PermaFusion

ENGINEERED STORAGE SYSTEMS

TECHNICAL BROCHURE

SERIES 02 / VOL. 02

PFN-GFS-2026

GLASS-FUSED-TO-STEEL SYSTEM

Steel that refuses to corrode.

PermaFusion is a vitrified silica glass coating molecularly fused to bolted carbon steel at 1,500 °F — a chemically inert, non-porous composite engineered for three decades of corrosion-free service.

— GLASS · BOND · STEEL —

KEY SPECIFICATIONS

GLASS THICKNESS	250–400 µm DFT
SURFACE HARDNESS	7,000+ Hv
VITRIFICATION TEMP	1,500 °F
PH RANGE (CONTINUOUS)	3 – 11
DESIGN SERVICE LIFE	30+ years
SINGLE-TANK CAPACITY	5M+ gallons

MANUFACTURED & TESTED TO

AWWA D103 · NSF/ANSI 61 · NFPA 22
ISO 28765 · ASTM A1011 · SSPC-SP10

§ 02 / THE COATING

Anatomy & *process.*

5-LAYER COMPOSITE
SYMMETRIC SANDWICH
DUAL-SIDE VITRIFIED
ISO 28765:2016

A PermaFusion panel is a **five-layer symmetric composite**: vitrified silica glass on both interior and exterior faces, bonded to the carbon-steel substrate by a thin iron-oxide transition layer formed during a 1,500 °F vitrification firing. Both glass surfaces are placed under permanent compression by the steel's faster cooling rate.

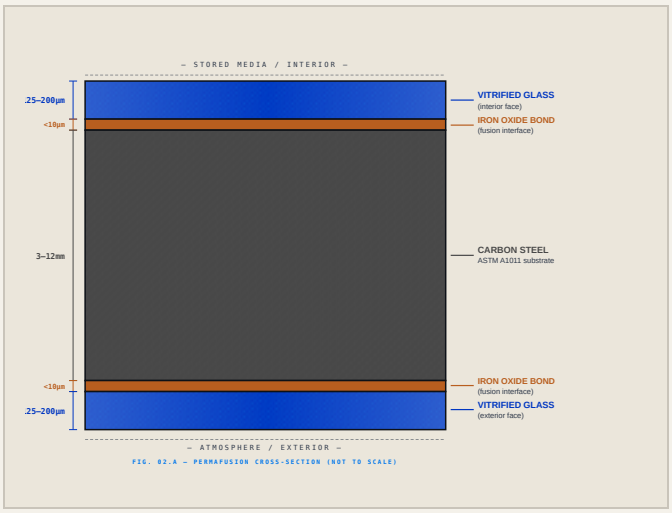


FIG. 02.A — PERMAFUSION CROSS-SECTION (NOT TO SCALE)

Vitrified Silica Glass — 125–200 µm/face

Inorganic borosilicate glass enamel on both faces. Non-porous, chemically inert across pH 3–11, ~7,000 Hv hardness. Color is in the molten glass itself — **not surface pigment**.

Iron-Oxide Bond Layer — <10 µm

Transition zone formed during vitrification when iron diffuses into molten glass. **Metallurgical bond** — not adhesive — same chemistry as porcelain enamel.

Carbon Steel Substrate — 3–12 mm

Hot-rolled **ASTM A1011**, blasted to **SSPC-SP10** near-white finish before frit application. Provides the structural strength of the vessel.

Compression Stress Field — Permanent

Steel cools faster than glass — leaving residual **compressive stress** on both glass surfaces. Prevents crack initiation throughout the asset's life.

GLASS COMPOSITION

Typical formulation by weight

SiO_2	B_2O_3	Na_2O	Al_2O_3	CaO	CoO/Cr_2O_3
Silica	Boron Oxide	Sodium	Alumina	Calcium	Color
50–65%	10–18%	8–15%	3–8%	3–8%	1–4%

§ 02.1 / MANUFACTURING PROCESS

STAGE I

Shot Blast

Steel blasted to SSPC-SP10 near-white finish, exposing fresh metal.

STANDARD	SSPC-SP10
PROFILE	2.5–4 mil

STAGE II

Frit Application

Powdered glass frit electrostatically applied to both faces.

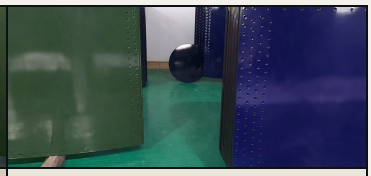
METHOD	Electrostatic
THICKNESS	250–400 µm

STAGE III

Vitrification

Continuous furnace above 1,500 °F. Glass molecularly fuses to steel.

TEMP	1,500–1,650 °F
CYCLE	8–12 min



STAGE IV

Compression & QC

Surface enters compression as it cools. Holiday + DFT tested per panel.

TEST	Holiday + DFT
ACCEPTANCE	ISO 28765

§ 03 / THE DATA

Performance & *comparison.*

TEST CONDITIONS
STANDARD 23 °C / 50% RH
PER ISO 28706
FACTORY VERIFIED

Typical PermaFusion glass-fused-to-steel coating performance verified under standard laboratory test methods, benchmarked against the most common alternative coatings used in bolted-tank service. **Comprehensive test reports available on request.**

PROPERTY	TYPICAL VALUE
SUBSTRATE	Carbon steel ASTM A1011
COATING TYPE	Vitrified borosilicate glass
THICKNESS (DFT)	250–400 µm dual-side
SURFACE HARDNESS	~7,000 Hv (Vickers)
OPERATING PH	3.0 – 11.0 continuous
INTERMITTENT PH	1.5 – 13.0 (≤8 hr)
OPERATING TEMP	−40 to 200 °F
PEAK TEMPERATURE	250 °F (intermittent)
THERMAL EXPANSION	~9 × 10^{-6}/°C (matched)
COMPRESSIVE PRELOAD	50–80 MPa (residual)
ADHESION	≥4.5 ISO 28706 class
IMPACT RESISTANCE	≥30 in-lb (direct)
PERMEABILITY	0 (non-porous)
SERVICE LIFE	30+ years

COMPLIANCE	STANDARD / TEST
TANK CONSTRUCTION	AWWA D103-19
DRINKING WATER	NSF/ANSI 61
FIRE PROTECTION	NFPA 22
VITREOUS ENAMEL	ISO 28765:2016
TEST METHODS	ISO 28706 series
SURFACE PREP	SSPC-SP10 / NACE 2
SUBSTRATE SPEC	ASTM A1011/A1011M
SALT FOG	ASTM B117 (5,000 hr)
WATER IMMERSION	ASTM D870
CATHODIC DISBOND	ASTM G8 / G42
IMPACT	ASTM D2794
ADHESION (PULL-OFF)	ASTM D4541 (Type V)
ACID RESISTANCE	ISO 28706-1 (Class AA)
HOLIDAY DETECTION	NACE SP0188

§ 03.1 / VS. THE ALTERNATIVES

ATTRIBUTE	● PERMAFUSION (GFS)	● FUSION-BONDED EPOXY	● CONCRETE	● WELDED & PAINTED
MATERIAL CLASS	**Inorganic glass** on steel	Organic thermoset polymer	Reinforced cement composite	Organic alkyd / urethane
BOND	✓ **Molecular fusion** 1,500°F	Thermal/mechanical ~400°F	Embedded rebar matrix	Chemical adhesion only
HARDNESS	✓ **~7,000 Hv**	~100 Hv	~200 Hv (surface)	~50 Hv
PH RANGE	✓ **3.0 – 11.0**	5.0 – 10.0	6.5 – 12.0 ! H_2S sensitive	6.5 – 8.5
UV STABILITY	✓ Inherent (inorganic)	! Requires topcoat	✓ Inherent (inorganic)	! Requires topcoat
RECOATING	✓ **Never** (lifetime)	Periodic touch-up	Liner: 15–25 yr	5–7 years
SERVICE LIFE	✓ **30+ years**	~20 years	50+ yr (struct.)	10–15 years (w/ recoat)
30-YR LIFECYCLE COST	✓ **Lowest** — no recoat	1.4× GFS	1.8× GFS	2.1× GFS
BEST APPLICATION	Long-term municipal & industrial	Potable, neutral pH	Large fixed reservoirs	Short-term, low-cost

§ 03.2 / ENGINEERING NOTES

Surface compression & crack arrest

During cool-down from vitrification, carbon steel (CTE **~11 × 10^{-6}/°C**) contracts faster than borosilicate glass (CTE **~9 × 10^{-6}/°C**), placing the coating in permanent compressive stress of **50–80 MPa**. Cracks cannot initiate or propagate through a surface in compression unless an external tensile load exceeds the residual preload — a condition that does not occur in normal hydrostatic service. The coating effectively self-arrests micro-defects throughout the asset's life.

Failure modes vs. organic coatings

Organic coatings (FBE, polyurea, alkyds, urethanes) degrade through three irreversible pathways: **hydrolysis** of polymer backbones in aqueous service, **photo-oxidation** under UV exposure, and **microbiologically-induced corrosion** (MIC) in biologically active media. Vitrified silica glass is impervious to all three — no C–H bonds to hydrolyze, no chromophores to photo-oxidize, no nutritive substrate for microbial colonization at the steel interface.

MTW VERDICT | *For any asset measured in* **decades rather than years** *— and especially where contents are corrosive, biologically active, or simply too important to fail — PermaFusion is the lowest lifecycle-cost decision, every time.*

§ 04 / THE SERVICE

Engineered for *every service.*

SINGLE-SOURCE BUILD
ENGINEERED · MANUFACTURED
ERECTED BY MUNICIPAL TANK WORKS
CANTON, OHIO

PermaFusion is field-bolted into modular tanks ranging from **10K to 5M+ gallon capacity, 10 to 200+ ft diameter** — across the most demanding municipal and industrial bulk-storage services. Each project is delivered single-source from cost modeling through erection.

A.01
Potable Water

STANDARD	NSF/ANSI 61
PH	6.5–8.5
CAPACITY	50K–5M gal

A.02
Wastewater & Sludge

STANDARD	AWWA D103
H_2S	Excellent
CAPACITY	100K–3M gal

A.03
Fire Protection

STANDARD	NFPA 22
FM	Available
CAPACITY	100K–500K gal

A.04
Anaerobic Digesters

SERVICE	Biogas / Sludge
ROOF	Membrane
CAPACITY	200K–4M gal

A.05
Leachate Storage

PH	3.5–8.0
CHLORIDES	High tolerance
CAPACITY	50K–1M gal

A.06
Industrial Process

SERVICE	Power · O&G · F&B
TEMP	−40 to 200°F
CAPACITY	50K–5M+ gal

§ 04.1 / STANDARDS & COMPLIANCE

AWWA D103
Factory-Coated Bolted Carbon Steel Tanks for Water Storage

NSF/ANSI 61
Drinking Water System Components — Health Effects

NFPA 22
Water Tanks for Private Fire Protection

ISO 28765
Vitreous Enamels — Bolted Steel Tanks

ISO 28706
Vitreous Enamels — Test Methods

ASTM A1011
Hot-Rolled Carbon Steel Sheet & Strip

SSPC-SP10
Near-White Metal Surface Preparation

API 12B / FM
Production Liquid Storage / Fire Insurance

Municipal Tank Works
ENGINEERED STORAGE · CANTON, OH

PHONE (330) 970–6030
EMAIL info@municipaltankworks.com
MAIL 2014 Champions Gateway, Canton OH 44708

REQUEST TECHNICAL SPEC
info@municipaltankworks.com