**LESCALLOY® AF1410 VIM-VAR**

**HIGH STRENGTH ALLOY STEEL**

<table>
<thead>
<tr>
<th>Typical Composition</th>
<th>C</th>
<th>Mn</th>
<th>Si</th>
<th>Ni</th>
<th>Cr</th>
<th>Mo</th>
<th>Co</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.15</td>
<td>0.10</td>
<td>0.10</td>
<td>10.0</td>
<td>2.0</td>
<td>1.0</td>
<td>14.0</td>
</tr>
</tbody>
</table>

**GENERAL CHARACTERISTICS**

LESCALLOY AF1410 VIM-VAR steel exhibits both high strength and very high fracture toughness. It is typically used in the 235/260 ksi (1620/1793 MPa) tensile strength range for a variety of critical, fracture-sensitive aerospace structural applications. It is double vacuum melted (VIM-VAR…vacuum induction melted followed by vacuum arc remelting) to provide superior cleanliness, ingot homogeneity, and to enhance mechanical properties.

**PHYSICAL PROPERTIES**

- **Density:** 0.283 lb/in$^3$ (7.83 g/cm$^3$)
- **Modulus of Elasticity:** 29.4 x 10$^6$ psi (203 GPa)

**Critical Temperatures:**

- $\text{Ac}_3$: 1517°F (825°C)
- $\text{Ms}$: 637°F (336°C)
- $\text{Ac}_1$: 1162°F (628°C)
- $\text{Mf}$: 335°F (168°C)

**HEAT TREATMENT**

- **Normalize:** Heat to 1650°F (898°C) for 1 hr./in. of thickness and air cool.
- **Austenitize:** Heat to 1525-1575°F (829-857°C) for 1 hr./in. of thickness and air cool. Sections larger than 2 in. (5 cm) in cross section can be oil or water quenched for maximum properties if distortion is not a factor.
- **Sub-Zero:** To assure minimum retained austenite cool to -100°F (-73°C) for 1 hr and air warm.
- **Age:** For maximum strength heat to 900-950°F (482-510°C) for 5 hours and air cool to room temperature.
- **Anneal:** Heat to 1100-1250°F (593-675°C) for 1 hr./in. of thickness and air cool. For maximum softness heat to 1250°F (675°C) for 6 hours and air cool followed by 10 hours at 1100°F (593°C) and air cool. Resultant hardness should be approximately 28 HRC.

**WORKABILITY**

- **Forging:** Forge initially at 1800-2150°F (980-1175°C). Finish forging at 1550°F and air cool.
- **Machinability:** Lescalloy AF1410 VIM-VAR steel is most easily machined in the overaged condition. The overaging treatment consists of heating normalized material to 1250°F (675°C) and holding for a minimum of 6 hours followed by an air cool. The resultant hardness is approximately 35 HRC. Cobalt-bearing high speed tooling, such as M42, is recommended.
**LESCALLOY® AF1410 VIM-VAR**

**AVERAGE MID-RADIUS MECHANICAL PROPERTIES**

<table>
<thead>
<tr>
<th>Size</th>
<th>Orientation</th>
<th>Tensile</th>
<th>Yield</th>
<th>EI</th>
<th>RA</th>
<th>Impact Energy*</th>
</tr>
</thead>
<tbody>
<tr>
<td>in</td>
<td>mm</td>
<td>ksi</td>
<td>ksi</td>
<td>%</td>
<td>%</td>
<td>Ft-lbs.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MPa</td>
<td>MPa</td>
<td></td>
<td></td>
<td>Joules</td>
</tr>
<tr>
<td>6</td>
<td>Longitudinal</td>
<td>242</td>
<td>1669</td>
<td>17</td>
<td>73</td>
<td>62</td>
</tr>
<tr>
<td></td>
<td>Transverse</td>
<td>242</td>
<td>1669</td>
<td>17</td>
<td>70</td>
<td>56</td>
</tr>
<tr>
<td>9</td>
<td>Longitudinal</td>
<td>241</td>
<td>1662</td>
<td>17</td>
<td>72</td>
<td>61</td>
</tr>
<tr>
<td></td>
<td>Transverse</td>
<td>241</td>
<td>1662</td>
<td>16</td>
<td>68</td>
<td>52</td>
</tr>
<tr>
<td>13.5</td>
<td>Longitudinal</td>
<td>242</td>
<td>1669</td>
<td>16</td>
<td>71</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>Transverse</td>
<td>242</td>
<td>1669</td>
<td>16</td>
<td>66</td>
<td>50</td>
</tr>
<tr>
<td>17</td>
<td>Longitudinal</td>
<td>244</td>
<td>1682</td>
<td>17</td>
<td>73</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>Transverse</td>
<td>243</td>
<td>1675</td>
<td>16</td>
<td>66</td>
<td>52</td>
</tr>
</tbody>
</table>

Average data from three heats after the following heat treatment:
- 1575°F (857°C) - 1 hr - oil quench
- -100°F (-73°C) - 1 hr - air warm
- 950°F (510°C) - 5 hrs - air cool

* Charpy V-Notch

**FRACTURE TOUGHNESS PER ASTM E 399**

This $K_{IC}$ property is important in many applications for Lescalloy AF1410 VIM-VAR steel. When heat treated to nominal strength levels, ASTM E 399 plane-strain fracture toughness is typically 150 ksi√in. (165 MPa√m).

**APPLICATIONS**

Lescalloy AF1410 VIM-VAR steel is used in aerospace structural applications that demand a combination of high strength and superior toughness properties.

**AVAILABILITY**

Lescalloy AF1410 VIM-VAR steel is available as bar and billet from Latrobe Specialty Steel.

**SPECIFICATIONS**

The following list of popular industry specifications is offered for general familiarization and cross-reference purposes. This should not be considered a complete listing.

- AMS6527
- MMS-214 (Boeing)
- LCM05-1421 (Lockheed)