15CDV6, 14CrMoV6-9, 1.7734, 1.7735, 1.8521

Aerospace and aviation industries demand high-performance steels capable of withstanding extreme mechanical stresses, high temperatures, and corrosive environments. Key alloys such as **15CDV6, 14CrMoV6-9, 1.7734 (FE-PL52S), 1.7735, and 1.8521 (15CrMoV5-9)** are widely used in critical components like turbine parts, landing gear, and structural elements.

This guide provides a **detailed comparison** of these steels, covering:

- **Chemical compositions**
- **Mechanical properties** (tensile strength, yield strength, elongation)
- **Heat treatment processes** (annealing, quenching & tempering)
- **High-temperature performance** (creep resistance, stress rupture)
- **Welding & machining characteristics**
- **Equivalent materials**

These **high-strength, creep-resistant steels** are essential in aerospace and aviation for critical high-stress, high-temperature applications. Understanding their **composition, heat treatment, and mechanical behavior** ensures optimal performance in demanding environments.

For **material selection, processing, or welding recommendations**, consult the relevant **AIR 9160/C, DIN, or EN standards** for precise specifications.

References:

- AIR 9160/C Aerospace Material Standards
- DIN EN 10028 (Pressure Vessel Steels)
- ASM Aerospace Materials Handbook

Applications

Steel Grade	Standard Designation	Key Applications
15CDV6	AIR 9160/C	Aircraft landing gear, high-stress structural parts
14CrMoV6-9	1.7735	High-temperature turbine components, pressure vessels
1.7734 (FE-PL52S)	12CrMoV6-9	Boiler tubes, heat exchangers, aerospace piping
1.8521 (15CrMoV5-9)	DIN 1.8521	Jet engine components, fasteners, high-load bolts
15CrMoV5-10 (1.7745)	DIN 1.7745	Exhaust systems, turbine casings

Special Steel

Practical Implications for Aerospace Applications

Thermal Management:

- **14CrMoV6-9 & 1.7734** (lower conductivity) are better for **thermal insulation** (e.g., turbine shrouds).
- **15CDV6** (higher conductivity) suits **heat exchangers & cooling systems**.

Dimensional Stability:

- **1.7734 has the lowest thermal expansion**, ideal for precision components.

Weight Considerations:

- All steels have similar densities (~7.85-7.87 g/cm³), making them **comparable in weight-critical designs**.

Stiffness at High Temperatures:

- **15CDV6 & 1.8521 retain stiffness best** at 500-600°C, useful for **engine mounts & load-bearing structures**.

Equivalent or Similar Grades - Chemical Composition

Element	15CDV6, AIR 9160	14CrMoV6-9, 1.7735	12CrMoV6-9, 1.7734	15CrMoV5-9, 1.8521	15CrMoV5-10, 1.7745
C	0.12-0.18	0.10-0.15	0.08-0.15	0.12-0.18	0.12-0.18
Si	≤0.40	≤0.50	≤0.50	≤0.40	≤0.40
Mn	0.40-0.70	0.40-0.70	0.40-0.70	0.40-0.70	0.40-0.70
Cr	0.90-1.20	1.80-2.20	1.80-2.20	1.00-1.30	1.00-1.30
Mo	0.50-0.70	0.90-1.10	0.90-1.10	0.90-1.10	0.90-1.10
V	0.15-0.25	0.25-0.35	0.25-0.35	0.25-0.35	0.25-0.35
P (max)	0.025	0.025	0.025	0.025	0.025
S (max)	0.025	0.025	0.025	0.025	0.025

Mechanical Properties

Room Temperature Properties

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Grade	Condition	Tensile (MPa)	Yield (MPa)	Elongation (%)	Hardness (HB)
15CDV6	+QT (Quenched & Tempered)	850-1050	≥700	≥12	248-302
14CrMoV6-9 (1.7735)	+HT (Heat Treated)	650-850	≥450	≥16	200-250
1.7734 (12CrMoV6-9)	+A (Annealed)	550-750	≥350	≥18	180-220
1.8521 (15CrMoV5-9)	+QT	900-1100	≥750	≥10	270-330
1.7745 (15CrMoV5-10)	+QT	950-1150	≥800	≥9	280-340

High-Temperature Properties

These steels retain strength at elevated temperatures (up to **600°C**), making them ideal for jet engines and exhaust systems.

Grade	Temperature (°C)	Creep Strength (MPa/10,000h)	Rupture Strength (MPa/100h)
15CDV6	500	250	450
14CrMoV6-9	550	180	380
1.7734	550	160	350
1.8521	600	200	420
1.7745	600	220	450

Physical Properties

Physical properties such as **density, thermal expansion, thermal conductivity, and electrical resistivity** are crucial for material selection in aerospace and aviation applications.

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Density (g/cm³)

Density affects weight-critical aerospace components.

Grade	Density (g/cm³)
15CDV6	7.85

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Grade	Density (g/cm³)
14CrMoV6-9 (1.7735)	7.87
1.7734 (12CrMoV6-9)	7.86
1.8521 (15CrMoV5-9)	7.85
1.7745 (15CrMoV5-10)	7.86

*Note: All values are near **7.85-7.87 g/cm³**, typical for low-alloy steels.*

Thermal Expansion Coefficient (10^{-6}/°C)

Thermal expansion impacts dimensional stability under temperature fluctuations.

Grade	20-100°C	20-300°C	20-500°C	20-600°C
15CDV6	11.5	12.2	13.0	13.5
14CrMoV6-9	11.2	11.8	12.6	13.1
1.7734	11.0	11.6	12.4	12.9
1.8521	11.3	12.0	12.8	13.3
1.7745	11.4	12.1	12.9	13.4

Key Takeaway:

- **Higher Cr-Mo-V content slightly reduces thermal expansion.**
- **Critical for turbine blades, exhaust systems, and high-temperature structures.**

Thermal Conductivity (W/m·K)

Thermal conductivity determines heat dissipation efficiency.

Grade	20°C	200°C	400°C	600°C
15CDV6	42	40	38	36
14CrMoV6-9	38	36	34	32
1.7734	37	35	33	31
1.8521	40	38	36	34
1.7745	39	37	35	33

Key Takeaway:

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- **Lower thermal conductivity in high-Cr-Mo steels (better for thermal barrier applications).**
- **15CDV6 has the highest conductivity, suitable for heat exchangers.**

Electrical Resistivity (μΩ·m)

Important for electromagnetic and grounding applications.

Grade	Resistivity (μΩ·m) at 20°C
15CDV6	0.22
14CrMoV6-9	0.25
1.7734	0.24
1.8521	0.23
1.7745	0.24

Key Takeaway:

- **Higher alloying (Cr, Mo, V) increases resistivity.**
- **Still low enough for most aerospace electrical applications.**

Specific Heat Capacity (J/kg·K)

Determines heat absorption capability.

Grade	20°C	300°C	500°C
15CDV6	460	520	580
14CrMoV6-9	470	530	590
1.7734	465	525	585
1.8521	475	535	595
1.7745	480	540	600

Key Takeaway:

- **Increases with temperature due to lattice vibrations.**
- **Higher Cr-Mo steels absorb slightly more heat.**

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Elastic Modulus (Young's Modulus, GPa)

Stiffness under load.

Grade	20°C	300°C	500°C	600°C
15CDV6	210	195	180	170
14CrMoV6-9	205	190	175	165
1.7734	200	185	170	160
1.8521	208	193	178	168
1.7745	207	192	177	167

Key Takeaway:

- **Decreases with temperature (critical for high-temperature structural design).**
- **15CDV6 retains the highest stiffness at elevated temperatures.**

Magnetic Properties

- **All grades are ferromagnetic (attracted to magnets).**
- **Magnetic permeability decreases slightly at high temperatures.**

Summary of Key Physical Properties

Property	15CDV6	14CrMoV6-9	1.7734	1.8521	1.7745
Density (g/cm³)	7.85	7.87	7.86	7.85	7.86
Thermal Expansion (10⁻⁶/°C, 20-600°C)	13.5	13.1	12.9	13.3	13.4
Thermal Conductivity (W/m·K, 20°C)	42	38	37	40	39
Electrical Resistivity (μΩ·m)	0.22	0.25	0.24	0.23	0.24
Young's Modulus (GPa, 20°C)	210	205	200	208	207

Heat Treatment

Grade	Annealing (°C)	Quenching (°C)	Tempering (°C)	Recommended Condition
15CDV6	850-900	920-950 (Oil)	600-650	+QT (Quenched & Tempered)
14CrMoV6-9	880-920	950-980 (Air/Oil)	650-700	+HT (Heat Treated)
1.7734	860-900	920-950 (Air)	620-680	+A (Annealed)

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Grade	Annealing (°C)	Quenching (°C)	Tempering (°C)	Recommended Condition
1.8521	870-910	930-970 (Oil)	600-650	+QT
1.7745	880-920	940-980 (Oil)	620-670	+QT

Processing Performance

- **Machinability**: Moderate (similar to low-alloy steels, requires carbide tools).
- **Weldability**: Preheating (200-300°C) and post-weld heat treatment (PWHT) recommended to avoid cracking.
- **Formability**: Good in annealed condition, but high strength in +QT state limits cold forming.

Equivalent Materials & Cross-References

Grade	EN/DIN	UNS	AISI/SAE	Similar Grades
15CDV6	-	-	-	AISI 6150 (modified)
14CrMoV6-9	1.7735	-	-	14MoV6-3 (DIN)
1.7734	12CrMoV6-9	-	-	13CrMo4-5 (similar)
1.8521	15CrMoV5-9	-	-	15CrMoV5-10 (DIN)
1.7745	15CrMoV5-10	-	-	14CrMoV6-9 (similar)

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