

# Vanadium

V

## **General Information**

### **Discovery**

Vanadium was discovered by A.M. del Rio in 1801 in Mexico City. However, a French chemist incorrectly declared that this new element was impure chromium, and del Rio accepted this judgement. Vanadium was rediscovered by N.G. Selfstrom in 1831 in Falun, Sweden.

### **Appearance**

Vanadium is a shiny, silvery, soft metal.

### **Source**

Vanadium is found in about 65 different minerals including vanadinite, carnotite and patronite, and also in phosphate rock, certain iron ores and some crude oils in the form of organic complexes.

Vanadium of high purity can be obtained by the reduction of vanadium trichloride with magnesium. Much of the vanadium metal now being produced is made by calcium reduction of vanadium (V) oxide in a pressure vessel.

### **Uses**

About 80% of the vanadium produced is used as a steel additive. In this form it produces one of the toughest alloys for armour plate, axles, piston rods and crankshafts. Less than 1% of vanadium and as little chromium make steel shock- and vibration-resistant.

Vanadium (V) oxide is used in ceramics, as a catalyst and in producing superconducting magnets.

### **Biological Role**

Vanadium is an essential trace element but some compounds are toxic.

## **General Information**

Vanadium has good corrosion resistance to alkalis, dilute acids and salt water, but the metal oxidises rapidly above 660K.

The element was named after the Scandinavian goddess Vanadis because of its beautiful multi-coloured compounds.

## Physical Information

|  |                                     |
|--|-------------------------------------|
| Atomic Number  | 23                                  |
| Relative Atomic Mass ( $^{12}\text{C}=12.000$ )            | 50.942                              |
| Melting Point/K  | 2160                                |
| Boiling Point/K  | 3650                                |
| Density/kg m <sup>-3</sup>                                 | 6110 (292K)                         |
| Ground State Electron Configuration                        | [Ar]3d <sup>3</sup> 4s <sup>2</sup> |
| Electron Affinity (M-M <sup>-</sup> )/kJ mol <sup>-1</sup> | 61                                  |

## Key Isotopes

| Nuclide           | <sup>48</sup> V | <sup>49</sup> V | <sup>50</sup> V        | <sup>51</sup> V |
|-------------------|-----------------|-----------------|------------------------|-----------------|
| Atomic mass       | 47.952          | 48.948          | 49.947                 | 50.944          |
| Natural abundance | 0%              | 0%              | 0.250%                 | 99.75%          |
| Half-life         | 16 days         | 330 days        | 6x10 <sup>15</sup> yrs | stable          |

## Ionisation Energies/kJ mol<sup>-1</sup>

|                                    |       |
|------------------------------------|-------|
| M - M <sup>+</sup>                 | 650   |
| M <sup>+</sup> - M <sup>2+</sup>   | 1414  |
| M <sup>2+</sup> - M <sup>3+</sup>  | 2828  |
| M <sup>3+</sup> - M <sup>4+</sup>  | 4507  |
| M <sup>4+</sup> - M <sup>5+</sup>  | 6294  |
| M <sup>5+</sup> - M <sup>6+</sup>  | 12362 |
| M <sup>6+</sup> - M <sup>7+</sup>  | 14489 |
| M <sup>7+</sup> - M <sup>8+</sup>  | 16760 |
| M <sup>8+</sup> - M <sup>9+</sup>  | 19860 |
| M <sup>9+</sup> - M <sup>10+</sup> | 22240 |

## Other Information

|   |       |
|---|-------|
| Enthalpy of Fusion/kJ mol <sup>-1</sup>       | 17.6  |
| Enthalpy of Vaporisation/kJ mol <sup>-1</sup> | 459.7 |

### Oxidation States

|        |   |
|--------|---|
| Main   | V <sup>III</sup> , V <sup>IV</sup> , V <sup>V</sup>                                     |
| Others | V <sup>-III</sup> , V <sup>-I</sup> , V <sup>0</sup> , V <sup>I</sup> , V <sup>II</sup> |

### Covalent Bonds/kJ mol<sup>-1</sup>

Not applicable