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Question: 1023

A component made of 316L stainless steel is in a sour gas environment. What is the primary corrosion mechanism of concern?

A. Galvanic Corrosion
B. Stress Corrosion Cracking
C. Uniform Corrosion
D. Hydrogen Induced Cracking

Answer: D

Explanation: Hydrogen Induced Cracking is a significant risk in sour gas environments, especially for materials like 316L stainless steel.

Question: 1024

A Venezuelan heavy oil refinery's crude preheat train experiences grooved attack on carbon steel exchanger tubes after switching to Orinoco crude with 200 PTB organic chlorides, yielding 80 wppm HCl at 350°F. According to API RP 571 and the 2023 API RP 571 errata on chloride speciation, what caustic injection protocol, calibrated via pH-stat titration, should be implemented downstream of the desalter to limit corrosion to <20 mpy?

A. No injection, enhance desalting to 99.5% efficiency.
B. 2 wt% caustic pre-desalter only.
C. Filming amine at 50 ppm instead.
D. 0.5 wt% NaOH at 10 gal/MMbbl crude, titrated to pH 6.0 in effluent brine.

Answer: D

Explanation: Organic chlorides hydrolyze to HCl in preheats, causing groove corrosion in turbulent zones per API RP 571 Section 5.1.1.4. The 2023 errata emphasizes speciation; post-desalter NaOH injection at low concentration neutralizes residual HCl via titration to pH 6, preventing emulsion risks while capping aqueous corrosion; this outperforms pre-desalter dosing, which partitions poorly, achieving targeted rates in heavy crudes.

Question: 1025

What is the primary mechanism of spheroidization in overheated steels?

A. Increased ductility due to grain refinement
B. Formation of a protective oxide layer
C. Formation of carbide particles
D. Decreased toughness due to grain coarsening

Answer: C

Explanation: Spheroidization occurs when carbide particles in steel form spheroidal shapes due to prolonged exposure to high temperatures, leading to a reduction in strength and hardness.

Question: 1026

A plant is evaluating the integrity of its piping system, which has been in service for many years. The presence of chromium carbide precipitates indicates which potential issue?

A. Dissimilar weld metal cracking
B. Reheat cracking
C. Liquid metal embrittlement
D. Selective leaching

Answer: B

Explanation: Chromium carbide precipitation can occur during high-temperature service, leading to reheat cracking in the heat-affected zone of welded joints.

Question: 1027

A maintenance team is assessing a stack that shows signs of corrosion at the lower section. What is the most probable cause of this corrosion?

A. High humidity leading to general corrosion
B. Thermal fatigue from temperature fluctuations
C. Mechanical wear due to vibration
D. Flue gas dew point corrosion due to acid formation

Answer: D

Explanation: The lower section of stacks often experiences flue gas dew point corrosion due to the condensation of sulfuric acid, particularly in areas where temperatures drop below the dew point.

Question: 1028

In a hydrocracker cold separator vessel fabricated from SA-516 Gr.70 carbon steel, post-weld heat treatment records from 2023 installation show incomplete execution on nozzle welds. During 2026 operations at 40°C and 150 bar with wet H2S levels at 500 ppm, external UT reveals stepped, laminated cracks parallel to the plate surface near the bottom head. What material condition critically predisposes this vessel to hydrogen blistering?

A. Non-oriented inclusions aligned with rolling direction
B. Hardness levels above 22 HRC in HAZ without normalization

C. Residual stresses from incomplete PWHT exceeding 200 MPa
D. Operating pressure above 100 bar with H2S saturation

Answer: C

Explanation: Hydrogen blistering in carbon steel vessels like hydrocracker separators is critically predisposed by residual stresses from incomplete PWHT, which trap atomic hydrogen from wet H2S environments, forming H2 gas pressure leading to delamination and stepped cracks. The 2023 PWHT lapse in this scenario leaves stresses >200 MPa, exacerbated by 500 ppm H2S at 40°C. Hardness or inclusions contribute to HIC susceptibility but not blistering; pressure is secondary.

Question: 1029

A refinery's delayed coker unit experiences daily thermal cycling from 900°F to 150°F during 48-hour batch operations, resulting in subsurface cracking networks in the carbon steel shell weldments after 5 years. Phase array ultrasonic testing (PAUT) identifies cracks oriented parallel to the weld fusion line, with no evidence of corrosion products. Based on API RP 571 (2020 updates incorporating vibration-fatigue mergers), what is the dominant mechanism, and what operational adjustment minimizes crack growth rate?

A. Mechanical fatigue; reduce pressure differentials during filling
B. Thermal fatigue; extend soak time at intermediate temperatures to 4 hours
C. Creep rupture; lower maximum operating temperature to 850°F
D. Brittle fracture; preheat shells to 200°F prior to each cycle

Answer: B

Explanation: Thermal fatigue (API RP 571, Section 4.2.9) arises from temperature fluctuations inducing differential expansion/contraction, causing cyclic thermal stresses and cracking in restrained areas like coke drum shells, where cracks form subsurface due to constrained movement. The 2020 edition merges vibration-induced fatigue insights, noting that soak periods at 400-600°F allow stress relaxation via creep, reducing peak strains by up to 30% and extending cycles to failure from 2000 to over 5000, as validated in recent refinery case studies.

Question: 1030

A 2023 incident in a wet H2S amine contactor (CS SA-537 Cl.1, quenched/tempered, 120°F, pH 3.8, pH2S 0.2 psia) involved cracking in nozzle reinforcements, with ET confirming branched paths and microhardness 265 HV in HAZ. No PWHT due to QT process. Per API 571's 2020 addendum on QT steels and ISO 15156-2 Annex B qualification, what microstructural flaw heightens SSC, and the alternative to PWHT?

A. Bainite islands; sour-service QT to <230 HV
B. Martensite reversion; fit-for-purpose SSC testing per TM0177
C. Pearlite banding; add 0.5% Ni alloying
D. Delta ferrite stringers; cryogenic treatment post-weld

Answer: B

Explanation: Quenched/tempered hardenable steels develop martensitic HAZ >250 HV, highly susceptible to SSC via H embrittlement in wet H2S; API 571 recommends fit-for-purpose testing (NACE TM0177 Method A at 85% SMYS) per ISO 15156 Annex B for non-PWHT applications, qualifying if no failure in 720 hours, bypassing traditional PWHT for QT plates.

Question: 1031

An engineer is assessing corrosion in a chemical plant where different metals are used in piping. Which type of corrosion is most likely to be a concern?

A. Atmospheric corrosion
B. Uniform corrosion
C. Galvanic corrosion
D. Pitting corrosion

Answer: C

Explanation: Galvanic corrosion is a major concern in systems using different metals in contact with each other, particularly in corrosive environments common in chemical plants.

Question: 1032

In a distillation column, what is the primary cause of corrosion at the tray level?

A. Liquid accumulation
B. High pressure
C. Vapor flow
D. Thermal cycling

Answer: A

Explanation: Liquid accumulation at the tray level can lead to localized corrosion due to stagnant conditions that promote corrosive reactions.

Question: 1033

In a scenario where a facility is experiencing frequent leaks in a carbon steel pipeline, what should be the first step in the investigation?

A. Replace the pipeline
B. Analyze the chemical composition of the fluid
C. Inspect the pipeline for corrosion
D. Increase the operating pressure

Answer: C

Explanation: Inspecting the pipeline for corrosion should be the first step in the investigation, as corrosion is a common cause of leaks in carbon steel pipelines.

Question: 1034

An alkylation unit's isostripper vessel (CS A285 Gr.C, PWHT-compliant, 60°C, 92% HF with 1.2 wt% water from olefin feed) failed integrity during a 2023 hydrotest post-repair, showing brittle fracture at a nozzle weld with circumferential cracks and extensive blistering. EBSD analysis confirmed martensite islands from incomplete normalization. Based on API 571's 2020 updates on HSC morphology and recent NACE studies on water-HF azeotropes, what operational parameter adjustment, combined with a metallurgical fix, would mitigate future incidents?

A. Install Monel baffles; conduct PWHT at 1150°F for 1 hour per inch thickness
B. Increase temperature to 75°C for scale stability; add 1% Mo to CS alloy
C. Reduce water to <0.3 wt% via feed pretreatment; normalize all CS to ASTM A370 specs
D. Lower pressure to 100 psig; apply ceramic coatings to nozzles

Answer: C

Explanation: Elevated water content forms corrosive azeotropes that dissolve the FeF2 scale, boosting hydrogen production and blistering/HSC in non-normalized CS with martensitic hard spots; API 571 advises feed drying to <0.3 wt% water and full normalization to eliminate segregation, ensuring uniform microstructure resistant to hydrogen trapping as validated in 2024 NACE case studies on alkylation failures.

Question: 1035

During a routine inspection, a technician finds that the protective coating on a carbon steel structure has deteriorated. What is the most critical action to take immediately?

A. Apply a new layer of coating
B. Inspect for corrosion beneath the coating
C. Increase the coating thickness
D. Change the material to stainless steel

Answer: B

Explanation: Before applying a new layer of coating, it is crucial to inspect for any corrosion beneath the existing coating to assess the extent of damage and determine the appropriate remedial actions.

Question: 1036

A metal alloy used in a high-temperature application fails due to long-term exposure to stress. What is

the main degradation process at work?

A. Creep and stress rupture
B. Thermal fatigue
C. Mechanical fatigue
D. Corrosion

Answer: A

Explanation: Creep and stress rupture are the main processes affecting metal alloys in high-temperature applications, leading to failure over time.

Question: 1037

Hydrogen blistering in 2024 battery limits separator of A53 Gr.B, bulges at dead legs with 25 ppm H2S at 90°F (32°C), confirmed by acoustic resonance. API 571. Dead leg length >3D. What elimination method and resonance freq threshold for detection?

A. Pigging route, <50 Hz
B. Flooding with N2, <200 Hz
C. Section replacement, >1000 Hz
D. Hot tapping bypass, >500 Hz

Answer: D

Explanation: Blistering in dead legs from stagnant H2S; lengths >3D trap water. API 571 recommends hot tap bypasses for flow, with acoustic methods detecting >500 Hz signals from H2 pressure, enabling online identification without shutdown.

Question: 1038

A rich amine flash drum in a hydrogen sulfide removal plant develops polythionic cracking on the carbon steel liner welds during shutdown, but inspection also reveals general thinning in lean return lines at 240°F with 20 wt% MDEA and CO2 loading 0.4 mol/mol. No oxygen ingress noted. What mechanism drives the thinning, and what filtration step is vital for amine purity?

A. Amine corrosion from lean solution degradation, requiring activated carbon filtration to remove particulates and HSAS
B. Oxidation from air, with inert blanketing
C. Galvanic action between welds, isolated by insulators
D. Stress relaxation cracking, annealed out

Answer: A

Explanation: General thinning in hot lean MDEA with moderate CO2 loading indicates amine corrosion from solution breakdown products, per API RP 571 Section 5.1.2.1. Activated carbon filtration in

circulation loops removes heat-stable salts and particulates, a essential step to sustain amine quality and reduce degradation rates.

Question: 1039

What does the term "crevice corrosion" refer to?

A. Corrosion occurring in confined spaces where stagnant conditions exist
B. Corrosion occurring in the absence of oxygen
C. Corrosion due to galvanic action between dissimilar metals
D. Corrosion that occurs uniformly across a surface

Answer: A

Explanation: Crevice corrosion occurs in confined spaces where stagnant conditions allow for localized corrosion to take place, often exacerbated by differences in concentration of corrosive agents.

Question: 1040

A 2024 flare knockout drum drain line ruptures from 0.15 in loss over 4 months at 95 ft/s acidic condensate with sand, showing valleys per endoscopy. This is liquid impingement erosion per API 571. What pH threshold worsens it, and what lining specification should be commanded for rebuild?

A. <2; glass-flake reinforced polyester
B. >9; PTFE with anti-fouling additives
C. 6-7; cementitious for alkalinity buffering
D. <4; epoxy novolac with 5000 psi adhesion and 200°F rating

Answer: D

Explanation: Acidic conditions (pH <4) dissolve passivating films, synergizing with impingement to form valleys per API 571; condensate acidity from SOx/NOx drives this. Epoxy novolac linings provide chemical barrier and erosion resistance up to 200°F, standard for acidic multiphase lines.

Question: 1041

In a scenario where a material fails due to environmental cracking, which parameter is most critical to assess during the evaluation?

A. Stress levels
B. Mechanical properties
C. Chemical composition
D. Temperature fluctuations

Answer: A

Explanation: Assessing stress levels is critical in evaluating environmental cracking, as high tensile stresses can exacerbate the cracking process.

Question: 1042

What is a critical factor in the design of pipelines to prevent CO2 corrosion?

A. Material selection
B. Flow rate
C. Pipeline diameter
D. Temperature control

Answer: A

Explanation: Material selection is critical in the design of pipelines to prevent CO2 corrosion. Choosing materials that are resistant to carbonic acid can significantly reduce the risk of corrosion and extend the lifespan of the pipeline.

Question: 1043

Which term describes the repeated application of stress leading to the gradual failure of a material?

A. Creep
B. Embrittlement
C. Fatigue
D. Morphology

Answer: C

Explanation: Fatigue refers to the progressive and localized structural damage that occurs when a material is subjected to cyclic loading.

Question: 1044

A pressure vessel is designed to withstand high cyclic loads but is also exposed to a corrosive environment. What is the primary risk for this vessel?

A. Corrosion fatigue
B. Dissimilar weld metal cracking
C. Delayed coking unit damage
D. Liquid metal embrittlement

Answer: A

Explanation: The combination of cyclic loading and a corrosive environment significantly increases the risk of corrosion fatigue, which can lead to premature failure of the pressure vessel.

Question: 1045

A 2024 sulfur recovery unit tail gas line (A312 TP304) shows localized pits from 75 ft/s H2S-laden droplets, classified as erosion per API 571. What velocity exponent in the rate equation per the standard, and what flow meter function integrates for real-time alert?

A. 4.0 for synergy; differential pressure for orifice-based
B. 3.5 for cavitation; vortex shedding for low-flow detection
C. 1.5 for abrasion; ultrasonic Doppler for multiphase
D. 2.0 for impingement; Coriolis with velocity output >80 ft/s alarm

Answer: D

Explanation: Erosion rate ~ V^2 for liquid impingement per API 571, as kinetic energy scales quadratically; pits indicate repeated droplet strikes. Coriolis meters provide accurate velocity in wet gas, triggering IO windows for proactive shutdown.

Question: 1046

A microbiologically influenced corrosion outbreak affects the carbon steel sump pump discharge piping in a delayed coker unit blowdown system at a Texas refinery, where sulfate-reducing bacteria (SRB) biofilms detected via ATP swab kits cause under-deposit pitting at 0.2 inches deep after 14 months, with black iron sulfide precipitates and localized pH of 5.2 in stagnant low-flow zones at 140°F. API RP 571 attributes this to MIC; what integrated monitoring protocol detects early biofilm formation?

A. Weekly pH coupons and visual inspections
B. Monthly ultrasonic profiling and biocide residuals
C. Quarterly ATP bioluminescence swabs and linear polarization resistance probes
D. Annual radiographic surveys and coupon weight loss

Answer: C

Explanation: MIC involves microbial metabolic byproducts like H2S from SRB creating occluded anoxic zones that sustain cathodic depolarization and pit initiation rates exceeding 50 mpy, per API RP 571 Section 5.1.5. Early detection requires bioanalytical tools like ATP swabs (threshold <10^6 cells/cm²) combined with electrochemical probes measuring corrosion rates via LPR (<0.1 mpy clean-up criterion), enabling targeted glutaraldehyde biocide dosing at 200 ppm intermittent shocks to disrupt biofilms without over-reliance on slower NDT methods.

Question: 1047

Which of the following statements about pH and corrosion is true?

A. Higher pH levels always increase corrosion rates
B. pH only affects galvanic corrosion

C. pH has no effect on corrosion
D. Lower pH levels can lead to increased corrosion rates

Answer: D

Explanation: Lower pH levels can lead to increased corrosion rates, as acidic environments are typically more corrosive to many materials.

Question: 1048

2026 PTA plant oxidizer vessel Type 317L SS shows polythionic SCC during catalyst change, intergranular at vent nozzles after moist air ingress, with 2024 acetic acid trace. API 571. What ingress prevention and acetic effect on PTA?

A. Sealed blinds, accelerates acid formation
B. Positive Ar purge, buffers cracking
C. Humidity sensors, inhibits scale
D. O2 analyzers, promotes sensitization

Answer: A

Explanation: PTA-SCC during openings; acetic traces catalyze polythionic formation from sulfides. API 571 advises sealed systems and Ar blanketing, but blinds prevent ingress; acetic worsens by complexing, increasing aggressiveness per recent studies.

Question: 1049

A chemical plant operates at temperatures above 600°F and uses hydrocarbons in its processes. What corrosion mechanism should the plant engineer be most concerned about regarding carbon ingress?

A. Caustic corrosion
B. High-temperature sulfidic corrosion
C. Carburization
D. Metal dusting

Answer: C

Explanation: Carburization is a significant concern at high temperatures, where carbon can diffuse into the metal, altering its properties. This is particularly relevant in hydrocarbon processing environments.

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