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COMPARE API5L GR.B PSL1 PSL2 AND A333 GR.6 NACE

Table : Compare API5L GR.B PSL1 PSL2 AND A333 GR.6 NACE

Property	API 5L Gr. B PSL1	API 5L Gr. B PSL1 (with Impact Testing)	API 5L Gr. B PSL2	ASTM A333 Gr. 6 (NACE MR0175)
Standard	API 5L	API 5L	API 5L	ASTM A333 + NACE MR0175
Chemical Composition	C: ≤ 0.28%, Mn: ≤ 1.20%, P: ≤ 0.03%, S: ≤ 0.03%	Same as PSL1	C: ≤ 0.26%, Mn: ≤ 1.20% (≤1.40%*), P: ≤ 0.02%, S: ≤ 0.015%	C: ≤ 0.30%, Mn: 0.29–1.06%, P: ≤ 0.025%, S: ≤ 0.025%
Yield Strength (MPa)	245	245	275	240
Tensile Strength (MPa)	415	415	450	415
Impact Test Temp (°C)	Not required	**0°C or as required**	0°C	-45°C or lower
Sour Service	Not applicable	Suitable with testing	Suitable	Suitable for sour service
Hardness Limit	Not applicable	Max 22 HRC (if sour service required)	Max 22 HRC	Max 22 HRC (as per NACE MR0175)
Temperature Range (°C)	-20°C to 232°C	-50°C to 232°C	-50°C to 232°C	-101°C to 399°C
Hydrostatic Testing	Required	Required	Required	Required
Applications	General-purpose pipelines	Sour service with impact testing	High-strength, sour service pipelines	Low-temperature, sour service pipelines

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Key Points About PSL1 with Additional Impact Testing in substitute with PSL2 :

1. **Chemical Composition:**
   - PSL1 has slightly looser limits for carbon (C), phosphorus (P), and sulfur (S) than PSL2. However, with stricter manufacturing controls and quality assurances, PSL1 can still perform adequately in sour service when combined with impact testing.
2. **Impact Testing:**
   - Adding Charpy V-notch impact testing at 0°C ensures PSL1 meets the toughness requirements for PSL2, making it interchangeable in applications that demand impact testing.
3. **Mechanical Properties:**
   - The yield strength (245 MPa) and tensile strength (415 MPa) of PSL1 remain slightly lower than PSL2 (275 MPa yield, 450 MPa tensile), so adjustments to design parameters, such as increasing wall thickness, may be required for high-pressure applications.
4. **Cost Efficiency:**
   - PSL1 with impact testing may provide a more cost-effective solution compared to PSL2 or ASTM A333 Gr. 6 with NACE compliance, particularly when high strength or low-temperature performance is not critical.

Why Choose PSL1 with Additional Impact Testing?

1. Interchangeability: Adding impact testing makes PSL1 suitable for applications typically reserved for PSL2, such as sour service pipelines.
2. Cost Savings: PSL1 is often less expensive than PSL2 or ASTM A333 Gr. 6, even with the additional testing.
3. Customization: PSL1 can be tailored to specific project requirements by controlling impact test parameters and material composition.

Considerations for Substitution

1. **Sour Service Compliance:**
   - If PSL1 is used in sour service, ensure compliance with NACE MR0175 by testing for sulfide stress cracking (SSC) and hydrogen-induced cracking (HIC).
   - Confirm the hardness does not exceed 22 HRC for sour environments.
2. **Design Adjustments:**
   - For higher-pressure applications, evaluate whether additional wall thickness is required to offset the slightly lower yield and tensile strength of PSL1.
3. **Certification:**
   - Ensure the material is supplied with Mill Test Certificates (MTC) reflecting the impact test results, hardness tests, and chemical composition controls.

Conclusion

API 5L Gr. B PSL1 with additional impact testing can be a practical substitute for PSL2 in many applications, including sour service, provided proper testing and certification are performed. While ASTM A333 Gr. 6 with NACE compliance remains the superior choice for low-temperature environments, PSL1 with impact testing offers a cost-effective alternative for applications with moderate toughness and strength requirements.

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Why ASTM A333 Gr. 6 (NACE MR0175) Can Substitute API 5L Gr. B PSL2

1. **Low-Temperature Performance:**
   - A333 Gr. 6 is specifically designed for low-temperature environments, with impact testing conducted at -45°C or lower, exceeding the requirements for PSL2 (tested at 0°C). This makes it suitable for applications involving colder climates or cryogenic conditions.
2. **Sour Service Capability:**
   - With NACE MR0175 compliance, A333 Gr. 6 meets the criteria for sulfide stress cracking (SSC) and hydrogen-induced cracking (HIC), just like PSL2. The stricter chemical composition limits ensure material purity and reliability in sour service environments.
3. **Mechanical Properties:**
   - While A333 Gr. 6 has slightly lower yield strength (240 MPa) and tensile strength (415 MPa) than PSL2 (275 MPa yield, 450 MPa tensile), it provides sufficient strength for most applications. Wall thickness adjustments can address any strength concerns.
4. **Chemical Composition:**
   - A333 Gr. 6's stricter limits on phosphorus (P) and sulfur (S), along with the addition of silicon (Si) and optional nickel (Ni), enhance toughness and performance in both low-temperature and sour environments.
5. **Versatility:**
   - A333 Gr. 6 offers a broader temperature range (-101°C to 399°C), making it more versatile than PSL2 for projects involving fluctuating temperatures.

Points to Be Aware of:

1. **Strength Adjustments:**
   - The slightly lower yield strength and tensile strength of A333 Gr. 6 compared to PSL2 should be considered. For high-pressure applications, evaluate whether increased wall thickness is required.
2. **High-Temperature Applications:**
   - A333 Gr. 6 can operate at higher temperatures (up to 399°C), but for consistent use near its upper limit, material performance should be evaluated carefully.
3. **Certification Requirements:**
   - Ensure that the A333 Gr. 6 material is supplied with NACE MR0175 certification and Mill Test Certificates (MTC) to verify compliance with both sour service and low-temperature conditions.

Conclusion:

ASTM A333 Gr. 6 with NACE MR0175 compliance is a reliable substitute for API 5L Gr. B PSL2, particularly for applications involving:

- Low-temperature environments.
- Sour service conditions.

While A333 Gr. 6 offers advantages in temperature versatility and sour service compatibility, the slightly lower strength should be addressed during the design phase. This substitution provides a cost-effective and technically sound solution without compromising safety or performance.