CAN CONSIDERABLY INCREASED BY FLAME - OR INDUCTION HARDENING, OR ALTERNATIVELY, IT MAY BE NITRIDED.

**TYPICAL APPLICATIONS**

SHAFTS, GEARS, BOLTS, COUPLINGS, SPINDLES, TOOL HOLDERS, SPROCKETS, HYDRAULIC MACHINERY SHAFTS. FOR THE OIL INDUSTRY-DRILL COLLARS, KELLY BARS, TOOL JOINTS, SUBS, ETC.

**MECHANICAL PROPERTIES - ANNEALED**

THE FOLLOWING ARE AVERAGE VALUES AND MAY BE CONSIDERED AS REPRESENTATIVE:

|                               | 1"            | 2-1/4"         | 4-1/2"         | 7-3/4"         |
|-------------------------------|---------------|----------------|----------------|----------------|
| <b>TENSILE STRENGTH, PSI.</b> | <b>98,000</b> | <b>101,500</b> | <b>100,000</b> | <b>100,000</b> |
| <b>YIELD STRENGTH, PSI.</b>   | <b>61,000</b> | <b>62,000</b>  | <b>57,000</b>  | <b>58,500</b>  |
| <b>ELONGATION, % IN 2"</b>    | <b>23.0</b>   | <b>26.0</b>    | <b>25.0</b>    | <b>21.0</b>    |
| <b>REDUCTION IN AREA, %</b>   | <b>54.0</b>   | <b>55.0</b>    | <b>56.0</b>    | <b>59.0</b>    |
| <b>BRINELL HARDNESS</b>       | <b>197</b>    | <b>212</b>     | <b>202</b>     | <b>197</b>     |

**ALLOY STEELS- 4140**

**AISI /SAE 4140 (UNS G 41400)**

CHROMIUM-MOLYBDENUM STEEL

**MECHANICAL PROPERTIES - HEAT TREATED AND STRESS RELIEVED**

THE FOLLOWING ARE AVERAGE VALUES AND MAY BE CONSIDERED AS REPRESENTATIVE:

|                               | 3-1/4"  | 4-1/2"  | 6-1/4"  | 8"      |
|-------------------------------|---------|---------|---------|---------|
| TENSILE STRENGTH, <b>PSI.</b> | 156,165 | 145,870 | 136,590 | 139,780 |
| YIELD STRENGTH, <b>PSI.</b>   | 141,085 | 126,005 | 111,070 | 114,695 |
| ELONGATION, % IN 2"           | 17.1    | 16.0    | 18.1    | 15.5    |
| REDUCTION IN AREA, %          | 55.9    | 49.8    | 55.1    | 46.9    |
| BRINELL HARDNESS              | 321     | 331     | 311     | 321     |

**MECHANICAL PROPERTIES - HEAT TREATED RC 22 MAX. FOR SOUR GAS.**

THE FOLLOWING ARE AVERAGE VALUES AND MAY BE CONSIDERED AS REPRESENTATIVE:

|                               | 2-1/2"  | 4"      | 6-1/4"  | 9-1/2"  |
|-------------------------------|---------|---------|---------|---------|
| TENSILE STRENGTH, <b>PSI.</b> | 106,600 | 108,177 | 108,118 | 105,000 |
| YIELD STRENGTH, <b>PSI.</b>   | 92,060  | 88,834  | 86,424  | 82,405  |
| ELONGATION, % IN 2"           | 25.0    | 28.7    | 26.7    | 31.0    |
| REDUCTION IN AREA, %          | 69.0    | 66.7    | 67.0    | 66.4    |
| HARDNESS - RC                 | 21      | 18      | 18      | 18      |

**MECHANICAL PROPERTIES- HEAT TREATED TO ASTM A.193 GRADE B7**

THE FOLLOWING ARE AVERAGE VALUES AND MAY BE CONSIDERED AS REPRESENTATIVE:

|                               | 3/4"    | 1-1/4"  | 2"      | 3"      |
|-------------------------------|---------|---------|---------|---------|
| TENSILE STRENGTH, <b>PSI.</b> | 154,000 | 131,000 | 140,000 | 134,000 |
| YIELD STRENGTH, <b>PSI.</b>   | 142,000 | 119,000 | 126,000 | 107,000 |
| ELONGATION, % IN 2"           | 20.0    | 18.0    | 18.0    | 19.0    |
| REDUCTION IN AREA, %          | 57.0    | 55.0    | 56.0    | 22.0    |
| BRINELL HARDNESS              | 311     | 269     | 286     | 277     |

## **ALLOY STEELS- 4140**

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### **THERMAL TREATMENTS**

### **DEGREES IN CELSIUS**

FORGING

**COMMENCE AT 1200 ° MAX.  
FINISH AT 950 °**

ANNEALING

**815/850 ° COOL SLOWLY IN FURNACE**

NORMALIZING

**870/900 ° COOL IN AIR**

HARDENING

**820/870 ° OIL QUENCH**

TEMPERING

**430/700 ° ACCORDING TO PROPERTIES REQUIRED**

### **MACHINABILITY**

4140 IN THE ANNEALED CONDITION HAS A MACHINABILITY RATING OF 66% OF AISI 8-1112. AVERAGE SURFACE CUTTING SPEED IS 110 FEET PER MINUTE.

### **SHEAR STRENGTH**

THE ULTIMATE SHEAR STRENGTH IS APPROXIMATELY 63% OF THE ULTIMATE TENSILE STRENGTH.

### **WELDABILITY**

4140 IS ON THE BORDER LINE OF WELDABILITY BECAUSE OF ITS RELATIVELY HIGH CARBON CONTENT. IT CAN BE WELDED BY ANY OF THE COMMON WELDING PROCESSES PROVIDING THE SECTION IS PREHEATED AND STRESS RELIEVED AFTER WELDING. THE GRADE OF WELDING ROD TO BE USED DEPENDS UPON THE THICKNESS OF SECTION, DESIGN, AND SERVICE REQUIREMENTS, ETC.